

# Measuring and Evaluation of ICT-supported Services in the Domestic Environment

Stefan Junstrand<sup>(\*,\*\*,\*\*\*)</sup>  
s.junstrand@arch.kth.se  
www.arch.kth.se/~junstrand

Ulf Keijer<sup>(\*\*\*)</sup>  
ulf.keijer@arch.kth.se  
www.arch.kth.se/~keijer

Interactive Institute<sup>(\*)</sup>  
Centre for User Oriented IT-Design<sup>(\*\*)</sup>  
Dept. of Architecture<sup>(\*\*\*)</sup>  
Information Technology in Design and Real Estate Management  
Royal Institute of Technology  
100 44 Stockholm, Sweden

## Abstract

A full-scale business structure (IT-BO) for providing ICT-supported services in a domestic environment has been set up in collaboration between a major Swedish telecom company and a leading housing company in a suburb of Stockholm, Sweden. There four working ICT-supported services, viz. *a new electronic key, a digital bulletin board, a new access telephone system and free internal telephony* have been implemented in a multi-storeyed residential building. These services have been evaluated using an evaluation model including a mix of methods and fields of knowledge. The theoretical model was introduced earlier but here it has been developed and tried in practice. The final discussion points out the importance of building ICT-supported services on existing and well-known functions for high user acceptance and frequent use. But also can delays in implementations cause concern of unfulfilled expectations among the tenants.

*Keywords: domestic, evaluation, ICT, measuring, models, services, tenants.*

## 1 Background

### 1.1 Changing market for owners of residential buildings

Since the early 1950s housing companies in Sweden – both profit and non-profitmaking – have relied on substantial subsidies from the government, so as to be able to construct and offer spacious and well-equipped flats to practically all families in Sweden. This public scheme lasted for decades and has been very successful; today, the average Swede resides on some 45 sq.m. dwelling area [1]. The subsidies have not been confined to new buildings but comprehensive refurbishment programmes have also been conducted. During this period potential tenants lined up for vacant flats at the public housing companies, as most of the rent was paid by the state, effectively. During the 90s most housing companies began to face a completely new and different situation. The rents rose and people began to ask for cheaper, e.g. smaller flats, as they could no longer pay the actual cost. Today, in many places in Sweden, the housing companies have to compete hard in order to attract tenants. If so, what can a housing company do in the future to attract interesting tenants and, not less important, to keep their old? Improving the services provided to the tenants by using information and communication technology (ICT) has been identified as one possible way to make the buildings and the flats more attractive to the user [2].

### 1.2 A set-up for a new business structure of residential services

In 1994 a total new business structure, called IT-BO, was set up in collaboration between a major Swedish telecom company and a leading housing company with the idea of providing ICT-supported services in the domestic environment. A *business structure* for the actions that have to take place, in order to provide the customers with the services they ask for, includes all roles necessary for having a particular service produced and transferred to the customer. For IT-BO the different actors organise their activities as business entities and negotiate with their counterparts on equipment and functions of the systems to be installed, requirements, payment and time schedules. In this context *test sites*, from their start, should

function as *real businesses*. Although new services are supposed to be based on ICT, the *technical issues* are not in focus in the project; more essential is to define the *services needed* and requested by the end users, *i.e.* the tenants. See further in depth [2].)

In the IT-BO project the scope of the activities relate very clearly to *residential buildings*, especially the buildings' ability to fulfil needs and aspirations of those who live in them, the tenants. In particular, the different services each tenant openly or tacitly asks for, related to his or her entire living conditions are in focus. Access to augmented services to all residents in a particular building is further supposed to have beneficial effects also for persons with special needs, *e.g.* disabled and elderly persons. On a platform available for everybody in his or her home, additional equipment and services could be designed for an individual, probably more easily than starting from the beginning each time. Although the development of new services and the adaptation to individual needs is a very interesting theme, indeed, further discussion on this matter must take place elsewhere.

### 1.3 Test beds

*Test beds* or *exploration sites* are inherent parts of the development of viable ICT-supported services for the IT-BO project. As we look at housing areas and the people living in their homes, these test beds should reflect residential living as much in depth as possible. The test beds serve the research with practical cases for the assessment and the verification of ideas and hypotheses, too [3]. Of course, the settings will be different, to which due consideration must be taken for each site. The hypothesis is, however, that a general organisation, or business model, will cover a variety of settings and service clusters so as to fit many practical cases within a general framework. In this article the concepts of test bed and test site will be used somewhat interchangeably. However, primarily, the *site* denotes the very place *where* the implementation of services and equipment takes place, while the (*test*) *bed* designates, more specifically, *how* the different services are designed and implemented.

A test bed could be seen as a site laboratory for testing new products, new services and new systems of different kinds. They should not be conceptually mixed up with a similar figure very often applied in R&D, *viz.* the *demonstrator*. The demonstrator is established in order to show (demonstrate) an idea, a product or a system, and is, in general, abandoned after the completion of the project. The *test bed*, on the other hand, *is designed to offer a living laboratory and to adapt to new ideas, products and systems*, which are to be tested, evaluated and improved continuously [3].

*The test beds* play an important role in the total business development programme. A number of test beds will successively be developed. It is likely that the test beds will differ from each other in various respects. Although conforming test beds could offer advantages, primarily from a scientific evaluation point of view, a variety of applications are supposed to be more advantageous for the development of strategies for a broader implementation of the results. Some basic elements, however, will be held fixed for each test bed.

### 1.4 User involvement

With the test beds the *user involvement* comes very naturally. The services and the systems sought for and studied are motivated by the desire to improve the living conditions for the residents of the buildings. The users have to be regarded as real participants in the different activities. It is necessary to avoid thinking of the tenants as objects for the housing company's undertakings or, still worse, as subjects for an inevitable technology development. Nor is it to be expected that the tenants will provide the project with very precise information of their needs, interests and expectations related to new information and communication technology and its possibilities. The procedure to develop a dialogue between the project and the users-to-be of the services and infrastructure will in this way be a part of the total project.

## 2 Measurement and evaluation

At the Royal Institute of Technology (KTH), Dept. of Architecture, a so-called virtual laboratory, **SIBElab** (a virtual **laboratory** for measuring and evaluation of IT-supported **Service Infrastructures** in the **Built Environment**), has been established. By 'virtual' we mean that the location of expertise of the laboratory can, and often is, remotely located of the formal centre of the lab. In fact, the virtual character of the lab will be a prerequisite for the engagement of necessary competence for several evaluation issues

that will be raised. With 'virtual' it is understood, too, that the laboratory is based on existing knowledge in existing institutions, in Sweden and abroad. Then, further, it is necessary to systemise the evaluation questions that immediately are raised for such a multi-disciplinary setting represented by the test sites. The research laboratory, the **SIBElab**, is established in order to handle this type of issues.

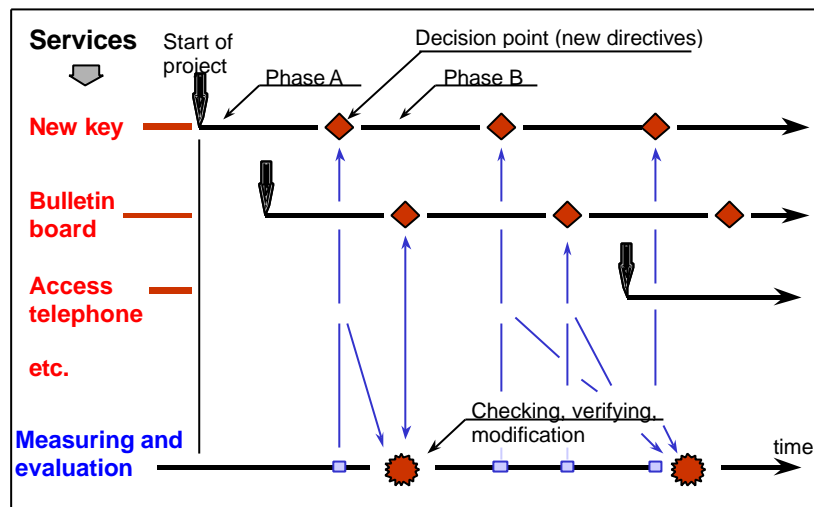


Figure 1. The role of measurement and evaluation as a part of the total activities of the test beds. The operational activities are exemplified.

The function of SIBElab for the test beds is dynamic and proactive. Figure 1 illustrates the role of measurements and evaluation (M&E) for the operational activities of a test site in general. Some typical project activities are indicated. The M&E activities have a decisive role for the dynamic development of the test sites and their performance as services markets and business activities. This is illustrated in figure 1 by the decision points for each project of the test site. Defined activities are executed and monitored by distinct phases. Each phase comprises a complete service and a clear objective of the phase is prescribed. The outcome of the phase can then be fully evaluated, provided adequate measurements in all relevant aspects can be performed. On the other hand, from the figure it can be found (bottom part) that M&E is seen as a knowledge development activity of its own during the course of different projects of a test site [4]. A site programme could be seen as a number of partly *parallel projects*, each of which are subdivided into *phases*. Improvement of methods for evaluation and measurements of consumer-oriented services in residential living is an important objective for the on-going research activities. Thus, the sites serve as practical experimental test beds for the research in the M&E field.

## 2.1 Jämtlandsgatan 152 in Vällingby – the first test site

The suburb of Vällingby, situated some 13 km from the Stockholm City centre, was originally planned and developed during the 1940s and 1950s. Its planning was very much influenced by the international discussion of *new towns*, e.g. in the UK, in combination with *the Swedish modern project*, which had got its clearest expression already with the 1930 Stockholm Exhibition. Greater Vällingby was to encompass and fulfil, for all categories of the population, the need for housing, work and all kind of services for daily life, see e.g. [5] [6].

Svenska Bostäder, a housing company fully owned by the city of Stockholm, was established 1944. The early development of the company is very much linked to the development of Vällingby. Presently, it owns some 10000 flats in the area. With close to 50 000 flats altogether it is the biggest housing company in Sweden. As most of the buildings in Vällingby now are 40 years old or more, comprehensive refurbishing programmes have been carried out and still are.

For the Vällingby test site Svenska Bostäder is the project owner. For its day-to-day operation and for the strategic planning it has appointed a specific organisation, **Bolab**, which is responsible, both for the organisation of the services part of the development and for technical purchase, installations, and maintenance. The test site began with a specific ten-storied residential building. The future planning includes more buildings in the area.



Figure 2. "Test site Vällingby" – the residential building, J152, in Vällingby where the initial measuring and evaluation has taken place.

The test site is a building located about 200 meters from the commercial centre of Vällingby. It's a 10 storey residential building with elevator and a total dwelling area of about 2420 sq.m. It was constructed in the years of 1952/53 and originally it had a number of 48 flats, now changed to the actual figure 42 due to unification of smaller flats into larger ones. The equipment standard is modern according to the Swedish definition with a recent refurbishment completed including the exchange of stoves and refrigerators. District heating and air evacuation systems serve the building. It has common space for laundry, storage of bicycles and recycling of garbage on the entrance floor and storage for each flat in the basement. The flats are relatively small, about 50 sq.m. Generally, the flats are in good condition, regarding their age. The immediate environment of the house is in a good state, too. The Vällingby area as a whole shows no signs of decay, even more than 40 years after its establishment.

Installations of infrastructure and implementing services over some period of time have taken place. Four working ICT-supported services installed and evaluated are the following:

- ❑ the new key,
- ❑ the bulletin board in the entrance,
- ❑ access telephone,
- ❑ free internal telephony.

The aim of this article is to describe the evaluation procedure with focus on the measurement model used and the results related to the specific services. A *user's perspective* was taken at the evaluation, meaning that all services were regarded from the users' point of view. The evaluation consisted of a *measuring part* both concerning quantifying and evaluation in detail studying the users in action, and an *evaluation part*, including both analysis and synthesis, leading to overall results. This total procedure is called measuring and evaluation, M&E.

## 2.2 Concepts

For the measuring and evaluation a number of relevant concepts have been used, of which some of certain importance will be presented. It should be observed, however, that the concepts used for the evaluation and by Bolab do not always coincide with those used by the tenants for describing the ICT-supported services. The interviewer must clearly take this fact into consideration when interviewing the tenants about issues not being absolutely evident to the interviewed persons.

**Access telephone** refers, in this context, to the new access system telephone set placed at the entrance of the apartment, including the function as access telephone connected to the entrance system of the building and the Bewator telephone.

**Attitude** refers to an expressed (explicit) relation to the project, to a specific service or to some other relevant phenomenon.

**Behaviour** refers to the experiences the tenants have from technology including their use of technology both in general and specifically considering some ICT-supported service, as well as its consequences?

**Bolab** refers to the organisation established and located in Vällingby to develop and provide ICT-supported services in the residential building J152, and later, extended to more houses in the Vällingby area.

**Bulletin board** refers to a digital screen in the entrance hall of the building displaying information to the tenants passing and persons visiting the house.

**ICT-supported service** refers to a service rendered or supported by the use of ICT, also including physical products for the use or distribution of services.

**Information environment** refers to the general information disseminated about the implementation of ICT-supported services at the site, as well as the information given and received about the specific services.

**Installation and interior design** refers to how the ICT-supported services are integrated into the environment and what effects the services and equipment invokes.

**Free internal telephony** refers to the possibility of calling free of charge within the building (to other flats and to the laundry facility, available to all residents) and to Bolab.

**IT-BO** refers to the general business, research and development project in Vällingby.

**New key** refers to a new digital locking system, both the keys and the locks. Also subfunctions connected to the system are included, e.g. the automatic door opening function.

**Personal and social status** refers to the personal and social situation of the user at a given point of time.

**Technical function** refers to the factual technical function of an ICT-supported service, e.g. availability at all, up-time, down-time, program and system crashes, etc.

**Use** refers to when and how often a system is used.

**User** refers to persons living in the house, J152, where the actual measuring and evaluations have taken place.

**User interface** refers to the design of an ICT-supported service with the general and specific cognitive design, as well as the form, function, colour, contrast, structure etc.

### 3 Research questions

The introduction of technology into the domestic environment seems very much to affect the organisation of people's life both in time and in space [7] [8]. This seems to be a research field to which surprisingly little attention has been paid, although, lately the interest from ICT developers and providers successively is increasing [9]. A general question for the implementation of the ICT-supported services in the test bed at Vällingby could be formulated as follows:

*What are, from a user perspective, the prerequisites and the actual experiences from the ICT-supported services implemented in Vällingby by Bolab?*

From this question of a general character a number of specific questions could be derived according to the different aspects of the evaluation mentioned above. However, the number of tenants is limited and it could be crucial to draw far-reaching conclusions of the results from one single phase of a test site. The methods applied for the M&E and experiences of the procedure are considered, at this point of time, just as interesting as the concrete results. Some of the questions guiding us in our work with the development of methods and with the planning and conducting of the actual measuring, were the following:

- ❑ what is supposed to be measured and what methods should be used?
- ❑ how should the results be presented?
- ❑ how should the results be fed back into the development sites?

A theoretical model for measuring and evaluation has been developed and applied. The model consists of a number of *measurement fields*. Each field covers a part of the total spectrum of interesting and governing questions. The model includes both individual and general background informations, creating a context to the provided services and specific information about each of the evaluated ICT-supported services. The questions related to each *measurement field*, have been formulated according to the following:

- ❑ *Technical function*: How does the availability and accessibility to the system for the particular service function from a pure technical point of view?
- ❑ *User interface*: How are the ICT-supported services designed, with hidden structures, graphical forms, etc. and how does the actual physical design look like (form, colour, contrast, structure)? How is the cognitive interface designed of the particular ICT-supported service and how is it adapted to different user groups?
- ❑ *Installation and interior design*: How and where are the physical products placed and how is the physical environment designed (cabling, colouring, lighting, sound, need of space, etc.)?
- ❑ *Personal and social status*: How does the information look like at the individual level (age, sex, mother tongue, capability of speaking Swedish, civil status, level of education, occupation, working hours and time spent at home, structure of family and social network) and the house hold level (number of members of the household, ages)? How are the general situation of life of the individual and what specific conditions could affect the particular ICT-supported services?
- ❑ *Information environment*. What information about the project is received, understood and internalised by the tenant? What information of the particular ICT-supported services is received?
- ❑ *Attitudes*: What sort of attitudes expresses the tenant to Bolab, to technology and to computers/ICT? What attitudes do the tenants express to the particular ICT-supported services, at present and in a longer perspective?
- ❑ *Behaviour*: How do the users act in relation to their previous experience they have of home technology for the different ICT-supported services and what are the consequences?
- ❑ *Use*: When and how often are the particular ICT-supported services used?

## 4 Methodology

The methodology of this research includes the definition of concepts, the development and the refinement of the methods for the measuring procedures and the presentation of the results. Three rounds of measuring and evaluation have taken place at the Vällingby development site since 1995.

The first one took place in 1995. Its purpose was to develop an overall description of the tenants of the house first considered for the Vällingby site, Jämtlandsgatan 152 (in the following referred to J152), see picture 2 above. It consisted mainly of interpersonal semi-structured interviews on site in the flats of the each tenant. The information served the initial activities performed by IT-BO.

The second evaluation round was conducted in June 1997 in an adjacent house very much of the same size and age as J152. This round took place before any implementation of ICT-supported services at all. It consisted of two parts. Initially, an interview was carried out by telephone with the tenants. It was a combination of a structured and a semi-structured interview. After having scrutinised the results of these initial telephone interviews, a structured selection among the tenants was made for interpersonal interviews on site. These were essentially qualitative interviews meant to shed light and deepen a number of specific questions mainly related to the use of different kinds of technology used in the domestic environment. After the latter interviews the personal characteristics of the interviewed persons were outlined as written "portraits". The purpose was to formulate direct impressions of the individuals just interviewed.

The third evaluation round took place in May-June 1998 after the implementation of these four earlier mentioned ICT-supported services. It took place at J152. It consisted of four parts; 1) a personal semi-structured interview with a person representing both the service provider and the real estate managing company; 2) a series of interviews with the tenants carried out by telephone using a combination of a structured and a semi-structured interview; 3) a number of interpersonal interviews and observation on sight; and 4) an own evaluation (directly by the researchers). The methods used in this round of the evaluation are further elaborated below.

During the evaluation and measuring process a model for the evaluation of the different ICT-supported services, first presented in [10], has been designed and improved. It represents a number of specific fields of knowledge, here called *measurement fields*. The long term objective, partly initiated already, is to add to and improve available expertise of the various fields of knowledge concerned. A general example of the model is shown below. A number of questions within each measurement field are formulated for the ICT-supported services that are going to be evaluated. It is important to differentiate between issues to be examined without explicit service being executed, here called *No-service*, and issues with some service provided or in use, here called *In-use*. Further, some questions are, in principle, independent of the individual user and others are not. Figure 3 below illustrates this. The model is later adjusted for every specific ICT-supported service. In figure 3 a general model is presented.

Measurement field	No-service/ In-use	General Factor	Individual Judgement	Comments and cases
Technical function	No-service In-use	x (b) x (t,b)	o o	Up-time, down-time, crashes Time to repair, etc. for functions activated
User interface	No-service In-use	x (e) x (e)	(x) x (t)	Technical/cognitive, size, colour, font
Installation and interior design	No-service In-use	x (e,b) -	x (e,t) -	Placement, cabling, lighting, sound
Personal and social status	No-service In-use	o -	x (t) -	Age, sex, mother tongue, family, social network
Information environment	No-service In-use	x (b) x (t,b)	x (t) x (t)	Information around the service (distributed and acknowledged)
Attitudes	No-service In-use	o o	x (t) x (t)	Attitudes to the service provider and the specific service
Behaviour	No-service In-use	o -	x (t) -	Consequences of the use
Use	- In-use	 o	 x (t)	Time and frequency of use

Figure 3. Measurement fields for the evaluation of the ICT-supported services. The letter "x" indicates a relevant measurement field. "-" Indicates a non-relevant measurement field. The letter "o" indicates that a measurement cannot take place. The designations "b", "t" and "e" indicate the source of information (b=Bolab, t=tenants, o=own evaluation).

## 5 The measuring and evaluation procedure in detail

Experiences from the evaluation rounds in 1995 and 1997 were analysed and fed into the planning and execution of the evaluation that took place in 1998. From now on, the rest of the article confines itself to the latter evaluation, which will be described and analysed more in detail.

The reader is referred to the four explicit steps of the measuring and evaluation described above:

1. interview with a representative of Bolab,
2. telephone interviews with all the tenants,
3. interpersonal interviews with a selected sample of the tenants,
4. own evaluation by the researchers.

First, an interpersonal semi-structured interview was applied to a person representing both the service provider and the real estate managing company. The aim was to get a state-of-the-art report about the project from the service provider's point of view. Another aim was to collect information about the technical function, installation and interior design and the information provided to the tenants about the project. The state of the specific ICT-supported services provided by Bolab was asked about, too. The interviewed person demonstrated the house and the installation to the researchers. A list of telephone numbers of the tenants was obtained from Bolab. Bolab issued a signed paper to all tenants about an imminent telephone investigation to be carried out by researchers from the Royal Institute of Technology.

Second, a form, partly used at the previous investigation in 1997, with a questionnaire, was developed and tested with subsequent modifications. The form so modified was then used for all the interviews. Each telephone interview took between 15 and 55 minutes. All interviews were carried out during a period of four weeks. All households were called, up to five times. In some cases the number of attempts exceeded 30. The calls have been tried at various times of the day and during all days of the week, except Saturdays. All households that couldn't be reached by telephone were at least once approached by knocking at their doors in the evening.

The third step, interpersonal interviews in the tenants' flats, was then conducted. The reason for this step was to get a deeper understanding of how the ICT-supported services were experienced in real life and to observe the ICT-supported services in use. These interpersonal interviews had an open character and were rather qualitative than quantitative. Observations were partly done with the "talking-while-doing" method. This means that the user talks while performing his task, which is supposed to lead to a better understanding of how the user thinks. Interviews and observations were completed in the flats of the interviewees, in the entrance hall of the building and in some other common spaces. The interviews took between 30 minutes and one hour each. For the first two interviews one of the interviewers made the formal interview with the other listening, and vice versa. The interview procedure was then modified according to experiences from these first interviews. The subsequent interviews were then carried out with only one interviewer.

As a fourth step an own evaluation of the ICT-supported services were performed by the evaluators concerning user-interfaces, installations of equipment in the flats, and interior design.

The interpersonal interviews and observations, the interview with the person representing Bolab, and the own evaluation were tape-recorded and summaries were compiled textually.

### **5.1 Loss**

An important aim for the telephone interviews was to reach as many of the adult persons (above 16 years) as possible living in the J152 house. The loss, though, was significant. Almost 50% (27 persons out of 55 couldn't be reached). Anyhow, we got into contact with 28 of the 55 persons living in the building, representing 25 out of 42 households. The following is known about the character of the loss

- seven persons have not been reachable at all
- five persons are children (with children is meant persons younger than 16 years including a girl of 20 whose mother considered her being a child whom we were not allowed to talk to),
- five persons didn't want to participate,
- three persons were too old or sick to be interviewed,
- one person had a telephone number that was not able to locate.
- one person terminated abruptly the interview halfway,



- one person had a private telephone number,
- one person didn't speak Swedish nor English and thus was incommunicable,
- one person was a roomer without his own telephone,
- one person was supposed to be on vacation and could not be contacted,
- one person was a key-person of the project (at Bolab) and was disregarded.

## **5.2 Selection for the interpersonal interviews**

For the eight interpersonal interviews the primary selection criterion was that the interviewed persons should represent:

- two young persons (16-30 yr.) including one child living at home,
- two middle-aged persons (31-64 yr.),
- four older persons (65+ yr.),
- a mix of sex (four women and four men),
- tenants representing both users and non-users of some of the ICT-supported services,
- tenants representing users both without and with physical disabilities.

All these criteria were fulfilled by the persons selected although one of the eight interviews was later cancelled as nobody representing a young person living at home was possible to contact.

## **5.3 Presentation of the data**

Below follows a presentation of the data we have found most interesting. Initially, background information is presented. Thereafter information follows from the four ICT-supported services. That information concerns both quantitative and qualitative data from the interviews done by telephone, the personal interviews, observations and own evaluation. Also data lying behind is presented when considered relevant and interesting.

From the interviews quantitative data have been extracted and inserted into a database, with a certain classification and grouping. Some questions/answers have been left out, primarily those which, to too large an extent, are overlapping and others where relevant data not have been able to extract, mainly due to the phrasing of the question and resulting content.

The questions were mainly formulated so as to look for an indication in the answers, e.g. yes / no or much / little. In some cases people answered "don't know" or similar. For those cases the answer has been disregarded.

Regarding the specific ICT-supported services a more refined evaluation scale than just "yes/no" or "good/bad" was looked for. Therefore, alternatives such as "very good/good/bad/very bad" have been used. In cases where only an indicative answer has been given, e.g. "good", the answer has been considered to be too vague and has not been used in the analysis.

Finally, it should be underlined that the data presented below represent only the interviewed tenants, not all persons living in the J152 house.

## **6 The tenants**

The background information about the tenants is meant to create a context as a reference to the services provided.

### 6.1 Personal and social status - individual and household

Half of the interviewed persons are 65 years or older; nobody is below 16, figure 4. Six persons don't speak Swedish as their mother tongue. 17 persons live alone and 11 persons live together with a partner or a child.

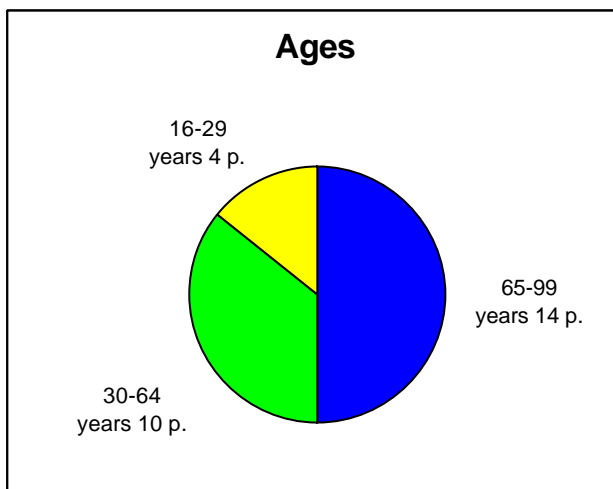


Figure 4. The distribution of ages of the people living in J152.

The level of education is rather high, concerning the age of the tenants, figure 5. Twelve persons have completed comprehensive school only, nine persons have completed high school and seven have studied at the university (although not all with a full degree, e.g. B.A.).

Half the tenants, 14 persons, are retired, 11 work full time and six study. Nobody is unemployed, which is noteworthy. It has to be kept in mind, however, that a large portion of the tenants has not been interviewed. It is likely that there is a positive correlation between a person's willingness to answer personal questions, and, for example, that they have a regular employment.

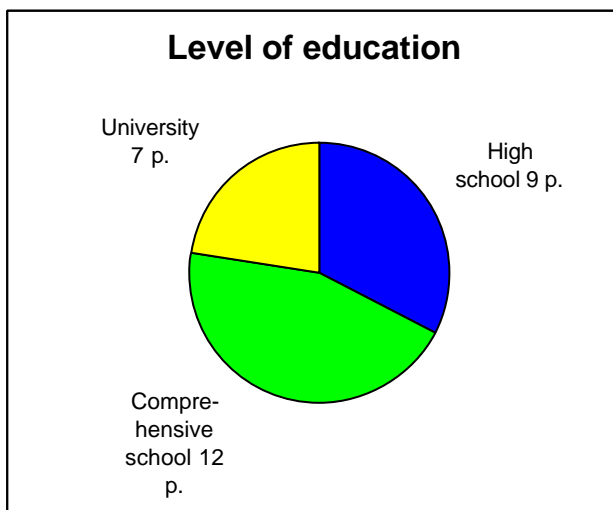


Figure 5. Level of education among the tenants

Many of the tenants have difficulties in describing their spare time activities. This might depend on the fact that they do not participate in organised activities and that they do not consider, for example, watching TV as a real spare time activity. Noteworthy, though, is that the time spent for spare time activities varies very much. Many people seem to prefer outdoor activities. One fifth are a member of study circles. Half the tenants are members of the tenant's organisation and one third are members of some other organisations. The level of organised activities could be considered relatively high, regarding the amount of old people living in the house. However, on the other hand, it confirms a Swedish tradition

of engaging oneself in organised activities of the kind just mentioned. And, why shouldn't old people fulfil old habits? No specific information is available on the intensity of the engagement.

Seven persons (out of 28) claim that they do not have any functional disability. Four persons have regular contact with some nursing institution, at least once a week. Four persons receive visits "every day" or "several days a week"; eight persons have visits "once a week" and 16 "more seldom than once a week". Strong relationships between neighbours are rare. Only two persons state that they have a more close relation to some other neighbour (to each other). Most people (24 persons) say that they at least speak to some of their neighbours sometimes.

## 6.2 Knowledge about the ICT-supported services and Bolab

Regarding the understanding of information in general, information about the project and the ICT-supported services in particular, it should be remarked that six of the tenants have not Swedish as their mother tongue. One interview was impossible to carry out, neither in Swedish nor in English, due to language problems (this person is included in the loss). Thus, some of the information obtained through the interviews may have pitfalls, due to misunderstandings and misinterpretations.

It has to be underlined that the concept "ICT-supported services" always is not related to the ICT-supported services introduced into the house, but rather looked upon as extended functionality of already existing services, e.g. "the key" and "information board". The interpretation by the individual of the concept "ICT-supported services", is ambiguous and may be another source of misunderstanding.

By being asked: "Today there is a number of ICT-supported services implemented into your house; do you know any of these?" the majority of the tenants were able to identify several of the services referred to. When they didn't understand the question or the concept "ICT-supported services" the answers usually differed considerably. The names the tenants used in order to represent the offered ICT-supported services differ, too, and what the actual content of a specific service really stands for was often unclear.

The way the interviewees received information about the different services was primarily through printed information or at meetings arranged by Bolab. The majority of the tenants said that they "used to get information about what's going on in the house, e.g. repair and similar activities". The way they get this information was normally through printed information in their mailboxes (79%) and/or through the traditional information board at the entrance hall of the building (64%). Almost all (27 persons out of 28) think that the information they get is "satisfactory".

## 6.3 Attitudes to Bolab, technology and computers

On the question of the knowing about the activities of Bolab 13 persons answered "little" and 11 "much". A big majority (93%), however, was satisfied with the way Bolab manages the house. Further, 17 tenants thought that they could influence on Bolab's activities in the house. Seven said that they would like to move immediately, if possible.

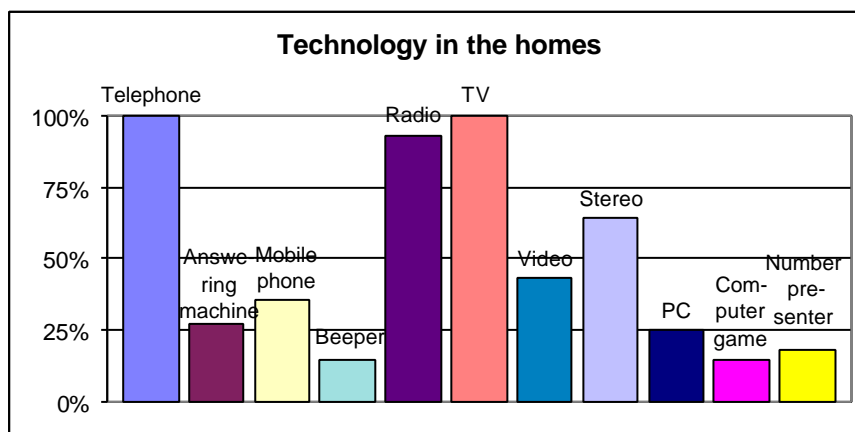


Figure 6. Technology in the homes.

Two thirds of the tenants know how a PC works, while ten out of 23 thought it be difficult to handle a computer. In total 23 persons think that new technology, in general, means improvements for the people while three think it doesn't.

All tenants have a TV set and a phone; 36% have a mobile phone and 25% a PC at home. 32% use a PC at home (the fact that the number of users exceeds the number of possessors depends probably upon some persons having portable computers owned by the companies they work for which were used at home). 65% have acquired some new technical gadget during the last year; 36% have used Internet and 25% have sent or received e-mail, see also figure 6.

Regarding the overall structure of the tenants (age, education, etc.), their general experience and awareness of home equipment and ICT is surprisingly good. This fact is supposed to facilitate future introduction of further equipment and services into their homes.

## 7 The ICT-supported services

The four working ICT-supported services: *the new key*, *the bulletin board*, *the access telephone* and *free internal telephony*, introduced as the first services at J152, have been evaluated. The results from this evaluation are presented in this section.

### 7.1 The new key

The new key refers to a key system with a digital key and key reader. The digital key system was at the time for the evaluation installed for access to common spaces of the building. Later it will be installed for the entrance doors of the flats, too. The key is round and flat and made of blue plastic with a hole to fit into they key ring. The keyreader exists in two versions; one is round, the other rectangular. The key has a built in door opening function for the two entrance doors. Figure 7 and figure 8 show the key and the two different key readers.



Figure 7 and 8. The digital key, the round key reader, and the rectangular key reader.

The tenants very much liked the key and on the question "What do you think about the new key system?" 19 persons say "very good" and the rest (nine) say "rather good" (see figure 10). Primarily, it seems to be the fact that the key is easy, fast, and in most cases reliable, which makes it attractive to the average user. The key is also used for the automatic opening of the entrance doors, when closed but not locked. In a longer perspective people are less positive, which may depend on the digital key system being not yet perfect, and a worry about future possible malfunctions. An impeccable key function is indispensable for all.

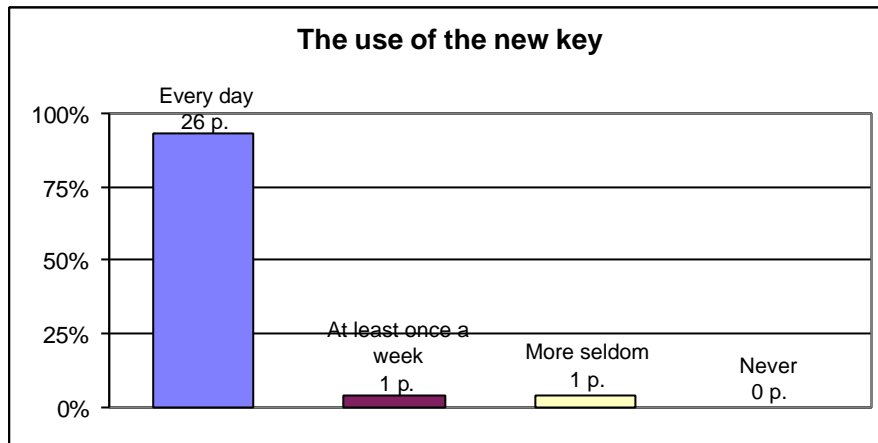


Figure 9. The use of the new key.

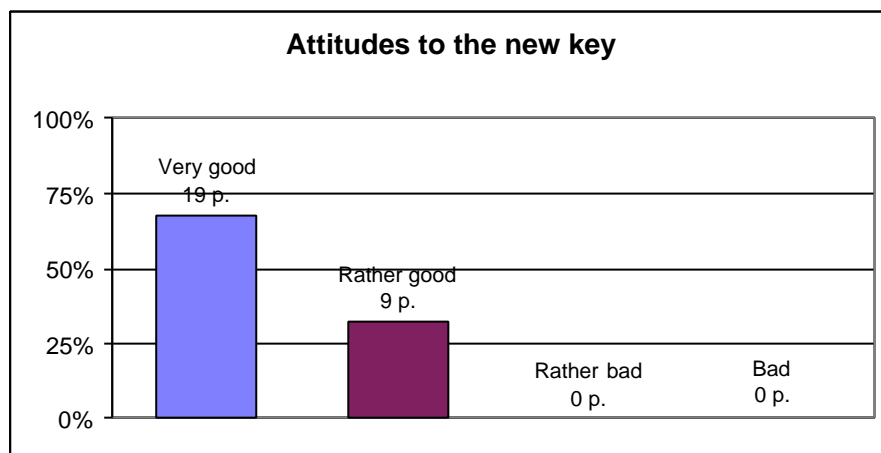


Figure 10. The attitudes to the new key.

### Experiences of the new key

The key system works well in general and is very popular. Many, however, still bring the old traditional key, as they do not fully trust the new system. There were two different designs of the key readers. The one placed at the entrance was round and seemed to work well. The rectangular key reader for doors leading to common spaces of the building functioned less well for many users. It is not a very good idea to have different techniques and solutions for the same function. It confuses people. Further, concerning the rectangular key reader there were difficulties in understanding where to put the key, in the middle of the reader or over the small LED lamp in the upper left corner.

The automatic door opening system, connected to the digital key system serving the entrance doors to the building, is fast and the door stays open for four seconds only, which was observed to invoke problems for people with physical disabilities. The entrance doors are heavy and do not stop pushing or pulling even if there is something in their free way and somebody is affected.

### **7.2 The bulletin board**

The bulletin board is placed between the outer and the inner entrance doors. It consists of a VDU screen displaying information to the tenants, e.g. about activities in the house such as planned repairs and installations, the telephone number to Bolab and about the weather and outside temperature.



Figure 11. The bulletin board is the screen to the left. On the right hand side there is a screen listing the tenants and their internal telephone numbers (not included in the evaluation of the bulletin board). On the very right one can find the digital key reader, the entrance telephone and a hole for future implementation of a digital videocamera. On the left somebody has left a message on a paper announcing the disappearance of a cat!

On the question "What do you think about the digital bulletin board as a way to receive information?" all were positive, also in a longer perspective, although apprehensions were expressed on not having the information printed. All but three stated that they read the information on the bulletin board. Of these three one was visually impaired, compensated, however, by having his wife reading the information for him. This man sometimes used the possibility to achieve the same information through a pre-programmed internal telephone number, free of charge at Bolab. Most persons seemed to throw a glimpse on the screen when passing by and read the information when there was something new on the display.

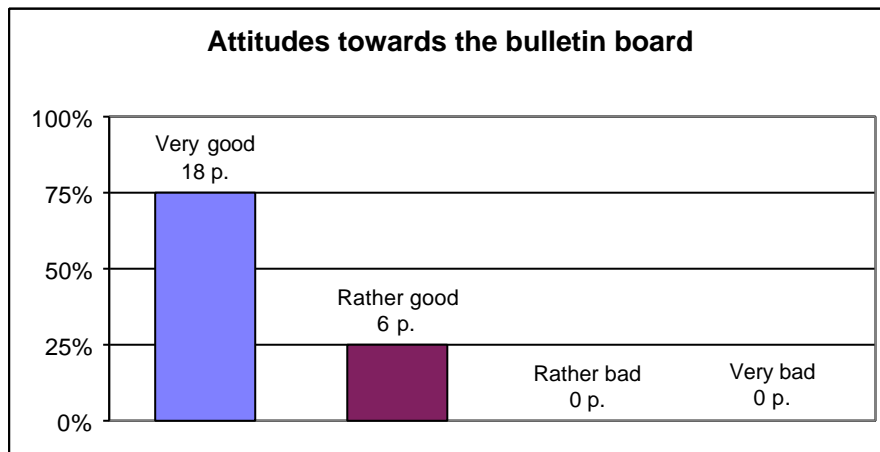


Figure 12. Attitudes towards the bulletin board.

Most people found it possible to read the text on the screen, however, regarded the font size being too small, and recommended it to be increased. 24 out of 26 persons understood the messages on the board and 23 say that they remember what they have read. The location of the board was considered adequate.

#### Experiences of the use of the bulletin board:

The tenants in general considered the bulletin board a convenient way to receive information. A bigger font and a better graphical layout should increase the readability for everybody, not only for persons with impaired vision. Also a more frequent updating of the information on the board would be desirable. Another observation was that the colors of the walls and the light in the entrance hall very much affected the readability of the screen.

Further, the tenants claimed that they remembered what they had read. It was noticed, however, that the interviewees very often couldn't repeat information distributed on the bulletin board only, not accompanied with printed information.

### 7.3 The access telephone

The access telephone consists of a system for communication between a visitor at the entrance of the building and a flat. In the flat the entrance telephone function consists of an additional traditional telephone mounted on a small shelf close to the entrance hall of the flat, see fig. 13. In the public space the system consists of two traditional Bewator entrance telephones placed outside the outer and the inner entrance doors, respectively, see fig. 14.



Figure 13 and 14. The access telephone placed in the hallway of a flat and the access telephone placed outside the entrance door of the building.

The attitudes of the tenants to the access telephone are not as positive as to the other ICT-supported services evaluated and described in this paper. The device was considered to be rather easy to handle even though its present functionality was found to be rather poor. Especially, there were problems of getting voice contact with the people at the bottom floor, and the operation of the entrance door from the flat. Tenants having visits after 9 p.m. also stated the difficulty for the visitors to recognise the gate codes placed inside the outer entrance door. The door automatically locks at 9 p.m. The visitors, also, had to repeat the call from both entrance doors. This was found a bit inconvenient. In a longer perspective the tenants seemed to be positive to the system if it will work well.

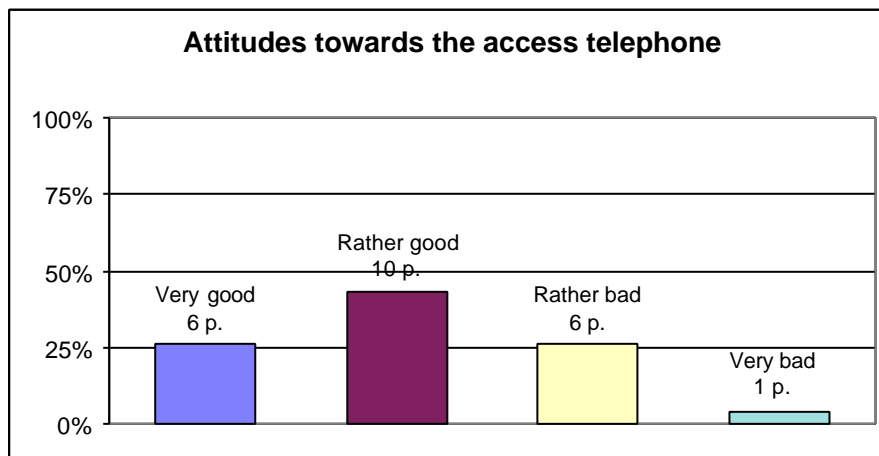


Figure 15. Attitudes towards the access telephone

Eighteen persons out of 27 state that the people visiting them use the access telephone. This is not too bad a figure as the tenants, in general, had few visitors according to what they revealed at the interviews.

#### Experiences of the access telephone:

Many of the tenants had the opinion that the access telephone was easy to use but, for the time being and for different reasons, it did not work well. In general, it was difficult to get in contact with the person

calling from the entrance. The operation of the entrance door from the flat was insecure, and even some had to go downstairs to the entrance in order to open the door manually. The sound signal is also far too low and it is difficult to increase the volume. Some also consider a wall hung telephone a better alternative than a phone placed on a small shelf

Although a folder with information about the access telephone service and its function was distributed, many people had considerable problems using this service.

#### 7.4 Free internal telephony

Internal telephony free of charge is a service provided to the tenants in the house. They can call internally inside the house and also to the common laundry in the entrance floor and to the Bolab office. This service works on the same system as the access telephony, i.e. the telephones at the entrance hall and the new telephones in the flats, fig. 13 and 14.

On the question "What do you think of the possibility to call free of charge inside the house?" only three out of 26 think it is unnecessary. The majority has tried to call at least some time. Some state that they use it in their contacts with Bolab and when they want to talk to someone in the common laundry. None uses the service every day. On the question "If the free telephone service was generally available for the whole area of Vällingby, both for other houses and for stores and offices?" the interviewed tenants were less positive.



Figure 16. The ICT-supported service "Free internal telephony" in use.

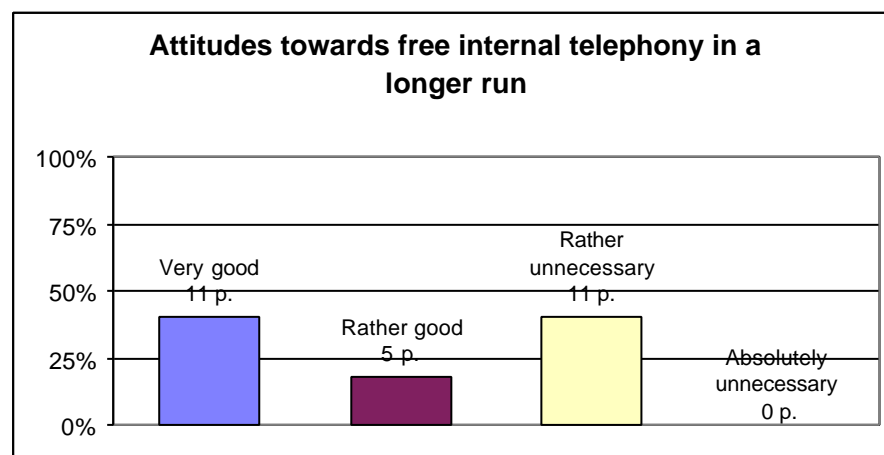


Figure 17. Attitudes towards free internal telephony in a longer perspective.



### Experiences of the free internal telephony:

Few people use the service more frequently, except for trying it directly after its implementation. They called the common laundry or Bolab, only. Many tenants have no closer relationships to their neighbours and, thus, have no reason for calling. Anyhow, the tenants had a fairly positive attitude towards the service, but they were less positive in a longer perspective. This may appear somewhat surprising. With more people connected to the service in the future, the service would look more attractive, one could suppose. However, it was generally noticed that people tend to be reluctant to future possibilities, which they may have difficulties to imagine, than to a less developed service they could try in practice.

## **8 Conclusion and discussion**

A project, IT-BO, for business development of ICT-supported services was described. A model for measurement and evaluation of this type of service was presented. Our overall judgement is that the interviews and observations of the tenants as a basis for the evaluations have worked well and produced results valuable for further improvement of the IT-BO development. Further, the procedure generated much insight into evaluation of ICT services in residential, thus improving the ability of SIBElab to conduct similar evaluations in the future with still higher precision and efficiency. The personal interviews generated a deeper understanding of the tenants' relationship to technology. A reflection is that the evaluation model introduced and used, with its measurement fields, has been effective by keeping the focus on the user perspective of the ICT-supported services. The model underlined the necessity to put the ICT-supported services in a broad context, including housing companies, users and services providers.

For the tenants the integration of the new services has primarily been built on, on one hand, well-known functions, and, on the other, extensions and improvements of known technologies. The digital key system and the bulletin board both fall into this category. The services are supposed to create an added value for the users without imposing too much new concepts and procedures. This is supposed to be one of the reasons for the over all very positive attitude to the implemented IT-supported services. Other reasons might be the great amount of information disseminated to the tenants and the personal contacts with the Bolab personal during the project. Such a phenomenon is not rare in any project involving end users.

The general positive attitude may also have its origin from the new digital key system. A new feeling of security has emerged. Now the residents seldom meet an unknown person at the entrance and strangers are not even occasionally found in the basement. Thefts of bicycles are barely a memory. The digital screen that offers fast and direct information could be more appreciated than fully understood by the evaluators. Or, maybe, life has become a little easier through a mixture of all these measures, different for each tenant. The users don't think much about how the technology behind the service works, but use the services very spontaneously. The tenants are eager to receive precise information about future services they have heard about. The relatively long introduction period has been indispensable for the engagement of the tenants. Now, they want to get more services quicker. But delays of the promised implementation of a number of new services have caused irritation due to unfulfilled expectations among the tenants. A crucial part, however, not an object for the evaluation this time, but, nevertheless, decisive for the future, will be the tenant's willingness to pay for the service offered.

The evaluation has resulted in a number of valuable indications on several issues contributing to the improvement of the implemented ICT-supported services and supporting the development of new services. The principal and most important findings were the following:

- ❑ the impact and acceptance of new ICT-supported services is much easily achieved among the tenants, if they are *built on traditional services* with familiar concepts and designations,
- ❑ very concrete, *simple modifications* of some of the services will improve them substantially, like larger fonts on the screen of the bulletin board, and louder signals of the access telephones in the flats,
- ❑ an *information strategy* relative to the tenants is necessary, both regarding new ways to disseminate information, such as the bulletin board, and how information about ICT-supported services should be communicated in general,
- ❑ *detailed specifications of the functions* of all existing and new ICT-supported services should be developed. This is considered to be one of the key factors for designing, implementing and improving ICT-supported services.

## 9 Acknowledgement

This study is a part of an ongoing research project *on IT supported services infrastructures in the built environment* funded by the Swedish Council for Building Research and the Swedish Council for Work Life Research. The collaboration with representatives of Bolab, Ericsson and Svenska Bostäder has been indispensable and is very much appreciated.

## 10 References

- [1] Keijer, U. Future organisation of the Building Process - The Building Process Seen as a Complex System. Royal Institute of Technology, TRITA-BKN, Report 8, Stockholm, Sweden, 1994.
- [2] Keijer, U. & Nilsson, B. Technology, Organisation and Market - The Application of a Model for Concurrent Business Development for the Emerging IT-based Home Services Market. The 6th Conference of the Joseph A. Schumpeter Society on Competition, Entry and Economic Growth - The Firm, the Innovator, the Entrepreneur and Market Competition, June 3-5, Stockholm, Sweden, 1996.
- [3] Simon, H. A. The Science of the Artificial, The MIT Press, 2nd edition, London, 1981.
- [4] Dahlbom, B. Going to the future, in J. Berleur & D. Whitehouse (eds.) An Ethical Global Information Society: Culture and Democracy Revisited. Chapman & Hall, London, England, 1997.
- [5] Popenoe, D. The Suburban Environment. Sweden and the United States. Studies of Urban Society, The University of Chicago Press, Chicago, Illinois, USA, 1977.
- [6] Pass, D. Vällingby and Farsta - from Idea to Reality. The Suburban Development Process in a Large Swedish City. National Swedish Building Research, Gothenburg, Sweden, 1969.
- [7] Hughes, J. Et a. Understanding Technology in Domestic Environments: Lessons for Cooperative Buildings. In: Streiz et al. (eds.) Cooperative Buildings, Integrating Information, Organisation and Architecture, First International Workshop, CoBuild '98, Darmstadt, Germany, February 1998, Proceedings, Lecture Notes in Computer Science 1370. Springer-Verlag Berlin, Heidelberg, Germany, 1998. pp. 248-261.
- [8] Caso, O. & Tacken, M. Telematics in Residential Areas - Spatial Effects for Dwelling and Neighbourhood, Publikatieburo Bouwkunde, Delft University, Netherlands, 1993.
- [9] Junestrand, S. & Tollmar, K. Video Mediated Communication for Domestic Environments - Architectural and Technological Design. In: Norbert Streitz et al. (eds.) Cooperative Buildings Integrating Information, Organisations, and Architecture Second International Workshop, CoBuild'99, Pittsburgh, USA, October 1999. Proceedings Lecture Notes in Computer Science 1670, Springer-Verlag Berlin, Heidelberg, Germany, 1999.
- [10] Hunhammar, M., Junestrand, S., Keijer, U. & Spets, K. Measuring and Evaluation of IT-supported Service Infrastructures in the Built Environment - SIBELab. Paper presented at the European Network for Housing Conference - New Communication Technologies for Housing, Helsingör, Denmark, August 26th - 30th 1996. In: Junestrand, S. IT OCH BOSTADEN ett arkitektoniskt perspektiv, Arkitekturens form och teknik, KTH, Stockholm, Sweden, 1998.