THE IT-BAROMETER – A DECADE'S DEVELOPMENT OF IT USE IN THE SWEDISH CONSTRUCTION SECTOR

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ABSTRACT: The IT-Barometer 2007 survey was carried out in the spring of 2007 in Sweden, as a follow-up to the IT-Barometer 1998 and 2000 surveys. This paper presents the most significant results from the survey with comparisons with the earlier ones. The Swedish survey was sent out to a statistically chosen selection from the whole country, divided into architects, technical consultants, contractors, property owners and manufacturers/trade. The survey provided knowledge of access to computers and communication tools, use of IT in the three areas CAD, project webs and electronic trade, and plans and strategies for the use of IT in future. 100 % of all employees work at workplaces with computers. Over 70 % of the employees, including site workers, have their own computer, their own e-mail address and access to the Internet at their workplace. The use of CAD in general has increased but was almost fully integrated already in 2000. The use of model-based CAD software has increased among architects as well as technical consultants. The use of project webs and electronic trade in the construction industry, which had started already at the time of the survey in 2000, is now widespread, even if the use is still not at a high level. The plans for IT investments are concentrated on well-tried techniques in the companies' support business, and at the top of the list at the moment are mobile solutions.

KEYWORDS: survey, IT, construction industry, CAD, product models, project webs, electronic trade, communication, Sweden.

1 INTRODUCTION

1.1 *Background*

The IT-Barometer project originally started in 1997 as an initiative of the Swedish R&Dprogram 'IT Bygg och Fastighet 2002', IT BoF, /IT Construction & Real Estate 2002/. The aim of the project was to create a measuring tool for the use of IT in the construction and facility management sector, and to perform measurements at intervals of some years. Three criteria were set up for the survey tool. It should:

1. Be repeatable and comparable over time.
2. Be comparable between countries.
3. Cover all categories of companies in the construction industry, which was defined as architects, technical consultants, contractors, facility managers and the materials industry.

The survey has then been performed twice in each of the countries Sweden, Denmark and Finland. The results for each country and comparisons between the countries have been presented in several papers, (Samuelson, 1998a; Howard & Samuelson, 1998; Howard et al. 1998; Samuelson, 2002). In Canada too, a survey was performed in 1999 with some changes as to the questions (Rivard, 2000).

During the years since the last survey, a lot of changes have occurred in the construction industry. Access to the Internet and different web services has increased; the way of communicating project information has changed; development of software regarding building information models has increased as well as the knowledge and awareness of them; and longterm work in standardisation of electronic trade has finally produced result in a visible increase in use.

In the light of this development, an initiative was taken to follow up the earlier studies to be able to make a longitudinal study of the subject 'IT use in construction'. The IT-Barometer has therefore been repeated in the spring of 2007 in Sweden and will also be performed in Finland later this year. This paper presents some chosen results from the Swedish survey in 2007 with comparisons with the older surveys.

When repeating the study in 2000 as well as in 2007, the guiding principle was to make as few changes as possible to make sure that comparisons could be made, but at the same time to adjust questions which had not been working well and also to add questions or alternatives to make the questionnaire up to date with the development in the sector.

1.2 *Purpose*

The purpose of this paper is to describe the development of the use of IT in the construction and facility manage-

ment sector during a nine-year period, by presenting the most significant results from the Swedish IT-Barometer 2007 survey, with comparisons with the situation in 1998 and 2000.

The results describe some common areas in respect of access to computers and equipment and then focus on three areas, which are stated as necessary in the use of IT to increase productivity and efficiency in the sector.

A more complete report on the results from the survey is planned to be presented in a journal paper at IT-con (Electronic Journal of Information Technology in Construction), where also the earlier surveys have been published (Samuelson, 2002). In that paper there will also be some comparisons, if possible, with other surveys that have been performed in the last few years.

2 MEASURING THE USE OF IT

To be able to measure the use of IT in a reliable way and, especially to make comparisons between measuring occasions and different surveys, the method has to be well described. Differences in methods regarding population, register for selection, selection method and weighting of answers must be clear, and therefore the comparisons are made on the same basis.

2.1 Method

The main method for the IT-Barometer was developed in 1997 (Samuelson, 1998b) and includes definition of target population and strata, selection of register for the population, principles for selection and weighting of answers to represent the right part of the industry. This method has been the same on all tree occasions, apart from a slightly more ambitious approach in 1998 where the purpose was to make statements of the combination of company category and size instead, which resulted in a bigger selection. In the two later surveys, 2000 and 2007, statements were made for strata divided into categories or sizes. Nevertheless, the selection was made in the same way.

The method is well described in (Samuelson, 2002) and this is a short summary. The target population is the construction and facility management sector, which has been defined on the basis of the register from Statistics Sweden and includes all workplaces in the five categories: architects, technical consultants, contractors, property owners and manufacturers/trade. A workplace is defined as each address where a company carries out activities. This approach makes the answers more balanced, since bigger companies with different activities may have difficulties in giving answers for the whole company. The workplaces are also divided into four groups of sizes with respect to number of employees: 1-9, 10-49, 50-199 and 200-. The selection was made as a stratified free random selection, where stratified stands for the division into the categories and sizes above. A free random selection was then made for each stratum.

Since the IT-Barometer is supposed to describe the situation in this industry as a whole, it is important to consider the size of the companies. The answers have been weighted with respect to number of employees in each workplace, to make sure that every answer represents its part of the industry. This method has been used each time and is well described in (Samuelson, 2002).

The total population in the register was 62 488 workplaces in November 2006. The selection was made at a confidence interval of 95 % with a margin of error of ± 5 %. This resulted in a selection of 1 385 workplaces.

2.2 Collecting data

For the first time, the IT-Barometer 2007 was set up as a web questionnaire. On the two earlier occasions, this method was rejected for obvious reasons. Questions about access to computers and the Internet are meaningless if the basic condition to answer is that there is access. In the late 1990's there were still a lot of companies, at least smaller ones, which did not use computers and their answers were as important as those which did.

However, there are advantages with web questionnaires; they are easy to use for the respondents and it is an efficient way of collecting and analysing data. The probability that a company in Sweden in this sector in 2007 should not have access to the Internet was this time estimated as small. The invitation to participate in the study was sent to all respondents in a letter by post, in which the study was described. The letter was addressed to the IT Manager at the company. Each respondent was given a unique web address for his/her answers and there was also the possibility of sending SMS answers by mobile phone, if access to computers or the Internet was missing. There were therefore two reasons for sending the invitation by post instead of by e-mail. Firstly, the register only includes physical addresses and no personal e-mail addresses. Secondly, the postal letter made it possible to get some answers from those who, contrary to expectation, lacked access to the Internet.

The letter was followed up by a reminder two weeks later, and finally there were telephone calls to approximately 20 workplaces, chosen from the biggest workplaces that had not answered. This resulted in 180 answers, which corresponds to an answer rate of 13 %. This is the lowest answer rate of the three surveys, see fig 1. The reason for this can be discussed. It has always been difficult to get people to answer surveys, but the feeling is now that it is getting harder and harder, since the number of surveys are constantly increasing. The access to the Internet and survey tools for the web has made it easy for many companies to create surveys and marketing investigations. IT managers especially are being burden with all kinds of studies, and they probably do not have the time to even read the letter. The best answer rate was in the 2000 survey. A reason for this can be that Statistics Sweden was involved in the whole process, which gave the study credibility and a serious impression which made the respondents more willing to answer.

The answer rate makes it impossible to interpret the results as statistical truths, but the answers still cover a big part of the industry and contribute to giving a picture of the status today and the development during the last nine years.

	2007	2000	1998
Selection size	1385	1316	2723[1]
Number of answers	180	641	636
Answering rate	**13 %**	**49 %**	**23 %**

Figure 1. Answering rate for the Swedish surveys.

2.3 *Comparability between surveys*

As mentioned above, the questionnaire has been slightly modified each time it has been used. Some questions have been removed and others have been added with the purpose of making it up to date. Also small changes have been made in formulations and alternative answers, which did not appear to work well. In some questions the differences have made it hard to make direct comparisons in figures. Still, it has been possible to estimate whether the measured property has increased, decreased or is more or less unchanged.

3 DEVELOPMENT OF THE USE OF IT IN THREE AREAS

The results from the survey are presented below in text and figures and start with common use and access to computers and equipment and then focus on the three areas: computer aided design, project webs and electronic trade.

3.1 *Access to computers and communication tools*

The two earlier studies stated that approximately 90 % of all employees in the sector worked at workplaces that had computers. Those who did not came from small companies, preferably contractors and property managers. In this study, the workplace computerisation is 100 %. It must be emphasised that this study was made as a web survey, which assumes access to a computer and to the Internet. However, there was also the possibility of answering by means of SMS if this access was lacking at the workplace. There were a few such answers, which indicate that this method worked. The computerisation is still 99.99 % and the figure has been rounded up to 100 % for access to a computer and to the Internet at the workplaces.

The employees' access to different equipment has been studied in slightly different ways on all three occasions. The result from 2007 is presented in fig 2. In 2000, 54 % of the employees in this sector had access to their own computer. This figure includes office as well as site workers. About 90 % of the office workers had access to their own computer. The question in 1998 was not asked in the same way, but the answers indicated approximately the same level as in 2000. In total, access to computers has increased noticeably, especially among site workers. One conclusion is that computerisation among office workers was fully integrated already in the late 1990´s and that it has been spread among site workers also in the last few years.

It can also be seen in fig. 2 that access to computers corresponds with access to e-mail addresses; persons with their own computer also have an e-mail address of their own. This was the case also in 2000, but the level was lower. Regarding access to mobile phones there has been an increase from 50 % to almost 80 % in the sector as a whole. There is no difference at all between categories of occupation, and the mobile phone has been a natural tool for all employees.
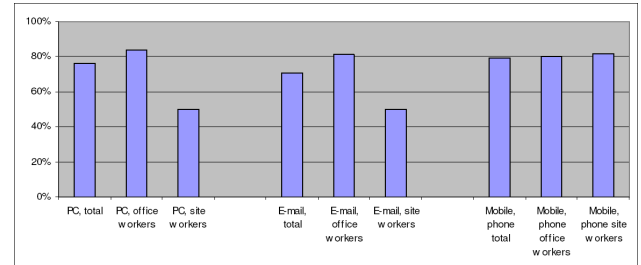

Figure 2. Proportion of employees at workplaces with access to own computer, e-mail, and mobile phone, 2007.

Also access to the Internet corresponds with access to computers. Within the margin of error, the figures in fig. 2 are practically the same as in fig. 3, apart from office workers. Some of them have their own computer but no access to the Internet. The development during the last decade is shown in fig. 4. There has been a continuous growth in access to the Internet from own computers as well as from jointly shared computers.
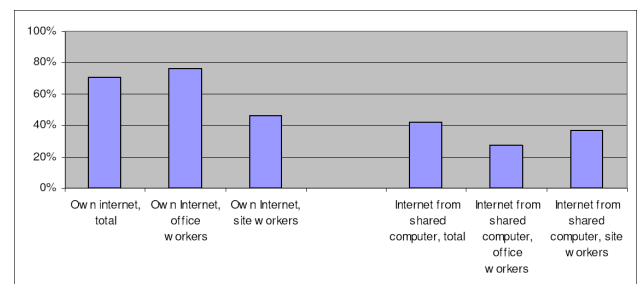

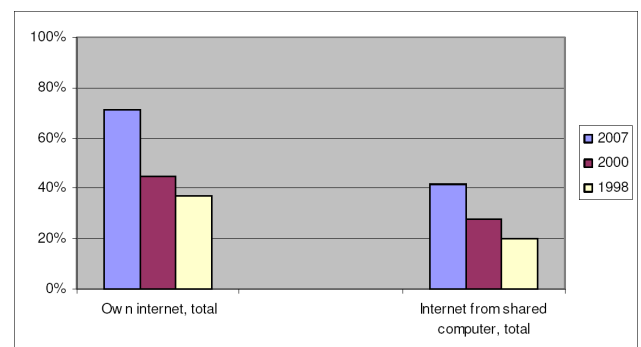Figure 3. Proportion of employees at workplaces with access to the Internet, 2007.

Figure 4. Proportion of employees at workplaces with access to the Internet, 1998 – 2007.

3.2 *Computer Aided Design*

Computer Aided Design, CAD, has been the main tool for design work since the middle of the 1990's. Workplaces with access to CAD are shown in fig. 5. The figures are

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[1] A bigger selection was made to get results for combinations of strata

almost the same as in the two earlier surveys. This indicates that CAD as a design tool was fully integrated by designers already in 1998. It should be noticed that not all of the technical consultants are designers, and therefore they do not use CAD.
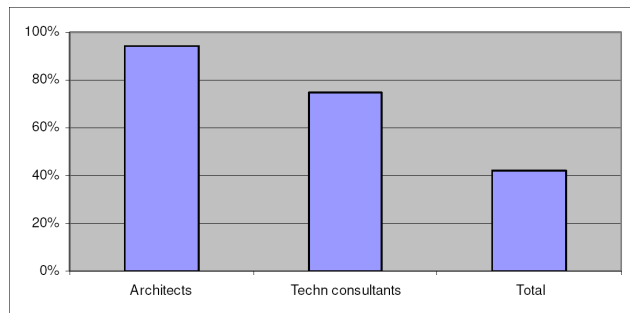

Figure 5. Proportion of employees at workplaces with access to CAD, 2007.

The way of using CAD in design work has been discussed since the childhood of CAD. Visions of using computer models in some way with more information than just geometrical started to occur in the 1980's. One way of measuring this development is to ask which type of programs and tools designers are using. This was done in the same way in 2000 and 2007, and the result is shown in fig. 6-7. An overall change that can be noticed is that use of plain AutoCAD has moved to use of AutoCAD ADT to a greater extent. This can be the result of the suppliers' way of licensing the product. However, the question was in fact the use of different tools, and figures show that the use of tools that can handle 3D and objects has doubled by architects and increased from 0 % to over 30 % by technical consultants.

Another change that can be measured is that drawing by hand has decreased by architects to approximately the same level as by technical consultants. By the latter, drawing by hand seems to have increased. However, this is probably not the case; the difference is more likely within the margin of error. In the earlier studies, the difference between architects and technical consultants was explained by the fact that architects were still making sketches and early drawings by hand. This seems therefore to have changed and architects too are now using CAD early in the process. The level of hand drawing seems to have stabilised around 10 % and this figure probably relates to sketches and "thinking with the pen" that hardly will be replaced by computers for a long time.
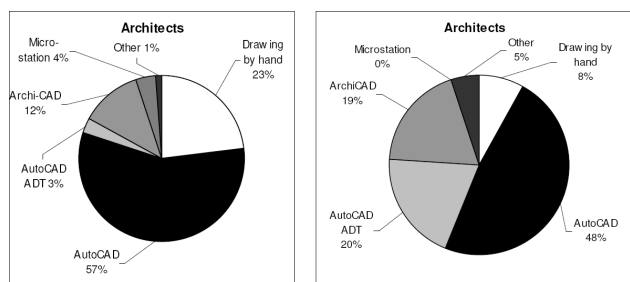

Figure 6. Proportion of techniques of the total design time in 2000 (left) and 2007 (right).
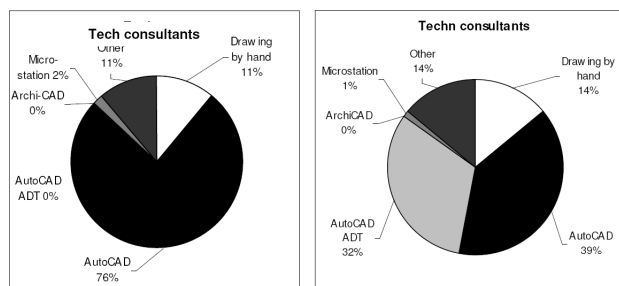

Figure 7. Proportion of techniques of the total design time in 2000 (left) and 2007 (right).

As shown in fig 6-7, the use of tools which handle 3D and objects has increased, which indicates that CAD is being used in new ways. To find out to which extent this is done, the respondents were asked to state in which of four different levels they use CAD, see fig. 8. Every level includes also the levels before, so the alternative "also object-based in databases etc." states that some use in this level occurs, but also in lower levels. Fig. 8 shows that few designers use CAD only for 2D drawings and that 60 % of the architects and 70 % of the technical consultants use CAD for geometrical data in two and three dimensions. The highest level, "also object-based in databases where several parts in the project have the right to retrieve and supply data", is used by over 15 % of the designers, both architects and technical consultants. This is verified by the fact that contractors and facility managers also use this level to almost the same extent, see fig. 9.
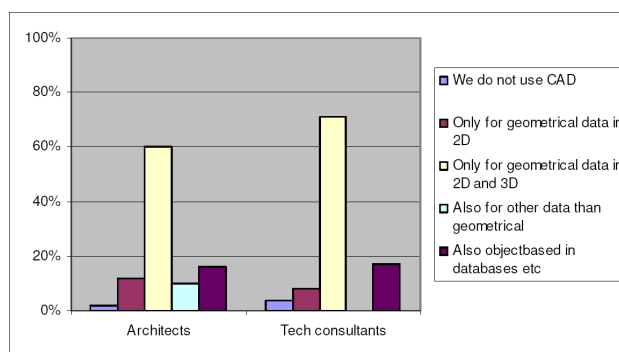

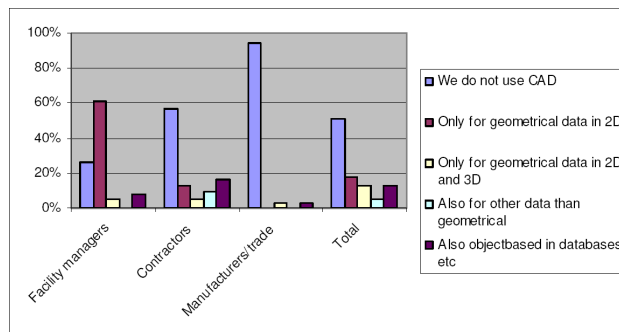Figure 8. Proportion of use of CAD for different types of data, designers.

Figure 9. Proportion of use of CAD for different types of data, other categories.

Those who answered one of the two highest levels were also asked to state which type of data, except geometrical, they use in their CAD databases. Surprisingly, it is not

data relating to "time" or "economy", which has often been used as an example of the benefits of using models. Instead, "product properties" are the most common data for architects and "other" for technical consultants, see fig. 10. The survey gives no answer to what is included in "other". This has to be investigated further. Questions about types of data in CAD were not asked in 2000, because the level of use was so low. Therefore, no comparisons can be made.
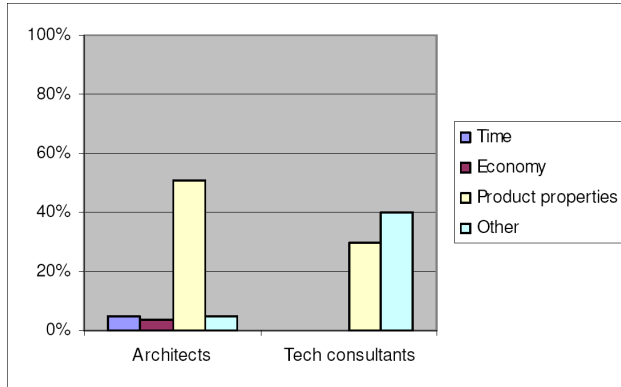

Figure 10. Proportion of non-geometrical types of data that is used in CAD, among those who use it.

The use of CAD for other purposes than geometrical is more common among architects than among technical consultants. 40 % of the architects, of those who use CAD for other purpose than geometrical, state that they use it in almost all projects. Since the base of respondents for this question is small, the figures in fig. 11 shall be considered with care.
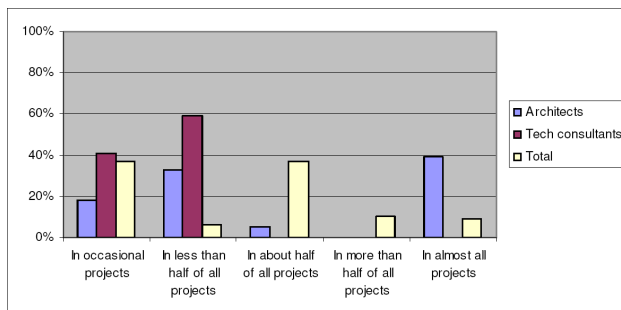

Figure 11. Proportion of how often CAD is used for other purposes than geometrical data, among those who use it.

3.3 *Project webs*

The use of the Internet as a communication tool and storage of common project data in a structural way on a web site was not measured in 1998. The technique existed but was not widespread in the construction industry. Already in 2000, the use of project webs had become more common and about 40 % of the consultants, (architects and technical consultants) had used it in some projects. Still they only used it in few projects, see fig 12. In 2007, the use has increased considerably among companies in the sector. 70 % of the consultants and almost 50 % of the contractors have been using project webs. The difference in use frequency is not as clear, and half of those who use it, only do it occasionally, see fig.13.
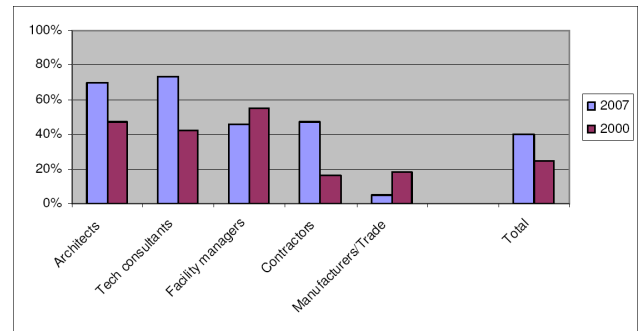

Figure 12. Proportion of employees at workplaces where project webs have been used in some projects.
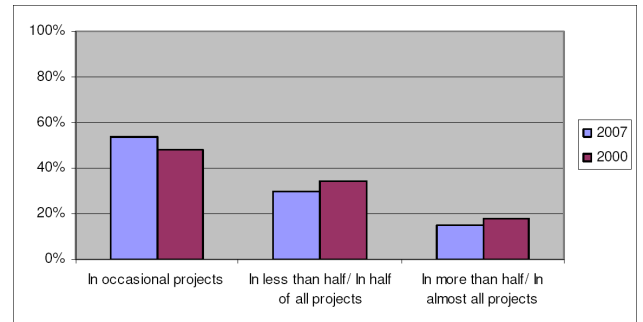

Figure 13. Proportion of how often project webs have been used, among those who use it.

3.4 *Electronic trade*

Electronic trade is an area, where a lot of standardisation work has been done during the last decades. The use has still not been widespread, but is increasing. Electronic trade is a wide concept, but the vision has been to create an unbroken link from information about the product via order and order confirmation to delivery information, invoicing and finally payment. This should be done in an electronic format where computer systems at the buyer's and the seller's exchange information. This is often called "full EDI". This way of doing business requires investments in systems and also long-term agreements between the parties involved. Because of this, only some of the bigger companies have implemented this way of working. In the two later surveys, almost the same question about using electronic trade was asked and the result is shown in fig. 14. In 2000 the question regarded annual turnover and in 2007 annual purchase. There is a big difference in use, and the difference is most clear regarding the fact that almost everybody uses electronic trade in some way or other, in 2007. Only 5 % state that they do not use it at all, compared to 64 % in 2000. There has also been a significant increase, from 3 % to 32 %, in the number of respondents who use it for 25 % or more. There are probably several explanations. Firstly, technical development at the web has enabled several safe solutions for web shops, market places and different types of web EDI, where the seller receives all information into their business systems, whereas the buyer has to fill in forms at the web site. Secondly, the use of full EDI between contractors and materials suppliers has increased as a result of technical development, standardisation work, and probably a maturity among the companies in the sector as well as in society as a whole. The use of electronic trade divided into four levels is shown in fig. 15. Individual com-

panies' web shops are the most common level for electronic trade by all categories of companies. But the use of full EDI is also at a relatively high level; 30 % of the contractors and 20 % of the materials suppliers are using it.
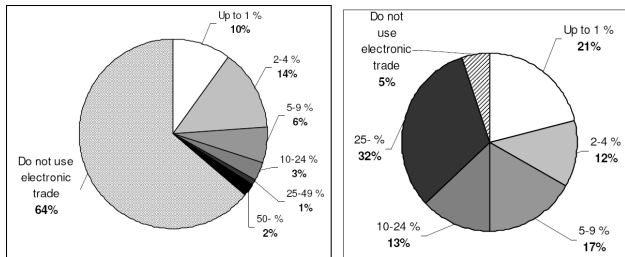

Figure 14. Proportion of value of annual turnover 2000 (left) and annual purchase 2007 (right) that comes from electronic trade.
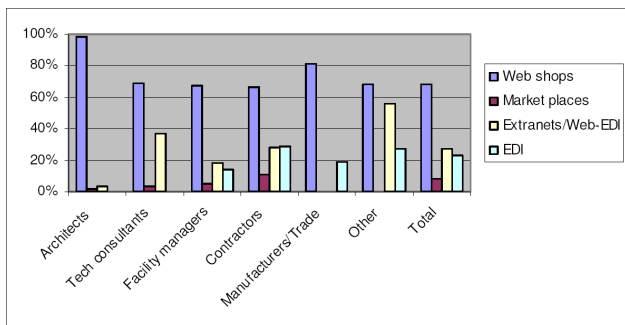

Figure 15. Proportion of employees at workplaces where different types of electronic trade are being used.

3.5 *Advantages and barriers*

Advantages with a greater use of IT have been measured each time. The respondents find it most important with "simpler/faster access to common information" and "Better financial control". Theses two was at the top also in 2000 and in 1998. "Possibility to develop new products/new business models is stated as least important. Also this has been on the same level at all three occasions.

The two most important obstacles or barriers are "Continual demand for upgrading hardware and software" and "Overabundance of information". The former has always been a great obstacle but the later has increased as an obstacle during the years. Investment cost has been at the top earlier but is now on the fifth place. It seems as investments in IT is acceptable but that maintenance costs in form of continual upgrades are expensive and unnecessary.

3.6 *Plans and strategies*

The respondents were asked to state in which areas they are planning to increase their use of IT in the next two years. At most, three alternatives in each area had to be chosen. Fig. 16 shows in which order the plans were prioritised in 2007, 2000 and 1998. The result shows that "document handling" and "accounting systems" still are among the top three as they have been each time. These are obviously areas that always are highly topical to the companies. A new area at the top is "portable equipment/mobile systems". The importance of communicating and having access to information anytime and anywhere

is clear. Wireless LAN, broadband at home and mobile phones with e-mail connections have made this possible.

There is no such clear area that has fallen in priority during the years. Some areas in the middle of the list seem to go up and down in periods, also depending on the different categories of companies. CAD is most important to designers, while for example electronic trade has been in focus for contractors and materials suppliers. At the bottom of the list of plans we find again "product models", "virtual reality" and "new business models and activities". As in the earlier surveys, this one shows that the focus is on support systems and not on more advanced techniques that can change the business. It will probably always be like this when asking a lot of companies; only few of them will take the lead and commit themselves to more complex techniques for the future.

Areas	2007	2000	1998	Trend
Portable equipment/mobile systems	1	4	8	↗
Document handling	2	1	1	
Accounting systems	3	3	3	
Information search via the Internet	3	8	2	
CAD	5	7	4	
Systems for costing/cost control	6	2	5	↘
Electronic trade via the Internet	7	6	7	
Project common sites for documents and files on the Internet	7	10	N/A	
Project management	9	5	6	
Systems for technical calculations	9	11	9	
Systems for real estate information	11	12	N/A	
Product models	12	14	11	
Virtual Reality	12	15	10	
New business models and activities	14	13	N/A	

Figure 16. Areas for planned IT investments, in order of priority.

4 DISCUSSION AND CONCLUSIONS

The selection of results presented in this paper mostly shows the results for the whole construction industry. Division into categories and sizes will tell more about how different parts of this industry have developed. However, the main picture for the industry is described, and shows that the infrastructure of IT is well developed with access to computers, the Internet, e-mail and mobile phones for a large number of employees, site workers not least.

In the focus areas there has been a clear increase of the use of IT in the last few years. Designers more and more use 3D and objects to describe the product, and building owners and contractors are starting to use CAD models for information. Project webs are a natural way of sharing information, even if they are not used in all projects. The use of electronic trade has increased to a level where almost all companies use it in some way. The use of web shops is still the most common way of trading electronically. Contractors are however using "full" EDI to a considerable extent.

The possibility of making use of IT to support new ways of working and to make the process more efficient is increasing. The companies are nevertheless doing this in small steps, and in their future plans they still focus on common well-known techniques, such as mobile solutions and document handling, instead of product models, virtual reality and new ways of doing business.

This third version of the IT-Barometer will be performed also in Finland. The total results will consist of a lot of

data, which will be analysed and presented in a more detailed way for the construction industry as a whole as well as for categories and sizes of companies.

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