IT-BAROMETER 2000 – THE USE OF IT IN THE NORDIC CONSTRUCTION INDUSTRY

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SUMMARY*: The IT Barometer 2000 was carried out in the autumn 2000 in Sweden, and in the spring 2001 in Denmark and Finland, as a follow up to the first survey, the IT Barometer 1998. This paper presents the most significant results from the Swedish survey and a few selected results from the comparison between the three countries. The Swedish survey was sent out to a statistically chosen selection from the whole country, divided into architects, engineers, contractors, property owners and manufacturer/trade. The survey produced knowledge about the use of computers, hard- and software, communications, and plans and strategies for the use of IT. 88 % of all employees work at workplaces with computers. The most common types of software are word processors, administration and e-mail. 54 % of employees have their own computer at the workplace. The use of CAD in general has increased and the use of model based CAD software has increased among architects. Property owners are those who use computers most widely in their core business, while contractors do this the least. The documents that are most often sent digitally are minutes of meetings and construction drawings. 83 % of all employees work at workplaces with access to the Internet and 45 % have access to the Internet from their own computer. The use of project webs and electronic trade in the industry has started but it is not widespread. Many companies are still increasing their investments in IT but the speed of increase is slowing down. The industry experiences that IT has increased productivity, mostly in general administration. Consultants experience a higher productivity rise than contractors. The greatest advantages with IT are stated as better financial control and faster access to information, while the greatest obstacles are costs, which are too high for investment and upgrading of systems. The motives and plans for IT investments are concentrated on well-tried techniques in the companies' support business. The comparison between Sweden, Denmark and Finland shows that Finland and Denmark have a greater use of model based CAD and that more employers have their own computer at the workplace. Companies in Sweden think they get better financial control with IT and also prioritise costing/cost control and accounting systems to a greater extent.*

KEYWORDS*: survey, IT, construction industry, computers, CAD, communication, the Nordic countries.*

1. INTRODUCTION

1.1 Background

The project IT Barometer started in 1997 as an initiative of the Swedish R&D-program IT Bygg och Fastighet 2002 (IT BoF). The aim of the project was to create a method and perform a survey for measuring the use of IT in the construction industry. The survey should:

- be repeatable and comparable over time.
- be comparable between countries.
- cover all categories of companies in the construction industry.

The first survey was performed in Sweden in the autumn of 1997 and the spring of 1998 as a postal questionnaire. The survey was also performed in Denmark and Finland at the same time. The questions were the same in the three countries except for small changes to adapt to local variations. The result from the Swedish survey was presented in the report "IT-Barometern 1998 – Läget för IT-användningen inom byggande och förvaltning i Sverige" (Samuelson, 1998a). Comparisons between the countries were also made and presented in two papers, (Howard and Samuelson, 1998) and (Howard et al. 1998). A slightly modified version of the IT Barometer was also performed in Canada in 1999 and was presented in a paper in the electronic journal ITcon (Rivard, 2000).

In the autumn of 2000 the IT Barometer was repeated in Sweden with the purpose partly to measure the use of IT in the year 2000 and partly to make comparisons with the situation in 1998. Denmark and Finland used the same questionnaire and repeated the survey in their countries in the spring of 2001.

1.2 Purpose

The purpose of this paper is to present the most significant results from the Swedish survey IT Barometer 2000, to make comparisons with the situation in 1998 and to show a few selected results from the comparisons between the three countries Sweden, Denmark and Finland.

A more detailed analysis of the comparison between the three countries is planned to be presented in a paper to the CIB W78 Conference 2002 in Aarhus, Denmark.

1.3 Quantitative and qualitative surveys

A number of surveys on the use of IT in construction have been carried out in different countries in the last few years. There have been both quantitative and qualitative surveys that complement each other in the way they express the use of IT in the industry. For example two surveys based on a qualitative approach were carried out in 1997 at Salford University, A Strategic IT Health Check (Shafagi and Betts, 1997) and Benchmarking Best Practice Report, Briefing and design (Atkin et al. 1997). An example of quantitative surveys is a study in New Zealand for the BRANZ building research organisation (Doherty, 1997), which is similar to the IT Barometer and measures IT use in the whole industry. Other surveys that concentrate more on a specific part of the industry are, 'Current state of IT usage by Australian subcontractors' (Thomas et al. 2001) and 'Architectural Practices and Their Use of IT in the Western Cape Province, South Africa' (Arif and Karam, 2001). These surveys were made more recently and can serve as a basis for international comparisons with the IT Barometer in further studies.

2. METHOD

The method for measuring the use of IT in the construction industry was developed at KTH, Stockholm in 1997 and is described further in a master degree thesis (Samuelson 1998b). There are some differences in the methods used between the three countries. In this paper the method for the Swedish survey is described. The differences lie partly in the selection of respondents and partly in the way of weighting the answers. This means that the comparison between the countries is not completely unambiguous, which should be considered when analysing the result.

2.1 Explanation of concepts

In this paper a number of concepts are used. These are explained and defined below.

- Construction industry — The industry has been defined on the basis of the register from Statisticals Sweden and includes all workplaces in the categories below registered in Sweden.
- Categories — Architects, Engineers, Contractors, Property owners and Manufacturer/Trade.
- Workplace — Each address, property or group of contiguous properties where the company carries out activity (not home addresses).
- Employees — Total number of employees at the workplace including working owner.
- Size — The selection is divided in the following four groups of size: 1-9 employees, 10-49 employees, 50-199 employees and 200 or more employees.

2.2 Selection of respondents

To make a representative selection of respondents, Statistics Sweden (SCB) was used. SCB keeps a directory containing all companies in Sweden. The directory is updated every 3 months. It is possible to make the selection either on the basis of companies, or on the basis of workplaces. In this survey the selection is made on the basis of workplaces. There are two main reasons for this. Firstly, many companies work with more than one type of business. Different workplaces can belong to different categories of companies and can also use IT to a different extent and in different ways. Secondly, if a big company should be represented by one questionnaire only, this would cause some disproportion in the result, since it is weighted regarding the number of employees. By choosing workplaces as a basis for selection, the possibility of getting a more detailed and true description of reality increases.

SCB was involved in the selection. The statistical method chosen was stratified free random selection. Stratified means that the population is divided into a number of groups with certain characteristics. The free random selection is then used to make the selection of units from these groups. In this selection each unit in the population has the same probability to be part of the selection. This method using two steps is necessary if the survey is to be able to say something about parts of the industry. Otherwise it is only possible to make statements about the industry as a whole. It was decided that the study should be able to make statements partly about the industry as a whole, partly about categories of workplaces and partly about sizes of workplaces, but not the combination of the last two, which would have resulted in a much bigger selection. The selection was therefore stratified with respect to the following 9 strata (5 categories and 4 sizes of workplaces):

- Architects
- Engineers
- Contractors
- Property managers
- Manufacturers/Trade
- 1-9 employees
- 10-49 employees
- 50-199 employees
- 200+ employees

This resulted in a selection of 1316 workplaces from a total population of 81 825. Apart from the questionnaire, two postal reminders were also sent out and finally a number of reminder calls via telephone were made. This resulted in 641 answers, which corresponds to an answer rate of 49 %. All answers are weighted to represent its part of the industry regarding category and size. This is described further in part 2.3. If the answer rate for a specific stratum (category and size of the workplace) in a specific question, is to low, the result has not been presented in the paper.

2.3 Weighting of the answers

One of the main goals with the IT Barometer was to be able to describe the situation in the industry as a whole. With this in mind it is important to consider the size of the companies. The big companies are few but each of them represents a big part of the industry since they have a large number of employees. On the other hand there are a large number of companies with few people employed. Each of them represents a small part of the industry. If each answer were given the same importance in the analysis, the result would be very misleading. Because of this the answers have been weighted with respect to the number of employees in each workplace, to make sure that each answer represents its part of the industry. This involved two steps. In the first step the answer is multiplied with the number of employees in each workplace. In the second step the answer is multiplied with a factor that makes the workplace represent the right number of workplaces in that stratum. The weighting was made of SCB in SAS (a statistic software). A simplified example of the method is showed in FIG. 1.

	A	B	C	D	E	F	G
		Number of employees in workplaces that have CAD	Total number of employees in the stratum	Number of workplaces that answered	Total number of workplaces in the stratum	Factor	Total number of employees that each answer represent
1	**1-9**		**2335**	**78**	**2446**	**31,36**	
2	Architect 1	5					156,8
3	Architect 2	2					62,7
4	Architect 3	8					250,9
5	etc…						etc…
6	**10-49**		**1790**	**33**	**105**	**3,18**	
7	Architect 79	21					66,8
8	Architect 80	11					35,0
9	Architect 81	22					70,0
10	etc…						etc…
11	**50-199**		**585**	**3**	**7**	**2,33**	
12	Architect 112	130					303,3
13	Architect 113	110					256,7
14	Architect 114	100					233,3
15	etc…						etc…
16	**SUMMA**		**4710**				**4521**
							96%

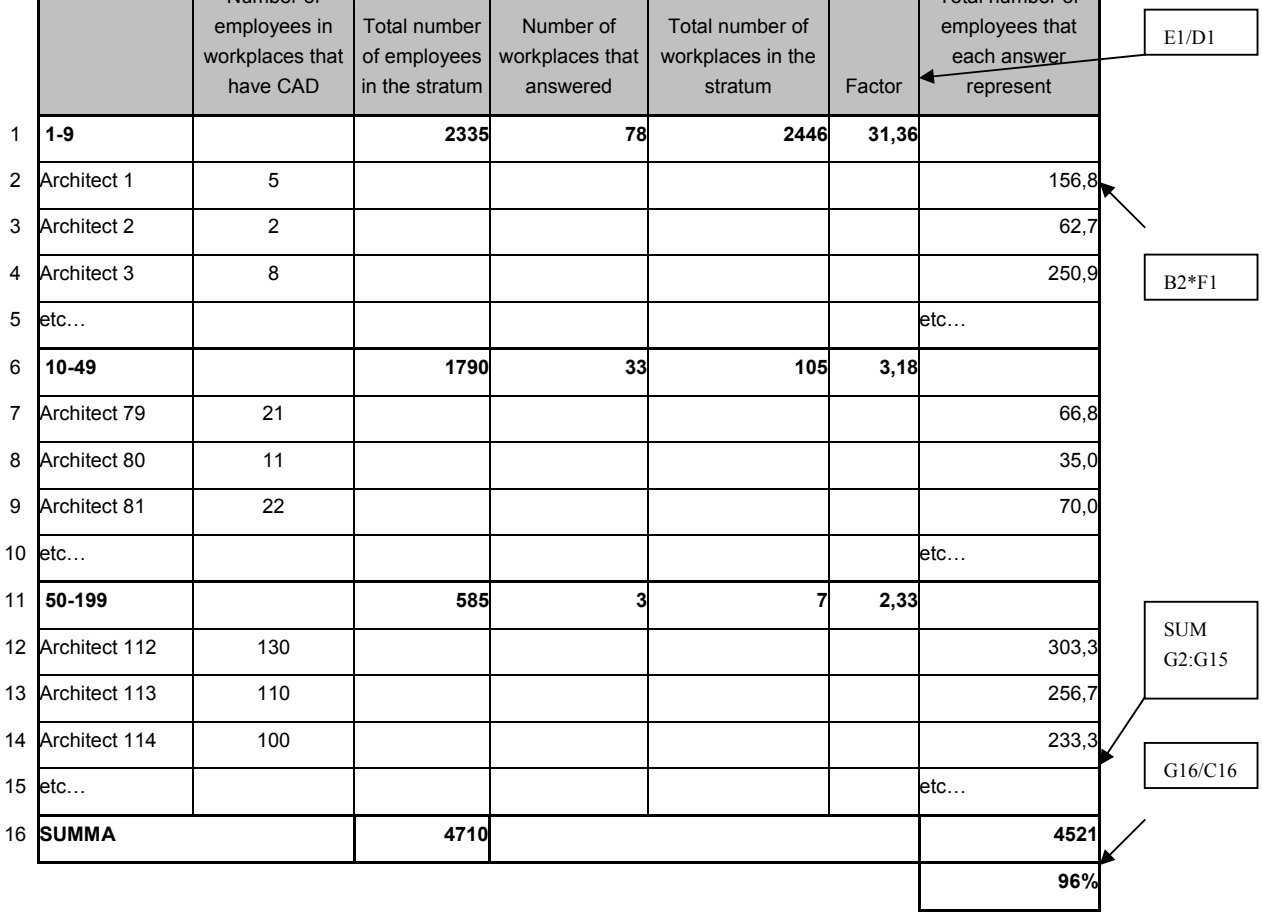


FIG. 1: Example of the weighting method. The example shows the result of the question: Do you have CAD at the workplace?

2.4 Comparability between the surveys 1998 and 2000

The ways of selecting respondents in the two surveys are similar, which is a condition for making fair comparisons. The only difference in the method of selection between the surveys is that there was a bigger selection in 1998 as shown FIG. 2. The reason for this was that the study aimed to make statements about the combination of categories and size of workplaces (compare with part 2.2). When the survey was repeated in 2000, a higher answering rate was prioritised. It is easier to get a high answering rate from a smaller selection, and this was found more important than the possibility of making uncertain conclusions about workplaces divided into both categories and sizes. It is also shown in FIG. 2, that the number of answers was almost the same in the two surveys but the answering rate was twice as high in the survey 2000, and the results are thus more reliable.

The questionnaire from 1998 was slightly modified before it was used in the survey 2000. Some questions were removed and others were added. Also small changes were made in formulations and alternative answers, since they appeared not to work well. The two questionnaires are mainly similar and most of the questions are comparable directly. In some questions however, the differences in the questions 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.

	2000	1998
Selection size	1316	2723
Number of answers	641	636
Answering rate	**49%**	**23%**

FIG. 2: Answering rate for the Swedish surveys.

3. RESULTS FROM THE SURVEY 2000 AND COMPARISONS WITH 1998

3.1 Access to computers, software and equipment

88 % of all employees in the construction industry work at workplaces with computers. This is approximately the same level as in 1998. Most of those who do not, work at contractors and property managers with less then 9 employees, i.e. small companies with a large proportion of skilled workers. The most common types of software used are word processors, administration software, E-mail software and spreadsheets. They are used at approximately 90 % of the workplaces (see FIG. 3). The use of other software depends much on the category of the company. This is further commented in part 3.2.

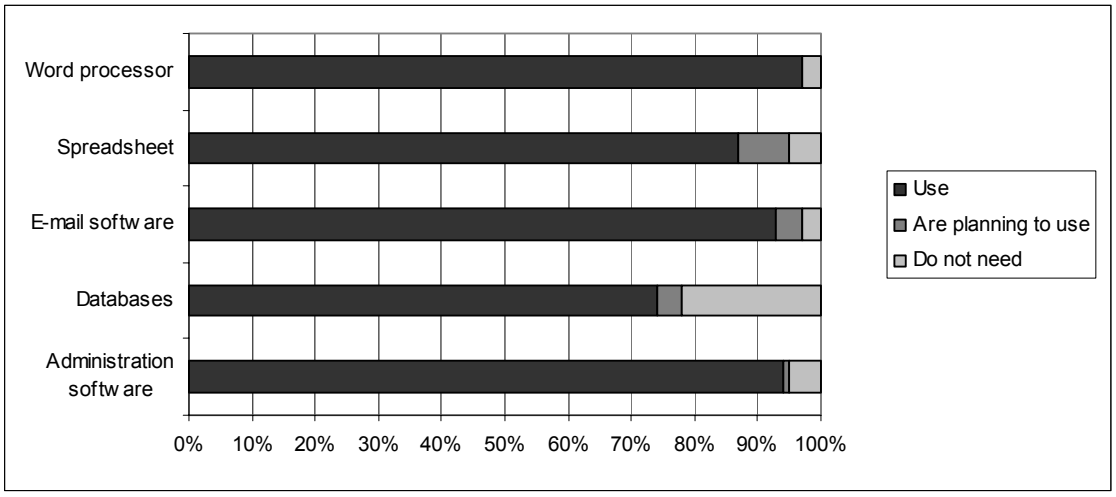


FIG. 3: Proportion of employees at workplaces with different kind of software.

Among all employees in the industry 54 % have their own computer at their workplace, see FIG. 4. 33% have a computer at home that is owned by the company. These figures include both white collar and skilled workers. In the 1998 survey the figures were given separately for white collar and skilled workers, which makes the comparison difficult. The answers indicate however that the access to a computer for personal use among white-collar workers has increased to a high level in all categories of companies.

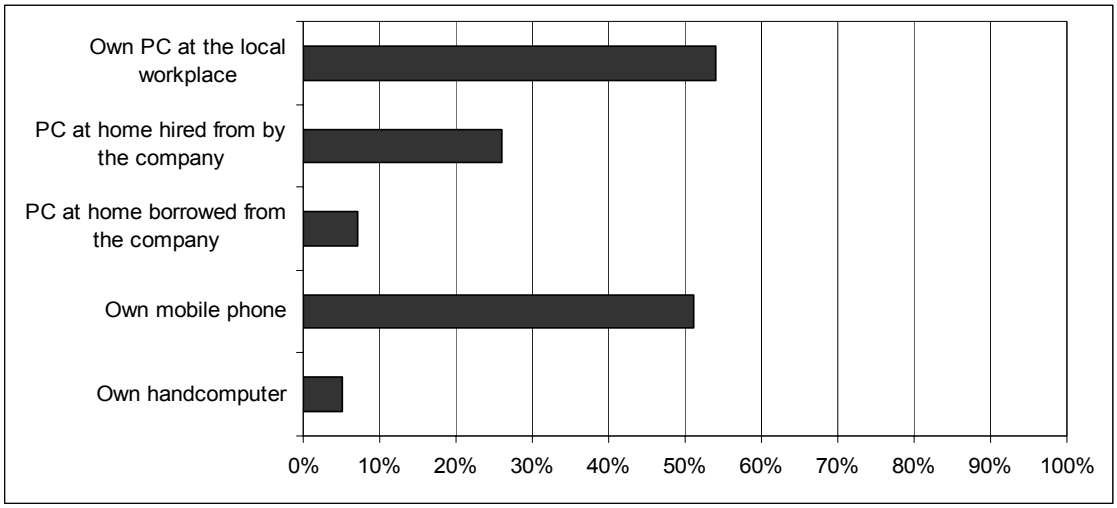


FIG. 4: Proportion of employees with access to equipment.

3.2 Use of computers and software

The respondents were asked to state to what extent they use computers for different operations. Some operations are of a more common or administrative nature. Others are specific to one or more categories of companies, depending on the different types of work they perform. Each operation has then been studied for the types of companies that mostly perform it.

Common operations

Bookkeeping and invoicing are the common operations that are most frequently performed with computers. As shown in FIG. 5, over 60 % of the industry uses computers all the time for these operations.

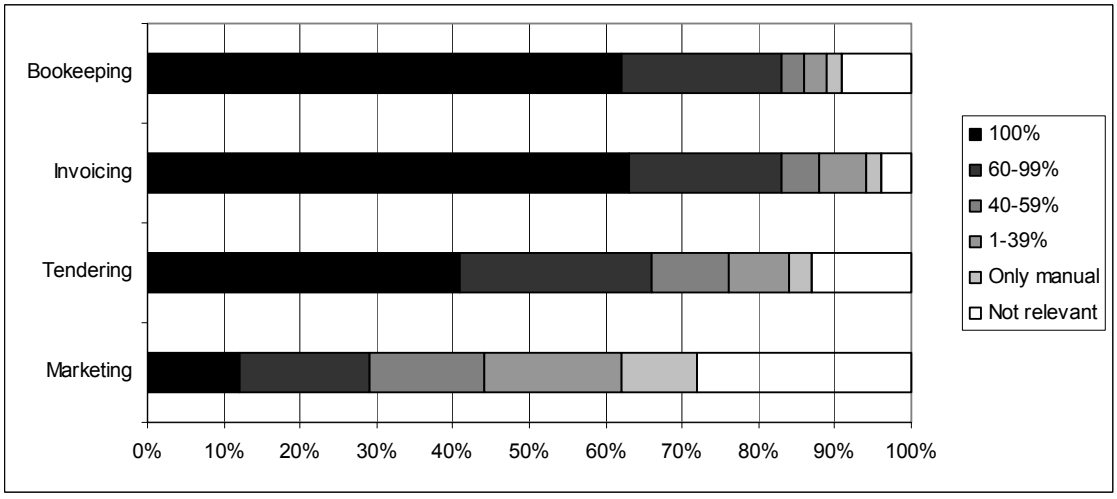


FIG. 5: Proportion of common work operations that is performed with computers, the industry as a whole.

CAD

Those who work with design were asked to state the percentage distribution between different design methods. The most common software is AutoCAD, which is used 76 % of the design time by engineers and 57 % of the design time by architects respectively. The difference between architects and engineers is shown in FIG. 6. The

architects use drawing by hand 23 % of the time while the engineers only use this 11 % of the time. On the other hand architects use model-based programs, such as ArchiCAD and AutoCAD ADT, to a greater extent than the engineers, who do not use them at all. Another difference between the categories is that 11% of the engineers use other types of software than those listed in the survey, while only 1% of the architects do this. The reason is probably that architects are a more homogeneous group than the engineers. Different types of engineers need different kind of applications.

The total use of CAD in design work has increased since 1998, among architects from 64 % to 77 % and among engineers from 87 % to 89 % (which is within the margin of error).

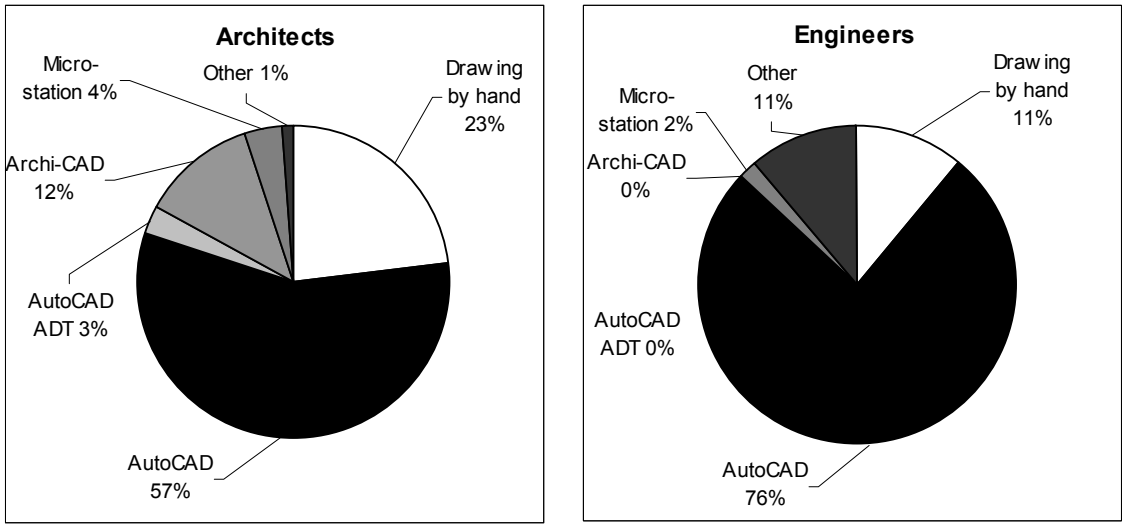


FIG. 6:Proportion of total design time that each technique is used.

Scheduling, costing and budgeting

Scheduling and resource planning is performed with computers by a surprisingly low share of the industry. In this area there are a lot of well-developed software that could offer many advantages. Despite this, 14 % of contractors perform all planning manually and only 10 % use computers all the time, see FIG. 7.Architects and engineers use them a little more. 27 % of engineers perform planning with computers all the time.

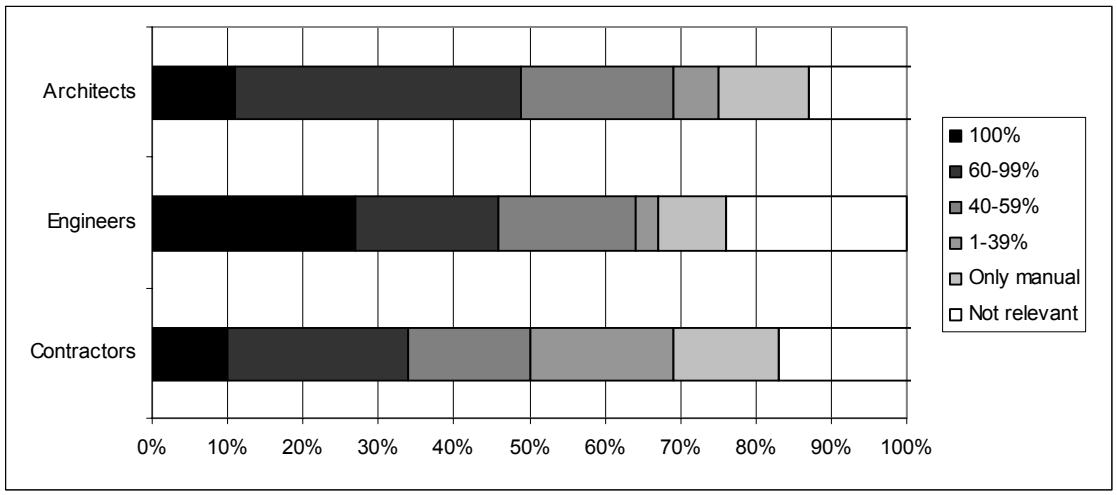


FIG. 7: Proportion of work with scheduling and resource planning that is performed with computers.

For costing and budgeting there are also many developed software, from common spreadsheets, such as Excel, to specially developed costing software with databases for prices and products. This is also shown by the fact that more than 60 % in all four categories in FIG. 8 are in the range 60-100 % of computer use. Property managers make most use computers for this purpose, with more than 80 % in the range 60-100 %. The contractors have the lowest use. However, it is remarkable that there are, in each category, those who perform this totally manually. For the contractors this figure is in fact 9 %.

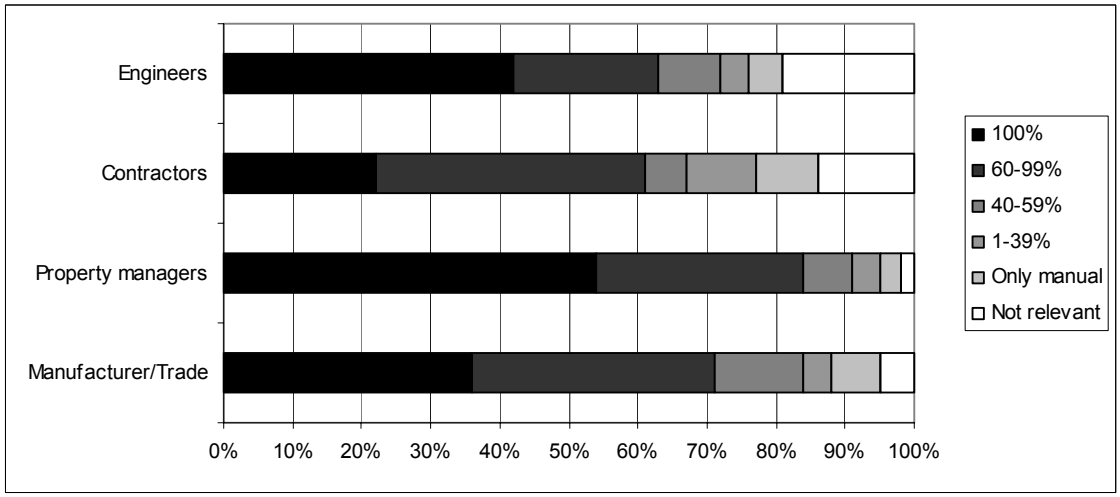


FIG. 8: Proportion of work with costing and budgeting that is performed with computers.

Software for real estate and Materials control

Operations for real estate have been studied only for property managers. FIG. 9 shows that over 70 % of the property managers manage all their rental administration, using computers. Also maintenance planning is managed to a great extent with computers, 36 % have computerised this 100 % and 31 % are in the range 60-99%, which indicates a high level of computerisation.

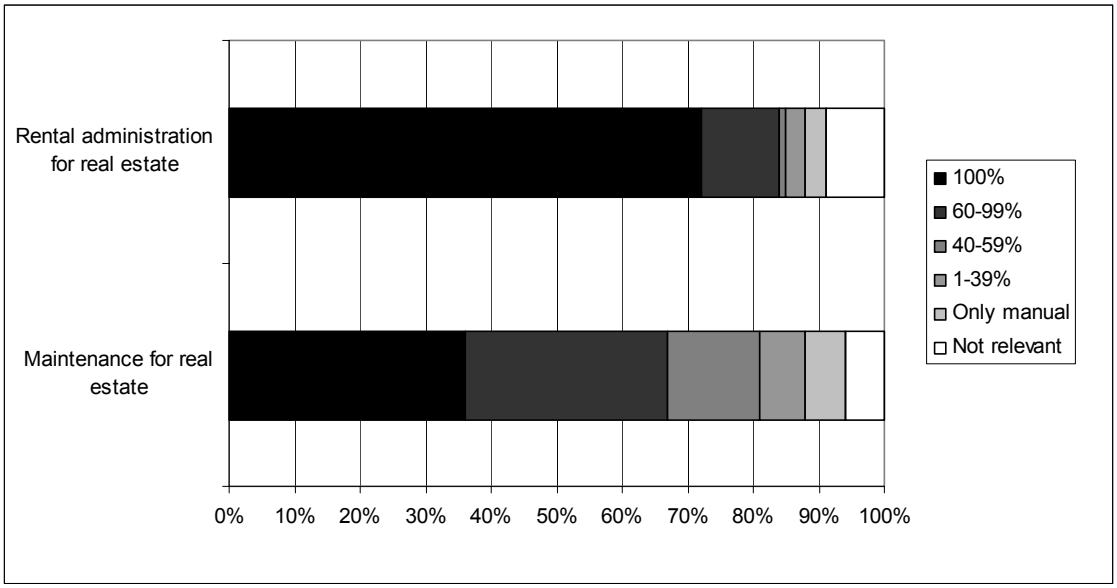


FIG. 9: Proportion of work with rental administration and maintenance that property managers are performing with computers.

Among those who perform materials control and purchase, manufacturer/trade is the group that mostly uses computers for these operations (see FIG. 10), which is natural since this is their core business. Contractors have a surprisingly low use of computers in this area bearing in mind that this is an important area also in their business.

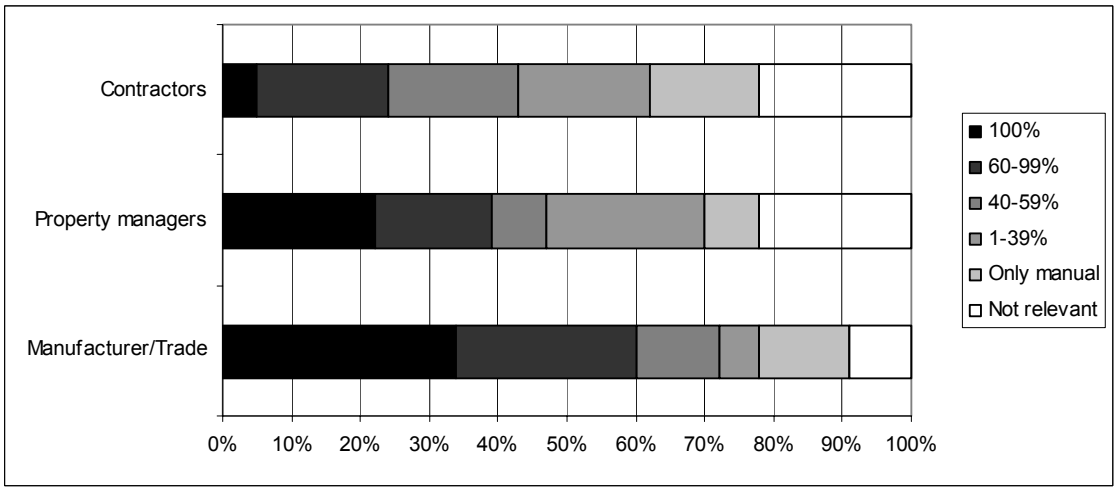


FIG. 10: Proportion of work with materials control and purchase that is performed with computers.

3.3 Communication

Access to Internet

83 % of all employees in the industry work at workplaces with access to the Internet, i.e. where at least one person has access (see FIG. 11). This is about the same as in 1998, which indicates that most workplaces got their connection to the Internet before 1998. All workplaces with 50 employees or more have a connection to the Internet.

The access to the Internet among the employees varies between the categories, which is shown in FIG. 12. Employees in 45 % of the industry as a whole have access to the Internet from their own computer and 28 % from other shared computers. This is a clear increase since 1998 when the corresponding figures where 37 % and 20 %. The access for the individual employees is greatest among the engineers and the architects, where 87 % and 66 % respectively have access from their own computer.

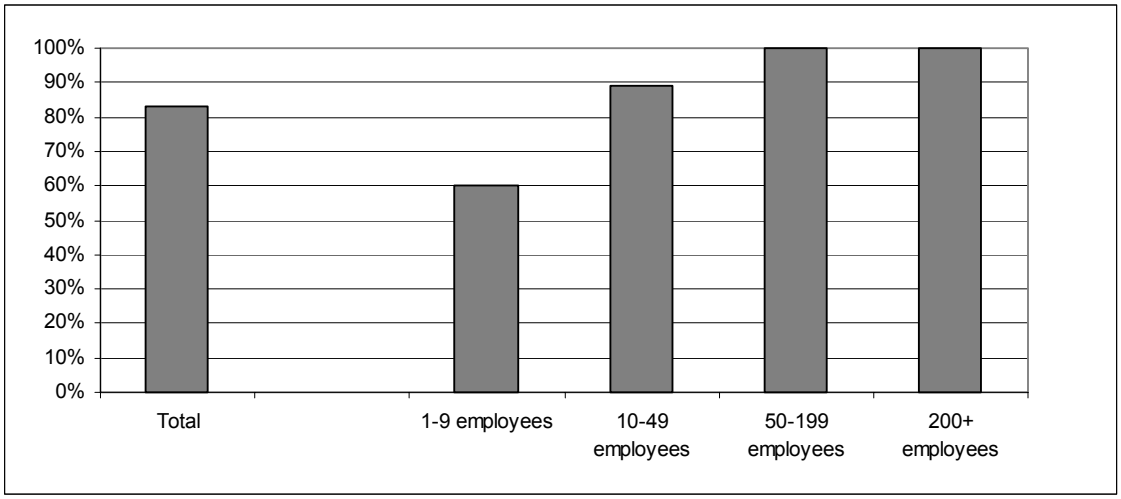


FIG. 11: Proportion of employees in workplaces, where the workplace has connection to the Internet.

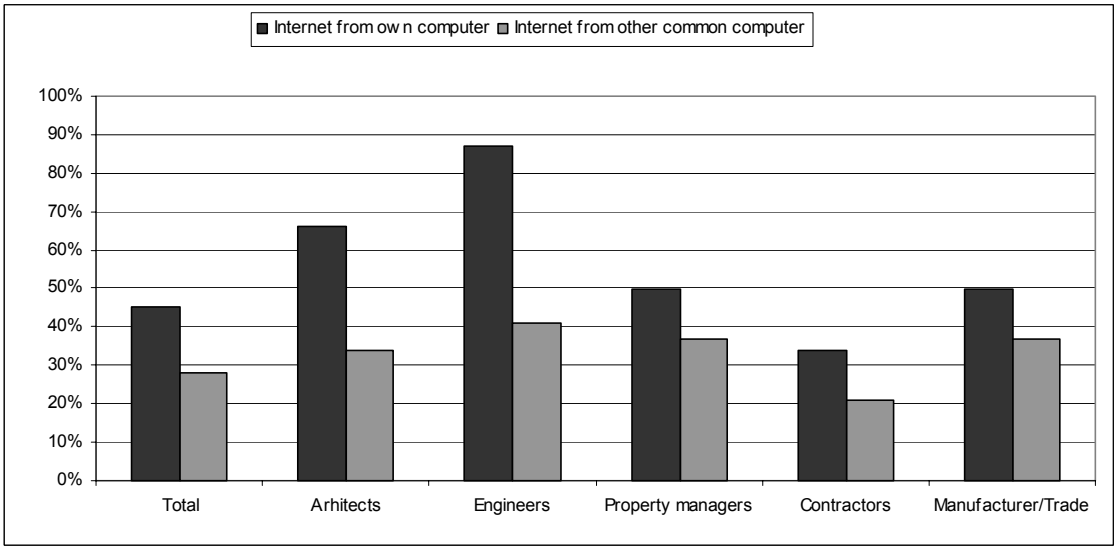


FIG. 12: Proportion of employees with access to the Internet from their own and other shared computers.

Use of Internet

In total 60 % of the employees in the industry work at workplaces where the company has its own website on the Internet (FIG. 13). This is equivalent to the result of 1998. Among manufacturer/trade the figure is a little higher with 70 % and, among property managers it is considerable higher with 90 %. The reason is probably that these categories have activities that are suited for offering products and services over the Internet.

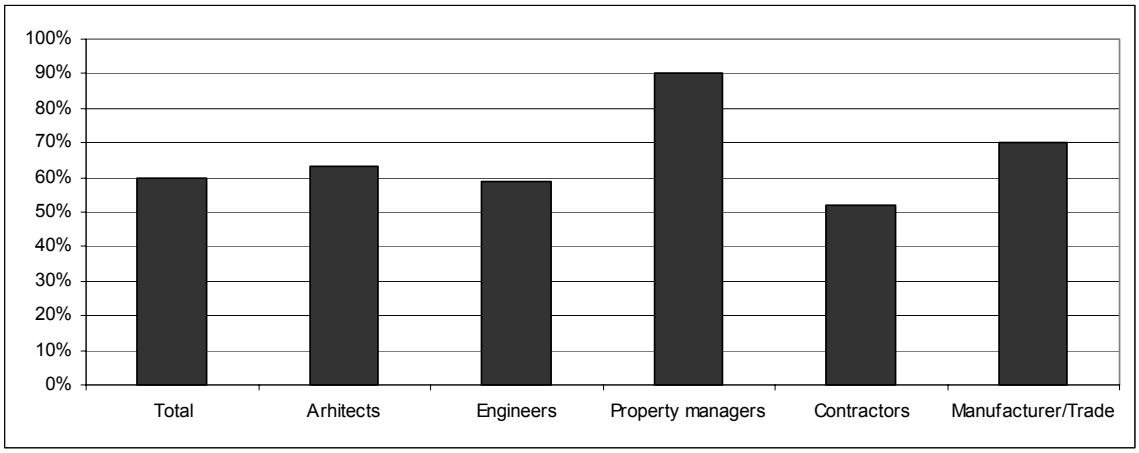


FIG. 13: Proportion of employees in companies with their own website on the Internet.

In total, only 25 % of all employees work at workplaces where a project web has been used in any project (FIG. 14). Among architects, engineers and property managers the figure is considerable higher, about 50 %. If the answers are sorted by size of companies, the corresponding figure is 75 % for companies with 200 employees or more. The use is obviously very dependent on the size of the company. Half of those who have used project webs have only used them occasionally. The use is, in other words, not widespread. Rather many have started to use them but only to a small extent.

Neither is electronic trade widespread in the industry. According to FIG. 15, 64 % of all employees work at workplaces that do not use electronic trade at all. Those who do, only use it to a small extent. 24 % of the employees work at workplaces where electronic trade represents 1-4 % of the annual turnover. However, 1 % is in the range 25-49 % and 2 % in the range 50 % and more, which indicates that a few companies have a widespread use of electronic trade.

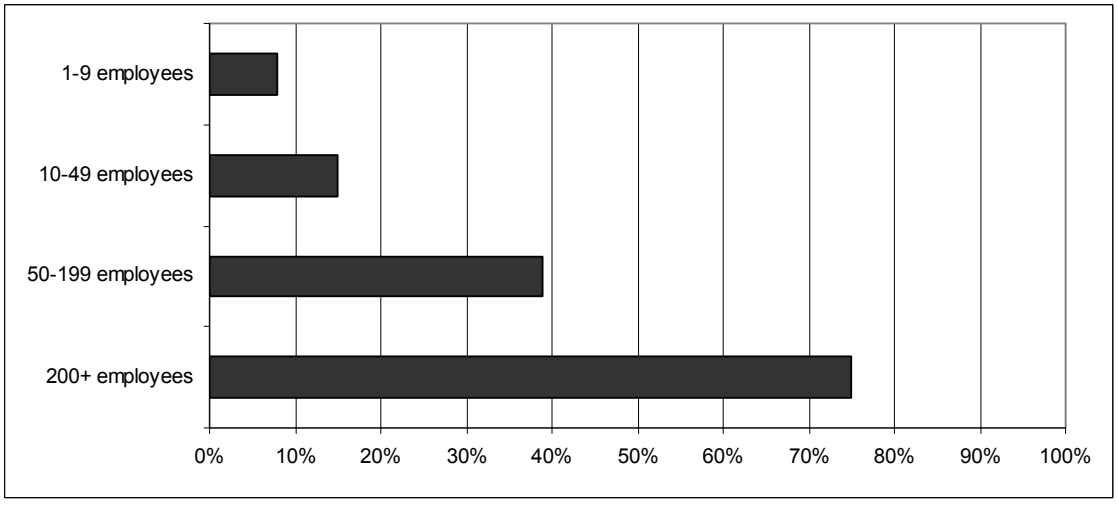


FIG. 14: Proportion of employees at workplaces where project webs have been used in any project.

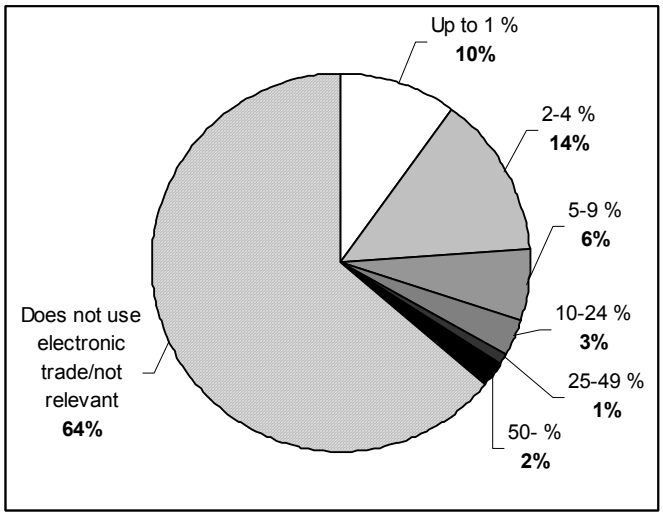


FIG. 15: Proportion of annual turnover that comes from electronic trade.

Distribution of documents in digital format

The respondents were asked to state to what extent they distribute different documents in digital format. Some documents are of more common or administrative nature, while others are specific to one or more categories of company. Each type of document has been studied for the types of companies it applies to.

Among common documents, minutes of meetings are the type that is most often sent digitally (see FIG. 16). The level is still low compared to the benefits that e-mail offer in relation to ordinary mail in terms of economy and speed. The share of descriptions that is sent digitally is lower, and orders, invoices, and tender enquiries are much lower. This may depend on security problems and/or lack of standards for digital signatures.

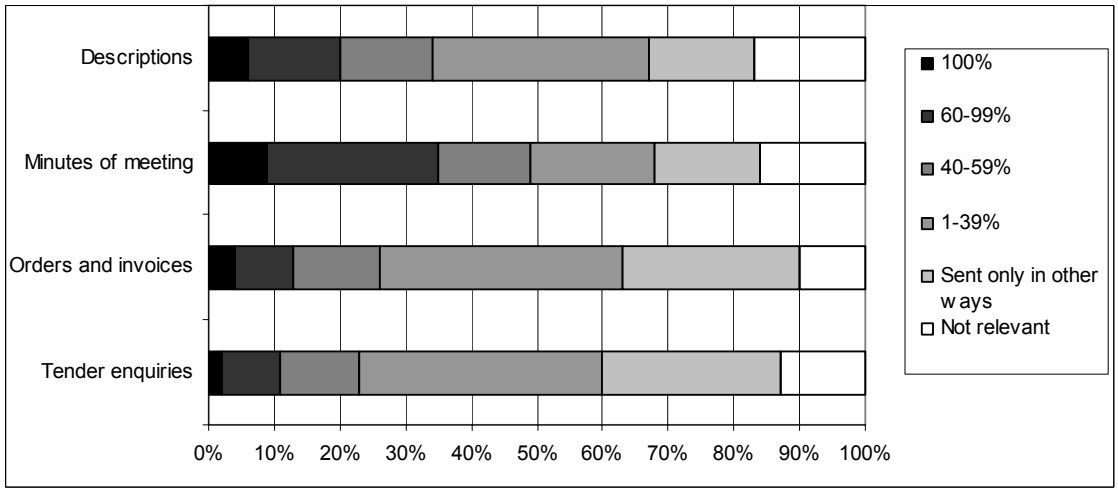


FIG. 16: Proportion of common documents that are sent digitally for the industry as a whole.

Graphical documents have been divided into three groups on the basis of three stages in the design process namely, drafts/programs, construction drawings and as-built drawings. Construction drawings seem to be the group in which most graphical documents are sent digitally. Half of the architects and engineers send 60-100% of their graphical documents digitally at this stage (see FIG. 17). Contractors, on the other hand, rarely send graphical documents by electronic means in all stages.

Quality results and testing-results for materials are seldom sent digitally. Manufacturer and trade are those who most often do this, where slightly less than 20 % send this type of material more than 60 % of the time (see FIG. 18).

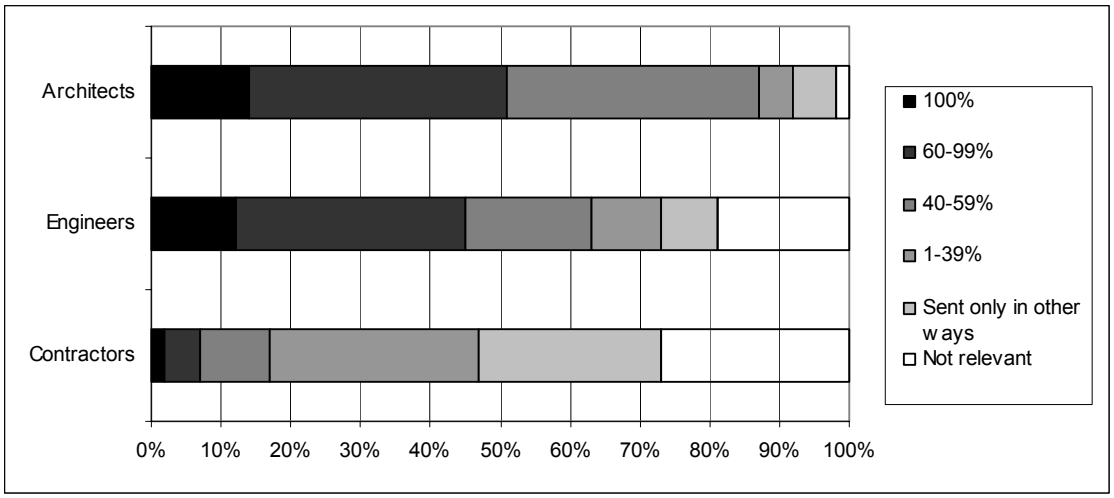


FIG. 17: Proportion of construction drawings that are sent digitally.

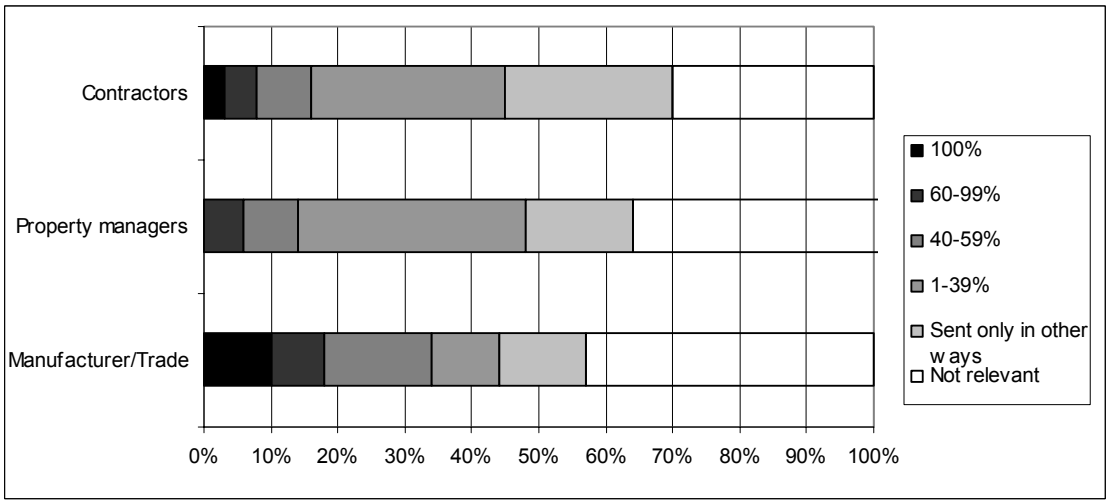


FIG. 18: Proportion of quality results and testing-results for material that are sent digitally.

3.4 Effects and strategies

IT Strategies

In total 40 % of the employees in the industry work at workplaces that have some kind of IT strategy. This is shown in FIG. 19. Most of those who have an IT strategy also have it written down. Only 8 percentage points of the 40 percent have an orally defined strategy. The majority of those who do not have any IT strategy state as a reason that they do not need one. Only architects and property managers state that they should have an IT strategy while the other categories mostly think that they should not.

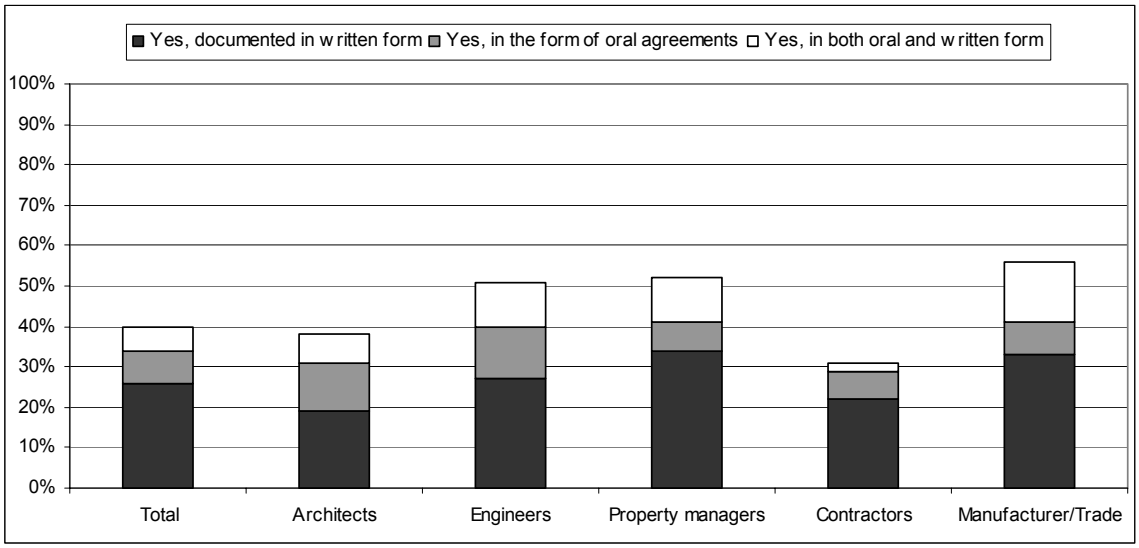


FIG. 19: Proportion of employees in workplaces with different types of documented IT strategies.

Motives and effects

In the questionnaire it was asked whether the investments in IT have increased, decreased or remained the same, in the last two years. The answers have been compared with the same question in 1998 about the two years to follow. FIG. 20 shows that the increase in investment has been less than the estimate of 1998. Those who predicted the future best were the contractors. The question about investment was also asked for the next two years, and the result shows that most companies are going to slow down their increase in investment further.

The explanation of the slowing down of the increase is probably that many companies have made great investments in IT systems in the last few years and that they are now decreasing the investment rate and focus on maintenance and updating their systems. It is however important to note that a big proportion of the companies are still increasing their investments and that many others are keeping them constant. Not many are decreasing their investments; it is the speed of increase that is slowing down.

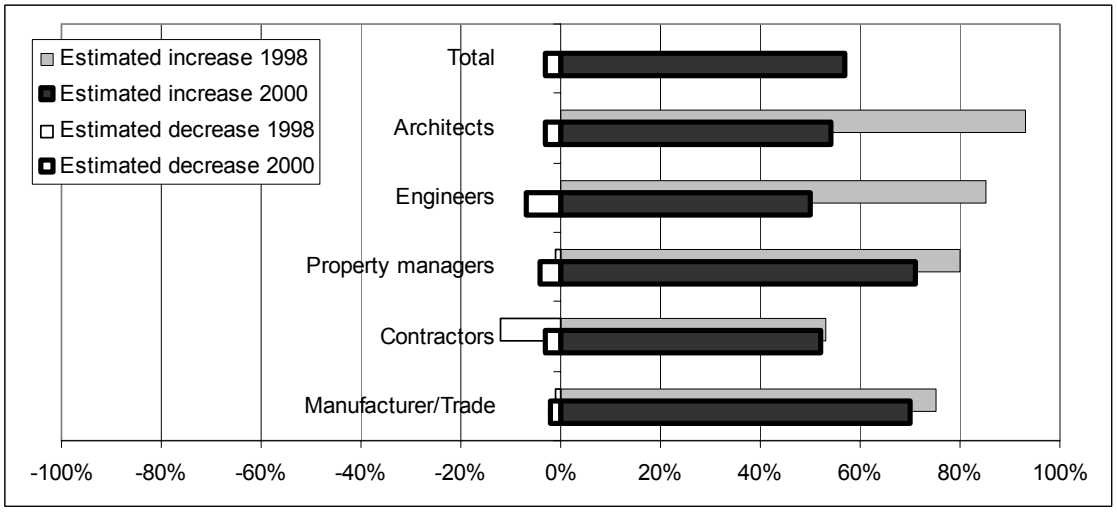


FIG. 20: Estimated changes in IT investments for the years 1999-2000. The estimations are made partly in 1998 and partly in 2000.

The respondents were asked how important different motives for decisions about new IT investments are. The result is shown in FIG. 21. In this type of question the bars in the graphs should be read relatively to each other, instead of in absolute figures, since it is easy to think that everything is important. The three most important motives are:

1.) Desire to make administrative work more efficient
2.) Desire to make technical work more efficient
3.) Necessary means of competition

These are the same three motives that were found most important in 1998, but in a different order. Thus it is still streamlining the more administrative support routines that motivate new investments. Among the less important motives to be found are: "Wish to develop new products/new business models" and "Desire to be in the vanguard of the technical development". It is worth noting that the companies do not use IT to develop and make changes but rather to make existing routines more efficient.

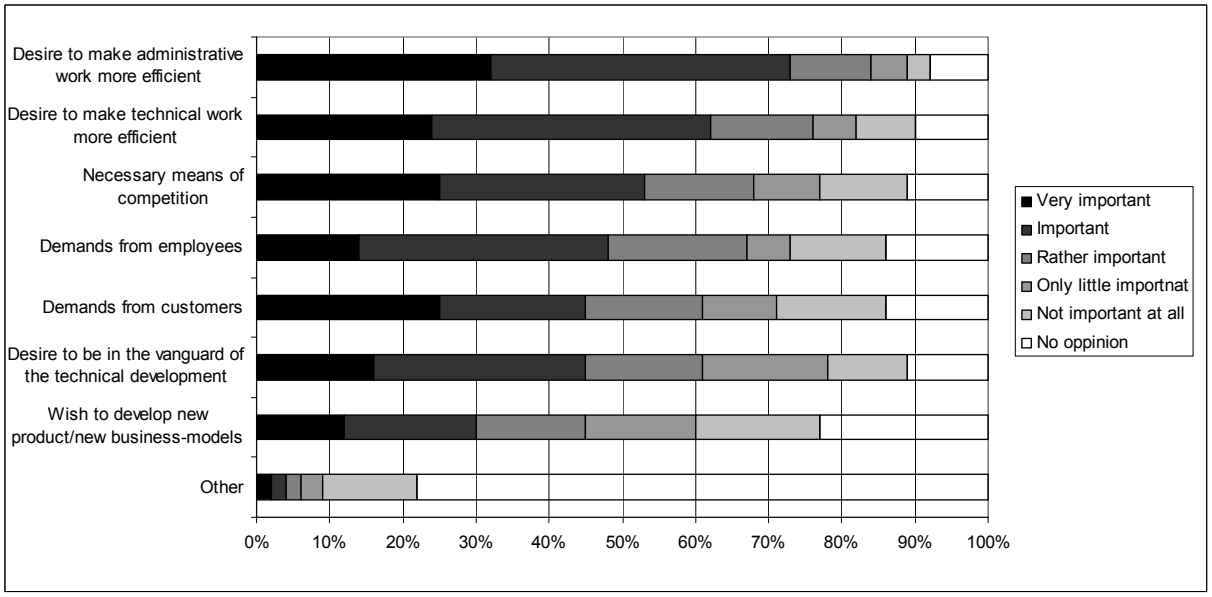


FIG. 21: The importance of different motives for decisions about new IT investments.

The most common changes that have been experienced as a consequence of an increased use of IT are that the quality of documents, the tempo in the processes and the share of new working operations, have all increased (see FIG. 22). A significant share of the respondents also think that the need for administration has grown, which can seem contradictory when the greatest motive for IT investment is to make the administrative work more efficient.

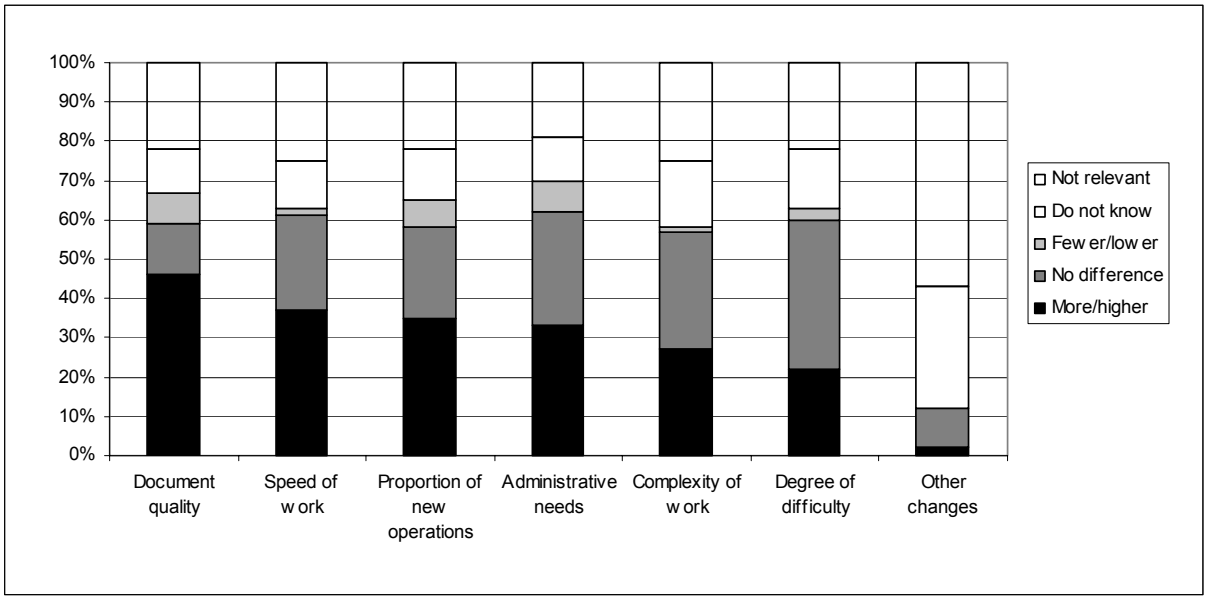


FIG. 22: Proportion that has experienced changes caused by IT in the design-, construction- or real estate processes in the past two years.

The survey shows that IT has the greatest effect on productivity in common administration. Also design, project management, and purchase/selling are areas where a considerable part of the industry found that productivity has increased. This is shown in FIG. 23. If the result is studied on the basis of categories, it is found that most categories experience an increase in productivity in their particular business. Architects and engineers experience an increase in design and project management, property mangers experience an increase in real estate administration, and manufacturer/trade in purchase/selling. The exception is the contractors, who do not experience that productivity has increased to any greater extent in materials administration and site management. Some even think that the productivity in site management has decreased. An explanation for this can be the lack of efficient applications and systems for construction sites.

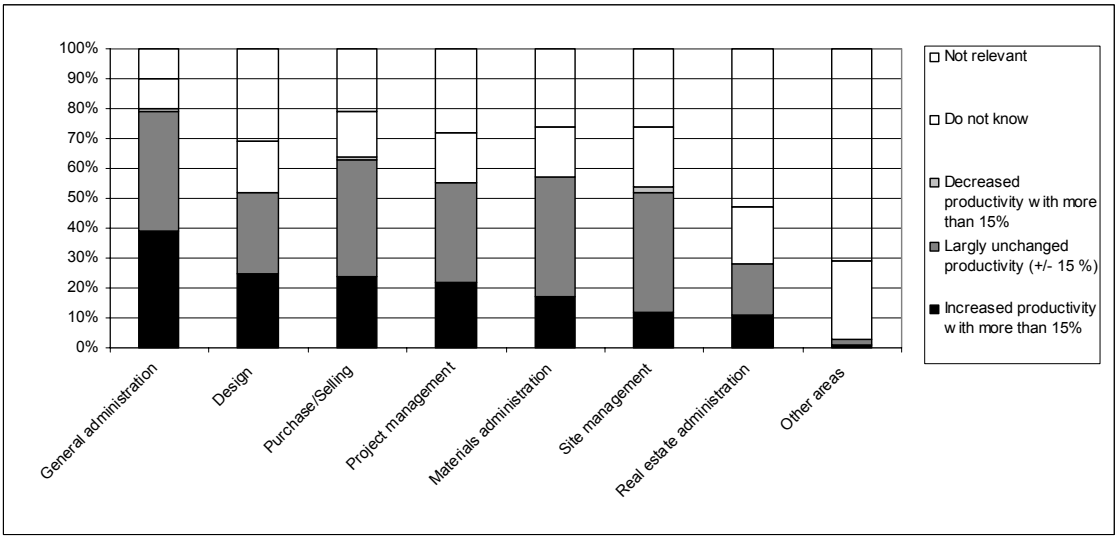


FIG. 23: Proportion that has experienced changes in productivity in different areas caused by IT in the past two years.

Advantages, disadvantages and plans

The respondents were asked to state what advantages and disadvantages/obstacles they have experienced with an increased use of IT. At most, three alternatives in each area had to be chosen. FIG. 24 shows in which order the advantages were prioritised in 1998 and in 2000. The greatest changes have been marked with arrows. The greatest advantages with increased use of IT are stated to be "better financial control" and "simpler/faster access to common information". The first advantage has climbed from fifth to first place in the priority, which must be seen as an acknowledgement that IT creates economical benefits. "Development of new products/new business models" is ranked low which further emphasises that few in the industry are working with IT in the forefront of research or as a potential for new methods of working. This is also shown in FIG. 21.

The three greatest obstacles to increasing the use of IT are stated to be "Continual demand for upgrading hardware and software", " Investment costs too high" and " Greater know-how required from staff". All obstacles are listed in FIG. 25. The three greatest obstacles are the same three that were stated in 1998, with a different order between the first two. Economical obstacles are still the greatest obstacles. Overabundance of information seems to be a greater obstacle now than in 1998 and has risen from seventh to fourth place. The increasing amount of information on intranets, websites and via e-mail has probably contributed to make overabundance of information a greater problem in recent years. Also "reduced security" seems to be a greater obstacle than in 1998.

Areas	2000	1998	Trend
Better financial control	1	5	↗
Simpler/faster access to common information	2	1	
Better communications	3	4	
Possibility of sharing information	4	6	
Easier to handle large amounts of data	5	7	
Work done more quickly	6	3	↘
Better quality work	7	2	↘
Greater flexibility for satisfying customers	8	8	
Possibility of teleworking/telecommuting	9	9	
Makes the company more attractive when recruiting staff	10	10	
Possibility to develop new products/new business models	11	N/A	
Possibility of reducing staff	12	11	
Other advantages	13	N/A	

FIG. 24: Experienced advantages with increased use of IT, in order of priority.

Areas	2000	1998	Trend
Continual demand for upgrading hardware and software	1	2	
Investments costs too high	2	1	
Greater know-how required from staff	3	3	
Overabundance of information	4	7	↗

General attitude that old ways of doing things have worked well throughout the years and changes are unnecessary	5	5	
Not compatible software	6	N/A	
Decision-makers have not time for IT efforts because of heavy work load	7	6	
Reduced security	8	13	↗
Risk that IT leads to inefficiency	9	12	↘
Difficulty in measuring profit/assessing investments	10	4	↘
Preference for manual working because of lack of standards/coordination problems	11	8	
Insufficient interest/commitment from the management	12	9	
Other obstacles	13	N/A	

FIG. 25: Experienced disadvantages/obstacles with increased use of IT, in order of priority.

The respondents were also asked to state in which areas they are planning to increase their use of IT the next two years. The result is listed in FIG. 26, which shows that "document handling" gets the highest priority. After this comes "systems for costing/cost control" and "accounting systems". Common to almost all categories is that document handling gets high priority. Otherwise there are differences between the categories. Architects and engineers prioritise CAD relatively high but not the highest. Property managers, contractors and manufacturer/trade prioritise respectively systems for real estate information, systems for costing/cost control and electronic trade via Internet, i.e. areas in each category's core business. The contractors put the alternative "do not plan to increase the use of IT in any area" in fifth place, which may depend on the fact that there are a lot of small contractors that mostly carry out physical activities in their work, and therefore think they do not need IT tools. A clear tendency that was also noted in 1998 is that the companies choose to concentrate on well-tried techniques, mostly in the companies' support businesses, such as document handling and accounting systems. Few investments are planned among more advanced systems on the research front. Product models, virtual reality and new business models and activities are to be found at the bottom of the list. An explanation may be that these areas are considerably more complex and much harder to implement than those that are at the top of the list.

Areas	**2000**	**1998**	**Trend**
Document handling	1	1	
Systems for costing/cost control	2	5	↗
Accounting systems	3	3	
Portable equipment/mobile systems	4	8	↗
Project management	5	6	
Electronic trade via Internet	6	7	
CAD	7	4	↘
Information search via Internet	8	2	↘
Do not plan to increase the use of IT in any area	9	N/A	
Project common sites for documents and files on the Internet	10	N/A	
Systems for technical calculations	11	9	

Systems for real estate information	12	N/A	
New business models and activities	13	N/A	
Product models	14	11	
Virtual Reality	15	10	
Other	16	N/A	

FIG. 26: Areas for planed IT investments, in order of priority.

4. COMPARISONS BETWEEN SWEDEN, DENMARK AND FINLAND

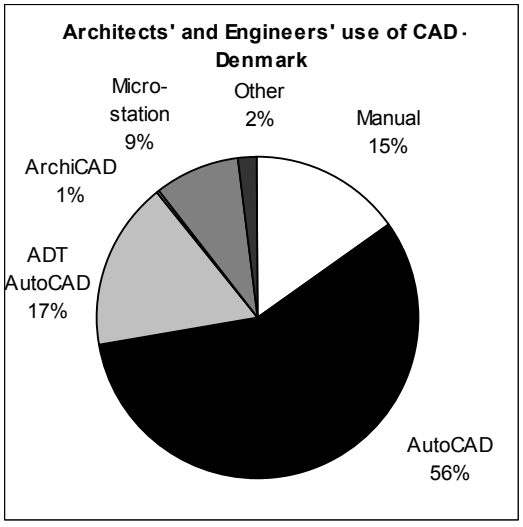
A few selected results from the comparison between the countries are presented in this paper to give an overview of some interesting differences and similarities. There are some differences in the methods between the countries. The most important difference is that the selections in Denmark and Finland are not stratified. There is also a big difference in the answer rate, as shown in FIG. 27. A more detailed comparison of the results and the differences in methods will be made and presented in a later paper as mentioned in the introduction.

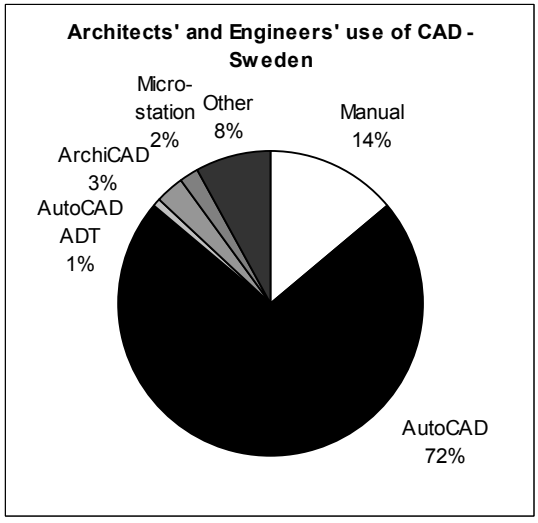
	Sweden	Denmark	Finland
Selection size	1316	1000	~900
Number of answers	641	136	93
Answering rate	**49%**	**14%**	**~10%**

FIG. 27: Answering rate for the three surveys. (The exact figure for selection size in Finland is not known, because the questionnaire was distributed by the professional organisations.)

4.1 Use and access

The use of CAD in the three countries is fairly similar. FIG. 28 shows that manual drawing is used for 14-18 % of the total drawing time. The difference is in the type of software that is used. In all countries AutoCAD dominates, but in Sweden this dominance is more substantial. The model based software ArchiCAD and AutoCAD ADT, have a wider use in both Finland (8 %) and Denmark (18 %).





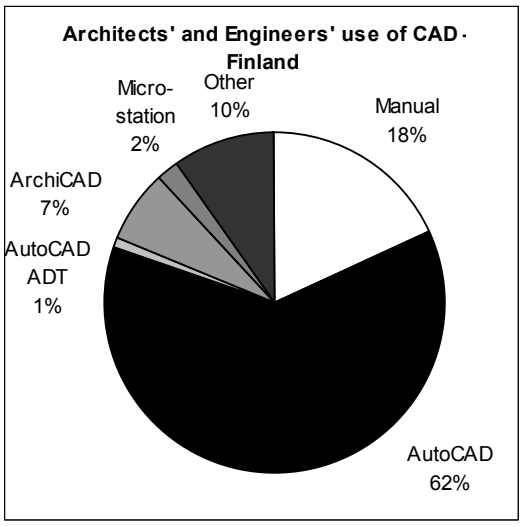


FIG. 28: Proportion of total design time that each technique is used

Access to equipment among employees varies between the countries (see FIG. 29). This is mainly seen in access to PCs. In Sweden, about 50 % of the employees have access to their own computer at the workplace. In Finland and Denmark these figures are respectively 75 % and 85 %. It is worth mentioning that skilled workers are included in the figures and that there are some differences in the methods of analysis used in the different countries. For example there are a lot of answers from engineers in Denmark and few from contractors, which could have an effect on the result. In the Swedish survey this type of error is corrected by the use of weighting factors. Another difference is that it seems to be unusual in Finland to have PCs at home, owned by the company. In Sweden there was a new law a few years ago that allowed companies to supply their employees with computers under beneficial tax conditions. This can be an explanation of the fact that Sweden has a relatively high share of home PCs, even if Denmark has an even higher share. The share of employees with their own mobile phones is fairly similar between the countries, with Sweden slightly ahead of the others.

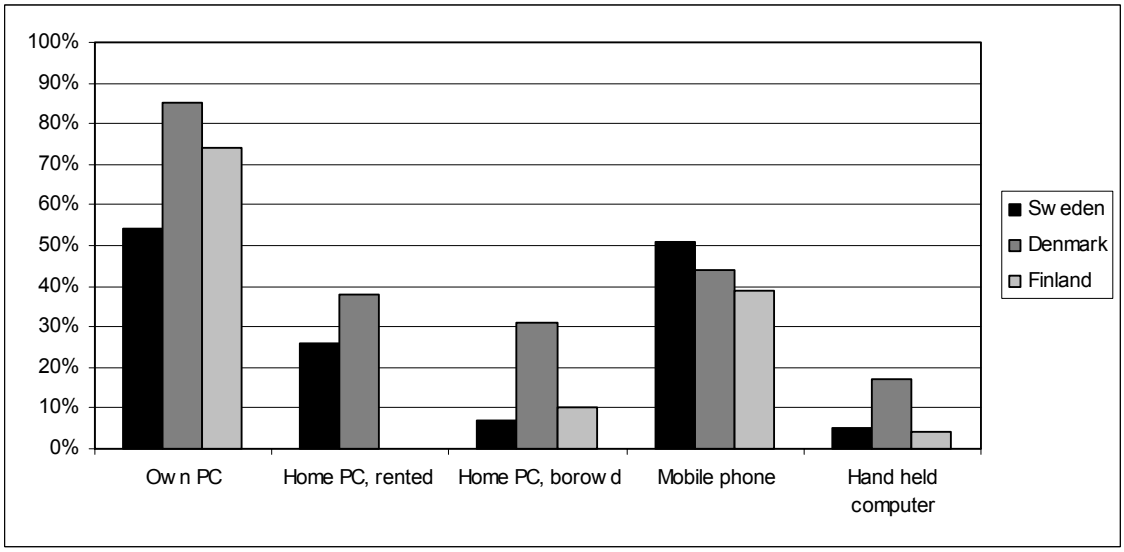


FIG. 29: Proportion of employees with access to equipment.

The use of project webs seems to vary a lot between the countries. Finland is top with more than 70 % of property managers and engineers using them, while there are few in Denmark. Their use in Sweden is somewhere between the other two. However, it has to be noticed that FIG. 30 only shows those who have used a project web on any one project. It does not say anything about how often they are used.

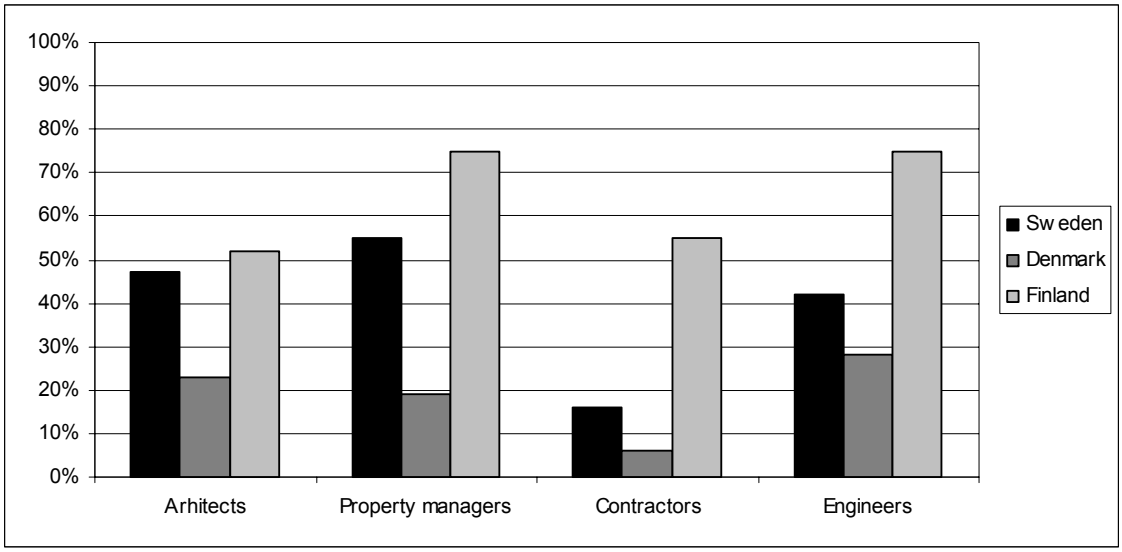


FIG. 30: Proportion of employees at workplaces (Sweden) /proportion of workplaces (Denmark and Finland), where project webs have been used in any project.

4.2 Effects and plans

In advantages experienced with the use of IT, there are as many similarities as differences between the countries. Among the main advantages in all three countries are "Faster access to information", "Better communications" and to some extent "Possibility of sharing information" (see FIG. 31). I.e. factors that in some way relate to access and use of the Internet and intranets. The most significant difference noticed is that "Better financial control" comes in first place in Sweden, while it is placed in seventh and eighth place in Denmark and Finland.

"Work done more quickly" has decreased in priority since the last survey in both Denmark and Sweden, which probably depends on these effects having already occurred and the level now being kept constant. In Finland this advantage is still placed high in second place.

	Sweden			Denmark			Finland		
	2000	1998	Trend	2001	1998	Trend	2001	1998	Trend
Better financial control	1	5	↗	7	5	↘	8	3	↘
Faster access to information	2	1		1	3		1	6	↗
Better communications	3	4		2	6	↗	3	5	
Sharing information	4	6		5	7		4=	8	↗
Handling large volumes of data	5	7		6	4		4=	3	
Work done more quickly	6	3	↘	4	1	↘	2	1	
Better quality of work	7	2	↘	3	2		4=	2	

Satisfying customers	8	8		8	8		7	7	
Working from home	9	9		9	9		9=	9	
Attraction to new staff	10	10		10	10		9=	11	
Developing new business	11	N/A		12	N/A		9=	N/A	
Reduction of staff	12	11		11	11		12	10	

FIG. 31: Experienced advantages with increased use of IT, in order of priority. The first four in each country are marked in a light grey colour. Advantages with same placing have been marked with a "=".

The companies' plans for investments in different areas are listed in order of priority for the surveys 1998 and 2000/2001 in FIG. 32. Common to all three countries is that document handling gets high priority. The big difference is between Sweden and the other two. Denmark and Finland prioritise the same four areas, but in reversed order between number three and four. Sweden on the other hand has three completely different areas at the top, namely "Costing and cost control", "Accounting systems" and "Portable/mobile systems". A reason could be that the large number of contractors in the Swedish survey has had a great influence on the result. Another explanation can be that, there have been lots of investments in CAD and Internet earlier in Sweden and that the companies now make efforts in new areas. It is however remarkable that the area Project webs gets low priority in Sweden. According to FIG. 30 the use of project webs is still relatively low, and obviously there is no plan to increase it in Sweden. In Finland and Denmark, on the other hand, it comes in respectively third and fourth place, which shows that they are planning to increase their use.

	Sweden			**Denmark**			**Finland**		
	2001	**1998**	**Trend**	**2001**	**1998**	**Trend**	**2001**	**1998**	**Trend**
Document handling	1	1		2	4	↗	2	1	
Costing and cost control	2	5	↗	8	5	↘	5=	5	
Accounting systems	3	3		6	2	↘	9	3	↘
Portable/mobile systems	4	8	↗	4			5=	7	
Project management	5	6		7	7		5=	9=	↗
Electronic trading	6	7		10	N/A		10	9=	
CAD	7	4	↘	1	1		1	2	
Internet information searches	8	2	↘	3	3		4	4	
No plan to increase IT use	9	N/A		N/A	N/A		15	N/A	
Project webs	10	N/A		5	N/A		3	3	
Technical calculations	11	9		9	6		8	6	
Property information	12	N/A		11	N/A		13	N/A	
New business models	13	N/A		12	N/A		12	N/A	
Product models	14	11		14	8		11	8	
Virtual reality	15	10		13			14	11	

FIG. 32: Areas for planed IT investments, in order of priority.

5. CONCLUSIONS AND FURTHER WORK

5.1 The use, and the change of use, of IT in Sweden

The results from a number of questions in each of the areas: access, use, communications, effects and plans/strategies have been combined to make a summary of the situation for the different categories. This summary is illustrated in FIG. 33. In the three diagrams to the left, the broken lines show the mean value to the industry, which should be taken as an index 1.0. The bars for each category show its relation to the index.

The results show that the differences between the categories are small concerning access to hard- and software. The differences increase in use, communication and "effects and strategies". Contractors are lower than the others in all areas. This is most significant in the areas of use and effects, which can be explained by the fact that there is a lack of effective applications for their core business. Property owners have increased their use of IT and are at the top in several areas, especially in communications and in plans and strategies. The level for architects and engineers is very much the same, but engineers have a slightly higher use.

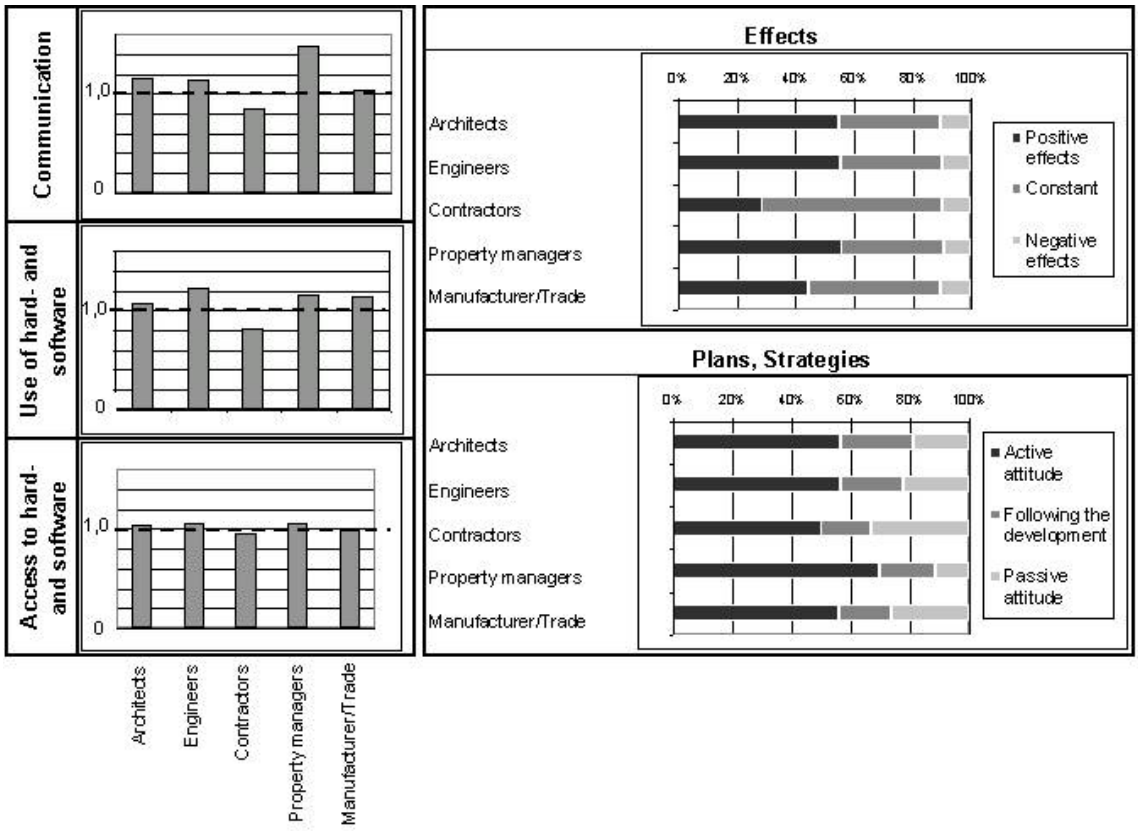


FIG. 33: Summary of the IT Barometer result, divided into categories.

Since 1998, the access to computers, the Internet, mobile phones and other equipment has increased. The use however is still concentrated on word processors, spreadsheets and accounts and administrative software. The use of project webs, electronic trade, product models and VR, is still low. Also among motives for investments, effects experienced and planned investments; the concentration is in administrative support routines. Areas closer to the companies´ core business and new products and business models, that can change and improve the whole process, get low priority. Despite this, rather many have IT-strategies and active attitudes towards the use of IT. This can mean either that it is a deliberate choice to only invest in well-known techniques in the support areas, or that there are differences between the strategies and the reality.

The result from the IT Barometer has answered to a lot of questions regarding: access to hard- and software, how IT is used in companies, which areas seem to be important at the moment and in which areas the companies are planning to increase their use. The answers however, give rise to a number of new questions, which are going to be investigated further. This is planned to be done within this year and is going to be presented as a licentiate dissertation.

5.2 The difference between the three countries

Among the few diagrams in this paper there are as many similarities as differences between the countries. The use of CAD versus manual drawing, the importance of fast and high levels of access to information and the priority of document handling, are areas where the results are quite similar. Among the differences can be mentioned a higher use of model based CAD-programs in Denmark and Finland. CAD also gets higher priority for future investments in these two countries. In Sweden the companies think that IT gives better financial control in a greater extent, and they also prioritise costing, cost control and accounting systems to a greater extent than the other two. The use of project webs also differs between the countries. In Sweden this area does not even get a high priority, which it does in Denmark and Finland.

Common differences seem to be that areas concerning consultants, such as CAD, access to computers and use of project webs, gets higher priority in Denmark and Finland, while areas concerning contractors, such as costing, cost control, financial control and access to mobile phones, get higher priority in Sweden. This can be the result of the different methods of selecting respondents. In the Swedish survey the contractors are represented by as high proportion of the result as their numbers really represents in the industry, while consultants tend to be over represented in Denmark and Finland. This has to be investigated in more detail to ensure that the results are comparable.

The comparison between countries in this paper is only made on the basis of a few questions. A further analysis has to be done which should take the whole result into consideration. This is planned to be done in a specific paper for the W78 CIB conference in Aarhus in the summer 2002. It is also important to compare the methods used in the different surveys, despite the questionnaires being very similar. It is necessary to find out to what extent the selection methods and the way of weighting the answers, have an influence on the results. This is planned to be done in a licentiate dissertation, mentioned in chapter 5.1. It would also be interesting to make comparisons with other countries outside the Nordic area, since it can be assumed that these three countries have rather similar access to, and use of, IT. Some possible surveys for comparison are mentioned in chapter 1.3.

The IT Barometer has now been performed two times in the three Nordic countries Sweden, Denmark and Finland at intervals of 2-3 years. It has turned out to be a usable method to compare the use of IT in the construction industry both between countries and over time. The intention is to continue to perform this type of survey at regular intervals and to develop the questionnaire and the method to make them better each time.

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