

# **SURVEYS OF IT IN THE CONSTRUCTION INDUSTRY AND EXPERIENCE OF THE IT BAROMETER IN SCANDINAVIA**

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EDITOR: B-C. Bjoerk

*Rob Howard, visiting professor,  
Department of Planning, Technical University of Denmark, DK 2800 Lyngby  
email:rh@gk.dtu.dk*

*Arto Kiviniemi, senior research scientist  
Construction & Facility Management, VTT Building Technology, FIN-02044  
email:Arto.Kiviniemi@vtt.fi*

*Olle Samuelson, civil engineer,  
Department of Construction Management, Royal Institute of Technology, S-100 44  
email:olle.samuelson@tyrens.se*

**SUMMARY:** *With many surveys being carried out on the use of IT, it is important to ensure that their results can be compared and that they can be repeated to gain a picture of the growth of IT use and of particular successes. The IT barometer survey summarised in this paper compares results from Denmark, Finland and Sweden on the use of computer hardware, software and communications. It is complementary to other surveys looking at the strategic use of IT within companies.*

*Microsoft products dominate both operating systems and office applications in all these countries but there is greater use Windows NT and UNIX in Finland. CAD is used in almost all design offices in Sweden, with Autocad as the dominant product, but Microstation is now more widely used by architects in Denmark. CAD data structures are becoming more advanced with objects being used by more firms in Finland and Sweden, but structured 2D data dominates in Denmark. Communications networks are used in about 90% of Swedish firms but only in about 60% in Denmark. Danish property managers make greater use of computers.*

*Further analysis is needed of the data from Finland, and comparable surveys are being carried out in other countries. The comparison of these is being coordinated by the CIB W78 group which plans to repeat the surveys, using similar questions, in 2000. This will help to measure the increase in awareness and use of IT resulting from national IT development projects which have started in Finland and Sweden. A network linking national IT centres is planned to exchange experience and coordinate this work, so that there can be greater integration of systems between different types of firm in construction, and within international projects.*

**KEYWORDS:** *survey, international, computers, CAD, communications, construction industry*

## **1. TYPES OF IT SURVEY**

### **1.1 Purpose of international surveys**

Surveys of the use of Information Technology are carried out in many countries in incompatible and misleading ways, and for a variety of purposes. The result is a reluctance by users to complete surveys, and some very poor marketing data often used only to prove some commercial point. The purpose of obtaining good base data is not to see which countries spend the most on IT but to study national differences and particular local successes, and to benchmark the take up of new applications and communications. It can also help establish the potential for integration of IT use across whole industries and internationally. Once a new technology is launched there is an assumption that it will be used immediately but, take up in an industry with many small companies, can be slow. Good, authoritative data on the rate of growth of IT use across whole industries, and allowing international comparison, is therefore an important research topic.

Data on the levels of take up of particular technologies can be collected from its users or their suppliers. The former is preferable and this was the method selected for the IT barometer surveys. Suppliers will know how many licenses they have sold but not whether their systems are in active use. They are often unable to classify their users accurately, and may be tempted to include users of old versions and even allow for pirate copies of software. The experience of carrying out the CICA CAD systems sales survey (CICA 1996) each year from 1981 to 1996, which involved collecting estimates from vendors of their annual sales, was that a single year's data should be treated with caution but that, going back to the same suppliers year after year, exposed any imaginative figures. The most authoritative surveys on spending on different types of CAD system are carried out by interviewing the suppliers regularly and checking their user lists and annual accounts. These are sold at a high price, mainly to other CAD vendors, by firms such as Daratech and Frost & Sullivan.

## **1.2 Experience of different types of survey**

The user survey, if only about one topic, such as IT, has the weakness of being returned by more of those who are using IT than those who are not. Ideally a few questions on IT should be included in more general surveys such as those carried out by institutions with their members. Where more detail is required, and there is a limit to the number of questions that will be answered accurately, a specific survey must be carried out with individuals in a company preferably representing both IT managers and users. Postal questionnaires are the usual method, but telephone or face-to-face interviews can explain questions and interpret answers better. It is tempting to use the Internet but this makes it difficult to get unbiased answers to questions such as 'Do you use the Internet?'

The IT barometer survey was developed at KTH, Stockholm in 1997 and targeted a representative sample of companies in the Swedish construction industry, spread throughout the country. Both personal interviews by students and a mailed survey form were used. (Samuelson 1998) 636 firms responded to make the results significant for the whole industry. The same questions, with a few local variations, were included in the Danish and Finnish surveys, but only 103 of these were returned in Denmark and 62 in Finland, and these results cannot be regarded as representative of the whole country. They should be read in relation to the number of firms of each type that did reply. Over time there are more and more surveys and the rate of response tends to fall off unless there are incentives, such as prize draws, or respondents are chased repeatedly by telephone. One principle that should be followed is to ensure that the results are returned to the respondents. The Building on IT series of surveys of large UK companies (CICA, KPMG 87, 90, 93) used similar methods of distribution to the IT barometer but the response level dropped from 28% in 1987 to 21% in 1993 and 18% in 1993. The colour printed reports of these surveys were offered at half price to respondents while, in the Danish IT barometer, the DTU report (Howard, 1998) and the Swedish report were sent free to each respondent. The next year in which it is planned to repeat the surveys is 2000, which would provide a 'Domesday' benchmark for a technology which only arrived in the last decades of the 20<sup>th</sup> century but will transform life in the 21<sup>st</sup>.

## **2. THE COVERAGE OF THE IT BAROMETER**

### **2.1 Links with international surveys**

The IT barometer survey set out to provide more authoritative data on the use of IT in the construction industries of Denmark, Finland and Sweden, initially, and is being followed up by, or linked to, similar surveys in several other countries. The intention is to repeat this survey at about two year intervals coordinated by a network of linked national IT centres. A similar survey was carried out in New Zealand in 1997 for the BRANZ building research organisation. It looked at the growth in hardware, software and communications since a previous survey in 1992 and was published in this journal (Doherty, 1997). Related surveys are also being carried out in the USA, Iceland and some other countries, and comparisons will be made at a later date. Information will be held on the IT surveys site maintained for CIB W78 by DTU at <http://www.ifp.dtu.dk/~it/itforsk.html>



FIG. 1: Symbolic image for the IT barometer survey. KTH

## 2.2 Quantitative and qualitative surveys

The first comparison between the Swedish and Danish results was presented at the CIB W78 conference at KTH, Stockholm in June 1998 (Howard, Samuelson 1998). It compared a few indicative figures with some previous surveys and figures gathered in other surveys in Finland and the UK. The comparison between Denmark and Sweden was affected by the greater response from contractors in Sweden and from consultants in Denmark, but the analysis by type of company produced some interesting contrasts. Danish building managers have a higher level of use of computers, while CAD is almost universal in Swedish design offices where more advanced data structures are being used. Networking is used in about 90% of Swedish, and about 60% of Danish, firms.

At this same conference a number of surveys based on the more qualitative approach pioneered at Salford University, 'The IT health check', (Construct IT, 1997) were presented. This has been applied in Hong Kong and South Africa and is complimentary to the more quantitative IT barometer. This type of survey is aimed at promoting strategic awareness of IT within a business. It has three stages which involve a company marking itself against a series of questions at four levels, with four degrees of compliance. Then the levels of compliance are listed under the headings of 'Competition and business strategy', 'The role of IT' and 'IT strategy'. Finally the list is reviewed and this leads to recommendations for further action. The report contains forms to help companies apply this process. This procedure is complimentary to the series of benchmarking studies in which groups of construction industry firms have compared their performance, using particular technologies, with each other and with a best practice example from another industry (Construct IT, 1997/8)

## 2.3 Coverage of the IT barometer

The main topics included in the IT barometer survey are classified in the following way:

0. **Type of company** - this includes building owners and managers, architects, engineers, contractors, materials suppliers and craftspeople.  
 Number of staff, location of offices, types of work, position of respondent.  
 In Denmark questions on annual turnover and the % spent on IT were added.
1. **Types and numbers of computers**  
 Proportion of usage of different operating systems, past and future change in IT investment, types of general application such as office suites, planning, technical calculations and administration.
2. **CAD**  
 Types of software and number of licenses, applications for building and use of GIS, proportion of drawings produced with CAD, types of data structures used.
3. **Level of use of IT**

Proportion of tasks carried out by each application, types of document transferred digitally, numbers of staff having computers and training, levels of computer competence by different types of staff.

**4. Communications**

Use of local area and wide area networks, proportion of employees with access to communications, time spent on IT, WWW home pages and Intranets

**5. Role of IT in the company**

IT department, managers, handbook and strategy, attitudes of staff to IT, reasons for investment, changes resulting from IT use, productivity, future investment

**6. Questions adapted to suit each country, for example:**

Awareness and use of research and standards, views on IT knowledge of newly qualified staff, ideas for areas in which research is needed.

The questionnaire occupied about ten sides of A4 paper and was probably longer than it should have been. Each respondent was given the opportunity to reply anonymously but most gave their addresses to obtain copies of the results. A complete copy is available at <http://www.ifp.dtu.dk/~it/itforsk.html>

**3. SELECTED RESULTS FROM DENMARK, FINLAND AND SWEDEN**

**3.1 types of company surveyed**

The survey was carried out at the beginning of 1998 in Denmark and Sweden, and in the summer in Finland. Responses varied both in number and in the types of company replying although samples for all sizes of company and regions of each country, were obtained from representative bodies for all the groups targeted. The types of company responding are shown as percentages of the total number of respondents in FIG 2. In Denmark most responses came from architects and engineers. In Sweden contractors and others dominated but the sample was selected to provide a balance of all types of firm in construction so the results, which were modified by two factors, are valid for the whole industry (Samuelson 98). Contractors and engineers also provided much of the response in Finland. Included in the 'Other' category were groups whose response was generally too low to separate out, such as product manufacturers and suppliers, craftspeople and public authorities.

**3.2 Operating systems and applications**

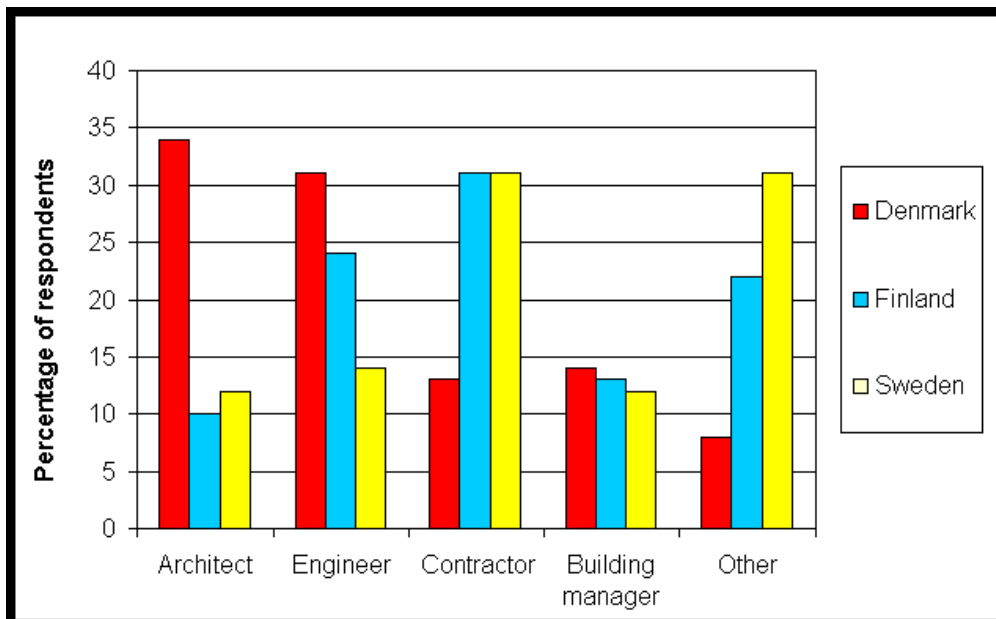


FIG. 2: Proportion of responses from the main groups surveyed in each country.

Included among the topics in the survey was general background information on the type of work carried out by the companies responding and their computing environment. This included the number and type of computers used and ratios of numbers to staff numbers. Much of this was analysed by the different groups taking part in the survey and comparisons between Denmark and Sweden were presented in the paper delivered at CIB W78 (Howard, Samuelson 1998). Intel PCs dominate the markets of all three countries and the proportion of use of different operating systems is indicative of this. For example, in Denmark Windows 95 has 57% of computer users in construction while it is 42% in Finland. However Windows NT has 25% of users in Finland but only 13% in Denmark. UNIX has 4% of this market in Finland but only 1% in Denmark, and Macintosh has 6% in Denmark but only 0,5% in Finland, probably reflecting the larger number of architects responding in Denmark.

Office applications software is dominated by Microsoft in all three countries. MSOffice has 68% of this market in Denmark, 77% in Finland and 90% in Sweden. This dominance is not reflected in Electronic Mail software where Microsoft has only 35% of the market in Sweden and the largest group was 'other' with over 40%. This variety shows the ability of these diverse systems to communicate. There were also local sources for other software with Planman <http://www.planman.fi> having a major share of Project Planning users in Finland, Concorde <http://www.columbus.dk> dominating the Danish market for administrative systems, and Point being the main building application used on top of CAD in Denmark and Sweden <http://www.cadpoint.se>. CAD was analysed in greater detail in the survey than other applications. It is interesting to compare the number of companies having particular types with the size of their installations. The proportion of all respondents with CAD is very dependent on the types of company responding in each country. Almost 100% of architects and engineers have some CAD in Sweden, while the corresponding figure for Denmark is about 80%. From the whole of the Finnish sample which includes many contractors, only 42% reported having CAD.

### 3.3 Computer aided design

Autocad, and its low cost alternative Autocad LT, prevail in all three markets, particularly in terms of the number of companies which use them, many of them small. When the number of licenses, as a proportion of the total number of licenses issued, is presented, FIG 3, the use of Microstation in Denmark becomes significant since a number of large architects and engineers have large networks. The 'other' category has a minor share of the market but contains a variety of systems with different ones occupying the 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> places in each country: *Denmark* 4 DOGS, 5 Arris, 6 AES, *Finland* - 4 Kymdata, 5 Archicad, 6 JCAD, *Sweden* - 4 Archicad, 5 Steelcad, 6 Medusa.

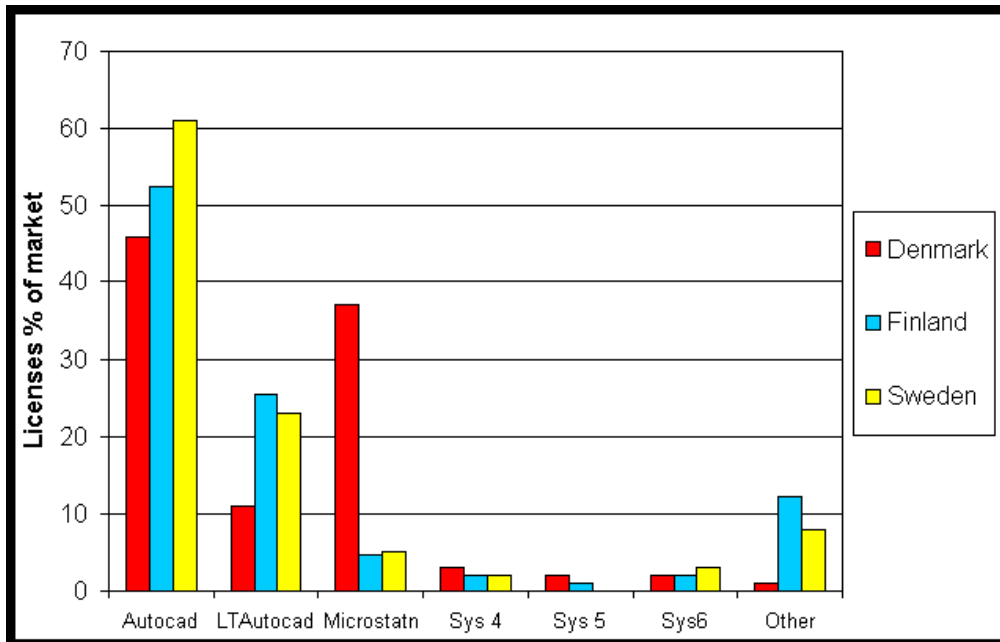


FIG. 3: CAD licenses by supplier as a proportion of all licenses reported by CAD users.

### 3.4 CAD data structures

The form in which data is held in CAD systems is important for the development of more useful models for interoperability and there is a gradual evolution from unstructured 2D data, via adding structure by layers or reference files, to 3D models using objects (FIG 4). It is difficult to know whether the responses represent the proportion of projects in which these different data structures are used or whether they represent the numbers of firms which have ever applied each type of data structure in any project. In Denmark it seems that half the CAD users have 2D structured data with a further quarter using reference files or databases. In Sweden there is still much unstructured data but also a quarter of users with 2- 3D objects. In Finland users are roughly equally split between the five types of data structure with the greatest proportion among the three countries (13%) claiming to use object-oriented models.

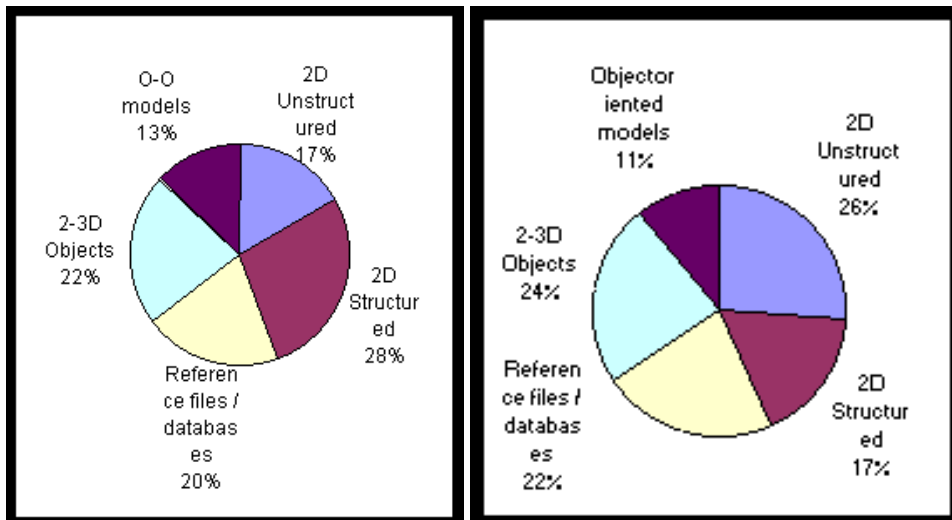


FIG. 4: CAD Data structures in Finland and Sweden

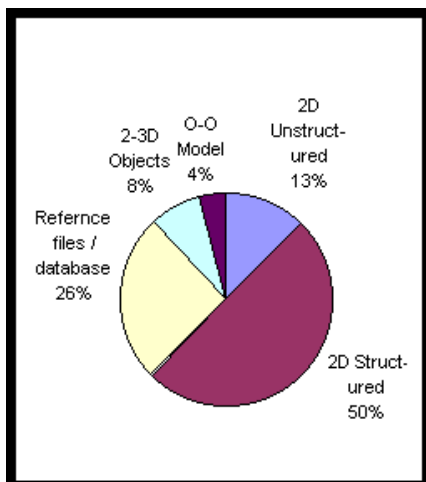


FIG. 4F: Denmark

### 3.5 Exchange of digital documents

The use of similar operating systems by different types of company allows interchange of documents and it is interesting to look at the types of building document which are regularly exchanged in digital form. Experience from the three countries studied is very similar as shown in FIG 5. Minutes of meetings are frequently sent between word processing systems over the Internet and specifications also involve the same type of

alphanumeric data. It is encouraging to see that almost as much digital data transfer takes place with graphical documents such as the main design drawings and the building production drawings.

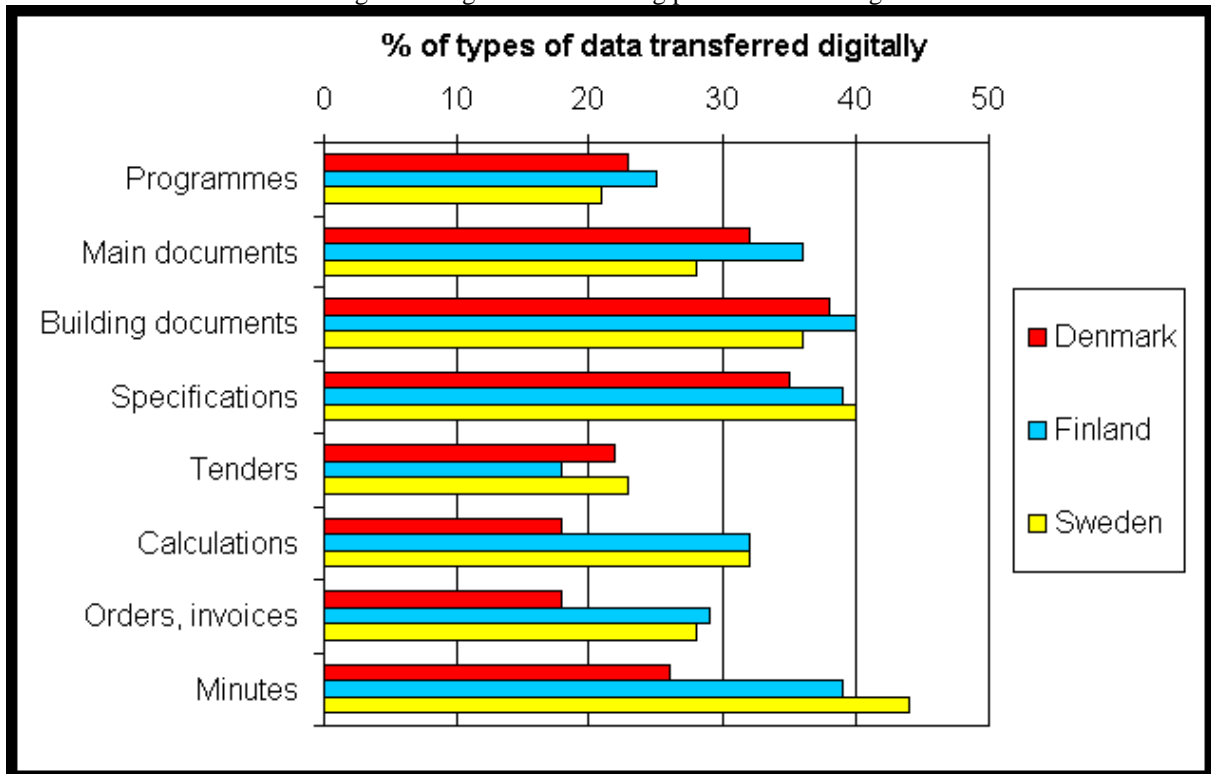


FIG. 5: Percentage of types of document exchanged digitally in the three countries

### 3.6 Communications

The ability to exchange data between all those involved in a building project depends upon the communications facilities which each company has. This is the area in which the fastest growth has occurred, particularly in Scandinavia. Figure 5 shows the percentage of all firms which are connected to external networks, the Internet in particular, and which have a home page on the World Wide Web. Sweden has the highest level of connection with almost 90% of firms linked to external networks and over 60% having their own Web pages. There may be some misunderstanding of the questions asked since almost all external networks are Internet based today and the Danish figures reflect this with 60% for each. In Finland there was a rather low response to these questions and previous surveys have shown higher usage of communications.



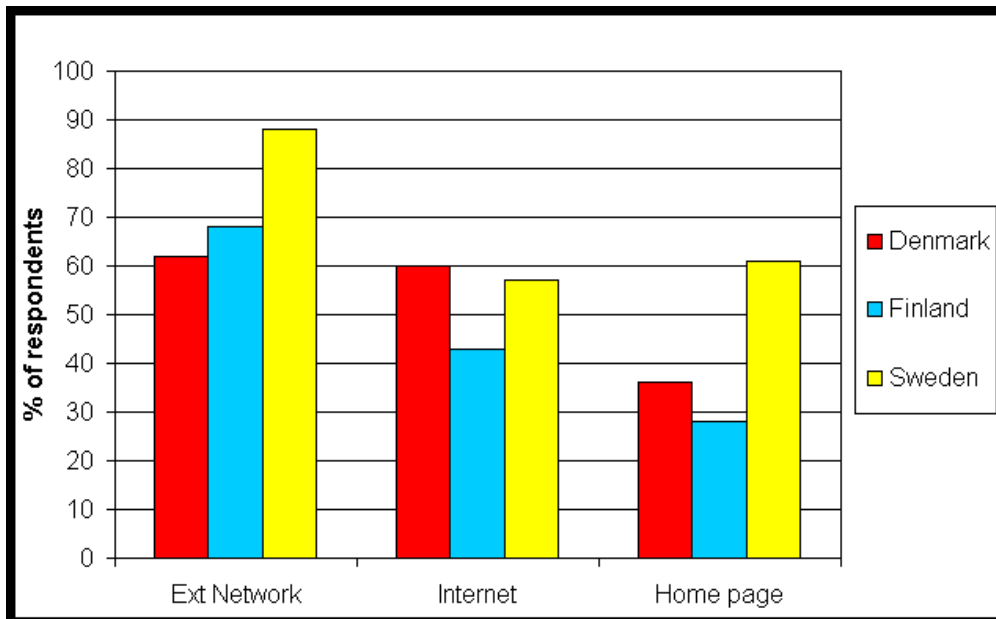


FIG. 6: Percentages of all firms responding with communications facilities

### 3.7 Increased productivity

The particular value of user surveys is to find out where benefits have been achieved. The IT barometer asked whether six common applications had produced a reduction or an increase in productivity or whether it had remained the same. Most applications showed little change but FIG 7 shows the percentage in each country that believed their productivity had increased as a result of each application. There are very similar responses from each country with design and administration showing high levels of benefit while management applications have resulted in little change. Sweden indicated over 60% of firms making some savings in administration. Although a high proportion of their responses came from contractors, they reported little change in productivity resulting from materials or site management.

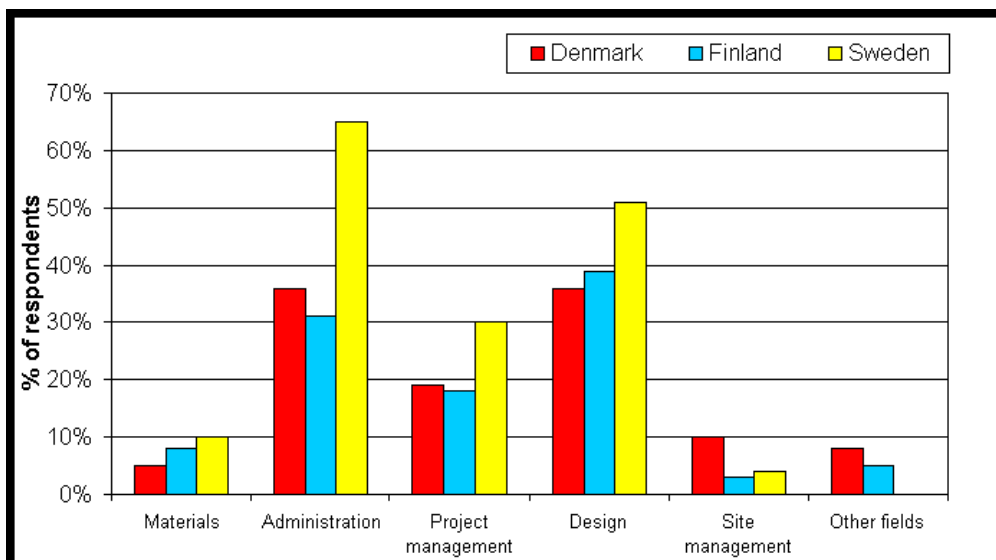


FIG. 7: Respondents reporting increased productivity from selected applications

### 3.8 Future investment in IT

Although this was not a marketing survey, it was important to know where firms in the construction industry are planning to invest in IT systems. A number of common types of system were given and FIG 8 shows the

percentage of firms which thought they would make some investment in the following two years. CAD, document handling, accounting and Internet/Web were the most popular types of system, while more recent technology such as product models and Virtual Reality had low priority. Generally the levels of expectation in Sweden were higher than those in the smaller countries of Denmark and Finland. Another questions analysed in these two countries was the change in levels of IT spending. In Denmark 68% of firms had increased their spending in the previous two years while only 47% planned to increase it in the following two years. The corresponding figures for Finland were 68% and 52%, and for Sweden, 94% and 77%.

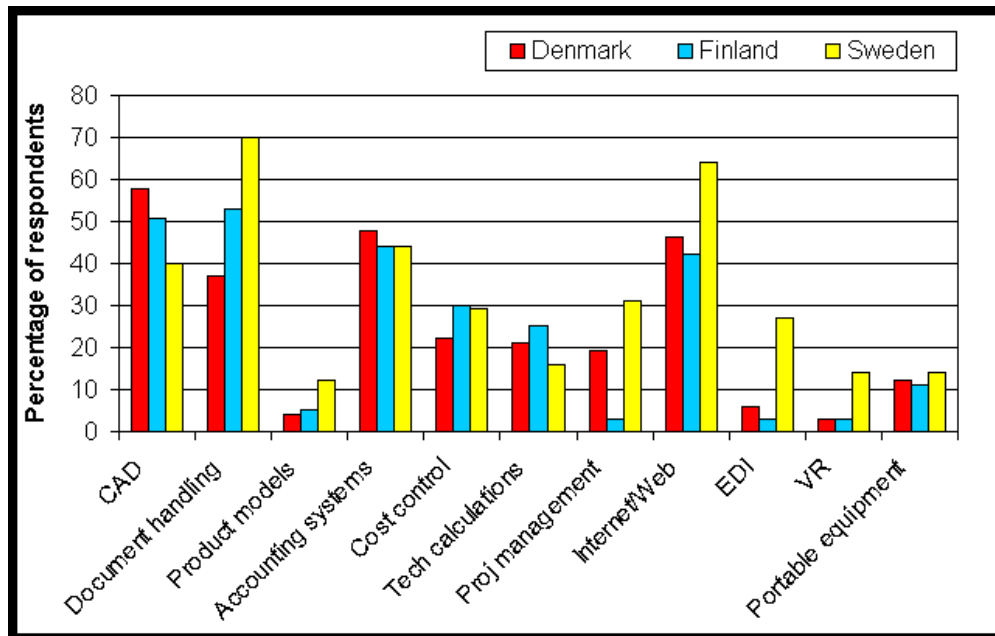


FIG. 8: Plans for investment in selected technologies in the near future.

## 4. CONCLUSIONS AND FURTHER WORK

### 4.1 Additional information available

These results are only a few of those that can be obtained from the IT barometer. They cover all the main groups involved in the construction process, although some responded at a low level. Analysis has already been carried out for each group which responded adequately (Howard, Samuelson, 1998), but is not yet available for Finland. The Swedish results are sufficient to allow projection onto their whole construction industry. From the data listed in Chapter 2 it is possible to see which other analyses could be carried out and how particular applications could be explored in greater detail.

Additional questions particular to each country were added in each national survey and these throw light on the awareness and use of research and standards. For example, in Denmark, the IBB CAD layer guidelines <http://www.ibb.dk> are used by 30% of respondents and the SfB classification system by 20%. However there is a lack of awareness of more recent systems such as the EDIFACT trading messages, Industry Foundation Classes and STEP model standards. A similar majority of respondents in Finland had not heard of the International Alliance for Interoperability, and even the well-funded VERA project. This is not surprising given the range of sizes and types of company covered, but it shows the need to promote new technologies through projects like VERA, IT Bygg in Sweden, and a network of linked IT centres.

### 4.2 Testing awareness of technologies

In Denmark levels of spending on IT per member of staff were explored and these show an interesting variety with a quarter of architects spending over 50,000 DKKroner (\$ 8,000) per person. 40% of engineers spend 20 - 50,000 DKK (\$ 3 - 8,000), but about 40% of contractors spend less than 1,000 DKK (\$ 150) on each of their staff, a figure that includes site labour.

Another area of interest to the research institutes carrying out the surveys is where companies believe there is a need for further research. In Denmark half the responses received were for more work on standards, particularly for exchanging documents electronically. This contrasts with the lack of knowledge of some of the existing techniques and standards for doing so, and also with plans for spending on IT. Surveys can raise awareness of new technologies and the particular value of repeating the same questions is to see how fast these are being taken up. However, the same questions must be asked of a similar sample since it is difficult to make comparisons with dissimilar data. For example, although a comparison between a 1995 survey in Denmark (Sorensen, 1995) and the IT Barometer in 1998, shows Internet use growing from 10% to 61% and use of Email from 5% to 37%, the smaller surveys carried out in Finland in 1997 and 1998 appear to show Internet access falling from 71% to 43%. This emphasises the need for repeated surveys with sufficient incentive to obtain adequate response levels.

### **4.3 Coordination and future work**

The W78 group Information Technology for Construction, of the CIB, the International Research Council for Building Studies and Documentation, <http://www.bcn.ufl.edu/cib> has started to act as a focus for similar and repeated surveys, either of the quantitative type based on the IT barometer, or of the qualitative approach from the IT Health Check (Construct IT, 1997). This group, with its annual conferences, can provide the continuity to help researchers in the many countries it represents to resist the temptation to redesign a survey each time it is carried out. The Internet can be used to provide access to the questions, and all variations should be confined to background data, where national regions and types of company can be reflected, and to answer specific local questions on national initiatives and standards.

Major IT development projects are under way in Finland and Sweden and it is proposed to measure their progress at the half-way stage by surveying the construction industries in about 2000. Denmark needs to carry out more promotion of its IT initiatives and could usefully measure awareness of these again in 2000. The UK, Canada, USA, Australia, Hong Kong, Norway, Iceland and several other countries, have started to carry out similar types of survey and the prospect of these being repeated at the same time could provide a 'Domesday book' of the level of IT use in construction worldwide. This technology is still in its infancy and a benchmark is needed for countries to be able to explore their differences, for suppliers of IT systems to meet specified needs, and for the many small local companies in construction to become more aware of the possibilities, particularly for networking with other companies anywhere in the world.

### **4.4 Acknowledgements**

Rob Howard was assisted at the Technical University of Denmark by Kim Jacobsen and Annelise Harkjaer. Arto Kiviniemi was assisted at VTT by Merja Hakkarainen. Olle Samuelson presented his work for a master degree at KTH supervised by Bo-Christer Bjork, and is now working for Tyrens Byggkonsult. All are grateful for the help with addresses from professional and trade associations and to all the firms who took part in the surveys.

The questionnaire is published on the DTU web site: <http://www.ifp.dtu.dk/~it/itforsk.html> and anyone is welcome to use this, preferably making as few changes as possible and contributing the results to the CIB W78 group which Rob Howard is leading. A summary of all national IT surveys in construction reported to this site is expected to be presented at the CIB W78 conference to be held in Vancouver, Canada May on 30 - June 3, 1999. For details see the 8<sup>th</sup> International Conference on Durability of Building Materials and Components. <http://www.nrc.ca/confserv/8dbmc/welcome.html>

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