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Topic (ii): Economic issues associated with the implementation of modern IT and management of human resources as driving forces to improve timeliness and quality of statistical data

MANAGERIAL ISSUES OF INFORMATION TECHNOLOGY IN STATISTICS NORWAY

Submitted by Statistics Norway[1]

I. INTRODUCTION

1. A national statistical institution is a large data warehouse containing primary data such as data on persons, enterprises and administrative units, and compiled data and information in the form of statistics covering most sectors of society. Statistics are based on both data collected directly by the statistical institution and to an increasing extent on data from administrative registers. Use of information technology is crucial both for data collection, compilation, storage, analysis, presentation and dissemination of statistics, and technology is today the backbone of our activities.

2. Different tasks require different types of technology; technology that changes rapidly and provides new possibilities and challenges. It requires experience that has to be renewed all the time and represents a major item in

[1] Prepared by Hans Viggo Sæbø. The document was considered at the 45th Plenary Session of the CES, Geneva, 10-12 June 1997 (CES/1997/5)

the budgets. New technology does not always function as expected, and there are many examples of developments which have not been a success. Management and organization of information technology have therefore been put on the agenda in most statistical institutions.

3. This paper describes the development, role and challenges of information technology in Statistics Norway, with emphasis on managerial aspects.

II. INFORMATION TECHNOLOGY IN STATISTICS NORWAY

4. Statistics Norway (SN) produces and disseminates official statistics. The institution also co-ordinates such statistics produced by others and carries out analyses and research based on statistical data. SN has about 800 employees, of which 500 are located in Oslo and 300 in Kongsvinger. The total annual budget is about NOK 350 million, of which 75 million or just over 20 percent comes from market based projects and sales.

5. About 10 percent of the staff work mainly with computing, though most of the employees use computers in their work. The annual expenses for computing activities are about NOK 55 million or 16 percent of the total budget. These expenses have been relatively constant over the last years, but they are lower now than 5-6 years ago.

Annex 1 shows the present organisation chart.

A. Historical snapshots

6. Statistics Norway's first *electronic* data processing machine came into use in 1958. However, punched cards were already used in 1891. In 1966 the first IBM mainframe computer was obtained, and several mainframe computers have been used up to now. The latest mainframe computer which is still our main computer for the production of statistics was installed in 1991 (Comparex).

7. Even if some local terminals were installed in Statistics Norway from 1978, the time period up to the end of the 1980ies was characterised by centralisation of information technology linked to one computer and a staff of computing specialists. With the arrival of the first personal computers and the installation our first UNIX-server and a local network in 1989 the situation has changed dramatically: The era of decentralisation and electronic data processing for and by the users had started.

8. Events or technological achievements that could be mentioned from later years are:

- 1991: Simple forms from the 1990 Population and housing census were read optically
- 1993: Forms from the Industrial Survey 1992 were read optically and interpreted automatically.

Statistics Norway was linked to external electronic mail via Internet
- 1995: Web-service via Internet and computer assisted interviewing (CAI) started.

B. IT strategy

9. A new overall strategy for Statistics Norway was implemented from 1991, promoting decentralisation in general and also with regard to information technology. Production of statistics is organised in 3 large departments which also include separate offices for electronic data processing. Only the Division for Computer Services and the Division for Computer Systems and Development were kept located centrally in the organisation. The latter division has since 1994 been organised together with the Division for Statistical Methods and Standards and the Division for Information and Publishing in the Department of Coordination and Development.

10. The strategy for information technology from 1991 requires a change from *internally* to more *externally* directed use of IT, with a stronger focus on data transfer and communication. It implies a gradual migration from use of mainframe computer to UNIX-servers with PCs in network. This technological change started as a planned process in 1992, and the objective is to finish it by the end of 1998.

11. Up to the 1991 major organisational change, computing functions including both services and development were centralised to one large division headed by a EDP-manager. Today, with several offices and divisions working mainly with IT, co-ordination is taken care of by a group made up by the leaders of all these units and headed by the head of the Division for Computer Systems and Development who reports to the top management through the head of Department of Coordination and Development.

12. Current strategy for information technology supports our general strategy by stating that information technology in Statistics Norway shall contribute to improved efficiency and development of new possibilities within:
- Data collection (both based on registers and forms)
- Revision of data and production of statistics
- Analyses
- Availability and dissemination of statistics and analytical results
- Office administration and support.

13. Statistics Norway has a strategy of increasing the use of administrative registers as a basis for statistics. One object of this is to reduce the use of surveys, and thus reducing the response burden on persons and enterprises. Use of registers requires computer systems of large capacity in general, and possibilities for mass storage in particular. Data which has to be collected directly from respondents should be collected and transferred effectively with a minimum of work for the data suppliers. Electronic Data Interchange (EDI) and optical reading of forms are relevant techniques in this context. Processing of data within SN (revision, aggregation, analyses and

presentation) and eventually dissemination also puts different requirements on computer systems and software.

14. The IT strategy outlined from the requirements above has been summarised as follows:

- Migration from mainframe computer to servers (with UNIX or later Windows NT operative system) with PCs in network
- Selection of standard software
- Development of reference databases for official statistics and metadata
- Data collection and dissemination via net.

15. One should realise that the variety and different nature of the tasks of a statistical institution require different technical solutions, and achievements and success of technological change vary for the different tasks. The difficulties and success of the described technological change have also varied over the years and in the organisation. The Department of Research established all necessary analytical tools and all its work on the new UNIX platform at an early stage, whereas the routines for production of statistics for most of the larger and heavy statistics are still on the mainframe computer. There are a few examples of electronic data collection (such as the computer aided interviewing), but it is in particular within dissemination of statistics and office administration that technological change most easily has led to results. Development has been slow with regard to the migration of large statistics production systems from the mainframe computer to new technological platforms, where we have met considerable obstacles in treatment of large amounts of data resulting from linking administrative registers. The different areas of change are considered in more detail in next paragraph.

16. As mentioned, we have been aiming at finishing the change from use of mainframe computer by the end of 1998 (less than 10 percent of computing power left on mainframe computer). The time schedule is just being reconsidered. Solving the mass storage problem (see paragraph 3.2) is crucial. At the same time we are planning to change server and PC operative systems from UNIX/DOS/Windows 3.X to Windows NT/Windows 95.

III. Managing technological change in Statistics Norway

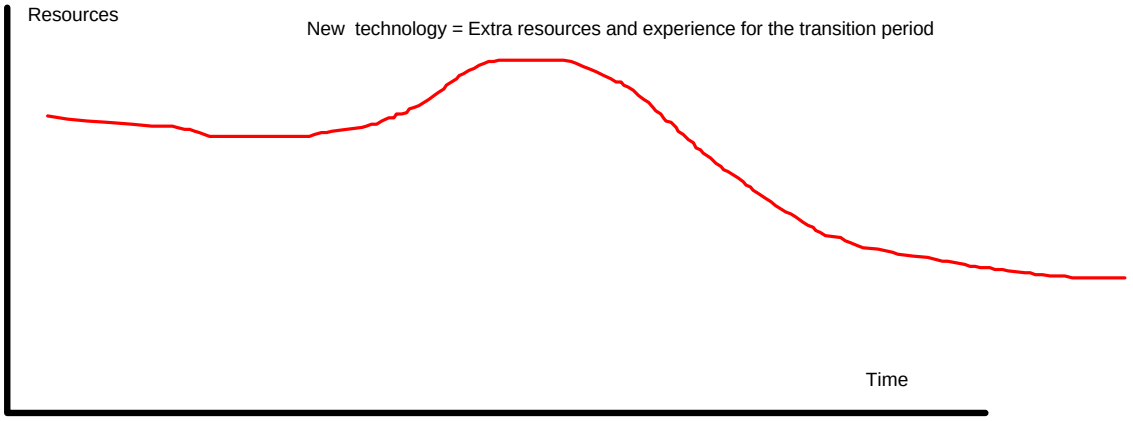
A. Why is management of technological change so difficult?

17. Management of information technology in a statistical institution is a difficult and large challenge because:

- Technology is new, and develops rapidly
- Technological experts tend to put ambitions too high
- New technology implies and is dependent on new organisation of work processes
- Organisation of technology is difficult, and poorly defined responsibilities and links to top management may be a problem
- Problems are often met with more resources; it is hard to admit that lack of IT experience may be the issue.

18. Development in and with the help of information technology normally requires extra input from experienced personnel. However, the tasks of a national statistical institution require continuos production. This makes it necessary to have increased resources for the development period, and costs will be higher in the short run even if the goal is increased efficiency in the long run. This is illustrated in figure 1, and contributes to explain why development and change of technology is a difficult and time consuming process. Some times the introduction of new technology implies increased production and quality, and in this case the curve in the figure may not fall after the transition period at all.

Figure 1. Resources for increased efficiency



B. Technological changes in Statistics Norway

19. The following examples illustrate different issues of technological change in Statistics Norway over the last years, as a basis for the consideration of managerial aspects in paragraph 3.3. Other examples could be mentioned, but the selected examples cover typical and different areas of work of a statistical institution, and different experiences with regards to successes or failures.

Register statistics and data processing

20. Today, about one third of Norwegian statistics (censuses not included) is based on administrative registers alone, one third is based on questionnaires and one third on a mixture of registers and questionnaires. We use about 120 administrative data systems for production of statistics annually. In Norway, there are three basic registers where important statistical units such as persons, enterprises and buildings are identified and updated:

- The Central Population Register
- Register of legal units
- Register for Ground properties, Addresses and Buildings (GAB system).

21. Most of the administrative data systems which are important for the

production of statistics can be linked to these basic registers by identification numbers assigned here. For example, this is the case for registers on income, taxes, VAT, education and employers/employees. Some of these registers will be the basis for the 2000 Population and Housing Census.

22. The use of registers provides new challenges in quality control and treatment of consistency and definitions, and requires as mentioned computer systems with sufficient capacity and possibilities for mass storage. As a result of the strategy of phasing out the mainframe computer, we have tried to establish new register based projects on the new technological platform of UNIX-servers. This has turned out to be a difficult process. A mass storage system was purchased in 1993 as an automatic data archive and to take care of backup and migration of data between daily use and long term storage. With the exception of backup, the system has not worked, in particular not with large amounts of data and with several users at the same time. Last summer we decided to terminate the contract with the supplier. The system was characterised as advanced, and a lesson to be learned is to avoid such systems if they have not been extensively tried by others.

23. The management of the introduction of the system has probably not been good either; we have too long been hoping for it to function, and strict dates of follow-up and decisions have not been set until last year. Responsibilities have not been clear, neither between SN and the supplier, nor internally in SN between the Division for Computer Services and the Division for Computer Systems and Development. Another effect of the failure of the mass storage solution is probably a general setback for the whole process of technological change, also in areas where such storage is not necessary. Bad experiences in one field creates suspicion and reluctance in the organisation to technological changes in general.

24. In addition to problems with mass storage, other capacity problems have also occured since we have not been able to expand our stock of UNIX servers in a co-ordinated way. At the moment, we have relatively few large servers compared to the number of small servers. Because of this and the mass storage problems, our core activities of data processing so far have not benefitted as expected from the transition to a new technological platform. We are now planning a co-ordinated approach for developing the necessary infrastructure comprising both hardware and software such as a data documentation system for the new technological platform.

25. For areas where migration to the UNIX platform have been completed, experiences are good if the mass storage problems and other capacity problems are not taken into account. Increased possibilities and flexibility with new and poweful software tools are mentioned in addition to more easy access to data. However, some people have difficulities in constructing statistical tables, since there are no dedicated tabulating programs on the new platform like on the mainframe computer. Tabulating has to be carried out by help of the different general and standard programs such as SAS and Excel. Thus, this is very much a question of teaching and experience, but all tables of course

have to be specified and programmed; a process that lasted for years also on the mainframe computer.

26. Most registers and other primary data systems used in SN consist of sequential files. However, the use of databases is assumed to increase rapidly in connection with the migration of the production systems from the mainframe computer to UNIX (or Windows NT) servers. In SN databases are used in the first steps of the production process and as a basis for dissemination. In the first case the bases contain microdata, whereas a reference or dissemination database primarily contains aggregated data.

27. A typical production line for statistics comprises:
- Registering and revision of microdata in an Oracle database, with user interface developed in SN using a development tool
- Inspection of data in the Oracle database
- Aggregation and links of several data sets carried out in SAS.

28. SN is taking major steps into the age of databases just now, by purchasing a development tool (Oracle Developer), establishing a training programme and starting planned and co-ordinated projects in this field.

29. Processing and analyses of time series data (such as indices) are carried out on the UNIX platform using a data system named FAME (Forecasting, Analysis and Modelling Environment), which has been specially designed for processing such data. It includes functionality for seasonal adjustments. In general, work on analyses and modelling in SN has taken advantage of the new technological platform.

Electronic Data Interchange

30. There are a few examples of the use of Electronic Data Interchange for data collection in Statistics Norway today. Most significant is the use of Computer Assisted Interviewing (CAI) which was introduced during 1995. SN has a Division for Sample Surveys with a staff of about 150 interviewers located all over Norway. In connection with the establishment of a new sampling design all interviewers were equipped with portable computers during 1995, and all interviews (by visits or telephone) are now carried out by registering answers directly into electronic forms stored in computers. Data are transferred to SN at night by use of modem and the telephone net. The introduction of CAI was well planned, with co-ordinated purchases of equipment and courses for interviewers after small scale pilot experiments.

31. Another successful example linked to the collection of data is the introduction of optical reading of forms mentioned under historical snapshots in paragraph 2.1.

32. EDI is also used for transferring data on prices and sales volumes directly from accounting systems of some of the shops reporting to the consumer price index statistics (CPI). Collection of data for accounts

statistics and pilot studies of data transfer from municipalities to SN are other examples of use of EDI. In addition, data from SN to Eurostat are transferred electronically. However, use of EDI is still at an early stage in SN. This is partly because EDI does not only require technology and adaptation of routines on the side of SN, but also on the side of data suppliers.

Reference databases

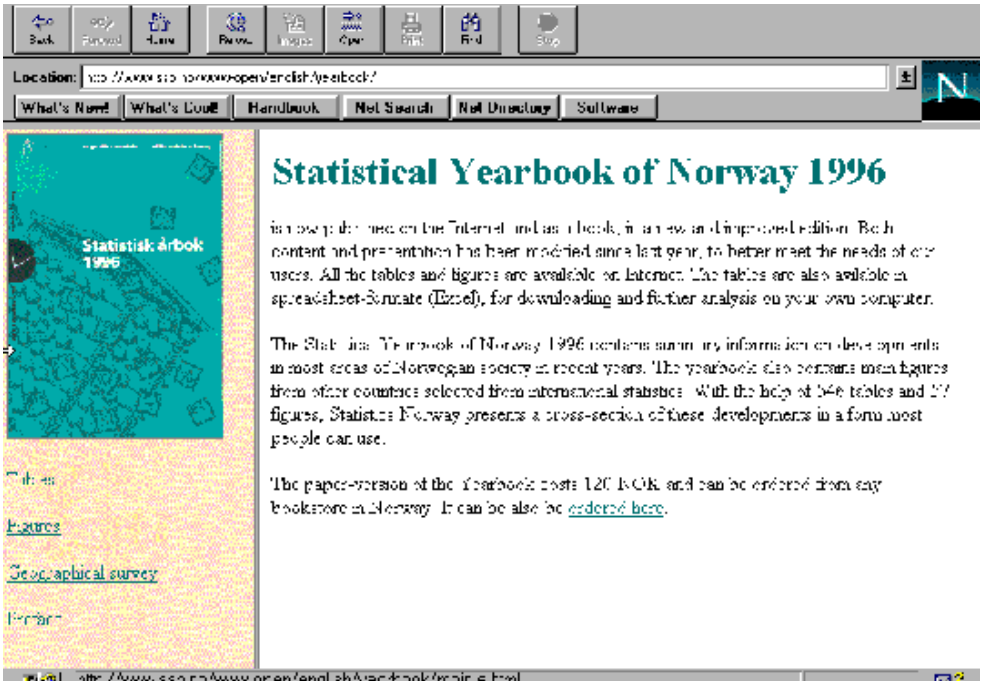
33. Work on establishing so called reference databases for regional data and time series is also being carried out in SN. The objective is that a reference database shall be the basis for publications and ad-hoc dissemination of statistics within SN. In addition to data, the reference databases shall contain sufficient metadata (information on data sources, definitions, standards, quality etc.). A reference database shall be easily available and attractive for internal use. It is possible to make parts of the reference databases available for external use, in the form of less detailed dissemination databases.

34. A first version of a regional database (RD) is available on the new technological platform and through a Windows interface. It is an Oracle database with an open data model ensuring maximum flexibility for combining data into statistical tables. Statistics from all subject matter areas are being put into this database, which represents a very promising application demonstrating the power of new technology in making statistics available and in the dissemination of statistics. Work on a time series database for similar purposes has just started. This database is based on the FAME data system.

Internet

35. Statistics Norway has disseminated statistics via Internet and World Wide Web (WWW) since March 1995, and this channel has rapidly grown to be our most important for electronic dissemination of statistics, even if a large amount of statistics also are distributed by diskettes and CD-ROMs. The number of “hits” on our Web pages has grown from 65.000 in April 1995 to 375.000 in January 1997. This year all tables and figures from the Statistical yearbook can be accessed and downloaded through Internet. A version of the regional database described above will also be accessible via Internet. Figure 2 shows an example from our Internet pages.

Figure 2. Statistical yearbook on Internet



36. Effective dissemination by Internet would not have been easy on the old technological platform (mainframe computer). But there is also another interesting lesson to be learned from the introduction of Internet in SN and earlier work on electronic dissemination. The rapid development of information technology causes new solutions to be perceived as old almost before they are implemented. But sometimes new technology suddenly represents a simple and unforeseen solution to problems. For years we have worked on different projects developing bulletin board systems (BBS) where users could select and interchange statistics. These projects were costly and time-consuming, but the demand for data made available in this way was poor. Data was originally supplied by an old-fashioned character based interface, and significant resources were spent to improve this. Then at the end of this project Internet and the World Wide Web were made easily available by existing and cheap software providing a graphical interface and hypertext, and we could shut down old BBS-systems and start disseminating official statistics over Internet more easily and with fewer resources than had been put into the preceding projects.

37. The principles of World Wide Web are convenient also for providing information internally in the organisation, and we are just now working to develop an Intranet system for Statistics Norway covering both information and administrative services.

Office support

38. A successful example of technological co-ordination was the introduction of one common office support system in SN. Since the first PCs were introduced in the organisation in the late 1980ies, we have had different word processing systems. Some departments and offices have used different worksheet systems, presentation programs and other PC software. Among other problems, this led to difficulties when transferring documents between people.

In the beginning of the 1990ies an attempt was made to standardise on one word processing system: WordPerfect which had been our major system so far. At the same time Excel was chosen as the one and only worksheet system available through the internal network. However, this decision was never really recognised in the organisation; may be the information had not been clear enough and it was also a fact that a large number of people, experts and non-experts had advised to choose Word which together with Excel and other programs were marketed as Microsoft office, a package for office support. In 1994 and after some investigations it was decided to reverse the original decision, and as a result SN in 1995 introduced Microsoft Office including both Word, Excel worksheet and Powerpoint presentation program. This time the decision was clear, and followed up with a comprehensive project with a gradual introduction, department for department, including courses for all staff, support and new infrastructure and routines such as computers (strong enough for the new software!), standard set-ups for letters, minutes etc.

39. A similar co-ordinated process is being planned for the introduction of new operative systems for servers and PCs (Windows NT and Windows 95) later, and eventually for the upgrading of office system, probably to Office 97.

C. Managerial aspects

Dependence on technological experts

40. Technological expertise is a precondition for development and migration of new and complicated technology in the institution, but the dependence on such expertise also represents a problem to management. Managers cannot themselves have the necessary insight in every technical question, and the use of internal and external advisers is crucial. SN has a decentralised organisation, and this makes it difficult to obtain unambiguous advice. Technological experts tend to agree on putting ambitions high, but at the same time they almost notoriously tend to disagree on specific choices of hardware, software and methodology. On several occasions reluctance from management and the rest of the organisation has saved us from wasting money and manpower, but this may of course also prevent important decisions to be taken and slow down necessary changes.

41. Diverging opinions in the organisation require clear decisions by top management, and when the decision has been taken, it must be followed by information and necessary resources.

Organisation

42. A decentralised organisation makes it easier for staff to identify with the statistical products, and promotes co-operation in projects which can be limited to one statistical subject matter area. A decentralised organisation of IT experts is also an advantage for their participation in such projects. However, questions of technological infrastructure (not only hardware such as computers and networks) cannot be successfully solved without a close co-

operation between experts throughout the whole organisation. In many cases the organisation as such will be better off with solutions that for some projects may be considered suboptimal. Hence, IT requires strong co-ordination, and this is of course a larger challenge in a decentralised organisation than in a centralised one. Another argument for strong co-ordination is the dependence on specialists which constitutes a scarce resource in Statistics Norway.

43. Until last year, Statistics Norway has had an EDP-manager centrally in the organisation, even if the IT functions are decentralised like our other functions. The EDP-manager has also been head of the co-ordination group consisting of all the leaders of EDP-units and the head of the central Division for Computer Systems and Development. Ideally, this should be a convenient solution, but it has been difficult to make the co-ordination group to function as a collegian. The members have tended to primarily act as representatives of their own departments. There might also have been a problem that local EDP-units and the central division have looked upon each other as competing rather than co-operating units. Therefore, we have recently reconsidered the role of the Division for Computer Systems and Development. In addition to having a purely co-ordinating or strategic role, it should function as a resource pool for staffing large and common projects such as the development of reference databases and our World Wide Web services. We have no person with the title EDP manager now, and we are emphasising development of integrity and good personal relations between our EDP leaders. However, the leadership of the co-ordinating group will still be linked to the leadership of the Division for Computer Systems and Development, reporting the Head of Department of Coordination and Development. But the leader of the co-ordinating group is more of an EDP co-ordinator than an EDP-manager.

44. Implementation or change of technology which involves several departments or the entire organisation calls for *project organisation.* This implies that the project leader who normally but not necessarily will come from a central unit (such as the Department of Coordination and Development in SN) controls the resources needed for the project even if it is staffed from different parts of the organisation. Rotation of staff between units and projects is also an issue in this context.

Choice of technology

45. As mentioned, it may be risky to choose the most recent version of technology if this is not well tried. A statistical institution is different from most other institutions, and in many respects it is more relevant to go abroad and compare ourselves with other NSIs than with other national institutions. Typical and often unique functions of a NSI are processing of large amounts of data resulting from the linkage of several administrative registers, use of statistical standards and production of statistical tables. In all these cases we have experienced difficulties linked to change of technology.

46. On the other hand technology and especially software should be purchased and not developed within the institution if convenient systems are available. Open systems that communicate with each other and on which it is easy to get support in the market might be preferred to more specialised systems even if the latter are regarded as better. There is a tendency in most technological environments to develop solutions themselves, which is natural since self-developed software more easily will fulfil the specifications, and development is more interesting than shopping. However, in addition to be expensive (when working hours are taken into account), self-developed software is vulnerable since it might be dependent on support from one or a few persons.

External advice

47. The issue of using external consultants is closely linked to the choice between buying and developing. Technicians are often reluctant to ask for external support for the same reason as they prefer to develop solutions themselves. On the other hand there are many examples of too extensive use of external consultants in many institutions which lack technological expertise. A mixture is often optimal, one should use external experts when they obviously have more experience than internal staff (or internal staff may be overbooked), but this use requires a certain level of experience within the institution, to avoid being dependent on the consultants and to implement the systems and ensure follow-up of results. To management, external experts will often represent a useful "second opinion" in questions where their own staff disagree.

48. It was mentioned that IT experts tend to put ambitions too high. This is often even more the case for external experts who on different occasions have severely underestimated the resources required for technological changes in SN. It is important to be aware of this when seeking external advice.

49. We have a discussion on whether the operation of parts of our IT infrastructure (for example mainframe computer) should be outsourced, and if so to which extent and when. When the use of our mainframe computer is reduced, we will reach a point when outsourcing is feasible from an economical point of view. This is not a purely economic question, there are for example some security issues, but lack of own expertise is also an issue. Outsourcing might make the management of IT in SN simpler, also because it will probably promote the migration from the mainframe computer, since it will lead to pricing of the outsourced facilities. We have no internal pricing in this area today.

Integration of IT in statistical work

50. Use of PCs and software for office support have made IT to an important part of every employees work. The major part of the institution’s work with IT is carried out by others than the IT specialists focused in this paper. In particular young statisticians, economists and other professionals are often well experienced in use of IT. However, there are some employees who still regard EDP in general as something for IT specialists. It is important that

simple tasks such as data extraction, transfer and analysis (including construction of statistical tables) are carried out by the people being responsible for the statistical products. Experienced IT-personnel are in short supply, and should be able to concentrate on support, systems development or adaptation and more strategic tasks.

Human resources

51. Principles and plans for management and use of IT may be good, but we will attain little if we do not have good human resources, even if external consultants are used in an optimal way. The labour market for IT specialists has varied over the years. For the time being, we have severe difficulties in keeping people with knowledge and experiences in new technology more than 1-2 years in SN. It is a paradox that if we do things well and successful projects are exposed to the professional society outside SN, the probability of loosing key personnel increases.

52. The question of human resources is therefore a major concern to management in this area. In Norway, Governmental organisations in general cannot compete with private businesses or research institutions on salaries. Hence other factors like interesting and challenging tasks, good working environment, possibilities for training and personal development must be emphasised. IT itself has enabled more flexible working conditions, and we have recently seen a tendency that companies with highly educated personnel such as consultancy companies have started to take advantage of this by for example including work at home in working hours. For large national statistical institutions with many types of employees this represents a challenge, and necessitates increased flexibility.

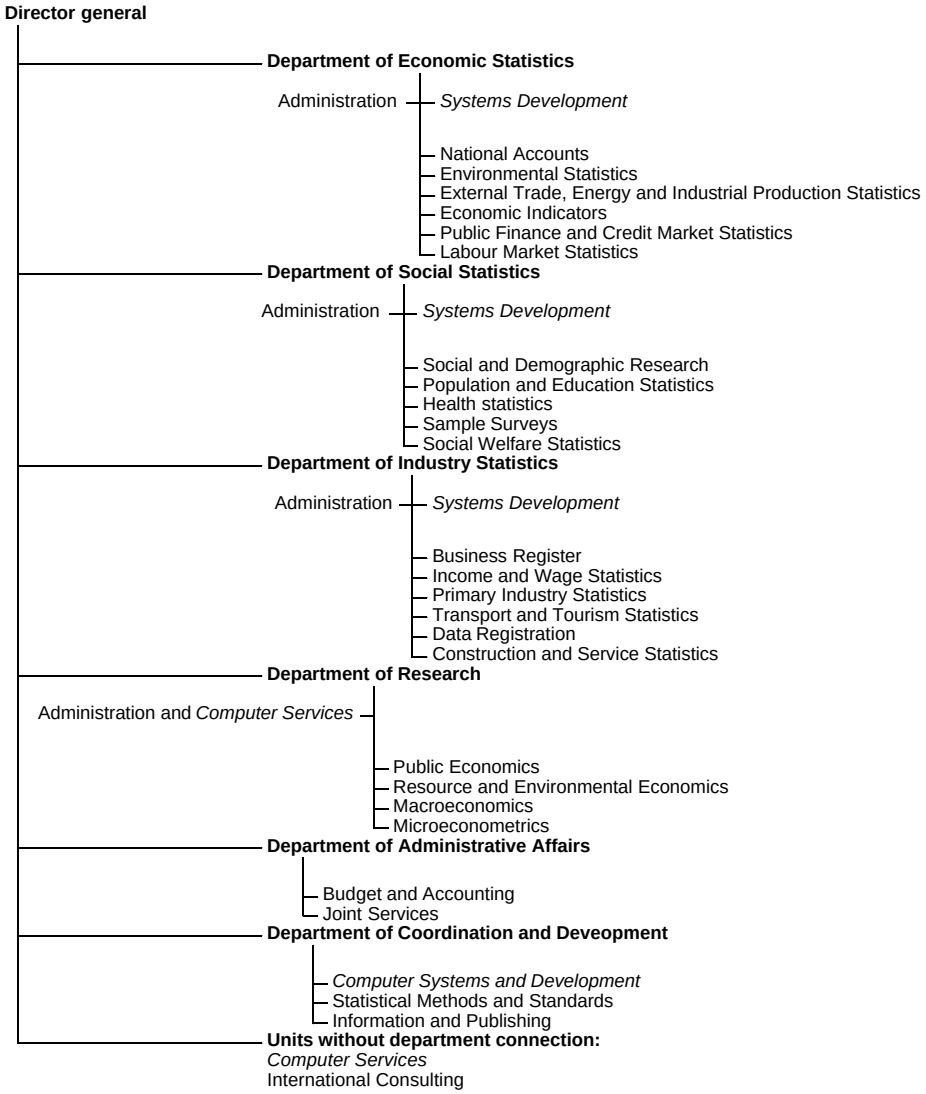
IV. Conclusions

53. Information technology is the backbone of the activity of a national statistical institute today, but managing it is difficult due to several reasons of which rapid changes, the dependence of specialists and organisational issues are important. In Statistics Norway we have had both successes and failures in this field, and it is a general experience that technological changes require more time and resources than foreseen. We are still facing many problems and challenges in this field, but some conclusions can nevertheless be drawn as for the management of IT:

- Ambitions should not be put too high.
- Decisions on technological change must be made clear by top management, and followed by information and necessary resources for the implementation.
- Strong co-ordination, well-functioning co-ordinating bodies and project organisation across a decentralised organisation is necessary.
- New technology implemented and applied should have been tried out in other institutions first.
- Some use of external consultants is convenient, but this requires corresponding internal resources to ensure follow-up of results.
- The issue of human resources is crucial, and consolidation of staff and

experience calls for flexibility.

Annex 1. Organisation of Statistics Norway 1997



IT units are marked with cursive.