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Nordic Benchmarking Analysis

Analysis on Maintenance and Production efficiency in Denmark, Finland and Sweden for the year 2000

DDV
Den Danske Vedligeholdsforening

Kunnossapitoyhdistys ry

FÖRENINGEN UNDERHÅLLSTEKNIK utek
The Swedish Maintenance Society

EFNMS
Member of the European Federation of National Maintenance Societies

Den Danske Vedligeholdsforening
Föreningen Underhållsteknik
Kunnossapitoyhdistys ry.

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Content:

1. Introduction

This report contains the results from the "Nordic Benchmark Analysis" for maintenance and production efficiency in Finland, Sweden and Denmark.

An increasing number of Nordic and European companies use benchmarking as part of the corporate management system. Benchmarking focuses attention on the company core business values and enables the companies to compare performance results and adopt improvements.

This process has effected change and development to the organisation of maintenance in many Nordic and European companies, and a number of maintenance organisations have completed the implementation of a benchmarking system in maintenance and production efficiency.

It is the hope from the National Maintenance Societies involved that this report and the figures in the report will be an inspiration for Maintenance and Production managers in the process of goal settings and development of maintenance and production.

The "Nordic Benchmark Analysis" is also the first - but hopefully not the last - Benchmark report, which are based on the key figures defined by the EFNMS. This enables the user to compar their own performance and results with the average industry by branch and by Nation.

The purpose of the "Nordic Benchmark Analysis" is to give at picture on the status of maintenance and production in the three Nordic countries. A deeper scientific analysis of the Nordic maintenance business has not been in the scope of this analysis.

Benchmarking in maintenance is also a possibility for the maintenance manager to illustrate the performance of the maintenance organisation and to put focus on areas with performance above the average, and to put focus on areas, which need improvement. This "Nordic Benchmark Analysis" acts as the foundation for improvement and development of the maintenance performance and organisation.

Authors to the report are the Nordic Benchmark project team with members from The Danish Maintenance Society, The Finnish Maintenance Society and The Swedish Maintenance Society.

We want to give special thanks to the participating companies for their effort to send the interesting data for this analysis.

The Nordic Benchmarking Report is available at the office of these National Maintenance Societies at 150 EURO.

December 2001

The Danish Maintenance Society, DDV / Tom Svantesson
The Finnish Maintenance Society, KPY / Kari Komonen
The Swedish Maintenance Society, UTEK / Jan Frånlund and Christer Olsson

2. Previous Benchmark Analysis in Denmark, Finland and Sweden

2.1 The EPSOM Project

In 1993 a EUREKA project 724 MAINE EBSOM (European Benchmark Study On Maintenance) was initiated by the Danish Maintenance Society and involved the other three Nordic Maintenance Societies. The aim for the project was to investigate the economical and administrative aspects in maintenance as well as indicate areas for improvement. Among other things the report included figures regarding maintenance costs, turnover, plant replacement value, type of organisation for maintenance, personnel, value of spare parts and training hours.

2.2 KPY, Finland

In Finland KPY, Finnish Maintenance Society, later with Federation of Finnish Metal, Engineering and Electromechanical Industries has collected data concerning industrial maintenance since 1989. During the years 1989, 1990, 1991 and 1992 all industrial branches were invited to join a benchmarking project. In the middle of the 90's for example in 1993-1994, data collection concerned only few branches and it was carried out with the help of a group of students. Since 1996 the study has been implemented annually. In 1998 only two branches were invited to participate. The number of replies has varied but usually about 100 plants have returned a questionnaire. The most active year was 1997 and the last effort, the data for the year 2000 was also successful (128). The quality of data has improved during the years, but still we have more steps to take.

2.3 DDV, Denmark

DDV, The Danish Maintenance Society conducted the first analysis on maintenance in 1978. Starting in 1978 data has been collected every second or third year. The number of respondents has varied over the years. The most successful analysis took place in 1999 with more than 230 respondents from the Danish industry.

One of the comments which DDV often has been presented with is the fact that we only have analysed maintenance, but not the result of maintenance: availability. Since availability and production efficiency is included we hope to support the members of the society who have asked for such information.

The key figures used and analysed in the former Danish analysis are for a large number similar to the key figures used in this report, which enables the Danish Maintenance Society as well as the maintenance manager to compare the development of his performance with the average within his branch.

DDV hopes that the Nordic Benchmark Analysis will attract focus to maintenance and production efficiency as it has been the case with the previous analysis.

2.4 UTEK, Sweden

UTEK, the Swedish Maintenance Society, has only been involved in one Benchmarking analysis before. That was the Swedish part of the EBSOM Project., mentioned above. Therefore UTEK now hopes that this report will inspire the Swedish companies to participate in the future Benchmarking activities.

3. Main conclusions and results

Some average figures for the participating industries in the Nordic countries are presented here.

Maintenance costs as a % of plant turnover and **Maintenance costs as a % of plant replacement value** were (4,1%) and (3,0%). The structure of a sample, e.g. plant size, technology and utilisation rate of equipment, has generally a great impact on the relative cost of maintenance. That calls for a deeper analysis in order to evaluate the efficiency of maintenance in the Nordic countries.

The usage of the production equipment seems to have a development potential as far as the **OEE** figure is concerned (76,4%). The **Availability** 88,1% gives also an opportunity for some branches to improve operations.

Total figures for three Nordic countries are generally quite reliable with exception of "Actual operating time / Number of immediate corrective maintenance events", which does not work well with a multi-branch sample.

When comparing three Nordic countries with each other, it was difficult to draw clear conclusions, because the structure of the samples was quite different in each country. The results of Finland and Denmark are more comparable. Sweden is more uniform, where the proportion of the chemical industry was almost 50 %. In addition to that the sizes of samples differed greatly and they were small in Sweden and Denmark. These facts must be considered when making comparisons

Maintenance costs as a % of Plant replacement value were in Finland and Denmark at the same level, but in Sweden a cost level was clearly lower (2,2%). **Maintenance costs as a % of Plant turnover** showed the lowest figure in Denmark (3,6%) and highest in Sweden (4,6%), which is difficult to explain, but can be related to the structure of the sample. A reason may be chemical industry.

The **OEE** and the **Availability** figures were close to each other. OEE indices were in Finland and Sweden at the same level and at a higher level than in Denmark. Differences in OEE may originate from different ways of calculate production efficiency and availability.

The costs of preventive maintenance (%) were in all countries at the same level. **The proportion of corrective maintenance** was very low in Sweden (17,8%), which results from the high proportion of chemical industry. In Finland the respective figure was 33,2%. **Planned and scheduled maintenance** was widely used in Finland (67,4%).

Contractor costs were highest in Finland and lowest in Denmark, which may be a correct result, and in alignment with previous analysis. Mean time to restore or **Immediate corrective maintenance time / Number of immediate corrective maintenance events** was the shortest in Denmark.

Swedish and Danish industry **invested in training** twice the amount of Finnish industry.

The general results have been summarised in the Chapter 7 "Average plant in the Nordic contries" and in Chapter 12, "Production efficiency and Maintenance in three Nordic countries in 2000".

Differences in key figures within different branches can easily be seen in Chapter 12. The cost of maintenance as a % of plant replacement value is lowest in Chemical industry

(2,6%), but the highest in relation to plant turnover. It has also a very high availability (97,3%) and the proportion of corrective maintenance is low (16,8%). Required operating time as a % total available time is high (94,8%). Instead, within metal-products corrective maintenance is intensively used.

In the Table 1, there is a column "Mean 2". The explanation for this variable is given later in chapter 4.

3.1 Key figures from the average Nordic Plant

Table 1. An Average Nordic Plant

	Mean	Mean2	Unit
Plant turnover	142,4		million euros
Plant replacement value	218,1		million euros
OEE	76,4		%
Required operating time as a % of Total available time	73,6		%
Actual operating time as a % Required operating time (Availability)	88,1		%
Shift work rate	3,5		1-5
Production operatives	209,0		Number
First line maintenance operatives	41,0		Number
Maintenance costs as a % of Plant turnover	4,1	2,8	%
Maintenance costs as a % of Plant replacement value	3,0	2,0	%
Stores investments as a % of Plant replacement value	0,8	0,7	%
Contractor costs as a % of Maintenance costs	34,7	31,9	%
Training man hours as a % of Maintenance man hours	3,1		%
Preventive maintenance costs as a % of Maintenance costs	36,2		%
Preventive maintenance man hours as a % of Maintenance man hours	38,4		%
Corrective maintenance man hours as a % of Maintenance man hours	29,8		%
Planned and scheduled man hours as a % Maintenance man hours	63,0		%
Actual operating time / Nr of immediate corrective maintenance events	241,1		hours
Immediate corr. Maint. time / Nr of immediate corr. maint. events	6,9		hours

Table 1. Result from the Average Nordic Plant

4. Analysis Process

4.1 Data Collection

EFNMS key figures have been clearly defined and documented for the data collection. However, companies do not always have information systems, which allow them to collect or present data according to EFNMS definitions. That is why, although the name of the key figure is the same, the content may vary.

Some of the questions were more difficult to answer than the others. For example, only about 70 respondents of the 166 plants were able to give OEE (Overall Equipment Efficiency), Actual operating time / Number of immediate corrective maintenance events ("MTTF") and Immediate corrective maintenance time / Number of immediate corrective maintenance events ("MTTR"=Meantime to restore). Instead, such questions as plant turnover, shift work rate, number of production operatives were easier ones and 143 respondents of 166 gave those figures.

Also the reliability of the data varies: For example, "MTTF" figures obviously were not very reliable. Clearly wrong figures were rejected in the analysis process. This could be data with mistakes: too high costs figures, or too high utilisation rates were given. Sometimes the plant replacement values were not plausible.

In Finland the questionnaire contained more questions than in the other countries. Especially questions concerning personnel, plant replacement values and costs were more numerous. Calls for data were carried out twice. About one half of the data were sent on the basis of the first letter. The second letter was successful because about 50 % of data were received after mailing that letter. Letters were supported by phone calls.

4.2 Data Calculation process

The aim of statistical analysis was to keep results easy to grasp but at the same time informative. The statistical significance of the results was quite high for the whole data and for Finland. Results by branches (processing of food, chemical industry and manufacturing of metal products, electric and electronics) were quite reliable. Sample sizes varied mainly between 15 and 25 depending on data required. Some variables were more problematic because of the low number of replies (Indicator 12, Indicator 13 and Indicator 14). Sometimes "outliers" (for example a value 20 times larger than the average) would have been influenced strongly on the results, because of small size of the sample. That is why, in spite of the character of outliers (correct figures or mistakes), they were rejected. Sometimes availability or utilisation rate was more than 100 %. Those cases were also rejected.
The Swedish and Danish results are strongly influenced by the structure of the respondents. For example, the high proportion of chemical industry in the Swedish data had a great impact on the Swedish figures.

For the whole data 95% confidence limits were estimated to point out the range, where the true mean is located with 95% probability. These confidence limits gave information for conclusions but they have not been presented in the text. For the other groups of the data standard deviation was presented to point out the range, which contains about 2/3 of sample cases. A wide range **may** indicate low reliability.

In the summary table, means for various key figures were calculated as an average of all respondents, who had answered to that question. As a test, those plants were selected, which had answered all questions. Those plants numbered 25. Interesting remark was that the most key figures got about the same value in both samples.

In this study, we have used a plant replacement value. It may have caused problems, because in the cost variable, "Maintenance costs / Plant replacement value", we have a mix of equipment and buildings, which may vary a lot. In the future, it is important to calculate cost figures / replacement values separately for equipment and buildings.

There are two ways to calculate means for various ratios

- We may first sum up, for example, maintenance costs of all the plants in the sample and then replacement values respectively and then finally divide the former with the latter. The result is a weighted mean for that ratio.

- **Secondly, we may calculate the mean of ratios of all the plants.**

These two methods to carry out calculation lead to different results. The first method puts more weight on the larger plants and the latter emphasises more smaller ones. When using the first method we probably get lower relative cost figures, because larger plants usually have lower costs than smaller ones. In the column "Mean 2" we have used method (1). The results are as expected.

Here, the calculation method 2 is more appropriate. That is why, the method 2 has been used in this study.

5. Background for the analysis

The "Nordic Benchmark Analysis" has been supported by two factors, which have made it possible to make the comparison between the three participating countries in the analysis. The first one being the definitions for the branches used in the analysis and the second one being the definitions on the benchmark indicators for maintenance and production efficiency.

5.1 Branches in questionnaire form

The branch division used in this analysis is the NACE, which describes a very detailed breakdown structure for branches. Based on the standard it has been selected 19 branches which are considered to be representative for the industry.

3.1.1	Mining, Quarrying
3.1.2	Extraction of crude petroleum and gas
3.1.3	Processing of food and liquid
3.1.4	Manufacturing of Textile, clothes, leather
3.1.5	Wood industry, Saw - milling, other wood processing
3.1.6	Paper and pulp industry
3.1.7	Graphic Industry
3.1.8	Manufacture of petroleum products, Refinery
3.1.9	Chemical industry
3.1.10	Manufacture Pharmaceutical and medicine
3.1.11	Manufacture of rubber and plastic products
3.1.12	Stone, clay and glass industry
3.1.13	Manufacture of steel, iron and alloys
3.1.14	Metal processing industry
3.1.15	Manufacture of electric and electronics
3.1.16	Public utilities, domestic heat, power water
3.1.17	General building and civil works
3.1.18	Transport general
3.1.19	Miscellaneous

Table 2. Branches used in the questionnaire form

5.2 Branches used in the Nordic Benchmarking analysis

According to the NACE Standard pharmaceutical industry and processing of food do not belong to the same industrial branch. However, in this Nordic benchmark analysis the number of respondents from the pharmaceutical plants was so low, that a separate pharmaceutical branch was difficult to analyse. Since the nature and characteristics of maintenance in the pharmaceutical business are similar to the one from the food processing industry the two branches were added together and treated as one branch.

Chemical industry
Manufacture Pharmaceutical and medicine Processing of food and liquid
Metal processing industry Manufacture of electric and electronics

Table 3. Branches used in the Nordic Benchmarking Analysis

5.3 EFNMS Figures

The key figures in the "Nordic Benchmark analysis" are based on the 13 key figures for maintenance issued by EFNMS. In addition to the EFNMS figures one key figure have been added: Production efficiency.

The Key figures used in production efficiency are based on the OEE (Overall Equipment Efficiency) taken from the TPM philosophy. The "Nordic Benchmark analysis" measures the production losses to:

Availability
Performance and
Quality

The key figures used in the "Nordic Benchmark analysis" are given in the table below. The first 13 figures are the figures recommended from EFNMS (European Federation of National Maintenance Societies).
The last figure is the production efficiency measured as the OEE value (Overall Equipment Efficiency).

- I:01 Maintenance costs as a % of Plant replacement value
- I:02 Stores investment as a % of Plant replacement value
- I:03 Contractor costs as a % of Maintenance costs
- I:04 Preventive maintenance costs as a % of Maintenance costs
- I:05 Preventive maintenance man hours as a % of Maintenance man hours
- I:06 Maintenance costs as a % of Turnover
- I:07 Training man hours as a % of Maintenance man hours
- I:08 Immediate corrective maintenance man hours as a % of Maintenance man hours
- I:09 Planned and scheduled man hours as a % of Maintenance man hours
- I:10 Required operating time as a % of Total available time
- I:11 Actual operating time as a % of Required operating time
- I:12 Actual operating time / Number of immediate corrective maintenance events
- I:13 Immediate corrective maintenance time / Number of immediate cor rective maintenance events
- I: 14 Production efficiency - OEE value

Table 4. Key figures used in the Nordic Benchmarking Analysis

5.4 Number of participants

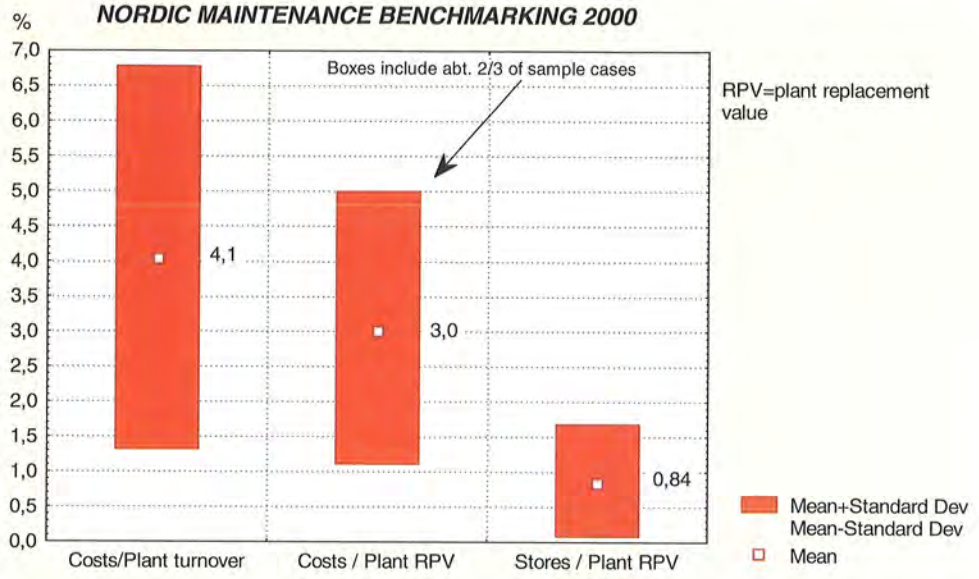
Questionnaires were sent to industrial plants and not to service companies. Participating plants numbered in Finland 128, in Sweden 19 and in Denmark 19. A reason for a high activity in Finland is that there has been the same kind of effort in every year or every two years. Another reason is that benchmarking has been one of the important topics in the professional seminars in Finland for 5 years. Surely, many plants did not have information systems for certain key figures and that lowered the activity to answer. Many of the maintenence terms have earlier been defined in differnt ways, which made data collection difficult. The terminology used in this report refers to the standard "Maintenance Terminology" EN 13306.

5.5 Comments on representation

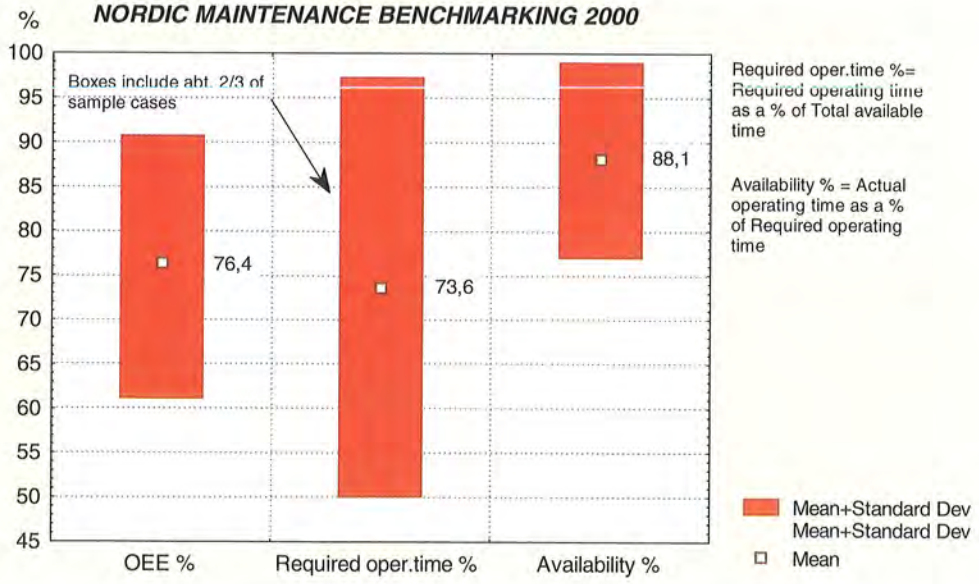
In Finland, the number of respondents was in 5 branches high enough in order to get reliable results for practical purposes. In the Nordic data there were 3 branches. Reliability of data varied also from one variable to another. For example, as far as "Actual operating time / Number of Immediate corrective maintenance events " and " Immediate corrective maintenance time / Number of Immediate corrective maintenance events " are concerned high deviation, number of outliers and/or size of the sample does not support the reliability of the results.

6. Results and Graphical Figures

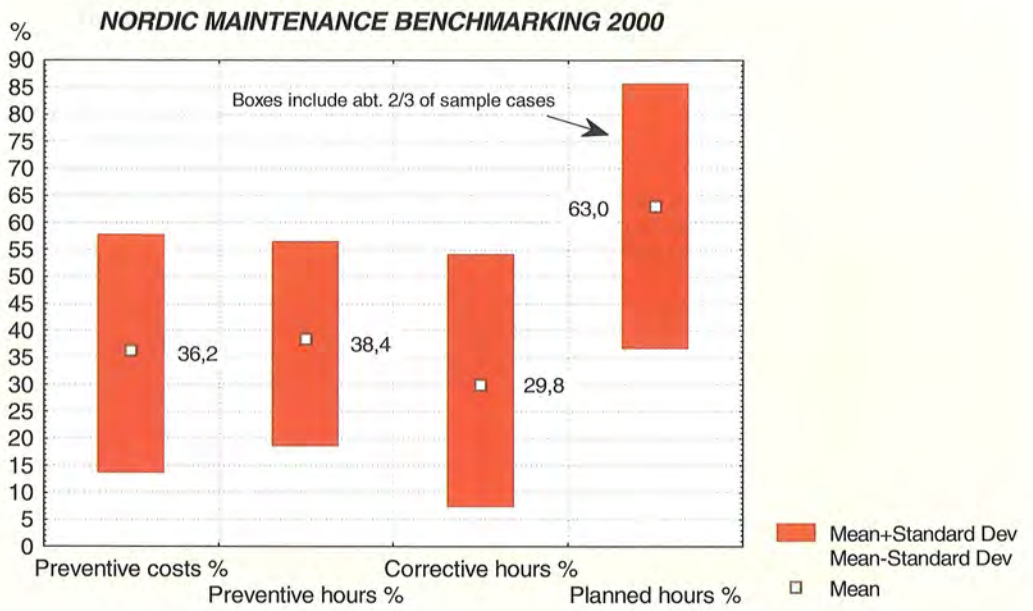
6.0 General results



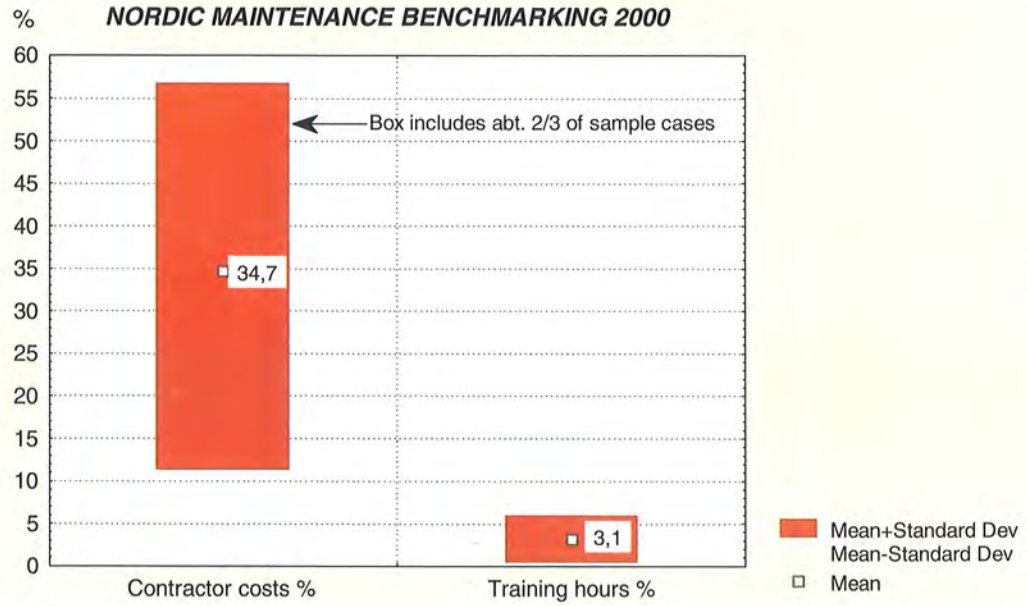
Graph 1. Cost figures of three Nordic countries



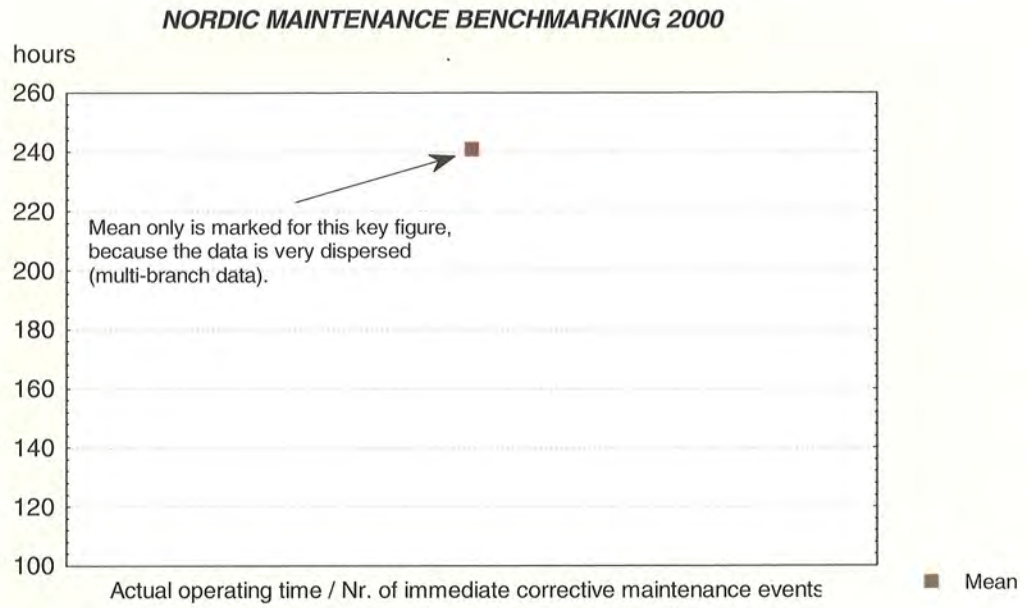
Graph 2. Figures concerning the use of equipment in three Nordic Countries



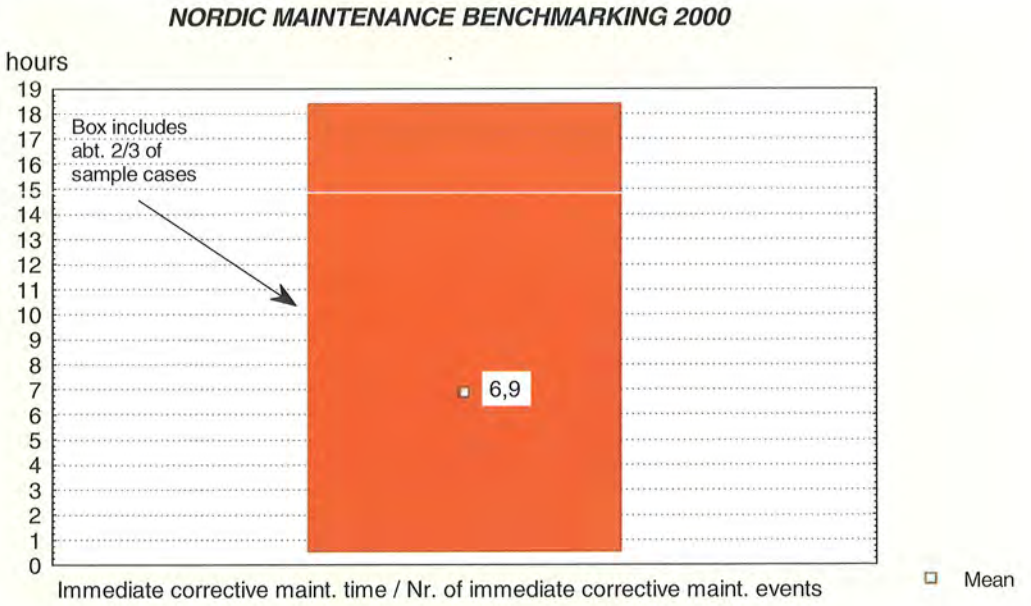
Graph 3. Maintenance practices in three Nordic countries



Graph 4. Contracting and training policies in three Nordic countries

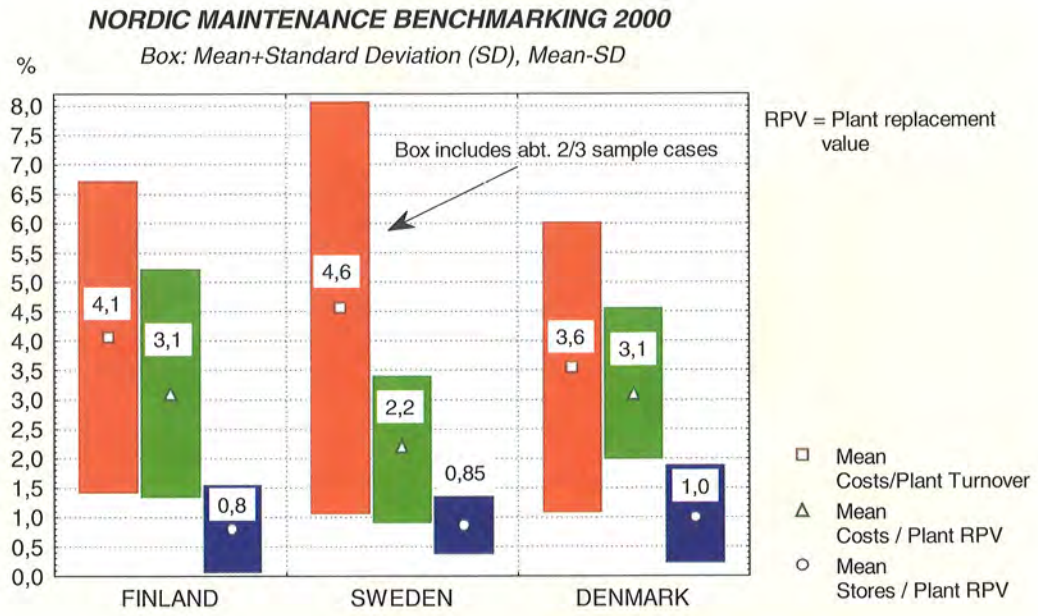


Graph 5. Actual operating time / Number of immediate corrective maintenance events

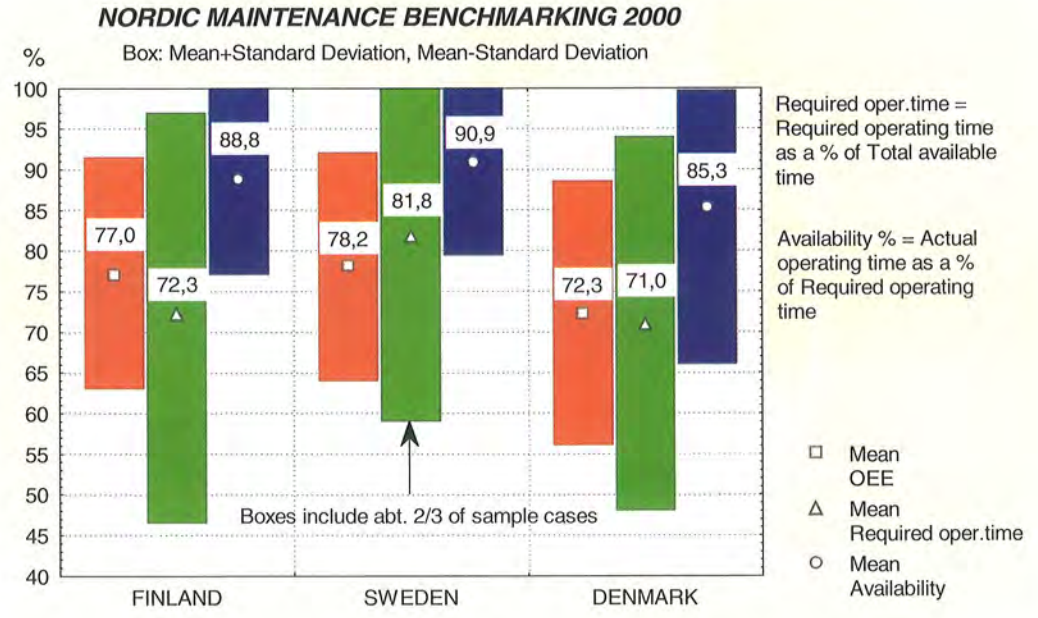


Graph 6. Immediate corrective maintenance time / Number of immediate corrective maintenance events

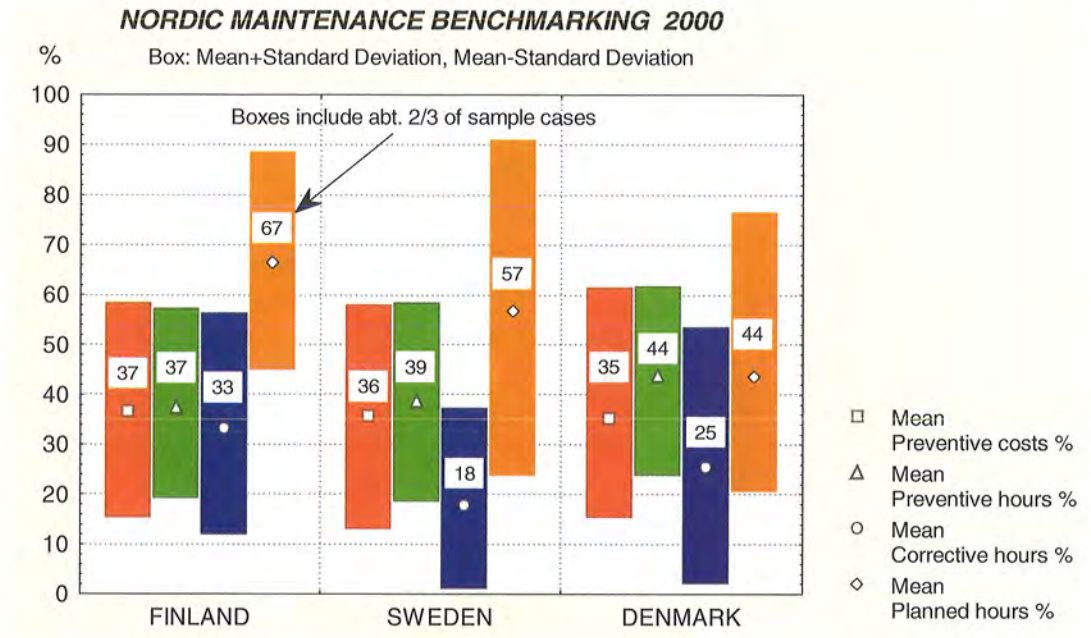
6.1 By nations



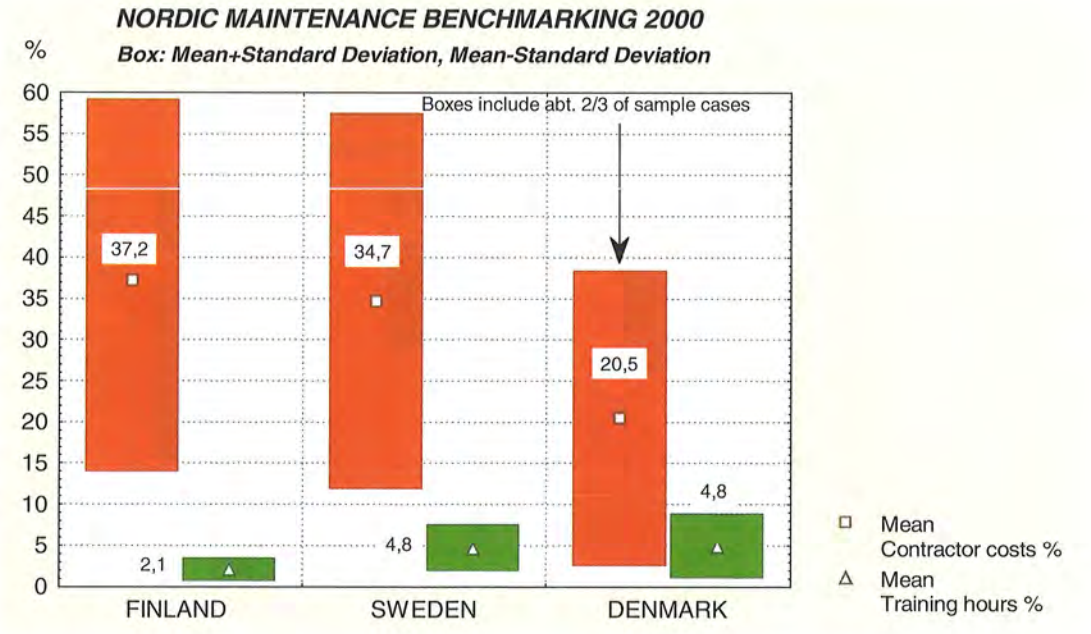
Graph 7. Cost figures for each country



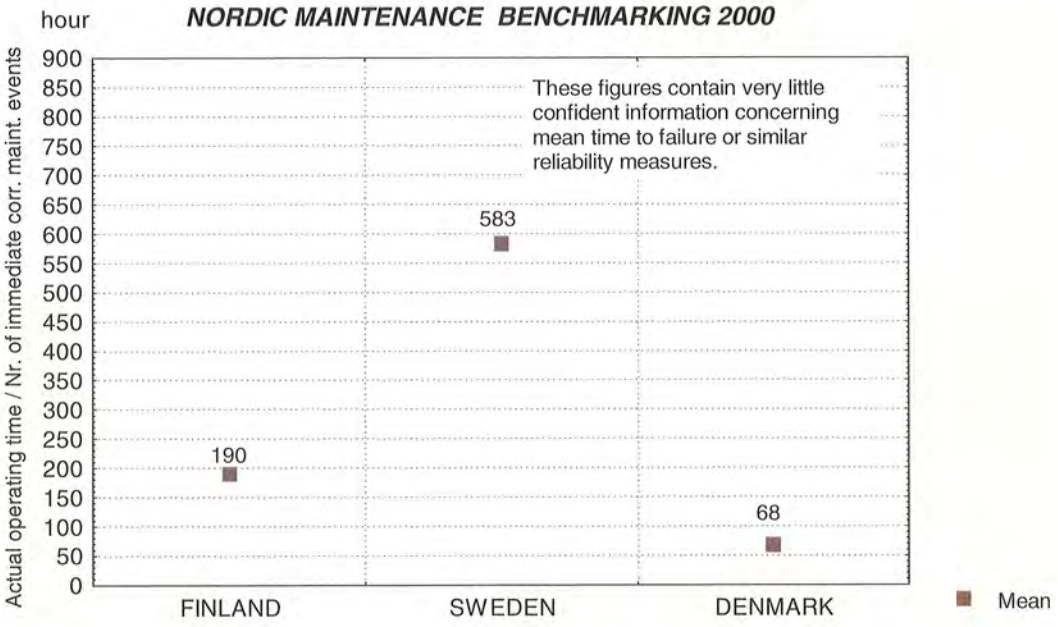
Graph 8. Use of production equipment in each country



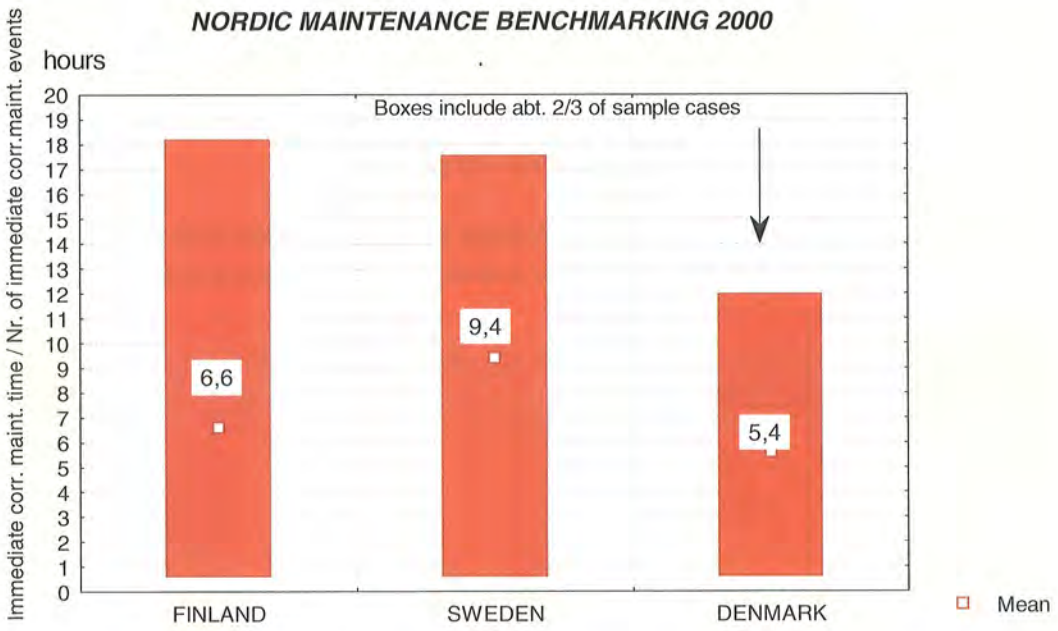
Graph 9. Maintenance practices in each country



Graph 10. Contractor and training policies in each country



Graph 11. Actual operating time / Number of immediate corrective maintenance events

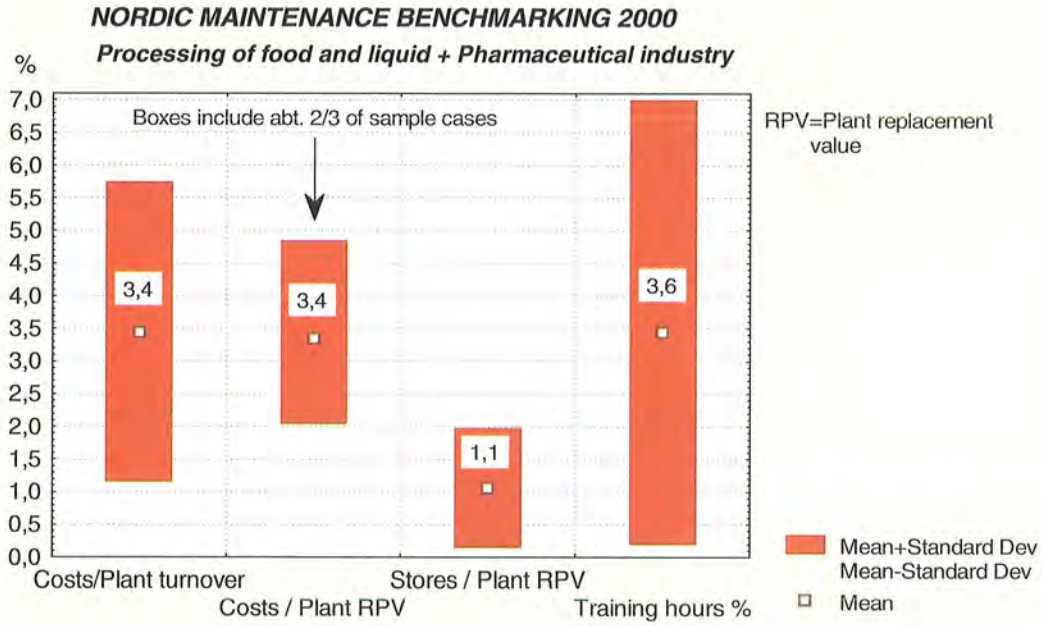


Graph 12. Immediate corrective maintenance time / Number of immediate corrective maintenance events

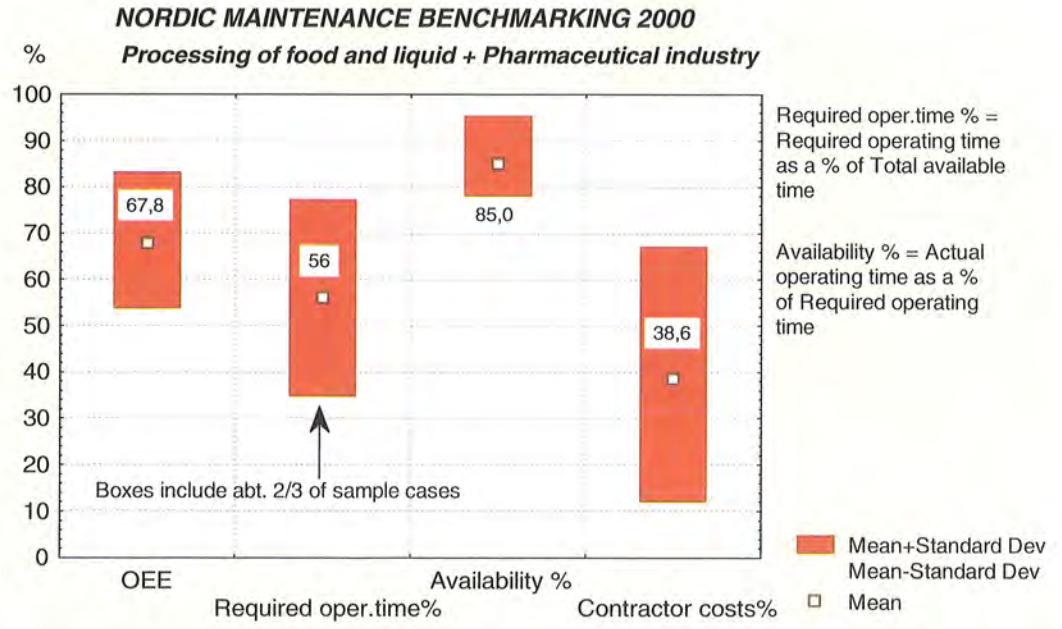
6.2 By Branches

6.2.1 Processing of food and liquid + Pharmaceutical industry

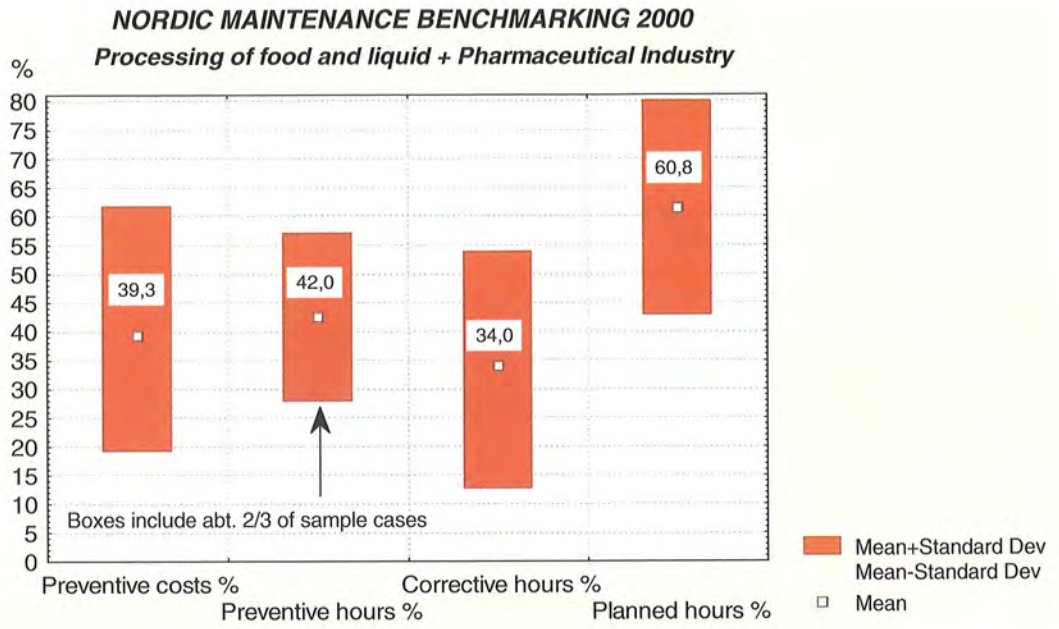
In official statistics pharmaceutical industry and processing of food do not belong to the same industrial branch. However, in this Nordic sample the number of pharmaceutical plants was so low, that a separate pharmaceutical group was not a possible option. The production process of it, however, resembles in many ways that of processing of food. That is why they have put together.



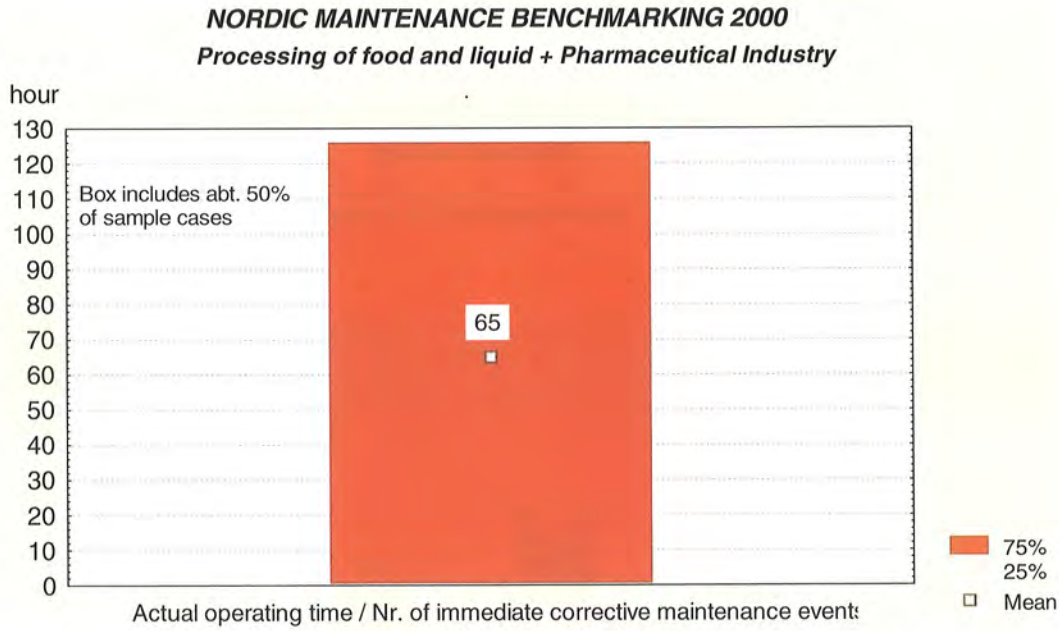
Graph 13. Cost figures and training policies



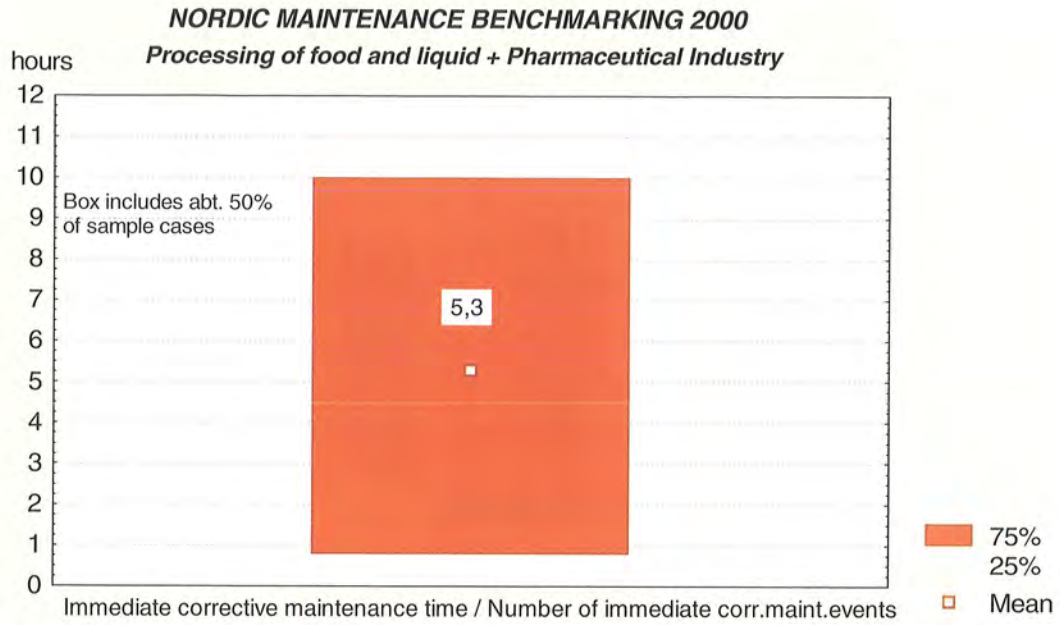
Graph 14. Use of production equipment



Graph 15. Maintenance practices

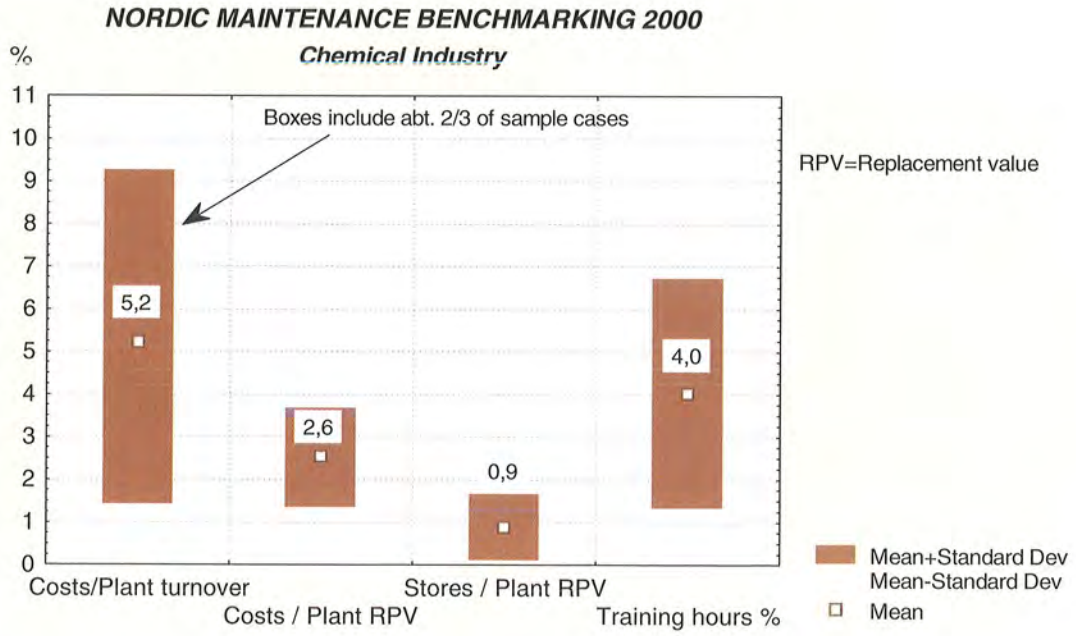


Graph 16. Actual operating time / Number of immediate corrective maintenance events

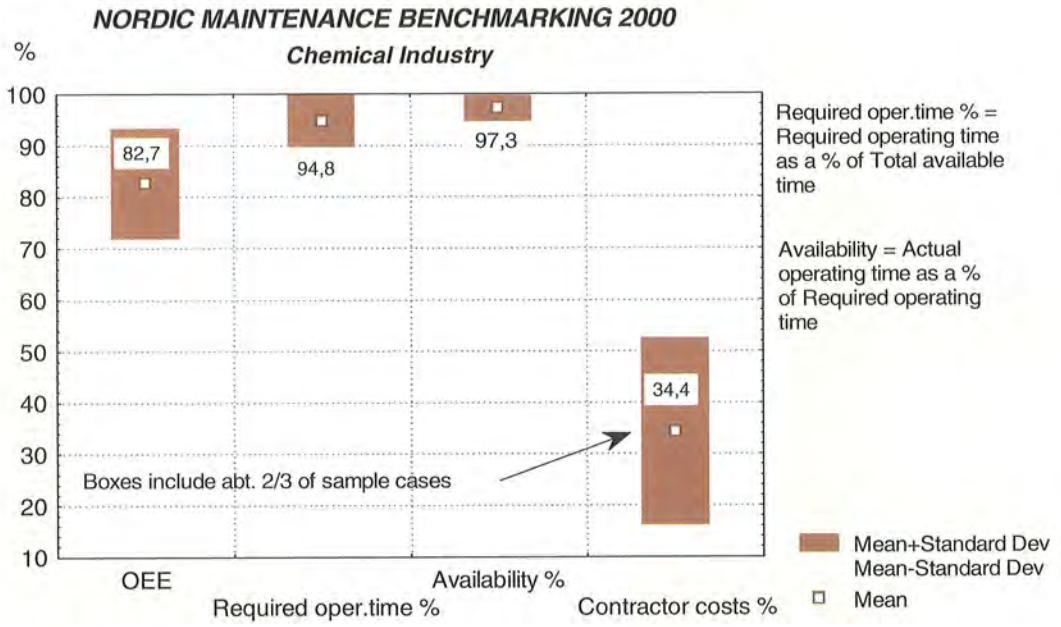


Graph 17. Immediate corrective maintenance time / Number of immediate corrective maintenance events

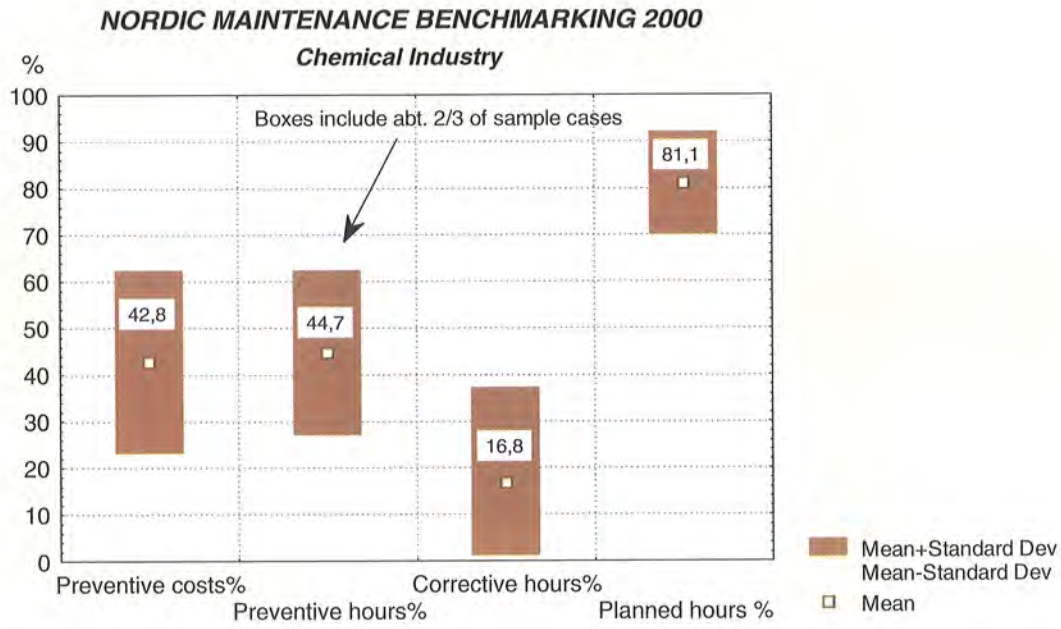
6.2.2 Chemical industry



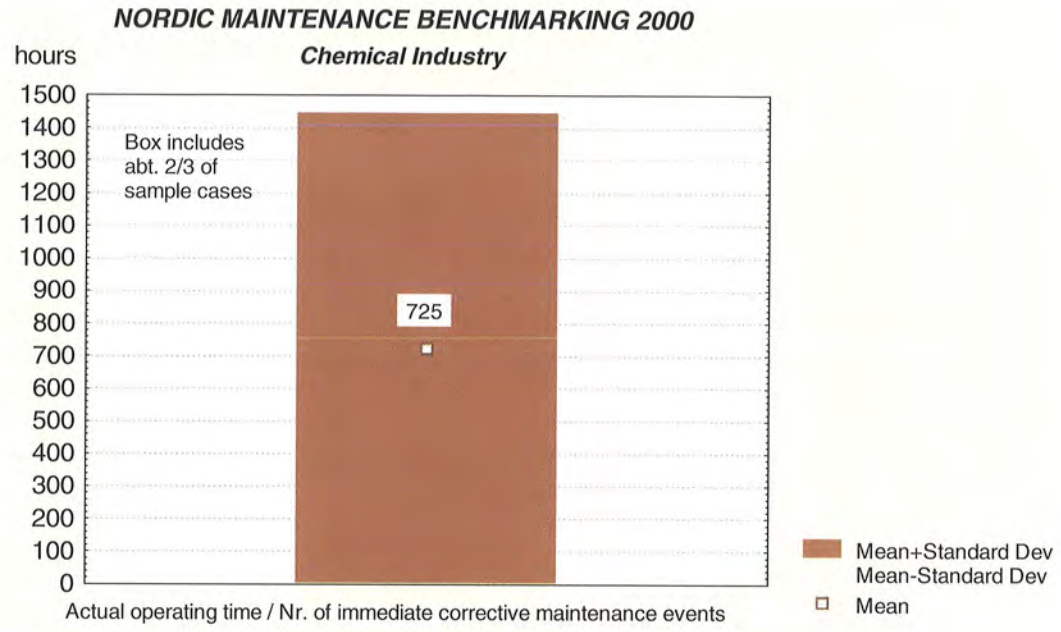
Graph 18. Cost figures and training policies



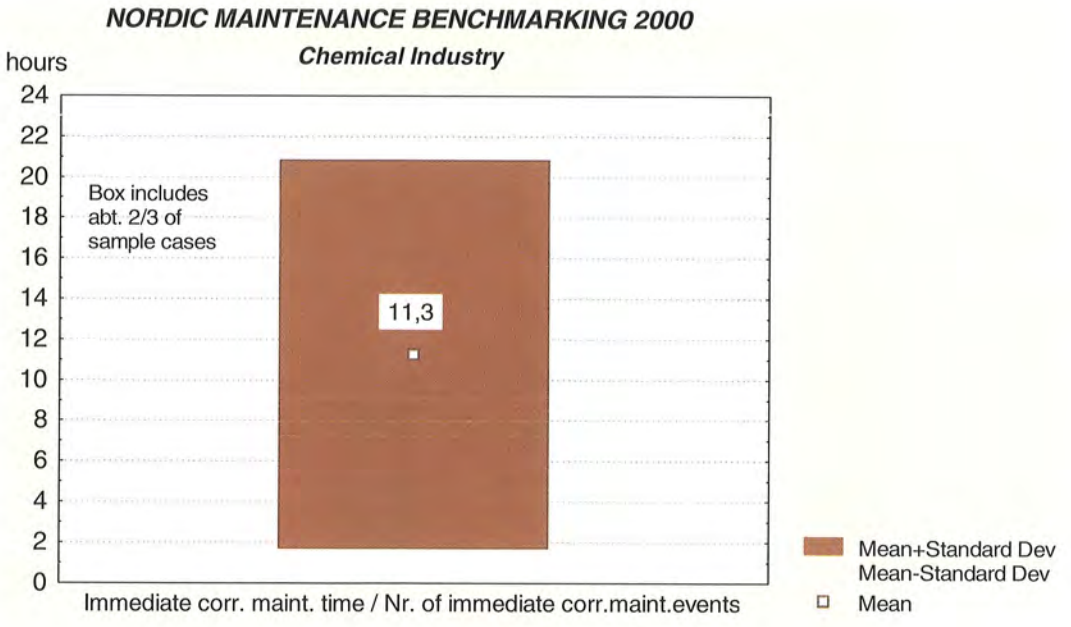
Graph 19. Use of production equipment and contractor policies



Graph 20. Maintenance practices

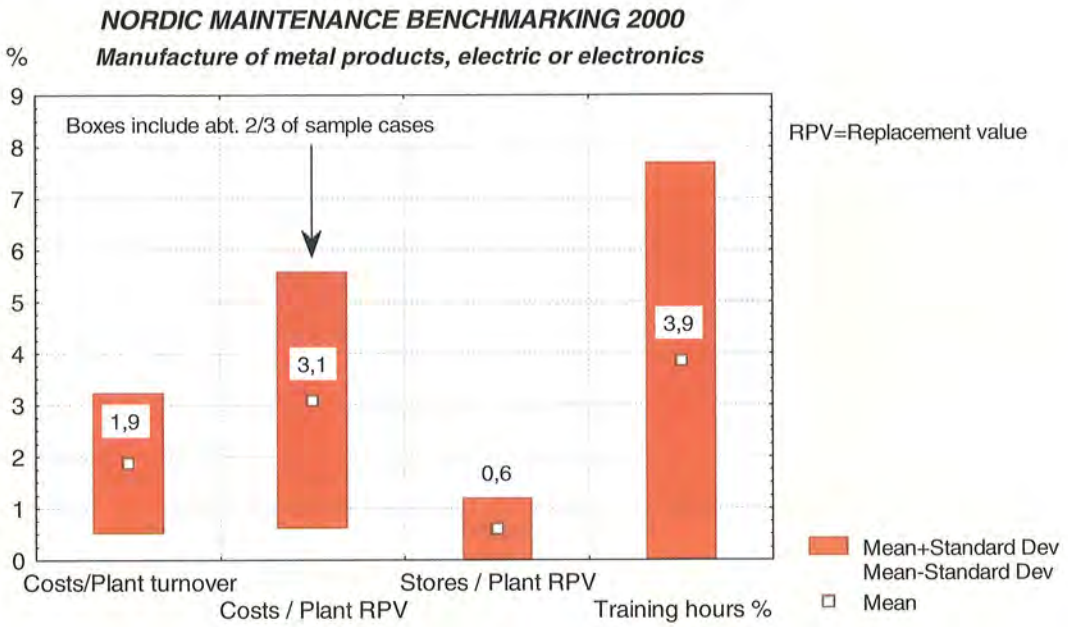


Graph 21. Actual operating time / Number of immediate corrective maintenance events

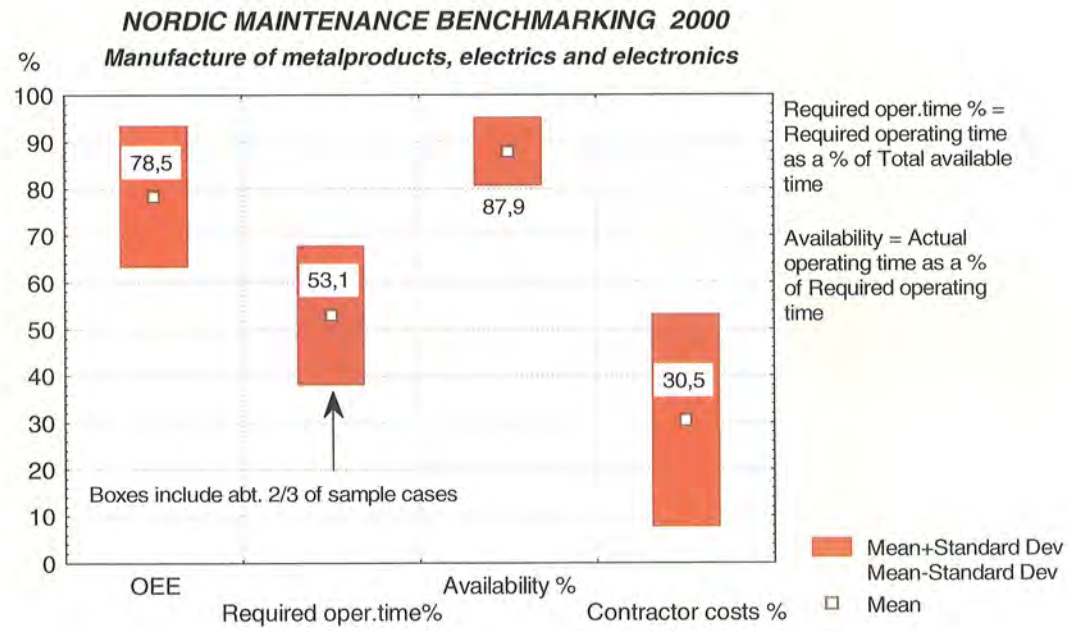


Graph 22. Immediate corrective maintenance time / Number of immediate corrective maintenance events

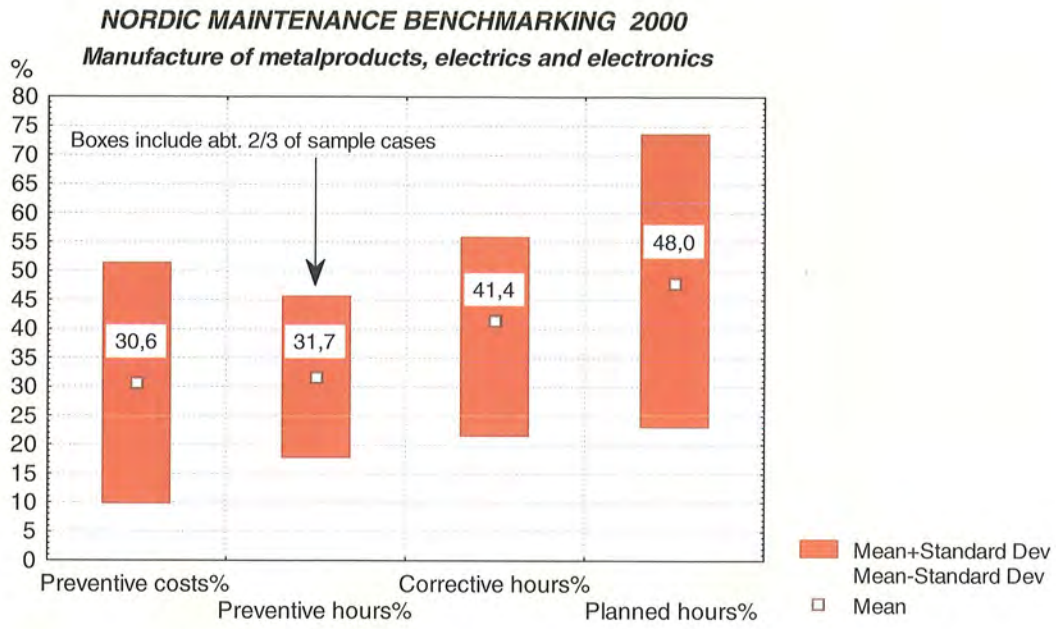
6.2.3 Manufacture of metal-products, electric and electronics



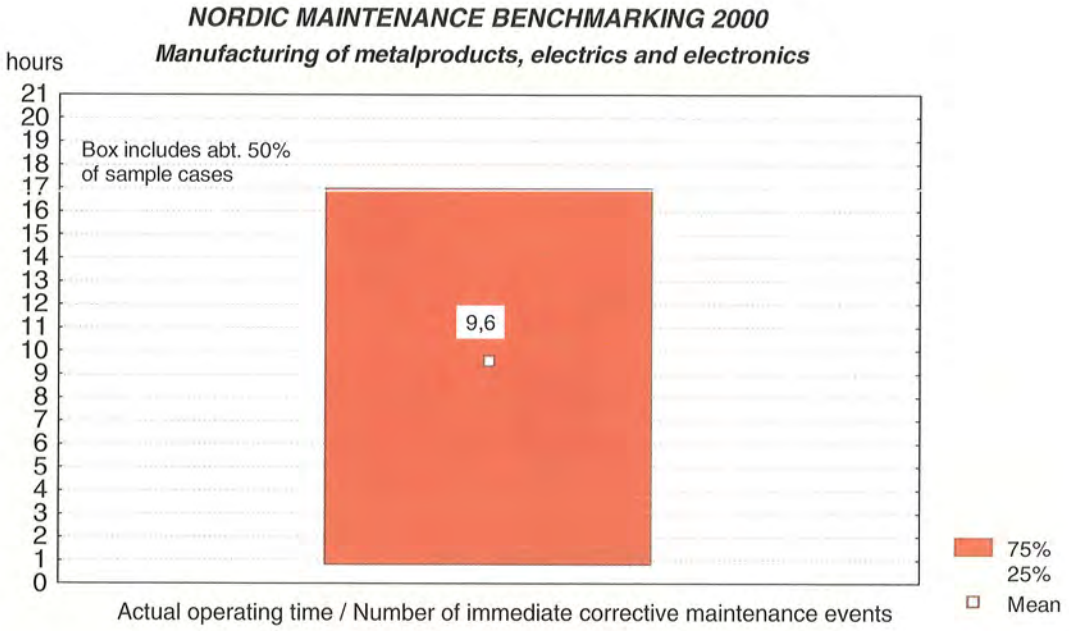
Graph 23. Cost figures and training policies



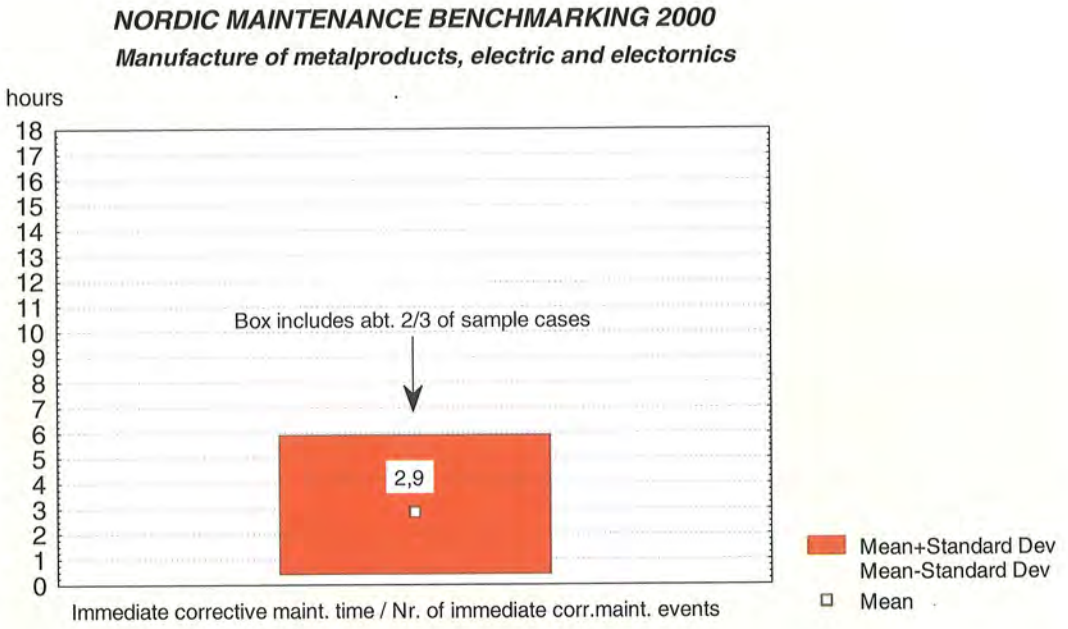
Graph 24. Use of production equipment and contracting policies



Graph 25. Maintenance practices



Graph 26. Actual operating time / Number of immediate corrective maintenance events



Graph 27. Immediate corrective maintenance time / Number of immediate corrective maintenance events

7. Average plant in the Nordic countries

	Num-bers	Mean	Mean2	Unit
Company holds a quality certification (ISO 9000 or equivalent)		89,5		%
Company holds an environmental certification (ISO 14001, EMAS or ...)		69,9		%
Strategy for resources				
a) Primarily internal resources		77,1		%
b) Primarily external resources		6,2		%
c) Maintenance is totally outsourced		16,7		%
Plant turnover	143	142,4		million euros
Plant replacement value	117	218,1		million euros
Age of physical assets	135	16,6		years
OEE	72	76,4		%
Required operating time as a % of Total available time	114	73,6		%
Actual operating time as a % Required operating time (Availability)	113	88,1		%
Shift work rate	143	3,5		1-5
Production operatives	142	209,0		Number
First line maintenance operatives	134	41,0		Number
Maintenance costs as a % of Plant turnover	135	4,1	2,8	%
Maintenance costs as a % of Plant replacement value	114	3,0	2,0	%
Stores investments as a % of Plant replacement value	122	0,8	0,7	%
Contractor costs as a % of Maintenance costs	95	34,7	31,9	%
Training man hours as a % of Maintenance man hours	81	3,1		%
Preventive maintenance costs as a % of Maintenance costs	89	36,2		%
Preventive maintenance man hours as a % of Maintenance man hours	107	38,4		%
Corrective maintenance man hours as a % of Maintenance man hours	105	29,8		%
Planned and scheduled man hours as a % Maintenance man hours	96	63,0		%
Actual operating time / Nr of immediate corrective maintenance events	66	241,1		hours
Immediate corr. Maint. time / Nr of immediate corr. maint. events	59	6,9		hours

Table 5. Results from the Avearge Nordic Plant

8. International benchmarks

The result from the Nordic Benchmarking analyses gives a picture of the Maintenance and the Production efficiency figures in Denmark, Finland and Sweden.

In order to get a picture of the potential for improvements the figures from the Nordic average plant is compared to "World Class" organisations
"World Class" companies are companies, which have an excellent performance in the area in question, in this case Production efficiency and Maintenance

World Class figures comes generally from the process industy such as Petrochemical industry, the Chemical industry and from the Car manufacturing industry.

World Class figures may not be applicable in other branches such as wood processing industry.

	Nordic Benchmark analysis	World Class
OEE	76,4	>90%
Actual operating time as a % Required operating time (Availability)	88,1	>90 - 95%
Maintenance costs as a % of Plant turnover	4,1	<3%
Maintenance costs as a % of Plant replacement value	3,0	<1,8%
Stores investments as a % of Plant replacement value	0,8	<0,25 %
Preventive maintenance man hours as a % of Maintenance man hours	38,4	40 %
Corrective maintenance man hours as a % of Maintenance man hours	29,8	5 %
Planned and scheduled man hours as a % Maintenance man hours	63,0	>90

Table 6. World class figures

9. Use of Key figures in maintenance

Working with maintenance gives you many challenges. The most important is to establish visibility and understanding for your results and your performance when managing maintenance and production efficiency.

The challenge is highlighted from the facts that today's management in general has a limited knowledge of maintenance and their available time to focus on maintenance are limited.

This forces the maintenance manager to address his management in business terms and not as preferred in engineering or technical terms. One way to create understanding for maintenance is benchmarking based on key figures or key indicators.

How can the maintenance manager use the figures?
EFNMS who is the European Federation of National Maintenance Societies has responded to this challenge and has formed a working group - WG7 - with the task of selection a number of benchmark indicators, that was selected by maintenance managers and regarded as important when measuring maintenance performance.

The Working Group has been working since May 1998 and presented their benchmark indicators including supporting definitions in May 2001.
Getting the right indicators was very easy. A master list of proposed indicators was issued to the members in the EFNMS societies, and based on the survey form the working group selected the 13 most important key figures. The next step was to define the indicators.
For instance is the term "Maintenance Costs" is very common used, but when it gets to define it, including looking at the definitions from 8 countries we were facing a challenge. After a number of useful discussions the Working Group succeeded in defining the definitions of the guidelines for the 13 benchmark key figures, which was approved in may 2001 by the EFNMS council.

The working group hopes that the maintenance manager will use the guidelines as a tool. First of all to measure the performance of his/her organisation and to create an understanding of the achieved maintenance results at higher level in the organisation.

Focus on Maintenance
The Nordic Maintenance Societies has conducted a number of benchmark analyses in Denmark, Finland and Sweden. The response from the members and the industry in general has been, that not only is the analysis an useful tool to compare their own performance with, but also to get inspiration from, as have to improve techniques and to get their organisation of maintenance improved.

Analyses like these attract the attention to maintenance and improvement of production efficiency on, not only at plant level but also on a national level.

Implementing in a organisation
After presenting the key figures and the definitions to the maintenance managers they most often reply "How do I get started".
There is no easy answer to this question. First thing onc has to realise is that implementing a benchmarking systems or performance measurements, is not a project with a fixed starting and a fixed finishing deadline. It is an ongoing process
Benchmarking and performance measurements is a process that has a starting date and evolves as the business goals and challenges changes and develops within the business. As the years go by new goals will appear and goals implemented in the beginning can change or become obsolete.

One procedure to implement benchmarking or performance measuring in maintenance is listed below:

- Get a sponsor in the organisation who is interested in benchmarking and key figures and can provide the resources and support to the project
- Provide information on background and goals for establishing benchmarking
- Decide the structure for the benchmarking and the key figures. This involves decision on way of presentation, structure for key indicators (triangle or Balanced Scorecard)
- Selection of important strategic plans or areas in the organisation which must be measured.
- Analysis and description of key indicators used presently by the organisation or key indicators used in the market or in the branch
- Selection of the most important key figures to be included in the benchmarking system
- Description and analysis of the required data's to produce the key figures and their sources
  This is the most difficult and time consuming task which one should never underestimate
- Distribute the responsibility for the data collection to the benchmarking system on one person

- Produce benchmark indicators in version 1 and adjust after 2 - 3 months

The procedure has successfully been used in projects for maintenance and engineering organisations in setting up a benchmarking system.

Experiences from benchmarking
The experiences gained from the implementation of benchmarking in a plant and in similar projects are:

- Higher degree of the staffs understanding for own participation to department or plant results
- It attracts focus to areas which needs improvement
- It also attracts focus to areas with an excellent performance
- It motivates the employees in maintenance
- Benchmarking generates an understanding to each individual on how he or she can contribute to improved plant performances
- Ability to compare own performance with market average

It is the hope from Working Group 7 that the figures and the definitions from the 13 EFNMS figures will be used when you construct your system for performance measuring.

10. EFNMS and EFNMS Nordic

The European Federation of National Maintenance Societies (EFNMS) was formed in November 1970. The EFNMS is a non-profit organisation whose objective is the improvement of maintenance for the benefit of the people in Europe. The results of the Federation's work will be made available for general use.

There are a number of Working Groups within EFNMS: Terminology, Trends, Training, Certification, Buildings and Benchmarking. This Nordic Benchmarking Analysis has used the Key Performance Indicators who have been decided as the most important ones by the EFNMS Benchmarking Working Group.

At the moment the sixteen National Maintenance Societies from Belgium, Croatia, Denmark, Finland, France, Germany, Great Britain, Ireland, Italy, Norway, Portugal, Slovenia, Spain, Sweden, Switzerland and The Netherlands are members and the National Maintenance Society of Slovakia is an observer.

Within the Nordic countries there is a close co-operation between the National Maintenance Societies from Denmark (DVS), Finland (KPY), Norway (NVP) and Sweden (UTEK).

11. Presentation of The National Maintenance Societies

11.1 DDV

The Danish Maintenance Society (DDV) was originated in 1978, with the purpose to exchange experiences and knowledge within Danish companies in the field of maintenance. In order to optimize the income and improve production efficiency, the companies must organise their maintenance.
DDV deal with the newest methods and advantages when implementing productive Maintenance, and thereby improving the understanding of the efficiency of the impact Maintenance has on the productivity, quality, environment and safety annd the connection between work environment, outer environment and maintenance.

DDV is an independent non-profit non-governmental organisation witch represents a broad spectre of members. This shown in the circle of the momentary members, such as industry, service companies, construction, architect, consultant, engineer, research and educational institutes, insurance's companies etc.
In one way or another, all the members are working with maintenance, in common, either as user, consultant or supplier. The organisation builds its activities on involvement rather than personal profit.

Home page for DDV: http://www.ddv.org

11.2 KPY

The 'Committee of Maintenance Affairs' founded originally in 1958, was later registered and changed into an association in 1972. It was then renamed as the 'Factory Service Society'. By the amendment of the Articles in 1992 the name was further changed into Kunnosapitoyhdistys ry. (Finnish Maintenance Society).
Finnish Maintenance Society's mission is to improve knowledge on maintenance issues by acting independently but in collaboration with different organisations.

The society circulates information on issues of research & development in the field of maintenance by arranging congresses and training, and publishes magazines named 'KUNNOSSAPITO' (Maintenance) and 'KUNNOSSAPIDON OSTO-OPAS' (Purchasing Guide To Maintenance). These publications are included in the membership benefits. The society also publishes materials for training and educational purposes (Basics of Maintenance, Vibration Measurements As Condition Monitoring Tool).
Finnish Maintenance Society takes initiatives to develop training & education in the field, engages in research & development work, and establishes contacts with organisations and communities both at home and abroad.
Together with its affiliate company KP-Media Oy the society organises special fairs and exhibitions accompanied with high-level congresses.

Home page for KPY: http://www.kunnossapito.fi

11.3 UTEK

The Swedish Maintenance Society, UTEK (Föreningen Underhållsteknik), that is a non-profit organisation, was formed in 1969. (UTEK is also one of the founders of the EFNMS.)

The aim for UTEK is to exchange knowledge and experiences among its members as well as to develop the areas of availability performance, maintenance and preserving of capital investments in assets (in production and buildings).

The members of UTEK are from the industrial and the building sectors, the transportation and communication sector, the schools and research organisations and from service companies.

UTEK arranges central and regional conferences, courses and seminars. UTEK has a member magazine and literature for sale and a library. UTEK perform maintenance audits and is acting as the official technical committee for Swedish standards in maintenance.

UTEK has a number of committees and projects in Benchmarking, Facilities, Human resources, Maintenance contracts, Research and Development, Terminology and Training.

Home page for UTEK: http://www.utek.se

12. Production efficiency and Maintenance in three Nordic countries in 2000

Key Figures: Means	Finland	Sweden	Denmark	Processing of food	Chemical industry	Metalproducts and electronics	
Company holds a quality certification (ISO 9000 or equivalent)	82,5	88,9	76,5	88	94,7	100	%
Company holds an environmental certification (ISO 14001, EMAS or ...)	71,4	72,2	41,2	64	78,9	37,5	%
Strategy for resources							
a) Primarily internal resources	70,6	88,9	88,9	48	94,7	78,3	%
b) Primarily external resources	9,5	11,1	5,1	4	5,3	4,3	%
c) Maintenance is totally out-sourced	19,8	0	5	48	0	17,4	%
Plant turnover	144,6	172,6	109,9	79,1	207,7	83,5	million euros
Plant replacement value	201,3	247,2	122,6	70,0	292,5	71,8	million euros
Age of physical assets	15,9	17,9	13,8	13,9	17,3	13,3	years
OEE	78,0	78,2	70,8	67,8	82,7	78,5	%
Utilisation rate	71,8	81,8	77,6	56,2	94,3	53,0	%
Availability	90,1	91,7	88,5	85,0	95,1	87,9	%
Shift work rate	3,3	4,2	3,3	2,5	4,4	2,5	1-5
Production operatives	216,1	193,4	399,3	122,1	145,2	340,1	Number
First line maintenance operatives	46,5	30,6	30,0	19,0	42,3	16,0	Number
Maintenance costs / Plant turnover	4,1	4,6	3,5	3,4	5,2	1,9	%
Maintenance costs / Plant replacement value	3,4	2,1	3,3	3,3	2,6	3,9	%
Stores investements / Plant replacement value	0,8	0,8	1,0	1,1	0,9	0,6	%
Contractor costs / Maintenance costs	36,5	34,7	20,5	38,6	34,4	30,4	%
Training man hours / Maintenance man hours	2,1	4,8	4,9	3,4	4,0	3,9	%
Preventive maintenance costs / Maintenance costs	36,8	35,1	38,0	39,3	42,8	30,6	%
Preventive maintenance man hours / Maintenance man hours	38,0	38,3	43,2	42,0	44,7	31,7	%
Corrective maintenance man hours / Maintenance man hours	34,0	18,0	26,0	34,0	16,8	41,4	%
Planned and scheduled man hours / Maintenance man hours	65,9	56,0	46,0	60,8	81,1	48,0	%
Actual operating time / Number of breakdowns (MTTF)	99,7	583,2	74,4	129,1	725,1	172,9	hours
Corrective maintenance time / Number of breakdowns (MTTR)	7,2	9,4	4,2	5,3	11,3	5,9	hours

Some key figures in Finnish Industry	*Wood industry*	*Pulp and paper*	*Manufacture of steel etc.*	
Plant replacement value	45,9	556,0	350,5	million euros
Maintenance costs / Plant turnover	5,1	5,1	4,4	million euros
Maintenance costs / Plant replacement value	4,6	3,1	4,4	%
Contractor costs / Maintenance costs	24,7	41,4	43,8	%
Training man hours / Maintenance man hours	0,9	2,2	1,8	%
Preventive maintenance man hours / Maintenance man hours	31,9	37,2	33,8	%

13. Appendix 1 Benchmark definitions

Definitions for terms used in the questionnaire fotm Revised 4th December 2001

A general definition
The European standard for maintenance terminology distinguish between **maintenance** and **modifications**

Maintenance
The combination of all technical administrative and managerial actions, intended to retain an item in, or restore it to, a state in which it can perform a required function

Modifications
The combination of all technical administrative and managerial actions with the purpose of changing the function of an item

NOTE: Modification is not included in the scope of maintenance if the task means a change in the function of the item.

The above mentioned note means the modifications and installation task performed on the item must be withdrawn from the maintenance costs. (If it is difficult to quantify the scope of modification and installation tasks then make an estimate.)

3.1 Branch
The division into branches is based on the NACE standard for branches.
Insert local division together with NACE number based on table

4.1 Availability[A]

$$A = \frac{\text{Required operating time} - \text{Down time}}{\text{Required operating Time}} \times 100$$

Required Time = (See definition in 5.4 below)

Down time = Time interval during which the item is in a down state

4.2 Performance efficiency [P]

$$P = \frac{\text{Actual production}}{\text{Maximal production}} \times 100$$

Actual production = The number of units produced per time interval

Maximal production = The maximal number of units per time interval when producing (Equivalent to max capacity.)

4.3 Rate of quality products [Q]

$$K = \frac{\text{Actual production} - \text{Cassation}}{\text{Actual production}} \times 100$$

Cassation = Produced number of products outside quality specifications

4.4 Overall Equipment Efficiency [OEE]

OEE = A x P x Q

The following definitions are based on the EFNMS guideline for benchmark definitions

EFNMS Working Group Benchmarking

The Benchmarks and the guideline for definitions was approved at the council meeting May 2001

5.1 Turnover of company site

Turnover is the net turnover of a company or a plant including deliveries for other plants of the company and production for own use. Net turnover is company or plant sales minus discounts, allowances and value added taxes (or other sales taxes.)

5.2 Plant Replacement value

The term Plant Replacement Value (PRV) is defined as the amount of capital that would be required to replace the plant. This is not the book value nor the current cost accounting value nor costs to build a state of the art replacement.
PRV is an estimate of the current costs to replace in kind what now exists.
(Normally the insurance value)

5.3 Total available time

The term total available time, means the theoretical amount of time the production equipment has the potential to produce.
(In general the total available time is 24 x 365 hours per year.)

5.4 Required operating time

The term required operating time is the number of hours the production equipment (item) is required to perform a required function by the user.
Required operating time includes transition (tool change, required process cleaning) time.

5.5 Actual operating time

The term actual operating time is defined as the number of hours the equipment (item) is performing its required function.

6.1 Maintenance costs

- Direct wages for direct maintenance staff (first line maintenance)
- Salaries for managerial and support maintenance staff
- Payroll added costs for the above mentioned persons (Taxes, Insurance, Legislative contributions)
- Spares and material for direct use in maintenance
- Spares purchased for inventory
- Consumables charged to maintenance
- Tools and equipment for maintenance purposes
- Contractor costs
- Costs for consultancy services in maintenance
- Administration costs for maintenance
- Costs for education of maintenance staff
- Costs for maintenance carried out by production staff
- Overtime for maintenance staff
- Costs for transportation, hotels, etc
- Costs for documentation, CMMS and Planning Systems

Exclusions:
- Depreciation of maintenance equipment
- Costs for product changeover or transaction time (Exchange of dies e.g.)
- Downtime costs

6.2 Contractor costs

Contractor costs include hours, spares, materials, equipment and transports delivered or used by contractor for the maintenance work.
(In general the amount stated on the invoice.)

6.3 Values of stores investment

The term stores investment is the amount of capital invested in spares, strategic parts and consumables used for maintenance.
(Items normally not depreciated.)

6.4 Preventive maintenance costs

The proportion of Maintenance Costs spent on preventive maintenance.

Preventive Maintenance is Maintenance carried out at pre-determined intervals or according to pre-described criteria and intended to reduce the probability of failure or degradation of the functioning of an item.

6.6 Maintenence man hours

Maintenance man hours is the number of hours available per time unit for the company's own first line maintenance craftsmen (mechanics, electricians).

If production staff conducts proportions of maintenance work the number of hours from production staff are added.

6.7 Training man hours

Man hours used for maintenance training for crafts and operators.

6.9 Preventive maintenence man hours

Preventive maintenance man hours is the number of hours spent on preventive works for first line maintenance craftsmen (mechanics, electricians).

If production staff conducts parts of preventive maintenance the number of man hours from production staff (if available) are added to preventive maintenance man hours.

6.11 Immediate corrective maintenance man hours

Hours spent on immediate corrective maintenance by first line maintenance staff. (Breakdown maintenance man hours.)

6.13 Planned and scheduled man hours

Predetermined number of man hours by first line maintenance staff to be used on planned and scheduled tasks.

Planning:
Tasks are defined in such a way that safety considerations, special tools or procedures, tolerance standards, required replacement parts or material are defined with an estimate of the downtime and man hours required to complete the work. All this information is available to the first line maintenance staff performing the work before it starts.

Scheduling:
To establish a time schedule, or the number of units of use, indicating when maintenance should be performed.

6.15 Immediate Corrective Maintenance Time

(Measured on item)
Number of hours measured on item where: a fault is detected, the item is in a down state, and immediate corrective maintenance is required on the item, including technical and logistic delays inherent in the immediate corrective maintenance.

6.16 Number of immediate corrective maintenance events

Number of occasions where a fault is detected, the item is in a down state and immediate corrective maintenance is required on the item.