

The majority (70%) of the companies are SMEs (Small and Medium-sized Enterprises), with fewer than 200 employees. Most of the companies have over 100 employed in the production department, and less than four in the maintenance department. Cooperation between these departments is generally quite good. A minority classified this as extremely good cooperation.

Every company has prepared a list of the prime targets for their industrial activities. These are mainly based on the company having sound financial management, being a market leader, and a reliable and credible supplier, with a real increase in productivity and turnover each year.

In around 20% of the companies, maintenance has a lower status than production.

2.2 Maintenance department

26% of the companies report that no personnel have maintenance as their main task. The majority have less than three of their senior personnel engaged in maintenance work.

The maintenance supervisor usually has the title of maintenance manager, and is frequently an engineer by profession. In smaller companies that lack a specific group with maintenance as their main task, a skilled workman is often responsible for maintenance.

A summary of the replies indicates that many supervisors have limited knowledge of modern maintenance principles.

Maintenance supervisors rarely take part in conferences, courses, seminars, etc. concerned with maintenance; most take part less than once a year.

About 56% of the companies have no formal maintenance and availability objectives. Of those that have defined such a goal, very few have made it sufficiently concrete for follow-up work and testing.

Most of the companies have a centralised maintenance section.

The levels of competence and skill in the maintenance department are thought to be generally quite high. This is particularly reported to be satisfactory in the mechanical and electrical sectors. The areas where more expertise is required are: instrumentation, automatisisation, reporting and quality control.

The work load in the maintenance department in about 45% of the companies is large or extremely large, and is increasing in about 22% of the companies.

It is very important to have specific maintenance and availability objectives, and use key variables in the maintenance management.

These results indicate that more companies should give priority to maintenance management.

2.3 Maintenance activities

Around 40% of the companies have prepared a preventive maintenance programme, mostly covering only equipment with a high purchase price. This programme has mainly been prepared on the basis of a combination of information from the equipment supplier, corresponding equipment, reference manuals dealing with the equipment and their own past experience. In nearly half the companies, preventive maintenance constitutes less than 30% of the total maintenance activities (see Figure 2).

The companies have the impression that this proportion is too small and they want more preventive work to be done (see Figure 3).

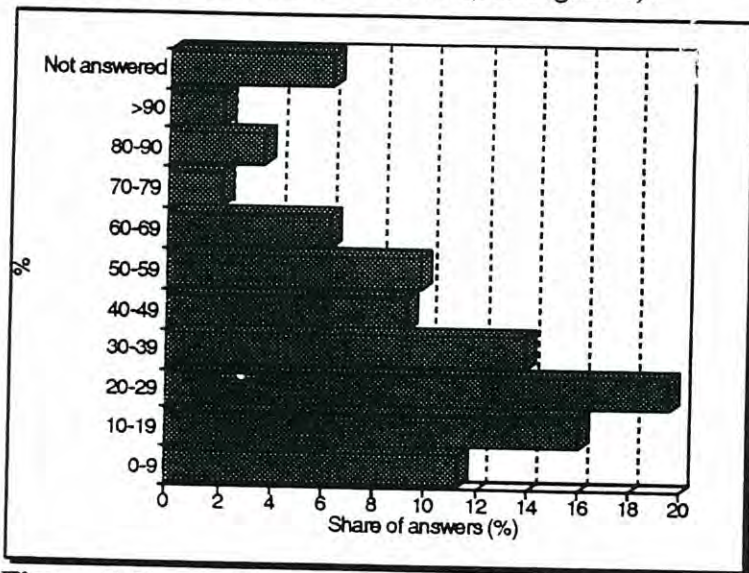


Figure 2 Share of preventive maintenance in maintenance activities.

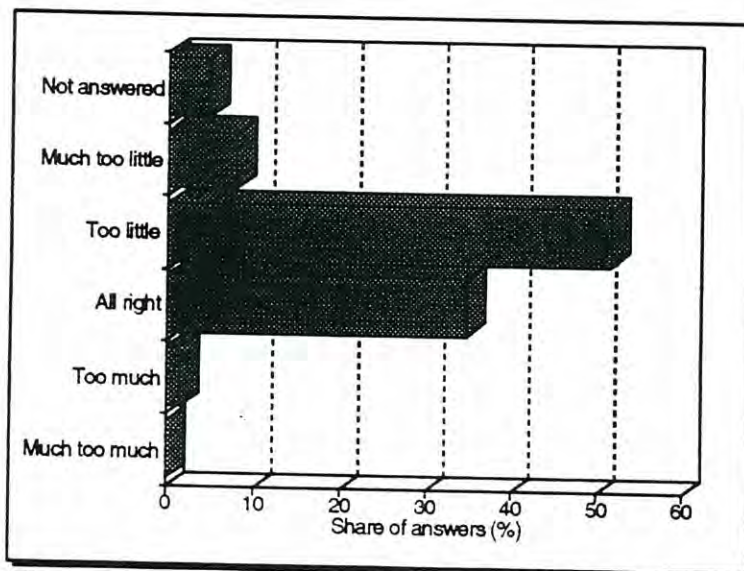


Figure 3 The companies subjective impression of their current share of preventive maintenance.

A system for determining an order of priority for carrying out maintenance work is used by about 54% of the companies.

Condition monitoring is carried out in about 60% of the companies. This mainly consists of visual inspections, vibration analysis, pollution control and oil analysis. The use of condition monitoring has often resulted in efficiency improvements, increased safety and large savings.

The most common reason for faults and failures is general wear and tear, but wrong use of equipment during production is also a considerable factor.

In most companies only the large jobs are planned.

Very few companies have production equipment that is very accessible for maintenance.

A small number of companies experience problems associated with the availability of spares. In most cases, it is high-cost parts that cause the waiting time.

Manuals have been prepared for the most usual maintenance activities. Their quality is quite good.

In about 77% of the companies, production personnel carry out the simple maintenance tasks.

The quality and efficiency of both their own and hired personnel is satisfactory, according to most companies.

Companies which reported unsatisfactory efficiency in their maintenance work, refer to faulty procedures and routines as being the main reasons.

One conclusion is that a lot of the maintenance activities are carried out more or less by chance. This may be caused by the lack of maintenance objectives and strategies.

2.4 Information systems in maintenance work

About 27% of the companies use a computer-based maintenance system, about 33% a manual system, and 40% have no system at all.

The companies that have a computer-based system are often larger ones with their own maintenance department. Very few of the smaller companies have such a system.

Computer-based maintenance systems in industry today are relatively new. The most frequent are standard commercial or modified standard commercial systems.

A specification of requirements had been worked out for about 78% of the systems. This had resulted in the implementation going quite well in more than half the companies.

User training should have been given more consideration. Other factors which the companies consider could have been improved are:

- better specification of requirements
- better reasons or aims for implementing the system
- better information given to the employees
- better motivation of management and staff

Few companies make full use of the potential offered by such systems. This may be because more comprehensive training of operators is needed.

Few companies make a complete input of data into the system. In about 60% of the companies, only the personnel in charge of maintenance carry out the input operation. The quality of the input data is quite good, but only 4% think it is extremely good. If the company is to be in a position to make use of these data, the quality must be very good because the data extracted from the system are a direct function of the data fed into it.

Comparing the situation before and after the introduction of the computer-based maintenance system, the efficiency of the maintenance function is said to have been improved in nearly every company.

Only about 31% of the companies that do not use a computer-based system think that their manual method is satisfactory. About 14% reply that the costs of purchasing and implementing such a system are too high. Only 5% consider they have no need for a computer-based system.

2.5 Maintenance costs

The maintenance costs vary from NOK 3500 up to NOK 200 million, the average is about NOK 2.5 million (median).

The firms define maintenance costs in different ways. Many use the following division:

- manhour costs
- spare parts and consumables

Few companies are able to supply a precise apportionment of costs.

The largest maintenance costs are attached to mechanical, electrical and constructional/HVAC.

Very few companies include calculations of lost production in the event of down time and stoppages.

The key variables are presented in more detail in Sections 3 and 4.

Maintenance costs seem to be quite high. The companies have to use modern maintenance principles, and work out new activities to increase availability and reduce maintenance costs.

2.6 Down time and stoppages

In almost 60% of the companies, maintenance work is the major cause of down time and production stoppages.

The entire production has not been closed down during the last three years in about 40% of the companies. Planned stoppages constitute an extremely small proportion of stoppages in most companies. Around 40% of the companies have less than 30% planned stoppages (see Figure 4). Hence, unforeseen incidents cause the remaining proportion of stoppages.

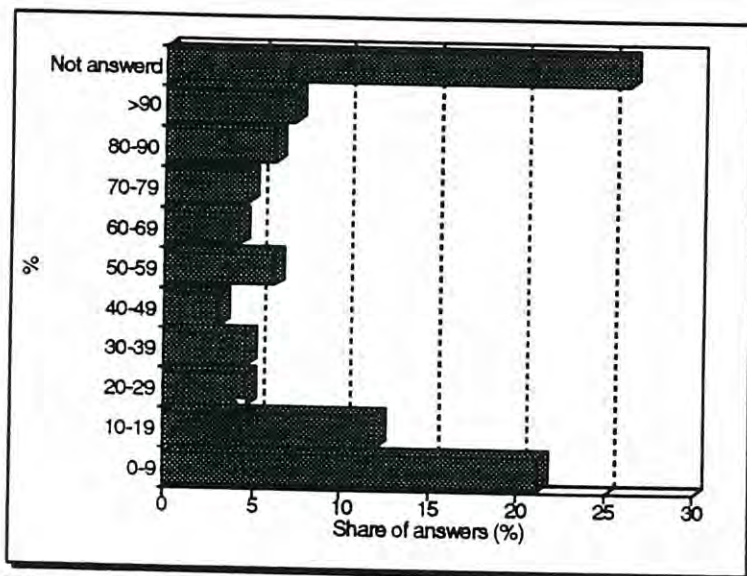


Figure 4 Share of planned stops.

About 40% of all the companies have not calculated the availability of the production equipment. Most of the companies that have calculated this figure have an availability from about 90% and upwards. Their aim is to be in the area of 95-99%.

It is important to have an effective maintenance system and a preventive maintenance programme for reducing stoppages.

2.7 Maintenance during planning

In about 73% of the companies, the maintenance supervisor participates in the preparation of the specifications of requirements when new equipment is being purchased.

When investing in new equipment, most companies base their choice on the purchase price and the way the equipment functions.

It is important that the maintenance department is represented in the preparation of specifications and requirements to ensure that maintainability is taken care of.

2.8 Safety

Safety with regard to personnel injury is generally quite high in Norwegian industry. The companies consider that only minor improvements are needed to raise the evaluation of safety to very high. If safety is to be improved, employee training particularly needs attention. More emphasis should be placed on preparing better working instructions and procedures and on installing protective devices in existing equipment.

Most companies cite human error as being largely responsible for personnel injuries. Human error is a very vague term, so it is important to examine the underlying reasons.

Most personnel injuries occur during production work (68%), but many (29%) also occur during maintenance work. If we examine this ratio in relation to, for instance, the numbers employed in production compared with the numbers employed in maintenance, it may indicate that the risk level in carrying out maintenance work is significantly greater than in production work. This needs to be evaluated and appropriate safety measures should be implemented. The vast majority of the companies use the National Insurance Administration form when registering accidents involving personnel injury. Both serious and minor personnel injuries are registered, and many companies also record near-accidents.

Much important information is inadequately registered on the National Insurance Administration form. For instance, no information is given about the reasons behind the accident, such as training, stress, ergonomics, procedures, etc. This leads to information not being used constructively to improve safety.

2.9 Future maintenance

The companies consider that demands will be made for greater use of preventive maintenance to increase the availability of the equipment. There is also a desire for improved maintenance efficiency (see Figure 5).

Proposals for improving maintenance work are largely linked to:

- increasing the proportion of preventive maintenance
- giving maintenance work higher status
- improving the organisation of the maintenance work
- raising the level of competence and skill in the department
- preparing a programme for preventive maintenance
- introducing a computer-based maintenance system

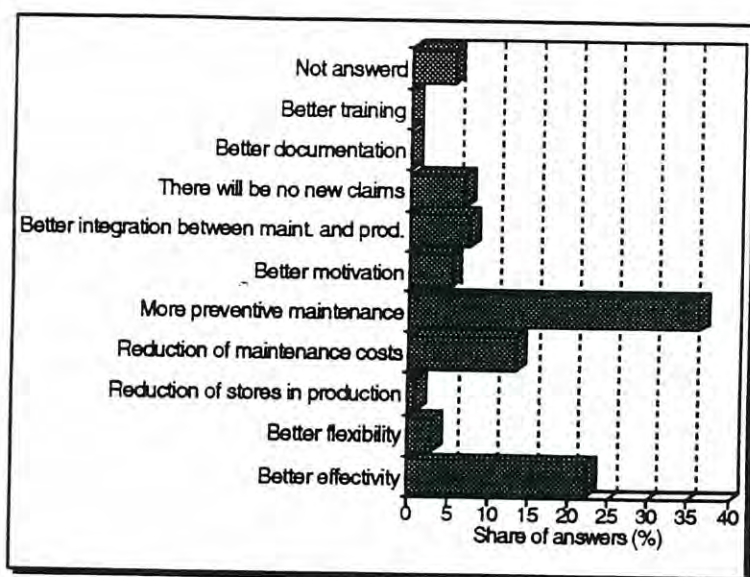


Figure 5 Future claims.

About 15% of the companies think that the existing offer of courses in this sphere are unsatisfactory, whereas about 32% have no definite opinion on the matter. This should indicate a need to increase the offer of courses in this field.

The future courses should first and foremost deal with:

- modern principles for maintenance
- computer-based maintenance systems
- quality of maintenance carried out
- organisation
- fault-localisation routines
- condition monitoring

3 THE AVERAGE NORWEGIAN COMPANY

This section gives the present status of maintenance in an average Norwegian company. The figures in this chapter are mean values and in some cases medians, depending on what was thought to be most descriptive for the average company.

The company

- the company has a turnover of NOK 82 million
- the production equipment is on average more than 10 years old
- the company has less than 200 employees
- the company has a production department with more than 100 employees
- the company has 7 employees in the maintenance department
- maintenance has the same status as production
- the most usual key variables are:
 - maintenance cost / production cost

- down time
- budgeted maintenance costs / actual maintenance costs

Maintenance department

- the company has a maintenance department or section
- the maintenance department has one supervisor
- the maintenance supervisor is a trained engineer
- the maintenance supervisor sometimes takes part (less than once a year) in conferences, courses, seminars, etc. on maintenance
- the company has no formal maintenance and availability target
- the maintenance function is centralised
- the work load in the maintenance department is large

Maintenance activities

- it takes on average less than 15 min. from when a fault or failure is found until maintenance work is started
- placing priority on continued production rather than maintenance is the usual cause of this waiting time
- the company uses a system of priorities for carrying out maintenance activities
- condition monitoring is used for some selected machines
- experience gained using condition monitoring is:
 - less down time
 - improved safety
 - less corrective maintenance
 - lower total maintenance costs
- a common cause of fault or failure is general wear and tear
- 35% of the maintenance activities are preventive
- the company considers that the proportion of preventive maintenance is too small
- no preventive maintenance programme has been developed
- the equipment is quite good with regards to maintainability
- unavailability caused by lack of spare parts does not represent any significant problem
- access to utility tools is quite good
- production personnel carry out simple, routine maintenance

Information systems in maintenance

- the average company does not have a computer-based maintenance system

The following gives a list of the average replies from companies that have implemented a computer-based maintenance system.

- the computer-based maintenance system is 3 years old
- the system is a standard commercial version
- better personnel training should have been given

- the modules included in the system are:
 - identification system (machine register)
 - job order section
 - preventive maintenance
 - control of spare parts
 - history
- proportion of maintenance activities that are fed into the system:
 - preventive maintenance 78%
 - corrective maintenance 74%
- maintenance supervisors feed data into the system
- the quality of input is quite good
- the efficiency of the maintenance function has improved due to the introduction of the computer-based maintenance system
- the reason why the average company has not implemented a computer-based maintenance system is that the manual method used today is satisfactory.

Maintenance costs

- the company has annual maintenance costs of NOK 2.5 million
- the maintenance costs consist of:
(the costs together add up to more than 100% because the figures represent the average in each category)
 - manhour costs of own staff 41%
 - manhour costs of hired staff 16%
 - spare parts and consumables 35%
 - manhour costs of production personnel who carry out maintenance tasks 12%
 - administration 6%
 - training 5%
 - tools 6%
 - workshop costs 8%
 - documentation 5%
- the distribution of the maintenance costs between different trades:
 - mechanical 55%
 - electrical 21%
 - construction/HVAC 15%
 - instrumentation 9%
 - automatisisation 10%

Down time/stoppages

- the most common cause of down time and stops in production are maintenance activities
- 30% of the down time is planned stoppage
- availability in the production plant is 90%
- the company thinks that a 7% increase in availability is realistic and economically justifiable

Maintenance in connection with planning

- maintenance supervisors help to prepare specifications on the need for new purchases
- the criteria used when new equipment is being purchased are:
 - purchase price
 - the way it functions

Safety

- the company registers accidents where personnel injury has incurred, on forms from the National Insurance Administration
- both serious and minor personnel injuries are recorded
- most accidents involving personnel injury are caused by human error
- the company believes that the following measures have the largest effect to improve safety with regard to personnel injury:
 - improved training of employees
 - improved working instructions and procedures
 - installation of protective devices on existing equipment and machines

Future maintenance

- the demands that will be presented to maintenance in the future are:
 - more preventive maintenance
 - higher efficiency
 - reduction of maintenance costs
- the following improvements are proposed:
 - give maintenance higher status
 - increase the proportion of preventive maintenance
- the company believes that the courses offered in the field are satisfactory
- future external courses should deal with:
 - computer-based maintenance systems
 - the quality of maintenance carried out
 - modern principles for maintenance

The figures show that:

- The maintenance costs share of the turnover of a sector is higher in most sectors in Finland.
- The maintenance costs share of the production equipment price is higher in Norwegian industry.
- The share of maintenance personnel in relation to the total no. of employees is generally higher in Finnish industry.

CLASSIFICATION OF INDUSTRIAL SECTORS:

1. Engineering industry
2. Iron, steel and other metal industries
3. Mining and quarrying
4. Food industry
5. Printing, publishing and allied industries
6. Woodworking industry
7. Wood processing
8. Chemical industry
9. Textile manufacturing
10. Energy production

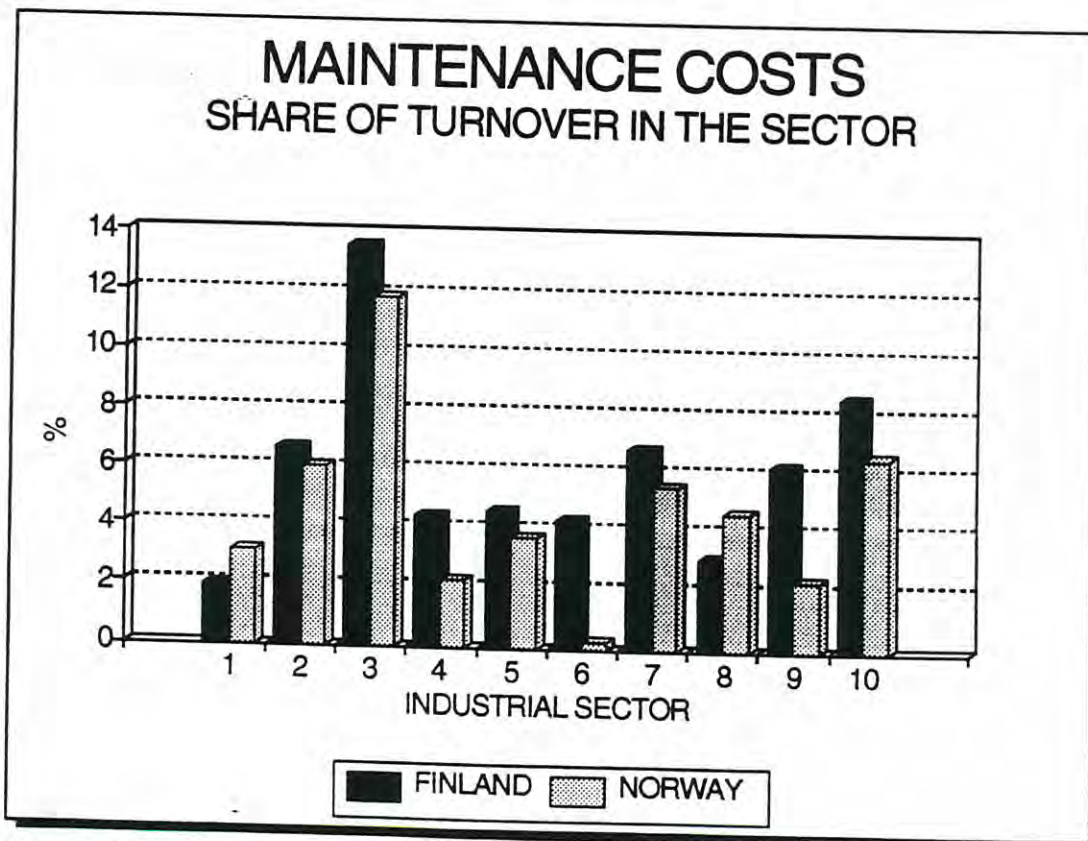


Figure 6 Maintenance costs share of the turnover in the sector.

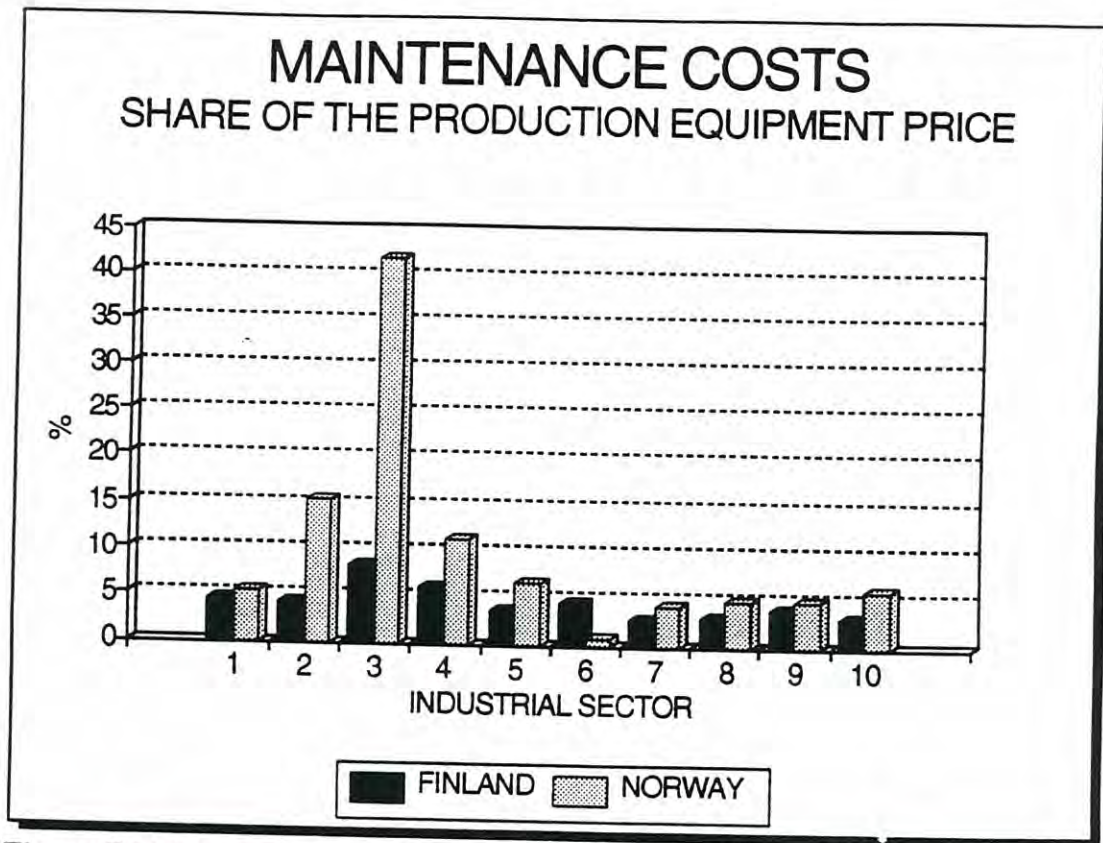


Figure 7 Maintenance costs share of the production equipment price.

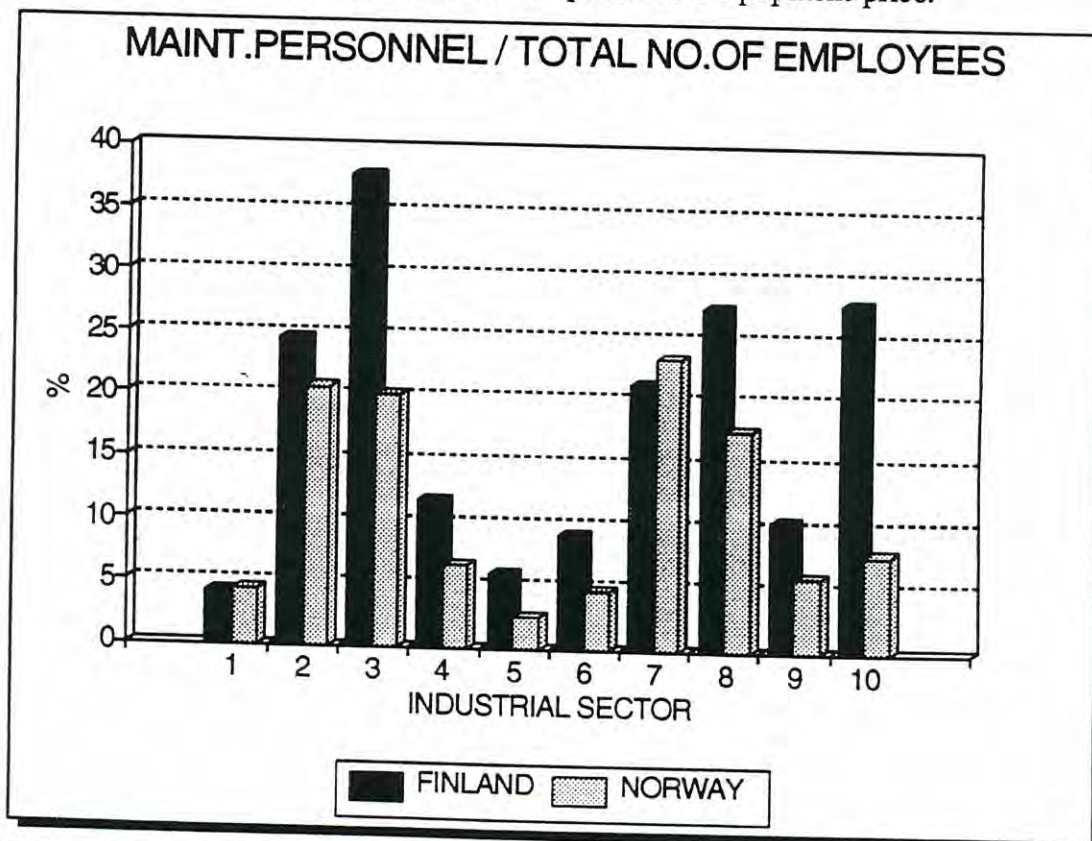


Figure 8 The share of maintenance personnel in relation to the total no. of employees.

5 FURTHER WORK

This is the most comprehensive project which has been done under the auspices of the Norwegian Society of Maintenance Engineers. We hope that other European countries will carry out corresponding investigations so it will be possible to exchange and compare data.

We have now started work on a report which will contain a more detailed discussion of the results and also a plan of action to create efficient operation and maintenance in industry. A Norwegian version of this report will be available in July 1992.

The results from the investigation will also be used in the planning of future courses in maintenance and availability.

EUREKA

European Benchmark Study on Maintenance

EBSOM - EU 724

Chapter 3



Kunnossapitoyhdistys ry.

Finnish Maintenance Society

Analysis made by Kunnossapitoyhdistys ry.

(Finnish Maintenance Society)

Maintenance in Industry 1991

1 December 1993



CONTENT

Page

1. Preface	2
2. The basis of the analysis	3
3. Key figures for maintenance	4
3.1 Maintenance costs	
3.2 Spare parts	
4. Maintenance methods	7
4.1 Distribution of maintenance costs	

Appendix

1. Average values for individual industrial branches in 1991
2. Questionnaire

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Kunnossapitoyhdistys ry.

Finnish Maintenance Society

Page 2

1. PREFACE

Kunnossapitoyhdistys ry. (Finnish Maintenance Society) is carrying out the EUREKA/MAINE project EBSOM (European Benchmark Study on Maintenance) together with maintenance associations in Denmark, Sweden and Norway.

The intention of the EBSOM project is that the result - key figures for maintenance - should be used by companies to:

- * pinpoint new areas for maintenance action
- * compare their own efforts and results with those of others
- * establish new maintenance goals.

In addition, the EBSOM project is to be used to clarify the question of which maintenance methods - organisational, technical and administrative - are most effective in the various countries and trades.

As part of the EBSOM project, the Research Committee of Kunnossapitoyhdistys ry. has carried out a questionnaire analysis on industrial maintenance from 1989 to 1992. This report deals with results from year 1991.

The results of the Finnish questionnaire analysis are presented in this report, which contains partly key figures (section 3), and partly an analysis of maintenance methods to determine the most effective with respect to minimising direct maintenance costs (section 4).

We hope and believe that this report will help to generate debate and development in the field of maintenance generally and at individual companies.

Research Committee of Kunnossapitoyhdistys ry.

1 December 1993

The members of the Research Committee were:

Harri Harjunpää Outokumpu Mining Services Oy
Rauno Kuoppala Pääesikunta
Ilkka Niemelä MET
Veli Siekkinen Tampere University of Technology
Hannu Tirinen OTSO

The numerical data were processed by:

Veli Siekkinen



2. THE BASIS OF THE KUNNOSSAPITOYHDISTYS ANALYSIS

The analysis made by the Research Committee of Kunnossapitoyhdistys ry. (Finnish Maintenance Society) describes maintenance in industry as it appears from the companies' responses to the questionnaire attached as Appendix 2.

The analysis is based on responses from 80 industrial companies. These companies account for approx. 12 % of the total turnover in Finnish industry and approx. 14 % of industrial employment.

It is primarily large and presumably well organised companies that have returned the questionnaire.

As will be seen from the following table of responses given as percentage of branch turnover, the representative value of the figures varies from branch to branch:

<u>Industrial branches</u>	<u>Response Percentage</u>
1 Mining industry	6 %
2 Manufacture of food and beverages	9 %
3 Manufacture of textiles, wearing apparel and leather goods	5 %
4 Manufacture of wood and wood products, excl. furniture	12 %
5 Manufacture of pulp, paper and paper products	12 %
6 Publishing and printing	4 %
7 Manufacture of chemicals and petroleum products	9 %
8 Manufacture of non-metallic mineral products	9 %
9 Basic metal industries	10 %
10 Manufacture of metal products, machinerys and equipments	14 %
11 Energy supply	10 %

The data for the average company have been processed on the basis of 80 companies in accordance with the distribution given above.

The classification of industrial branches used is the Standard Industrial Classification of all economic activities used by Statistics Finland (SIC 1988 Finland).

No results have been published from branches in which less than three companies have returned the questionnaire.



3. KEY FIGURES FOR MAINTENANCE

3.1 Maintenance costs

Maintenance costs include wages and salaries, spare parts, materials, external services, administration, etc. However, it has not been possible to include costs for production losses or decrease in value caused by insufficient maintenance.

For the following reasons, caution should be exercised when comparing key figures for direct maintenance costs:

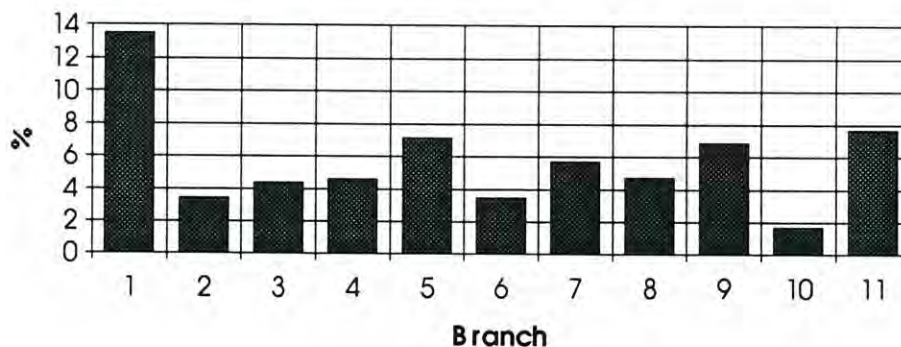
- * The basis differs - the age and quality of machinery and buildings differ.
- * Bookkeeping/accounting practice differs from one company to another.
- * Cost of unforeseen stoppages differs.
- * Different external requirements - for example, concerning safety.
- * The environment - corrosion, dust etc. - differs from one process to another.
- * Different attitudes to attrition/decrease in value.
- * Different attitudes to service level.

These differences are thus also reflected in a considerable spread in the key figures of the analysed companies.

Minimum, average and maximum values for key figures within the various branches are shown in Appendix 1.

Maintenance costs

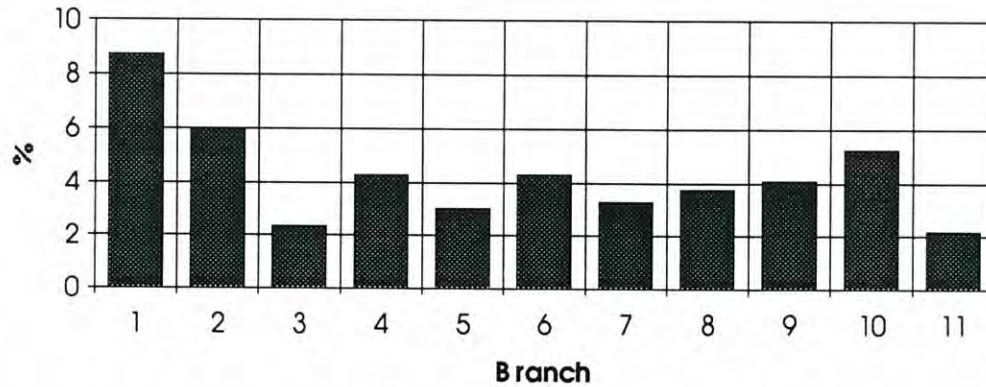
**Total maintenance costs in % of turnover in
1991**



On average, 4.8 % of the companies' turnover in 1991 was spent on maintenance - the same percentage as in 1990.

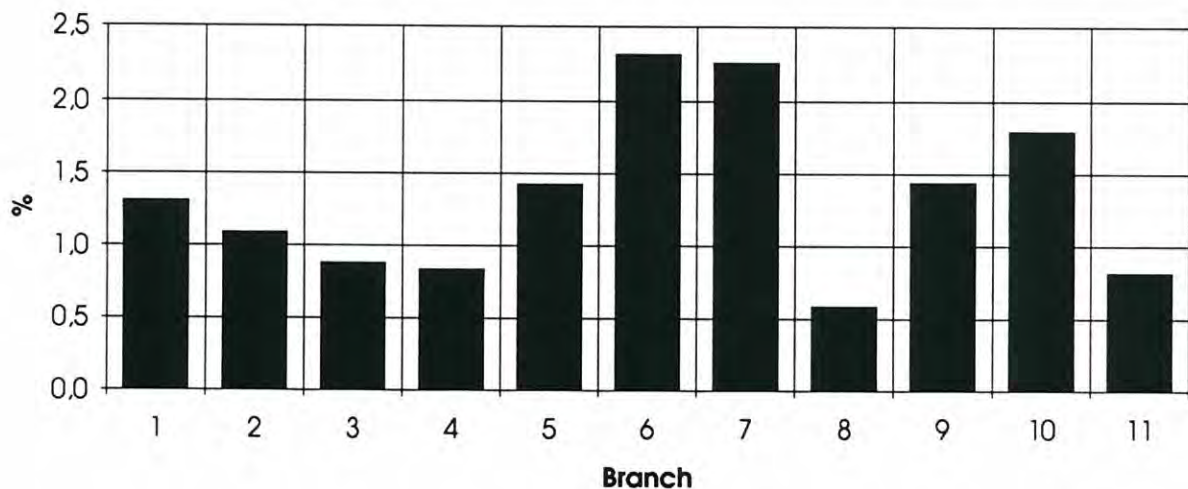


Total maintenance costs in % of production machinery value in 1991



On average, maintenance costs constituted 3.6 % of the value production machinery (replacement cost) in 1991, which is an increase 0.1 % compared with 1990.

Maintenance costs of buildings in % of their capital value in 1991

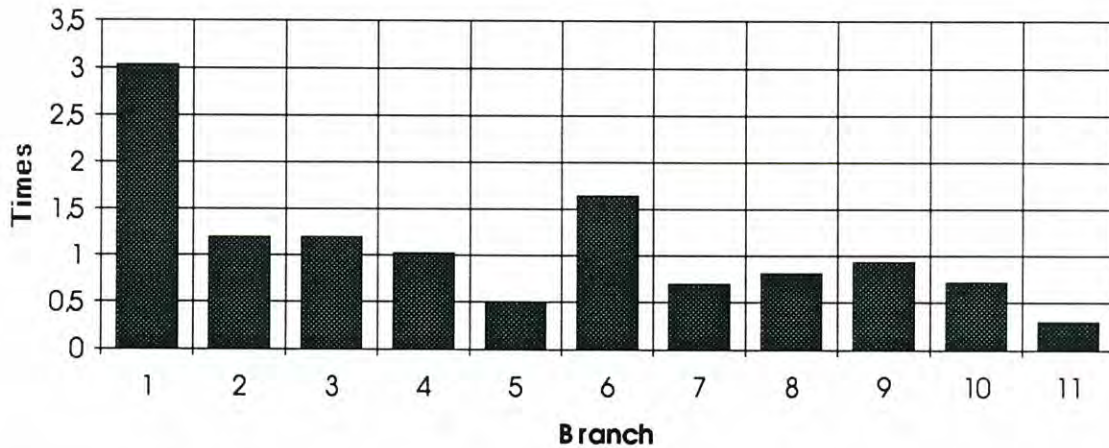


Maintenance costs for buildings is 1.4 % of the buildings' capital value, which is 0.2% higher than in 1990.



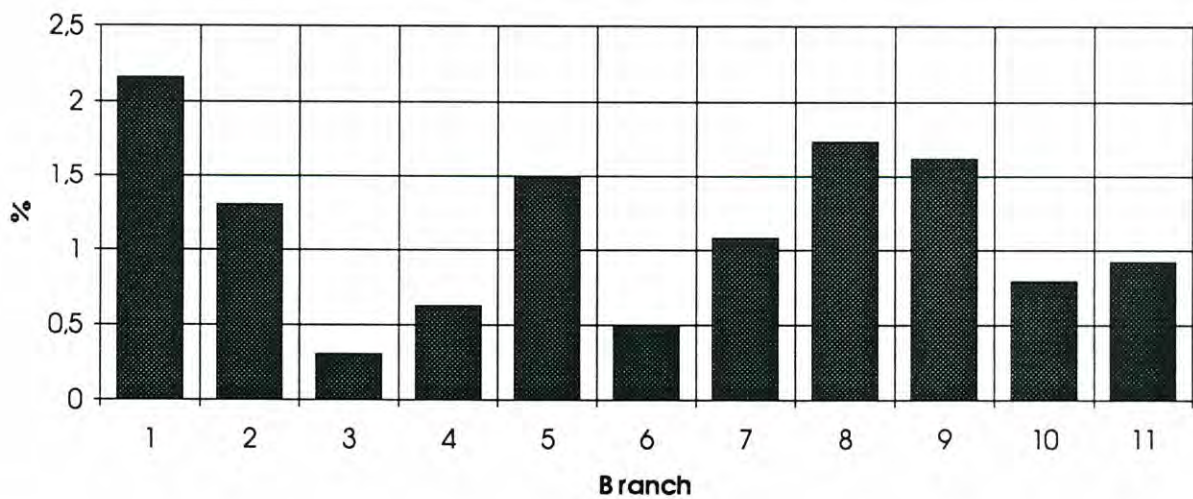
3.2 Spare parts

Circulating speed of maintenance material stocks in 1991



The average rate of stockturn decreased from 0.9 in 1990 to 0.7 in 1991.

Maintenance material stock's share in % of production machinery value in 1991



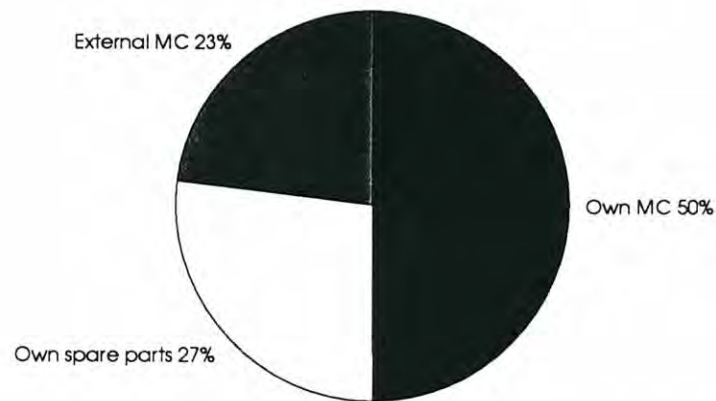
The average value was 1.3 % for the whole industry in both 1991 and 1990.



4. MAINTENANCE METHODS

4.1 Distribution of maintenance costs

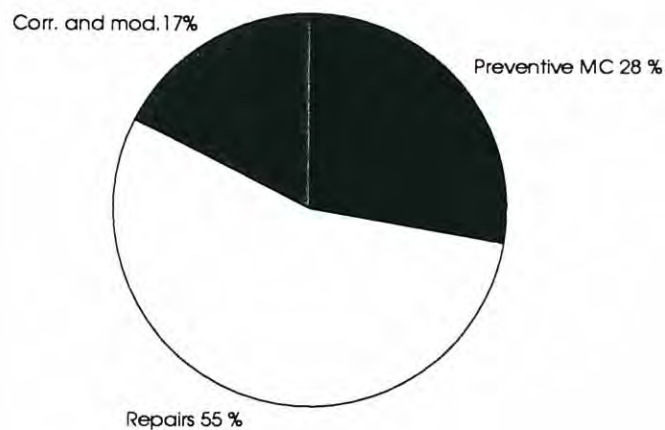
Distribution of maintenance costs in 1991



In an average company maintenance costs are distributed as shown in the figure with small variations from one branch to another. Administrative costs are included in own maintenance costs.

Preventive maintenance, repairs etc.

Distribution of MC of production machinery in 1991



About 60 % of all repairing works are planned.

MAINTENANCE ANALYSIS 1991

KUNNOSSAPITOMEDISTYS EY.

30.11.1993 VS

1	BRANCH NUMBER	Answers	1	2	3	4	5	6	7	8	9	10	11	Total	Average	Maximum	Minimum
			5	7	4	10	3	7	7	8	11	80					
2 BASIC INFORMATION																	
2,1	Turnover	Mmk	99,0	312,0	109,1	199,4	680,1	260,0	452,4	118,3	1022,8	689,3	187,5	33950,0	424,4	1022,8	99,0
2,2	Total personnel		133	373	342	395	621	417	457	178	1068	935	121	40290	503,6	1068	121
2,3	Three work shift	¥	80,0	28,6	50,0	60,0	100,0	100,0	57,1	28,6	75,0	0,0	50,0	4300,0	53,8	100,0	0,0
3 OWN MAINTENANCE PERSONNEL																	
3,1	Total maintenance personnel		40	37	35	39	133	15	102	14	278	32	38	6054,0	75,7	278	14
3,2	Personnel in central maint. org.		38	18	30	25	88	14	113	11	171	20	38	4352,7	54,4	171	11
4 MAINTENANCE COSTS (MC)																	
4,1	Total MC of production machinery	Mmk	12,3	8,7	3,7	8,1	43,2	6,3	20,0	5,0	60,2	7,8	12,0	1505,5	18,8	60,2	3,7
.1.1	Mechanical MC own	Mmk	8,0	5,1	3,0	4,6	24,7	2,7	13,3	3,3	35,4	3,0	5,0	860,4	10,8	35,4	2,7
.1.2	Mechanical MC external	Mmk	1,6	1,1	0,1	1,4	7,0	1,5	2,6	0,4	10,1	2,1	3,4	257,5	3,2	10,1	0,1
.1.3	Mechanical MC total	Mmk	9,6	6,2	3,1	6,0	31,7	4,2	15,9	3,7	45,5	5,1	8,4	1117,9	14,0	45,5	3,1
.1.4	Electr., instr. and autom. MC own	Mmk	2,2	1,8	0,5	1,7	9,5	1,3	3,5	1,2	11,1	1,6	3,0	305,1	3,8	11,1	0,5
.1.5	Electr., instr. and autom. MC ext.	Mmk	0,4	0,6	0,1	0,5	2,0	0,8	0,5	0,2	3,6	1,0	0,5	82,5	1,0	3,6	0,1
.1.5	Electr., instr. and autom. MC total	Mmk	2,7	2,5	0,6	2,1	11,4	2,1	4,0	1,3	14,7	2,7	3,6	387,6	4,8	14,7	0,6
.1.6	Total own MC	Mmk	10,2	6,9	3,5	6,2	34,2	4,0	16,9	4,4	46,4	4,6	8,0	1165,5	14,6	46,4	3,5
.1.7	Total external MC	Mmk	2,1	1,8	0,2	1,9	8,9	2,3	3,1	0,6	13,7	3,1	3,9	340,0	4,3	13,7	0,2
4,2	Total other MC	Mmk	1,1	2,0	1,0	1,1	5,3	2,7	5,9	0,6	10,0	3,9	2,4	284,2	3,6	10,0	0,6
.2.1	Other MC own	Mmk	0,9	1,0	0,7	0,8	4,8	0,7	5,0	0,3	7,3	2,5	1,9	210,0	2,6	7,3	0,3
.2.2	Other MC external	Mmk	0,2	1,0	0,3	0,3	0,6	2,0	0,9	0,3	2,8	1,4	0,6	74,2	0,9	2,8	0,2
4,4	All maintenance costs total	Mmk	13,4	10,7	4,8	9,2	48,5	9,0	25,8	5,6	70,2	11,7	14,4	1789,7	22,4	70,2	4,8
5 DISTR. OF MC OF PRODUCTION MACHINERY																	
5,1	Preventive maintenance	¥	29,6	25,0	22,8	23,3	30,6	21,7	22,0	26,7	32,7	24,5	43,6	2239,2	28,0	43,6	21,7
5,2	Repairs	¥	50,0	52,1	59,8	55,6	56,8	63,3	60,5	57,5	51,8	57,3	41,1	4366,1	54,6	63,3	41,1
5,3	Corrective and modifications	¥	20,4	22,9	17,5	21,1	12,7	15,0	17,5	15,8	15,5	18,2	15,3	1394,7	17,4	22,9	12,7
6	OVERTIME WORK	¥	4,0	4,0	1,5	3,9	4,3	10,2	3,3	6,5	3,2	2,9	3,2	317,0	4,0	10,2	1,5
7 CAPITAL VOLUME																	
7,1	Machinery and appliances of prod.	Mmk	13,4	179,5	203,0	215,5	1601,0	210,0	788,0	148,5	1720,3	223,0	666,7	49734,2	621,7	1720,3	148,5
7,2	Machinery and appliances of maint.	Mmk	2,6	4,0	0,3	3,0	13,1	1,1	28,9	1,1	26,0	3,6	20,1	823,1	10,3	28,9	0,3
7,3	Buildings	Mmk	84,4	184,2	114,3	130,8	375,1	116,7	260,1	104,2	696,1	219,6	298,5	20499,6	256,2	696,1	84,4
7,4	Total asset to be maintained	Mmk	240,3	367,7	317,5	349,3	1989,2	327,7	1076,9	253,8	2442,3	446,2	985,3	71056,9	888,2	2442,3	240,3
8 STOCKS OF MAINTENANCE																	
8,1	Annual consumption	Mmk	10,1	2,8	0,7	1,4	10,7	1,7	5,9	2,1	26,0	1,3	1,8	492,0	6,1	26,0	0,7
8,2	Mean tied-up capital	Mmk	3,3	2,3	0,6	1,4	23,8	1,0	8,5	2,6	27,8	1,8	6,1	658,6	8,2	27,8	0,6
8,3	Circulating speed		3,0	1,2	1,2	1,0	0,5	1,6	0,7	0,8	0,9	0,7	0,3	0,7	3,0	0,7	0,3

AN INQUIRY OF THE MAINTENANCE KEY-FIGURES OF SEVERAL INDUSTRIAL BRANCHES IN EUROPE IN 199__

CONTACT INFORMATION

Company: _____

Country: _____ Post address: _____

Contact person: _____ Tel. _____ Fax _____

1. INDUSTRIAL BRANCHES

- | | |
|-----------------------------|--------------------------------|
| 1. Mining | 7. Basic Chemical Industry |
| 2. Food Industry | 8. Construction Material Ind. |
| 3. Textile Industry | 9. Basic Metal Industry |
| 4. Saw Mills and Board Ind. | 10. Mechanical Engin. Industry |
| 5. Pulp and Paper | 11. Energy Generation |
| 6. Printing Industry | 12. Other _____ |

Additional information: _____

Notes: Used monetary unit _____ (M = Millions, B = Billions)
Ratio of used monetary unit to 1 ECU = _____/1 ECU

2. BASIC INFORMATION OF THE COMPANY OF 199__

- Turn over _____ money value
 - Total personnel _____, from which workers _____
- The main working shift system in production:
- One shift work Two shift work Three shift work (24 h/day)

3. OWN MAINTENANCE PERSONNEL (MEAN)

- Total _____ persons (sup.ind., foremen, clerks, craftsmen etc.)
- In central maintenance organization _____ persons
- In production organization _____ persons

4. MAINTENANCE COSTS

4.1 Maintenance costs of production machinery (Including salaries, overheads and material)

GROUP	OWN MAINT. COSTS	MAINT. COSTS PURCHASED OUTSIDE	TOTAL
- Mechanical M.C.			
- EC, Instrument and autom. M.C.			
4.1 Total			

4.2 Other Maintenance costs
(Industrial buildings and site/areas, industrial cleaning etc.)

	OWN WORK	FROM OUTSIDE PURCHASED WORK	TOTAL
4.2 Total			

4.3 Employee costs of Maintenance Organization
(Superint., foremen, secretary, clerks work planner and designers, planners etc.)

Number of employees _____
Cost of this personnel _____

- Includes in costs of 4.1 and 4.2 <input type="checkbox"/>	
- Not includes to 4.1 and 4.2 <input type="checkbox"/>	

4.4

ALL MAINTENANCE COSTS TOTAL (4.1 + 4.2 + 4.3)	
---	--

5. DISTRIBUTION OF MAINTENANCE COSTS OF PRODUCTION MACHINERY

- Preventive maint.	%
- Repairs	%
- Corrective and modification works	%
TOTAL	100 %

6.

- Overtime work of total working hours	%
--	---

7. THE CAPITAL VOLUME OF REAL ASSETS AND MACHINERY CAPITAL TO BE MAINTAINED (Replacement value or fire insurable value)

- Machinery and appliances of production	
- Machines and appliances of maintenance functions	
- Buildings	
Total assets to be maintained	

8. STOCKS (STORAGE) OF MAINTENANCE
(Stand-By machines in stock, spares, materials and utensils of maint.)

1. Annual consumption	2. Mean tied-up capital	1./2. = circulating speed

EUREKA

European Benchmark Study on Maintenance

EBSOM - EU 724

Chapter 4

Report

Key figures in maintenance in Swedish manufacturing industry

Swedish section of the EUREKA project EBSOM
(**E**uropean **B**enchmark **S**tudy **O**n **M**aintenance)

Föreningen Underhållsteknik, UTEK
Svensk industri
Närings- och teknikutvecklingsverket, NUTEK

EBSOM Group

Olof Malmholt
Leo Hagberg
Benny Halldin

4 November 1993

Föreningen Underhållsteknik, UTEK
Member of the European Federation of
National Maintenance Societies, EFNMS

Contents

1. Foreword	3
2. Summary	3
3. Background	4
4. Purpose of the project	4
5. Scope	4
6. Implementation	5
7. General experience of key figures	6
8. Results	7
8.0 Introduction	7
8.1 Presentation of data	7
8.1.0 General	7
8.1.1 General data	8
8.1.2 Financial data	9
8.1.3 Organisation	17
8.1.4 Supplementary analysis basis, operating time groups	17
8.2. The need for improvement	19
8.2.1 Introduction	19
8.2.2 Prioritising the need for improvements, total	20
8.2.3 The need for improvement according to branches of industry	21
8.2.4 The need for improvement according to operating time groups	21
9. The need for further research	22
10. Appendices (<i>not included in this translation</i>)	

1. Foreword

This project, which is the first of its kind in Sweden, is intended to examine certain aspects of maintenance activities in Swedish manufacturing industry.

The project has been executed by Föreningen Underhållsteknik, UTEK, and has been funded with contributions from NUTEK and industry. Those in charge of the project were: Olof Malmholt, Malmholt konsult AB, project manager, Leo Hagberg, L C P AB, and Benny Halldin, Röset AB.

The initiative came from the Danish maintenance association who aroused the interest of the European research organisation EUREKA and also involved the other Nordic countries' maintenance associations in corresponding surveys.

The project group wishes to extend its warmest thanks to those who provided information and who, despite pressure of work, filled in and returned the questionnaire. We would also like to thank Jan Frånlund, UTEK, who was responsible for overall contact with NUTEK and EUREKA, and those who helped us to test the questionnaire and provided other useful advice.

2. Summary

The project is designed to examine a number of economic and administrative aspects of maintenance activities in Swedish industry and to indicate areas for improvement in maintenance. The results are part of the EUREKA project 724 MAINE EBSOM. This provides the first stage in making comparisons with industry in other countries.

The Swedish project was carried out as a questionnaire survey among 71 large and medium-sized companies in different branches of industry. The first part of the report shows a number of average values and relationships based on companies' maintenance costs, turnover, capital value, type of organisation, human resources, value of spare parts, training time, etc. during 1992.

The calculation of relationships is however made difficult by the lack of definitions and an inadequate use of central terminology. We have also observed incompleteness in companies' maintenance data and data compilation routines. There is a great need to improve the use of existing terms and terminology and to give recommendations on routines for data collection.

The spread of the different values between companies is large. This results in uncertainty in the average values and the calculated relationships. The results of the study do, however, show a number of tendencies and similarities which, if used with caution, can constitute broad outlines. It was also shown, for example, that despite discussion on the advantages of decentralising maintenance, only a marginal amount was actually decentralised. Furthermore, training amounted to only around 3% but the companies were still satisfied with the skills level of their maintenance staff.

The material in the report has been sorted primarily by branch. During the course of the work, the project group has however come to the conclusion that other bases of division could give a better illustration of the need for maintenance in different companies such as operating times, plant structure, production technology, etc. Thus, a number of relationships have been calculated for companies on the basis of their documented operating times.

The second part of the report shows how the companies involved have assessed their requirements for improvements in maintenance. The highest ranking improvement requirements are:

1. The maintenance skills of production staff
2. The involvement of production staff in maintenance work.
3. The continuous use of key figures
4. Knowledge of maintenance among company management.

3. Background

Maintenance activities in Sweden are very important to society since they literally keep the wheels turning. The maintenance cost is considerable but there are plenty of opportunities for improvement. According to an investigation carried out by Professor Hans Ahlmann on the economic importance of reliability and maintenance in Sweden in 1991/92, costs amount to 150-160 billion SEK. This includes all sectors of society as well as direct and indirect environmental costs. Industry and its suppliers account for around 60% of this.

There is, however, a considerable need for investigations that improve the quality of statistical material. The long-term goal is to extend the scope of comparisons between companies, branches of industry and countries and thereby define the status and illustrate the need for development.

The study that has now been completed by UTEK is the first of its kind in Sweden. Similar studies have, however, been carried out previously in the other Nordic countries. Denmark carried out a study 10 years ago and Norway carried out a very comprehensive survey of Norwegian maintenance activities last year. There has been continuous activity in Finland for a number of years on statistics concerned with maintenance. The results from all the countries will now be compiled in a single EUREKA report.

4. Purpose of the project

UTEK's involvement in the EUREKA project 724 MAINE EBSOM comprises the compilation of an overview of economic and organisational factors and methods used in maintenance in Sweden broken down into branches of industry. This is designed to assist companies in the following:

- comparing their own maintenance efforts and results with those of others,
- identifying new areas where efforts are required and where maintenance efficiency can be improved,
- setting new targets for maintenance.

Section 8.1, Presentation of data, considers the first goal, whereas the other goals are considered in Section 8.2, The need for improvement.

5. Scope

The project is directed at:

- manufacturing industry,
- large and medium-sized companies, or departments within these companies,
- numerical data that are easy to define.

Part of the project is also designed to illustrate:

- which economic, administrative and organisational factors can be quantified,
- which factors are relevant for comparison,
- whether or not it is possible to formulate good key figures.

6. Implementation

The material has been divided into the following branches of industry. They were selected originally on the basis of the SNI standard but, because replies from some branches of industry were so few, data from closely-related branches of industry have been combined.

INDUSTRIBRANSCH	ANTAL / NO	BRANCH OF INDUSTRY
1. Kemisk	9	Chemical
2. Maskin & transportmedel	8	Machine & transport equipment
3. Stål- & metallindustri	11	Steel & metal works
4. Elektromekanisk	7	Electromechanical
5. Livsmedel	7	Food
6. Papper & massa	19	Paper & pulp
7. Övrig, t ex grafisk, trä, energi	10	Misc., e.g. graphical, wood, energy

71 of the 200 questionnaires that were sent to carefully selected companies were returned. Most of them were filled in completely. In the cases where the average value is based on less than 71 replies, the actual number of replies, *n*, is given in the result table in the appendix. The reply frequency thus amounted to 36% and the number of companies represented must be considered satisfactory bearing in mind the resources allocated to the task.

The analysis of Questions 4 to 14 is based on the replies from the companies who replied in full to all the questions. i.e. 44, while all 71 are included in the analysis of statements 15-32. In addition to the 44 companies, there are several who replied to Questions 4-14 in part. These are included in the database and are therefore available for special analyses of particular aspects.

The study was carried out in the spring of 1993 and the data collection is based primarily on 1992 figures. In view of the fact that the persons in the companies to whom the questions are directed have a heavy work load, the guiding principles when designing the questionnaire were:

- questions should be few in number, simple to answer, minimise definition problems, and be of interest to the respondent,
- the questionnaire should be easy to fill in, not excessively detailed, and with explanations given as an appendix.

The layout of the questionnaire and explanations are given in Appendix 1 and Appendix 2.

The questionnaire is structured as follows. After an introductory section with identification information, the first two sections contain factual data such as number of staff and amounts. The following two areas provide "soft" information such as value judgements and attitudes to the organisation and administration of maintenance.

General section (Questions 4-8):

Company size in terms of turnover, number of employees in different categories, capital value and its distribution, and production time.

Maintenance costs (Questions 9-11):

Divided into 3 parts: production plant and buildings etc., degree of decentralisation, and different types of cost.

Organisation (Questions 12-14):

Is there a written statement of maintenance goals: The effect of quality control and the training of blue collar and white collar workers in maintenance.

Management (Questions 15-33):

These questions concern the management of maintenance and can be divided as follows:

- management's knowledge of maintenance, goals and monitoring of maintenance,
- the potential for maintenance to regulate activities,
- the development of staff skills, the option of purchasing external maintenance services and the use of computer-aided systems.

The measurement of results and key figures:

This section was designed to illustrate how individual companies solved certain problems and to provide the analysis group with information for ideas and comments of a more general nature.

7. General experience of key figures

There is growing interest in using measurement results and key figures to assess maintenance activities.

- Does our maintenance cost too much?
- What is our position in relation to other companies in our branch of industry?
- What do companies X, Y and Z do that makes them so successful?

Lack of definitions used in maintenance

If we are to quantify, we must first define! The difficulties that have been highlighted concern the following:

- What activities come under the heading of maintenance? Examples are repairs and cleaning.
- Where is the boundary between maintenance and investment?
- How do we differentiate between production plant, buildings, installations, etc.?
- What about maintenance carried out by production staff?
- There is no uniform definition of overheads.
- How do we differentiate between spare parts, consumables, etc.?
- Differences concerning assessment and calculation of accessibility.

Problems associated with the questionnaire

We know that those in a position of responsibility in maintenance work are greatly interested in getting material associated with measurement results and key figures. We have been surprised that we have had difficulties in getting a sufficient number of completed questionnaires. Unfortunately the level of response is not what we had expected from a number of branches of industry.

There is a benefit in collecting maintenance data so that summaries can provide an indication of "status" and "areas for improvement" in the industry. Unfortunately, there is a gap between willingness and opportunities. We feel that the problems facing those providing information have included the following:

1. The above-mentioned lack of clarity in respect of terms, their definition and interpretation.
2. The lack of or limitations in a company's existing maintenance data resulting from:
 - incomplete data collection from operating activities,
 - inadequate routines which result in poor input data,
 - poorly adapted systems used for compilation.
3. Providing information on turnover, capital value, number of employees, etc.:
 - some providers of information do not normally have access to such information,
 - companies consider such information highly confidential.
4. The compilation of maintenance data in the company's current financial and maintenance systems is not consistent and makes it difficult to reply to some of the questions.

We feel that there is a considerable demand for more regular reporting and use of maintenance data so that, in the long term, we can work out good key figures.

8. Results

8.0 Introduction

The results are presented in diagrammatic form with associated comments on the following pages, and in tabular form showing the complete information in Appendices 3, 4, 5 and 6.

In the first section, 8.1, we look at costs and resources (page 1 of the questionnaire). The principal divisions of the material are traditional and by branches of industry. The material has been analysed in several different ways and is shown in the following pages. Another form of division is by operating time.

In the second section, 8.2, we focus on the need for improvement, as felt by those within the company who replied to the questionnaire. An assessment of the current position has also been used as a basis.

It should be pointed out that the results in the first section are based on facts wherever possible. The results in the second section are based on estimates of facts and attitudes, which makes them different but nonetheless valuable.

8.1 Presentation of data

8.1.0 General

This section shows the relationships in the material in the form of diagrams and comments. The tables in the appendices are available to anybody interested in a more detailed analysis. The companies recorded in the data represent considerable variations in terms of size, organisational structure, geographical location etc. As a consequence, the spread in the material is considerable. This is evident from a closer study of the tables, which show the standard deviation. There is also information on the number of companies who replied to each question.

Bearing the above in mind, we have not found it of interest to show absolute figures except in certain cases. Instead, we have concentrated on relationships such as "Maintenance costs / turnover" or how

different costs are distributed according to different factors such as "production plant, buildings, and other installations".

To clarify the degree of uncertainty in the material, we have given the standard deviation for each individual value in the tables. This spread is considerable in many cases and is due to the considerable differences between the participating companies.

A further factor in the validity of the values is that the number of answers, "n", has been given for each value.

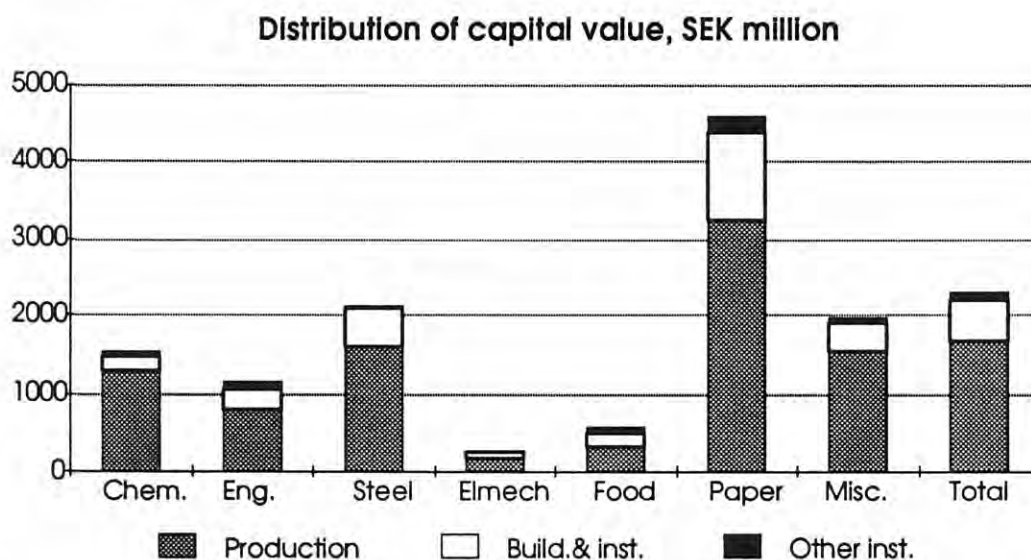
We have chosen to use diagrams to present the traditional key figures. We must, however, warn against making unqualified interpretations in view of the considerable spread and the use of branches of industry as a basis for division in the first section.

We have generally used abbreviations where the names of branches of industry have been too long. "Eng." = "Engineering and transport industry", "Steel" = "Steel and metal industry", "Elmech" = "Electromechanical industry", "Food" = "Foods industry", "Paper" = "Paper and pulp industry", and "Misc." = Agriculture, stone, graphical, wood and energy branches of industry".

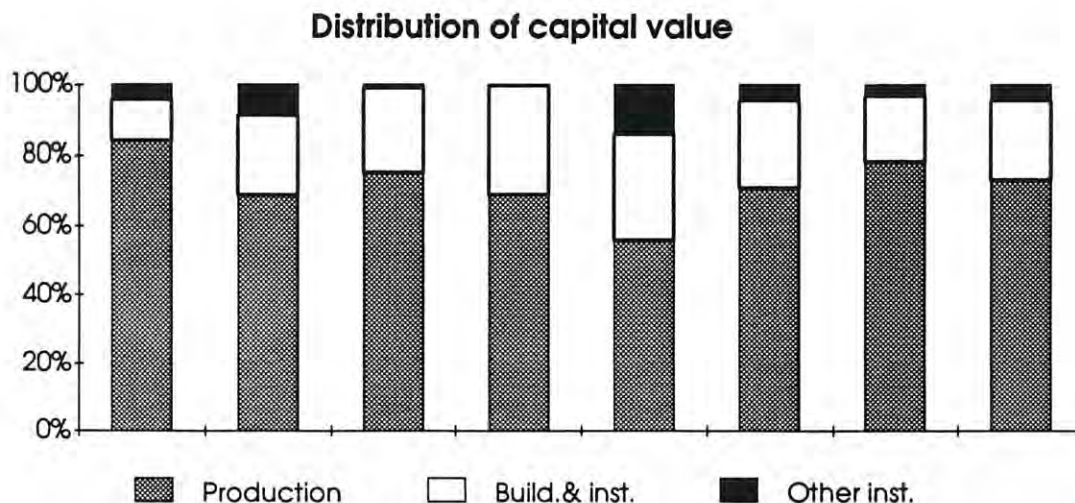
8.1.1 General data

8.1.1.1 Distribution of capital value

Company installations constitute the main target of maintenance activities. As a consequence, the survey starts with an overview of how the capital value of a company is distributed, on average, within the different branches of industry.



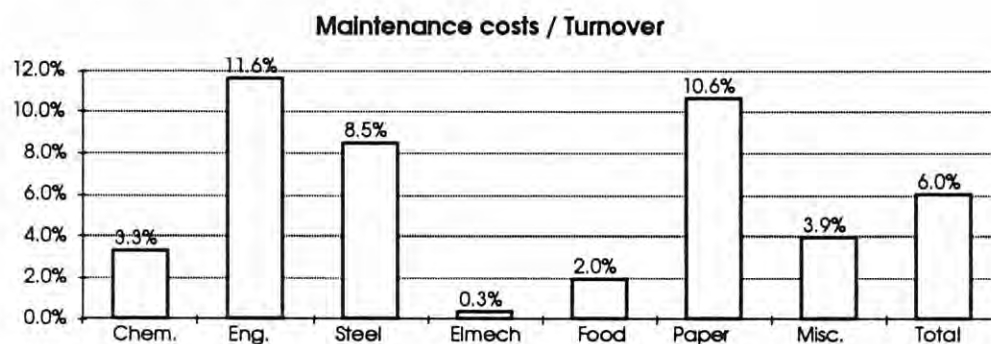
To illustrate the differences in investments in the different branches of industry, we have also included a diagram showing the absolute capital value. As expected, Paper has the disproportionately highest value and Elmech the lowest. It is surprising that Food has such a low value of production plant.



The capital value of production plant varies considerably - between 55% and 85%. Chem. is highest, whereas the value for Food is noticeably low.

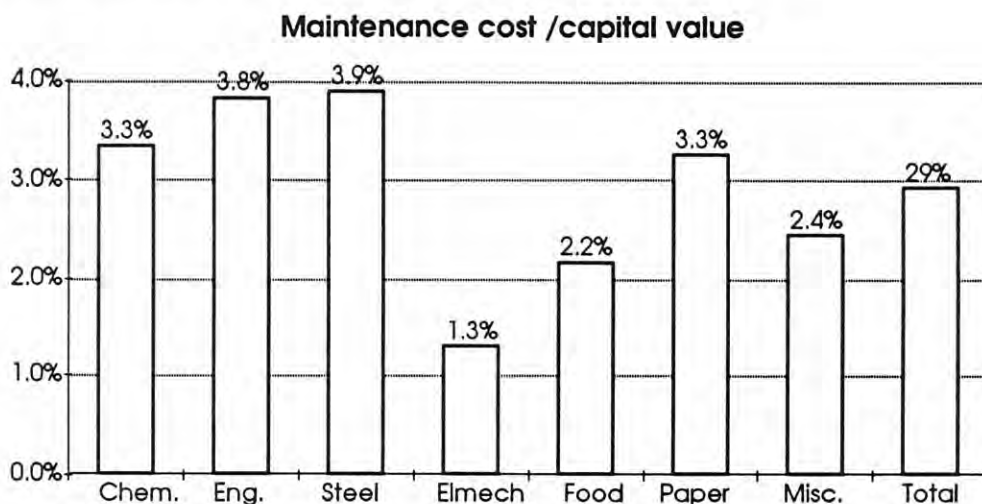
8.1.2 Financial data

8.1.2.1 Maintenance costs / turnover



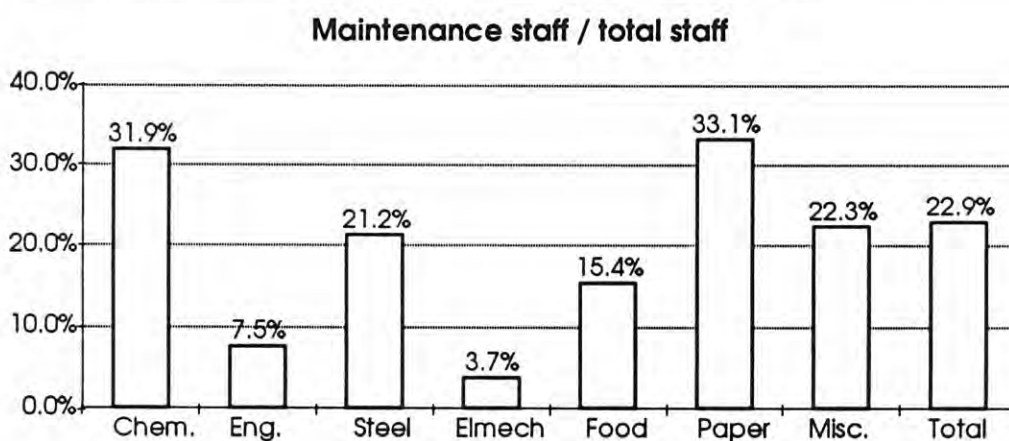
These relationships are heavily dependent on the individual companies and thus on the turnover of the various branches which have a considerable spread. Do not, therefore, draw any drastic conclusions from these relationships.

8.1.2.2 Maintenance costs / capital value



There is considerable variation from the average value of 2.9 % with 1.0 upwards and 1.6 percentage units downwards, respectively. It is interesting to note that both Elmech and Food lie so far below the average.

8.1.2.3 Maintenance staff / Production and maintenance staff



This shows clearly that the labour-intensive branches of industry Eng., Elmech and Food have relatively few maintenance staff.