Productivity Measurement

Methods and tools developed in TOPP

(A productivity program for manufacturing industries)

Research manager Bjørn Moseng

SINTEF Production Engineering

SUMMARY

The paper describes four methods (self audit, extended audit, self assessment, benchmarking) for measuring of productivity and competitiveness. The methods are developed in the Norwegian Productivity Program - TOPP, and is used in approximately 50 companies participating in the program. The self audit and external audit are developed mainly for mechanical industry (including shipyards, offshore and electromechanical industry) while self assessment and benchmarking are more general methods. The productivity is described by indicators given points on a scale from 1 to 7 (1 is far behind international competitors, 7 is "best practice").

1. PRODUCTIVITY MEASUREMENT

Measurement of productivity and competitiveness in industry companies is difficult and raise several questions. What is productivity? Does productivity means the same for different people and organisation? Different viewpoints and positions give different answers.

The classic definition of productivity is produced goods pr unit of production factors. This definition indicates a focus on the value adding and physical production process. However to produce a lot of goods with max. profit if there is no market has no sense. Customer satisfaction is an extremely important factor in obtaining competitiveness.

Measuring of performance could be looked at in 3 dimensions (fig. 1).

Figure 1 Performance measurement

In business terms the 3 views could be described as follows:

Effectiveness to which extent are customer needs satisfied

Efficiency to which extent are the total resources in the company used in an effective and economic way

Ability to change to which extent are the company prepared to handle changes in surrounding conditions (strategic awareness)

When establishing a measuring methodology it is important to have in mind all 3 dimensions. A lot of surrounding factors will influence the competitiveness of a company. Some important factors to consider are shown in figure 2.

Figure 2. Company surroundings

2. THE TOPP PROGRAM

Introduction Norwegian economy is very much based on export of raw materials and semi finished products (fig. 3). Companies working on the international market are often sub suppliers to multinational customers. The contribution from industry to the gross national product (BNP) is also very low, and much lower than countries we like to compare with (fig. 4).

Those factors were important arguments to look at productivity and international competitiveness in Norwegian industry. To meet this challenges the productivity program TOPP has been launched in Norway.

Exports	%	Imports	%
Mineral oil	23,0	Ship	9,5
Gas	10,1	Clothes and accessories	4,9
Aluminium	8,6	Computing equipment	3,9
Fish	5,7	Instruments	2,6
ship	4,3	Paper	2,5
Paper	3,7	Telecommunication	2,4
Raw materials for plastics	2,5	Cars	2,3
Pig Iron	2,5	Furniture	2,2
Nickel	2,4	Raw material for plastics	2,1
Total	62,8	Total	32,4

Figure 3 Norway - export/import (Source: Federation of Norwegian industries)

Figure 4 Industry contribution to gross national product (source: Norwegian Bureau of statistics 1993)

Goal The overall goal of TOPP is

to focus on total productivity for the whole enterprise and stimulate an industrial climate that improves international competitiveness.

Important objectives and key issues in TOPP are

- time to market
- quality
- flexibility
- total cost

The program involves co-operation between

- The Federation of Norwegian Engineering Industries
- Norwegian Institute of Technology (NTH)
- Industrial companies (~ 40)

and is sponsored by

- The Research Council of Norway

The TOPP program is planned for the period 1992-95. Following subprograms are scheduled:

1. Analysing company productivity and competitiveness (self audit, extended audit, benchmarking etc.)
2. Implementing actions for industrial productivity improvements (industrial projects, seminars, courses, industrial networks, etc.)
3. Generating new knowledge (research projects analysing productivity data, etc.)
4. Long term competence program (education , courses, dr.ing. programs, master degree, etc.)

3. METHODS DEVELOPED IN TOPP

Taking into consideration different views and dimensions in productivity and performance measurement, following approaches (methods) have been developed

- a) Self audit (questionnaire)
- b) Extended audit (experts)
- c) Self assessment (continuous improvement)
- d) Benchmarking (breakthrough)

The different methods will be briefly described in the following.

3.1 Self audit

Methodology The self audit is based on a questionnaire answered by the companies. The questionnaire consist of 3 parts asking for different types of information.

- Part 1 Fact data
- Part 2 General evaluation of functions and system variables (by individuals)
- Part 3 Detailed evaluation of functions and system variables (by group)

A lot of fact data or estimates have to be given in part 1. This consist of general information about the company, product data, cost distribution, maintenance cost, quality cost, strategies, customers, sub suppliers, systems, financial and economic data etc.

In part 2 individuals (~20) in the company are asked to give their overall evaluation of different functions (primary and support) and system variables (facilities, equipment, personnel, organisation etc.). This evaluation is given confidentially and is later compared with information given in part 3 (see fig. 6).

Part 3 is the largest and most detailed part of the questionnaire. The company is asked to build groups to evaluate a lot of detailed questions concerning all functions and system variables. Example on questions to evaluate the design function is shown in fig. 5.

Functions and system variables are evaluated on a scale 1-7 where 1 is far behind, 4 is on same level as most important competitors, 7 is "best practice".

By design we mean the function responsible for the production support either for order production or in connection to product development. Typical activities will be analysis, calculation, work out drawings etc.

- 6201 Evaluate the following areas/aspects as to current situation, and give a realistic possibility for improvement by estimating the status after 2 years. Judge how important the factors are for the company's competitiveness (N - No importance, M - Medium importance, G - Great importance).

Very bad		Medium				Very good	
1	2	3	4	5	6	7	
			Status today	Realistic status in 2 years	Importance for the company	1	M
a)	Tools and technical facilities		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		
b)	Design competence in own company		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		
c)	Design investigation and work through		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		
d)	Laying down of product parameters (function, form, material, dimension etc.)		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		
e)	Presentation of production support (drawings, piece lists etc.)		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		
f)	Quality safeguarding system for design work		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		
g)	Procedures for treatment of change orders		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		
h)	Systematic registration and reuse of empirical dates		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		
i)	Co-operation with production/production planning		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		
j)	Market and customer contact		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		
k)	Co-operation with contractors		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		
l)	Co-operation with purchase		1-2-3-4-5-6-7	1-2-3-4-5-6-7	N-M-G		

Figure 5: Question to evaluate the Design function (example)

Report - analysing of data: The data is collected and stored in a database. Different types of reports can be generated automatically. Individual reports based on data for one company or reports based on average data from a given number of companies can be generated. The report layout is exactly the same which means that companies easily can compare own data with data from groups of other companies. The report consist of 3 parts

- Main report with key indicators (10 - 15 pages)
- Enclosure for comparison (~ 50 pages)
- Enterprise specific enclosure (detailed economic and financial data) (~15 pages)

An example of evaluation of primary functions is shown in fig. 6.

Figure 6. Evaluation of primary functions

3.2 Extended audit

Methodology: The extended audit is performed by experts analysing the company. Measuring of productivity and competitiveness is done on 2 levels.

- a) Company level - using indicators and key factors with focus and viewpoint on the whole enterprise
- b) Company divided in parts - using indicators and key factors with focus on parts and separated areas in the company

An overview of the different areas (37) in the model is shown in figure 7.

Figure 7. Analysing areas - extended audit

Characteristics for the analysing areas are:

Economy - indicators and key factors which describes the economic conditions and potential. An important issue of this analysis is to evaluate the economic capacity for future investments and change.

External relations - indicators and key factors to measure the ability of the company to exploit and take advantage of surrounding conditions. This includes customers, competitors, use of external resources, strategic alliances, etc.

Internal relations - the ability to use existing internal resources (products, machines, personnel etc.) in a time and cost effective way, and to take care of the internal milieu.

Ability to change - the ability to foresee and be prepared to meet new trends and quick changes in the environments.

Systems variables - primary resources and conditions necessary to produce products

Functions - Activities in the product life cycle. The functions are divided in primary and support functions.

Cycles - to follow and analyse flows between functions. Flows could be of different types (material, information etc.). The objective is to measure co-operation and infrastructure between functions.

Philosophies - to analyse overall production and management philosophies used in the company

All 37 analysing areas are broken down in a hierarchy of sub indicators which are given points and weighted. Check list for all levels exist. Indicators for evaluation of the TQM process are given in fig. 8.

No.	Description sub Indicators	Points	Weight
1	Goals and strategy	3	10
2	Know-how and competence	5	10
3	Organisation and management	2	5
4	Information and analysis systems	2	5
5	Strategic quality management	2	15
6	Use of human resources	2	5
7	Quality control and quality improvements	3	5
8	Results of quality work	4	20
9	Customer satisfaction	3	20
10	Cooperation and information	4	5
Calculated		3,15	100%
Total score		3	

Figure 8. Evaluation of TQM (example)

Report: The methodology offer check lists of all 37 analysing areas. All areas are analysed, but focus is given to areas of main importance in the company. This means that in most cases only one philosophy (see fig. 7) is evaluated.

The results are presented in a report organised in 3 parts.

- 1) Analysis of main productivity key factors and indicators. Comments are given by the experts (~15 pages)
- 2) Proposed actions for the company to obtain better results. Evaluation given by the experts (5-10 pages)
- 3) Detailed description of sub indicators for all analysing areas (~50 pages)

Figure 9 shows an example of a profile chart of indicators for system variables and functions.

7 - best practice
4 - on the same level as most important competitors
1 - far behind

Figure 9. Profile chart - indicators

TOPP Self assessment is a modular system to help the companies to build their own tool for measuring of own performance. The self assessment focus on measuring of trends and is a tool to check if a business process is in control and continuous improvement (fig. 10) is taking place.

Figure 10. Measuring of trends - self assessment

The methodology consist of following steps:

- a) Identification of critical and important business processes in the company to be evaluated
- b) Selection of analysing areas and indicators to measure the business process
- c) How to organise the self assessment
- d) Collection of data
- e) Presentation of results
- f) Evaluation of results, actions

An overview of the methodology is shown in fig. 11. 22 different business processes with analysing areas, indicators and measuring techniques are described.

Figure 11. Self assessment

3.4 Benchmarking

Benchmarking is the process of continuously comparing and measuring an organisation against business leaders anywhere in the world to gain information that will keep the organisation take action to improve its performance (APQC¹ 93).

To use benchmarking to compare own processes with best practice and to learn and take advantage of others experiences, will often result in real breakthroughs (fig. 12). Best practice is often found in other branches or in different types of companies.

Figure 12. Benchmarking - breakthrough

Some reasons and benefits from using benchmarking are

- Establish effective strategic goals and objectives
- Understand and meeting changing customer requirements
- Striving for excellence through industry best practices
- Create a better understanding of own processes
- Establishing reference points for measuring of own performance

The different steps in the benchmarking process is shown in fig. 13

Figure 13. Benchmarking process

¹ APQC - American Productivity and Quality Center, Houston

4 ANALYSING RESULTS

All methods have been used in the TOPP program. The number of companies involved are:

- a) Self audit ~ 60 companies
- b) Extended audit ~ 40 companies
- c) Self assessment individual use
- d) Benchmarking 2 companies (in progress)

A lot of data about industry productivity and competitiveness are collected in the audits. A special research project has been performed to analyse those data, trying to find some general results and conclusions concerning the status of productivity and competitiveness of Norwegian industry. 8 different reports have been written focusing on different topics. The reports are:

1. General characteristics and possibilities
2. Analysing methodology
3. Analysing of procurement
4. Analysing of quality
5. Analysing of production planning and control
6. Analysing of product development
7. Analysing of marketing and sales
8. Analysing of strategy development

Figure 14 show a gap analysis from evaluation of different functions in the companies (self audit questionnaire).

Figure 14. Gap analysis concerning performance and importance of different analysing areas (37 companies)

The analysing areas are sorted in 6 groups. For each area the deviation from the average of all areas is shown. Group 1 shows areas where both performance and importance are better than the average. However the importance is greater than the performance, which indicates that the area is good, but there is still a lot to achieve.

This gap analysis is based on average values from 37 companies. However the companies are quite different (size, products, production methods etc.). Another grouping of the companies in more homogeneous groups would perhaps have given other results.

Figure 15 show some results from analysis of the design function.

Figure 15. Detailed analysis of the design function.

Areas to be improved seems to be

- design review
- definition product parameters
- quality assurance of design
- systematic registration and reuse of experience data

The 8 reports mentioned earlier and special branch reports for groups of companies (self audit) presents a lot of other analysis.

5 CONCLUSIONS

Measuring productivity and competitiveness for a whole enterprise is difficult. To find indicators, key factors and analysis areas which are relevant to different types of companies, and to harmonise this into a common methodology is even more difficult.

The methodology described is based on different approaches. However in any case there is much individual judgement. It is difficult (or impossible) to measure total productivity by summarising local measurements of sub areas. This is the reason for analysing the enterprises from different viewpoints. History has shown that economic success one year does not guarantee a competitive edge. Many perspectives that measure different factors have to be used to get a better understanding of competitiveness.

REFERENCES

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The references 2, 3, 4, 5, 6 and 7 are written in Norwegian.