

**ON THE USE OF QUANTITATIVE
METHODS IN THE DANISH
FOOD INDUSTRY**

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EXECUTIVE SUMMARY

1. The paper examines the use of quantitative methods in the Danish food industry and a comparison is made between the food industry and other manufacturing industries. Data was collected in 1991 and 107 manufacturing companies filled in the questionnaire. 20 of the companies were food companies.
2. The main purpose with this paper is to obtain a frame of reference for a much bigger investigation just carried out by the authors in the Danish food industry with particular emphasis on collection and processing of information during product development.
3. The comparison in this paper does not lead to any striking differences between food companies and other manufacturing companies. In both cases there is a heavy concentration on methods used to analyze internal processes.
4. The increasing focus on food products ready for consumption and the general increase in focus on market orientation is expected to lead to a more intensive use of proactive methods. It will be obvious to compare results from the new investigation with the results presented in this report in order to identify any trends in the use of quantitative methods.

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INTRODUCTION

To our knowledge there are very few investigations based on quantitative surveys with emphasis either on the collection and use of information to support managerial decision-making in the food industry alone or as a comparative study stressing differences in collection and use of information between the food industry and other industries. In this article special focus is put on the processing of information and studying the application of quantitative methods to assist in managerial decision-making in food and other manufacturing companies. Karakaya and Kobu's study (1995) is an example of one of the few comparative studies between the food industry and a high-technology industry, in this case the medical instrument industry. They focus on factors affecting the failure rate in new product development and find an 8% higher failure rate in food industry than in the medical equipment industry. This difference in failure rate may have many explanations. One possibility is that food companies differ from high-technology companies in the use of tools and techniques in the development process. Differences between food and non-food companies in the use of quantitative methods is also a potential explanatory variable for differences in success in other managerial areas than new product development. In this study we focus on the use of a wide variety of quantitative methods. In the literature, many examples can be found on the successful application of quantitative methods both in the food industry and other industries to solve specific problems. For the food industry examples are given in eg Dov (1992), Fairfield and Kingsman (1993), Kaffy (1992), Schuk (1985) and Steuer (1984). This study aims to describe the use of quantitative methods in the Danish food industry and to identify possible differences between Danish food companies and other Danish manufacturing companies in their use of the quantitative methods in question.

SURVEY DESIGN

The data material was obtained from a survey carried out in February to April 1991. 469 companies of the 3300 largest Danish companies in terms of turnover were randomly selected from a Danish company database called GREEN. Only 3 of the 469 companies had more than 5000 employees which is in good accordance with the industrial structure in Denmark. The managing directors in the selected companies were contacted by telephone and asked whether they would be willing to receive the four-page questionnaire applied in this survey.

The questionnaire contained questions about the size and main activity of the company. After these general questions, the companies were asked whether they applied quantitative methods in general. If the companies did not apply quantitative methods, reasons for this were investigated and if the companies applied quantitative methods, questions were formulated aiming to investigate the success of quantitative methods as well as the functional areas in which they were applied, the types of quantitative methods being applied and the supportive role of software and hardware.

The four-page questionnaire was sent to the managing directors willing to participate, and in case a filled in questionnaire had not been received after 2 weeks a follow-up procedure was applied (Østergaard 1993).

DATA MATERIAL

The sampling method resulted in a total of 285 questionnaires. 107 of these questionnaires were considered valid and filled in by manufacturing companies. The validity of the answers was for instance tested by placing a non-existing quantitative method among the real methods, and in case the respondent claimed to use this non-existing method, the questionnaire was dropped.

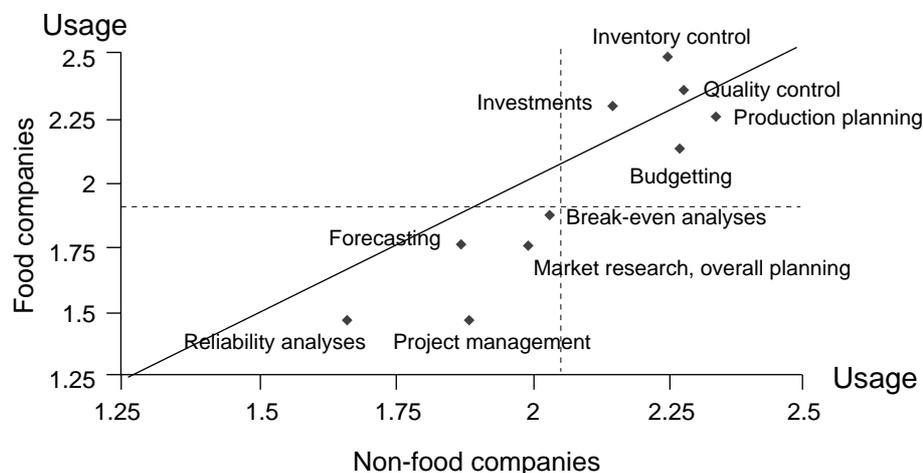
The reliability of the survey can of course be challenged although the response rate is rather high. There is some tendency that large companies in terms of number of full-time employees among the 469 more readily answered the questionnaire than the smaller ones, which may partly be explained by the fact that they are more frequent users of quantitative methods and therefore are more interested in answering. In general, manufacturing companies are among the largest companies in terms of number of employees and having a slightly higher response rate compared to non-manufacturing companies.

The 107 manufacturing companies are the ones that we concentrate on in this article. 20 of the manufacturing companies were food companies. It questions the validity of immediate comparisons between the results from this study and results obtained in earlier studies reported in the literature. Former surveys have mostly been carried out solely among companies with more than 10000 employees.

RESULTS AND DISCUSSION

In figure 1, the first axis represents the average use of quantitative methods for different functional purposes in food companies, and the second axis represents the same measure for non-food companies. The axes scale has the following interpretation in both cases. "1" is equal to no use, "2" is equal to sometimes and "3" is equal to use on at least a monthly basis. All methods below the diagonal line in the figure are used to a higher degree in non-food than food companies. The dotted lines represent the average of the averages. Hence in quadrant I formed by the two dotted lines the methods are used above average in both food and non-food companies.

Figure 1. Different application areas



There are not many significant differences between food companies and other manufacturing companies in Denmark as regards the use of quantitative methods. The application areas come in four blocks. Inventory control, quality control and production planning relate to internal matters. Investment appraisal, budgeting and break-even analyses are concerned with economic measuring. Forecasting and market research relate to external matters, and finally we have security analyses and project management. There may be many reasons for the more widespread use of quantitative methods for internal matters. Data on internal matters are relatively easy to collect and a lack of organisational support when it comes to market research may be some of the explanations. One reason for the high focus on inventories is given in Loar (1992) presenting the results from a comparison of inventory management in the food industry, the chemical/plastics industry, the electronics industry and the pharmaceutical industry in USA. It was found that the inventory to sales levels are lowest in the food industry, and the food industry had the highest physical distribution costs as a percentage of sales. It appears that companies perform some form of trade-off analysis as regards logistics. The high transportation and warehousing costs in the food industry force the food logistics manager to keep inventory levels at a minimum.

Forecasting is low in both industry segments. Sales forecasting is very important for inventory control and production planning but maybe Danish companies first of all rely on judgmental forecasting. Many other studies on the use of quantitative methods have found that judgmental forecasting is the most typical way to obtain a forecast (see eg Sanders and Manrodt (1994) and Dalrymple (1987)). Food companies differ from other companies as regards the use of quantitative methods in project management. They are more commonly used in non-food companies. A possible reason is that food companies are regarded as low-technology companies compared to other industries and project management tools are more applied in more complex settings. (Bubshait & Selen (1992). McFarlane and McDonald (1988) report that R&D expenditures in the US food processing industry were only 0.9% of sales compared to 3.5% for all US industry¹. Part of the reason for that may be the lower profit margins in the food industry (Graf & Saguy, 1991). McFarlane and McDonald (1988) expect that the low impact of technology may not continue in the food industry and give the following reason :

“With increasing consumer awareness of and demand for products with specific sensory and nutritional attributes the food industry is faced with using new technology that must be adapted and integrated into the processes, products and culture of a firm.”

Another motivating reason for more focus on R&D in the food industry reported by Graf and Saguy (1991) is the high correlation between R&D expenditure and profit.

¹ See also Grunert et al (1995) for additional data on the level of R&D expenditure

Figure 2. Statistical methods known and used by food companies

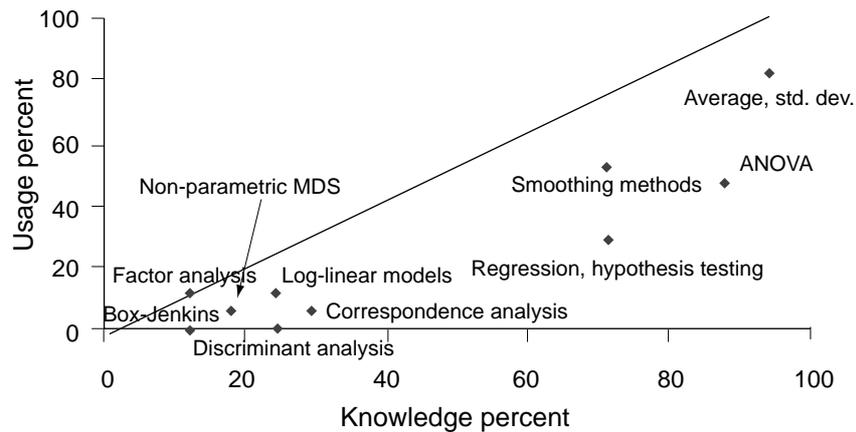
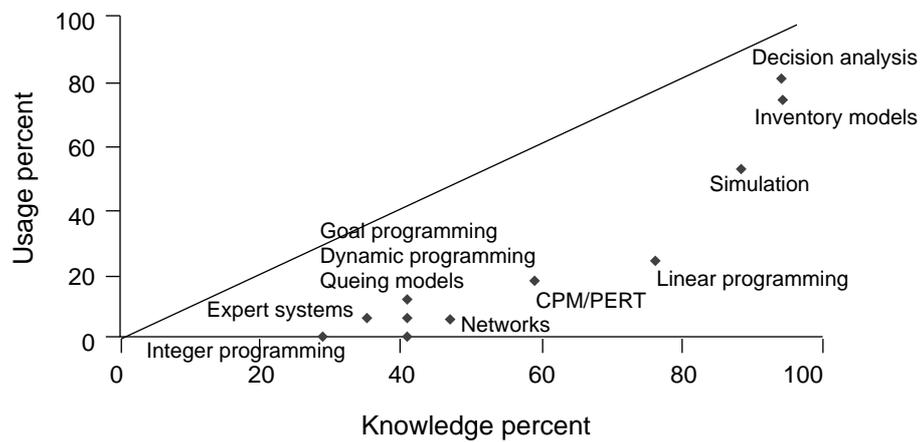


Figure 2 presents the use and knowledge percentages in Danish food companies for each of the statistical methods included in the study. The ease of use is an obvious explanation for the wide-spread application of elementary statistics and many problems in industry may be sufficiently analysed with quite elementary tools. Smoothing methods and regression analysis are equally well-known in the food industry but smoothing methods are more widely used. It may reflect a focus on short-term forecasts and extrapolative forecasting instead of causal forecasting. It may also have to do with lack of a sufficient database to build a regression model. The use of more advanced time series models such as Box-Jenkins models is non-existent and the method is not well-known in industry. The result concerning the use of Box-Jenkins methods is in good accordance with other surveys on the use of quantitative methods. Sanders and Manrodt (1994) question the marginal utility of the more difficult methods. An interesting result is that all companies knowing factor analysis apply the method. It may reflect the fact that this method will obtain higher importance in industry in the years to come. In general, the use of methods to analyse market information is low as expected. The food industry is forced to move away from mass-produced food-stuffs towards higher value-added products. When the food companies move from selling the commodities used in food to selling products ready for consumption market research becomes increasingly important in the effort to identify consumer needs. It is therefore disappointing to see the low application of the tools suitable to assist in this crucial part of the product development process.

According to Bierman, Bonini and Hausmann (1991), OR-methods may be divided into methods used when decision variables are certain or uncertain, and as a second criteria the complexity of the problem may be used. The wide-spread use of and knowledge about decision analysis, inventory models and simulation stress that models related to uncertain decision variables are the most commonly used OR methods. Decision analysis may be used for quite simple problems and simulation is typically used for more complex problems. As a result the degree of application depends on the complexity of the problem. It may also reflect that the number of problems in industry with great complexity is small compared to minor problems. Linear programming is suitable for problems with certain decision variables and CPM/PERT is a mixture because CPM identifies the

sequence of activities that will have the longest completion time of the entire project and PERT extends CPM's scope to deal with activity duration uncertainty in any project estimation task. The rest of the OR methods are hardly used but quite wellknown compared to the statistical methods. The borderline between OR methods and statistical methods is difficult to draw. All the methods with uncertain decision variables could be considered as statistical methods.

Figure 3. OR methods known and used in Danish food companies



Control charts normally are required to comply with recent JIT manufacturing procedures and quality standards. The results in figure 4 may also lead to a more negative conclusion based on the following considerations. Pareto charts and cause-and-effect diagrams may be used to identify the nature of the special causes and Taguchi methods are suitable to study effects from modifications in both the production process and the product itself. All three methods are used to a very modest extent and the results shown in figure 4 therefore indicate that a tendency in the food industry may be just to follow the production process but not to take the sufficient action.

Figure 4. Quality methods known and used in Danish food companies

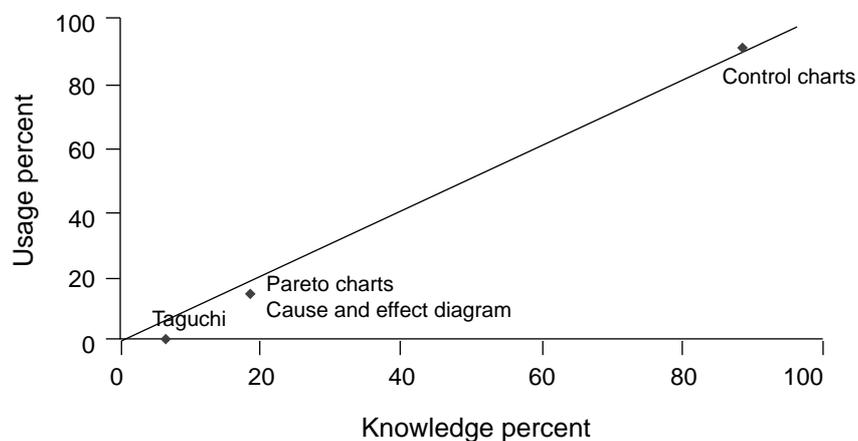


Figure 5. Use of quality methods

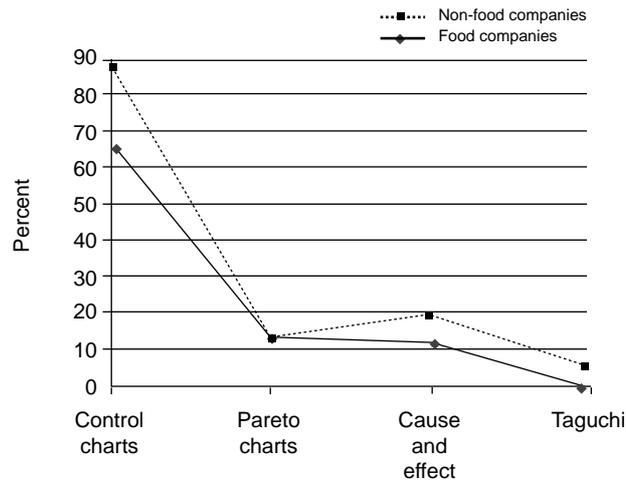
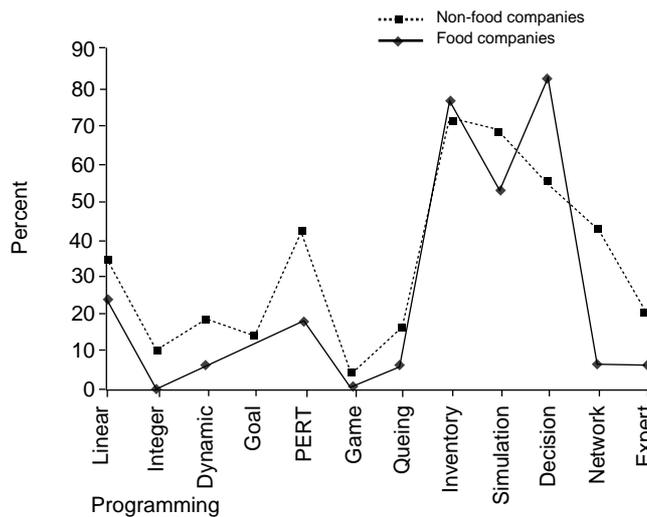


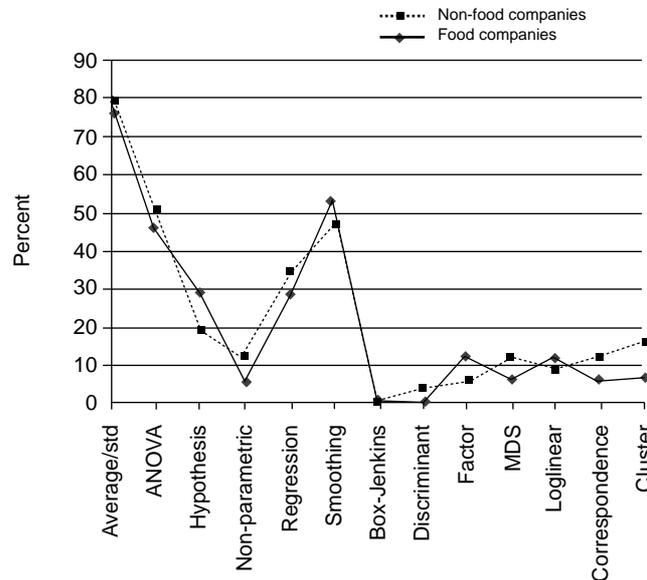
Figure 6. Use of OR methods



In figures 5, 6 and 7 the differences between food companies and other manufacturing companies are presented as regards the use of specific quantitative methods. It is only in the group of OR methods that significant differences are found. The production planning tool – PERT – is less used in food companies than in other companies and so are network models and expert systems. The result for PERT is in good accordance with the former more general results about application areas. As regards network models and expert systems the difference may be due to more conservatism in the food industry. Byrd (1993) reports that expert systems are slowly but surely moving into private organisations. According to Byrd (1993) the most important issues in implementing expert systems are 1) a willing and able expert, and communication between knowledge engineer and expert 2) proper introduction by top management 3)

availability of knowledge engineers and 4) time needed for successful implementation. The last significant difference between food and non-food companies is observed for decision analysis.

Figure 7. Use of statistical methods



Oakland and Wynne (1991) present results from the UK manufacturing industries comparing the use of quantitative methods in British-owned and foreign-owned companies. In table 1 we present the results for the British-owned companies and our results for Danish companies. The results are comparable because the British investigation were not limited to the large companies.

Table 1. Percentage of manufacturing companies using different selected tools

	British-owned companies (Oakland & Wynne)	Danish manufacturing companies
PERT	41.6	37
Exp. smoothing/ Smoothing	18.1	49
Linear programming	16.6	33
Pareto analysis	32.2	12
Quality control	60.2	71

Oakland and Wynne's (1991) general conclusion is that British companies lag far behind their foreign-owned counterparts and little change in knowledge and use of the methods is found in the period 1980-1987. When we compare with our results for Danish companies the picture is not clear. For some of the tools it can be seen that Danish companies have problems coping even with the British-owned companies and the British figures are four years older.

CONCLUSION

The survey results leave the general impression of a quite low application of quantitative methods in both non-food and food manufacturing companies. The heavy concentration on methods used to analyse the internal processes may be the consequence of a reactive approach to product development. As already pointed out the increasing focus on food products ready for consumption and the need to meet consumer demands as regards sensory and nutritional aspects of the product demand that food producers concentrate more on market research than earlier.

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