

Application of Quantitative Optimization Techniques to Small Businesses¹

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Abstract

In the paper, we discuss the possibilities, which offer solutions of decision-making problems in small businesses. Although small businesses vary so much in their size, type of clientele, and the market served, they deal with common problems to be solved in various stages of their life cycle. A study concerning the extent of usage of quantitative methods showed that these methods are used in Czech small and middle-sized enterprises only seldom. The reason of this situation consists first of all in unfamiliarity with these methods including possible effects that may be gained by their use. Certain operations research/management science (MS/OR) approaches can help small businesses to survive and to compete effectively on the market. It is essential at any time to know the right technique for each concrete situation and to know how to use such a technique. This requires certain knowledge, a sense of how to model a specific decision problem, and surely some practice.

Keywords

Optimization, modeling application, heuristics algorithms, MS/OR tools in management, quantitative methods in management, small businesses

1 MS/OR Techniques and Small Businesses

The use of operations research tools and techniques in a small business environment can appear as very doubtful from the economic point of view. Large businesses usually have resources for implementation of computer techniques and quantitative approaches when supporting decision-making processes. Nevertheless, small businesses also have to face complex problems that require the use of quantitative techniques in order to solve them efficiently. That is why small businesses not only can, but also should, use these decision supporting techniques and tools to solve their problems effectively. All businesses, i.e. small, middle and large, have to solve a variety of decision problems in their daily operations. In many cases, these problems are similar to both small and large businesses.

Certain MS/OR methods and techniques can be applied selectively to solve the problems arising in small businesses. Respecting the fluctuating environment within which small businesses operate, and the varied patterns of the problems, users must consider the aspects of sensitivity analysis before using the MS/OR models. This enables a manager to analyze what-if questions more efficiently.

Small businesses can encounter the following problems in their operations (Mehra, 1990):

- Demand forecasting for their products or services;
- Product mix determining;
- Distribution planning;
- Inventory controlling;
- Resources allocation;
- Layout of facilities planning;
- Quality controlling;
- Customer service improving;
- Scheduling,

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- Capacity planning;
- Failures predicting; etc.

There exist a lot of various techniques that can be used to solve these problems. It is a serious task for manager to find a match between a problem area and a specific technique. With personal computers easily available, manager can now use a number of tools supporting the decision-making process. We suppose herewith all sorts of forecasting procedures, inventory control systems, material requirements planning systems, statistical analysis techniques etc., but also the use of linear programming, transportation and assignment methods or scheduling rules and line-balancing procedures, which can be helpful by solving problems as determining product mix, allocation resources, planning capacity, locating facilities, and distributing products. To apply and adopt any of above techniques for a small business, its staff must have some minimal training in quantitative methods.

However, small businesses may not be able to solve these problems the same way, as can do large businesses. Financial and other resources are easily available in larger companies usually. Smaller businesses can choose between two principal possibilities:

1. they may have to seek free or subsidized external consultancy;
2. they can attempt solution of these problems by means of in-house resources.

Of course, there exists the third possibility too – to do nothing. This third way in today's changing competitive environment has not much chance of success, especially for small companies. Further, we will discuss the first two mentioned possibilities.

1.1 External consultancy

There can be considerable competition over how to deliver MS/OR services among *internal* specialists and *external* consultants – even within larger firms that have high potential demand for MS/OR services. A realized UK study (Ormerod, 1998) showed that the dominance of the internal OR groups of the '70s and '80s changed. Today, MS/OR services are delivered primarily by external OR consultants in large companies. These organizations focus on core competencies, and many specialist activities including OR services are outsourced.

It is not aim of this paper to discuss in detail the advantages or disadvantages of both the external and internal consultancy. This topic is discussed for instance in (Fildes, Ranyard, 2000). As we mentioned above small businesses often fail to reach the benefit of external consultancy considering their available financial resources. They have to seek free or subsidized external assistance from local or state agencies. Other not yet fully exploited source of help may be the universities with their potential of staff and students, which often seek for practical problems for instance for educational purposes or diploma work submission. Some universities house small business development centers, which can provide training for small business managers in MS/OR techniques.

1.2 Internal problem solution

Even if the small business can afford external consultants, this service requires certain time. The need of prompt implementation of the final decision inhibit from this requirement usually. A very short time period is available for most decisions necessary to execute in smaller businesses, even for decisions of fundamental and existential meaning. If some decision concerning a concrete situation or opportunity is not realized in a very short time, this opportunity and the relevant economic effect usually vanish beyond recovery. This leads to the conclusion that if small businesses use quantitative techniques, these techniques are frequently implemented not by OR/MS specialists but the skilled firm managers.

It is essential especially for the small businesses to know the right technique for each situation and to know how to use it. Wrong or poor-underlaid decisions can threaten the further company's existence. On the other hand, well-done decision analysis supported by the result of corresponding quantitative procedure can help to open an unexpected possibility for the next company's activities.

Now, because these procedures in smaller companies usually will be not performed by specialists in OR methods solution, it is possible to deliver a basic presumption for the use of quantitative methods in smaller businesses:

In smaller businesses practice such methods are applicable, that are:

- **simple** – also the manager who is not a professional OR specialist is able to apply them;
- **inexpensive** – preferably without any additional financial demand;
- **able to implement by means of computer technique and software in common use** (PC and modules of common PC-software or commercial available and inexpensive user-friendly software products).

2 MS Implementation Problems

A successful application of a MS/OR technique depends closely with the implementation of the method. It was presented in (Watson, Marett, 1979) that only about 40% of MS projects are ever fully implemented. The study analyses the major problems in implementing MS method from management scientist's point of view. The problems as the lack of good clean data, not enough time to analyze a real problem using a sophisticated approach, difficulty in defining problems for applications etc. were presented.

Our research from the manager's view (closely described in chapter 3) shows that the major reasons for non-using the MS methods are the poor educational background to appreciate MS methods by the top and middle management, the cost of developing and using models, and the lack of time to implement the MS methods because of actual problem solving.

It is obvious there are differences between the management scientists and managers opinion to this problem. It may often be that the management scientists do not understand the information needs of management. The management frequently requires so-called „quick and dirty“ analysis. This kind of analysis of the problem is inexpensive, does not have extensive data input requirements, and is available within the acceptable time for making the decision. There is necessary to understand what information is needed and how much money and time can be spend on the analysis effort.

The recommendation, which in our opinion suits well to the small business practice, is the initially building of small, tentative models with involvement by the end user. The building of more comprehensive models is advisable only when clearly justified. Similar recommendation can be found for instance in (Watson, Marett, 1979):

“In developing planning models it pays to think big but stat small. Initial cost should be minimized until the benefits of a model can be demonstrated through some concrete results. The natural initial tendency to incorporate everything one can think of into the model should be avoided.”

3 Study on Czech enterprises

Recently we finished one period of the research project concerning the survey of the applications of models, quantitative methods and rational procedures in Czech companies. Partial results of this research we presented in (Plevný, 2004). The objective was to obtain information concerning:

- the knowledge and awareness of various types of optimization methods;
- the use of quantitative procedures that supports decision making in companies (application types, methods and software used); respectively
- the disuse of these procedures (disuse reasons, eventual usage motivation, form of the access to the necessary information).

With respect to the objective of the research project only the companies stating manufacturing activities were selected. On the whole we obtained 103 duly filled-out questionnaires from the addressed companies (more details about the respondent selection and return rate see in (Plevný, 2004)).

The research provided a range of interesting information. The familiarity with particular methods in Czech companies is generally lower compared with west European and north American countries. The awareness structure about particular types of methods is similar. The high ratio of real applications in the field of quality control in Czech companies is very positive as a relatively new trend in

implementation of tools supporting decision-making. The use of widely available software products by the help of common computer technique (PC) dominates in the investigated (mainly smaller-sized) companies. The well-known and user-friendly environment and quick and operational accessibility at requested record computing is their primary advantage. Es example of the results we present here the Table 1 summarizing the main areas in which the respondents have applied the OR/MS techniques.

Tab. 1: Areas, where the MS/OR tools and techniques were applied (sequenced)

Application area	Never used	Several times	Regularly used
Production scheduling	77,7%	11,6%	10,7%
Inventory management	81,6%	8,7%	9,7%
Quality controlling	86,4%	6,8%	6,8%
Investment or capital decision making	90,3%	3,9%	5,8%
Expected development forecasting	91,3%	4,8%	3,9%
Marketing and advertising research	93,2%	2,9%	3,9%
Packaging and dispatch	94,2%	0,0%	5,8%
Maintaining and diagnostics	95,2%	1,9%	2,9%
Transportation problems	98,1%	0,0%	1,9%
Depot allocation	99,0%	0,0%	1,0%
Others	98,1%	0,0%	1,9%

The most popular areas of application seem to be Production scheduling, Inventory management and Quality controlling. Transportation problems and Depot allocation were used minimal, which logically results from the focus of the research not to transportation, logistics or service but production-oriented firms.

On the whole, only 13% companies use the MS/OR tools regularly. On the other hand, nearly three quarters of companies have never used these instruments. This state is not positive compared with economic advanced western countries. It is possible to state that these methods are used in Czech small and middle-sized enterprises only seldom. The reason of this situation consists first of all in unfamiliarity with these methods including possible effects that may be gained by their use. A great deal of responders affirms that they disuse quantitative methods because the nature of their activities do not allow it. However, it is paradoxical, that great deal of them at the same time declares they do not know any of these methods for decision-making support.

The mathematical optimization methods have been known in the company's practice a couple of decades already. Nevertheless, the Czech enterprises often cannot utilize these management tools efficiently. It is possible to examine a number of possible causes of this state. We can spot one of these causes according to how the strength of the quantitative optimization methods is presented in various courses or in the literature available in the Czech Republic. An effective aid with a list of relatively simple exact approaches and rational techniques, that could be applicable to solving decision-making problems in companies, is seldom available to senior managers in Czech companies.

4 Conclusion

Managers in all types of organisations – large or small, private or state, profit or non-profit, production or providing services – use exact methods to help them in their decisions. In consequence of increasing complexity, intensity and quantity of internal and external influences, managers meet and have to solve a large quantity of problems – from operational problems to difficult and important strategic ones. The managers are more and more expected to be able to make decisions based on logical thinking and complete analysis, and not only on their experiences and intuition.

The power of quantitative methods grows with regard to using of personal computers. The PC become as a very effective managerial tool, which enable to managers not only to get and to dispose immediately actual information (for example thanks to the internet), but also to process this information (thanks to relative cheap software) and to realise (on the base of gained results) measures and decisions.

These procedures in smaller companies usually will be not performed by specialists in OR methods solution. Therefore for the smaller businesses practice we can recommend the simple methods, which are inexpensive in their requirements, and can be implemented by means of computer technique and software in common use.

Finally, the philosophy "think big but start small" seems to be appropriate if solving the problems with the help of the quantitative tools in small businesses. It is recommended to gain some approximate or fractional solution at the early point in project development (so called "quick and dirty" solution) and keep the orientation of the project according the user's goals.

References

- [1] FILDES, R., RANYARD, J. Internal OR consultancy: Effective practice in a changing environment. *Interfaces*, 2000, Vol. 30, No. 5, pp. 34-50. ISSN 0092-2102.
- [2] McFADZEAN, E. Creativity in MS/OR: Choosing the Appropriate Technique. *Interfaces*, 1999, Vol. 29, No. 5, pp. 110-122. ISSN 0092-2102.
- [3] MEHRA, S. Applying MS/OR Techniques to Small Businesses. *Interfaces*, 1990, Vol. 20, No. 2, pp. 38-41. ISSN 0092-2102.
- [4] ORMEROD, R. Beyond internal OR groups. *Journal of the Operational Research Society*, 1998, Vol. 49, No. 4, pp. 426-429.
- [5] PLEVNÝ, M. Optimization methods practice – a study on Czech enterprises. *E+M Ekonomie a Management*, 2004, No. 2, pp. 54 - 60. ISSN 1212-3609. (in Czech)
- [6] WATSON, H. J., MARETT, P.G. A Survey of Management Science Implementation Problems. *Interfaces*, 1979, Vol. 9, No. 4, pp. 124-128. ISSN 0092-2102.