

# Matching Management Support Systems and Managerial Problem-solving Modes: The Key to Effective Decision Support

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This study investigates the impact of management support systems (MSS) on managerial decision-making. We hypothesize that the success of MSS depends on the extent to which they match with the problem-solving modes that are employed by managerial decision-makers. A problem-solving mode is a cognitive model that characterizes the problem-solving process of a manager. We test our hypothesis in the field of marketing by analyzing data of 38 management support systems. The results confirm our hypothesis implying that a demand-oriented approach to the design and implementation of management support systems is important for these systems to be successful. The demand-side perspective on management support systems developed in this paper offers help in analyzing and removing discrepancies between the demand and supply of decision support. Doing so will improve the impact of these systems. © 2001 Elsevier Science Ltd. All rights reserved.

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## Introduction

The development and implementation of management support systems requires substantial efforts and investments. Therefore, it is important to carefully analyze which type of system is most appropriate given the requirements of the decision-making situation before systems are built. We use the term management support systems (MSS) to refer to the whole set of tools. A management support system can be defined in terms of its components, as any device combining (1) information technology, (2) analytical capabilities, (3) data, and (4) knowledge, made available to one or more decision-maker(s), with the objective of improving the quality of management.

Studies on the *impact* of management support systems report mixed findings (see for example the reviews of Sharda *et al.*, 1988 and Benbasat and Nault, 1990). Impact can be defined as the extent to which systems are used and to which they improve the quality of decision-making. On one hand implementations with impact have been reported. For example, the use of the CALLPLAN model for the determination of optimal sales-call frequencies led to higher sales by an airline company (Fudge and Lodish, 1977). The success of CALLPLAN was also

documented for an application in the pharmaceutical industry (Lodish *et al.*, 1988). The new product market simulation ASSESSOR is reported to be applied in more than 6000 situations (Little *et al.*, 1994) and the SCAN\*PRO system that estimates the effects of sales promotions has been used in practical applications more than 500 times (Parsons *et al.*, 1994). On the other hand, several authors, especially in the context of OR-based marketing models, have expressed pessimistic views on the impact of management support systems in the marketing practice. 'The big problem with such models is that managers practically never use them' (Little, 1970, p. B-466). 'Even several decades after the earliest operational marketing models were first introduced, their impact on practice remains far below its potential,' (Eliashberg and Lilien, 1993, p. 19) and 'the practical significance of marketing science has remained very limited' (Simon, 1994, p. 40). Laboratory experiments that examined the effects of management support systems also did not report unequivocal results (e.g., Chakravarti *et al.*, 1979; McIntyre, 1982; Van Bruggen *et al.*, 1998).

The premise of this study is that in order to be successful management support systems should match the thinking and reasoning processes of managers (Todd and Benbasat, 1992; Wierenga and Van Bruggen, 1997). System developers should start by investigating the way that decision-makers solve problems and then develop systems that match with this problem-solving mode. Our hypothesis is that *the impact of a management support system depends on the match between the problem-solving mode employed by the decision-maker (i.e., the demand side) and the characteristics of the management support system (i.e., the supply side). The impact is larger if the match is better.*

## A Framework for Explaining the Impact of Management Support Systems

Both in the information systems literature (Chervany *et al.*, 1972; Lucas, 1973; Mason and Mitroff, 1973;

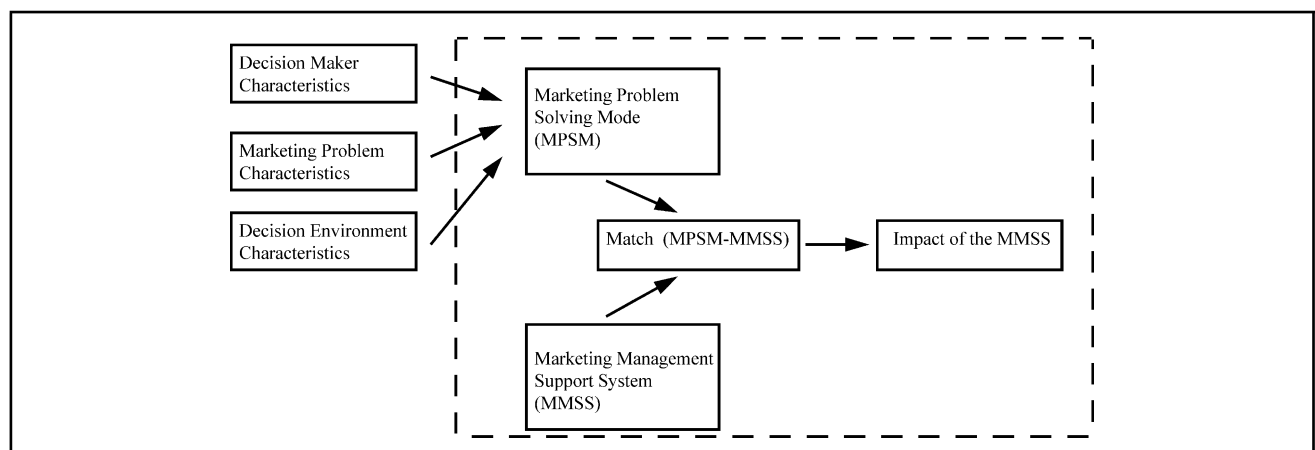
Mock, 1973) and in the management science literature (Little, 1970; Schultz and Slevin, 1972; Naert and Leeflang, 1978) attention has been paid to factors that determine the success of management support systems. From these studies four sets of factors emerge that drive the impact of an MSS. These are the characteristics of (i) the MSS, of (ii) the decision-maker, of (iii) the problem, and of (iv) the decision-environment. Several empirical studies have been conducted in which the use and effects of MSS are explained by concentrating on no more than one or two of these groups of characteristics.

In this study we divide these factors into two categories: demand-side factors (decision-maker characteristics, problem characteristics, and decision-environment characteristics) and supply-side factors (MSS characteristics). Through the introduction of the integrating concept of *problem-solving modes* (Wierenga and Van Bruggen, 1997) the three demand-side factors are simultaneously linked to the supply-side, i.e., the *management support system* (see Figure 1). A problem-solving mode is a cognitive model that characterizes the way a decision-maker solves a problem. Different problem-solving modes exist. The specific problem-solving mode that is used depends on the characteristics of the decision-maker, the characteristics of the problem, and the characteristics of the decision-environment (see Wierenga and Van Bruggen, 1997 for a more extensive description of this relationship). On the supply-side we specify the functionality of a specific management support system, which is a function of its characteristics. We elaborate on this functionality later.

The focus of this paper is on the part of the model that is within the dashed line of Figure 1. Here the *match* between problem-solving mode and management support system is the central element.

### The Demand Side: Problem-Solving Modes

We will only briefly describe the problem-solving modes here. For a more elaborate description and



**Figure 1 Conceptual Framework**

theoretical underpinning the reader is referred to Wierenga and Van Bruggen (1997). Four problem-solving modes are distinguished, i.e., optimizing, reasoning, analogizing, and creating. Together they are referred to as the *ORAC model*.

In the *optimizing* mode the decision-maker has a precise insight into the mechanism behind the decision problem. He/she uses a mathematical model that describes the relationships between the variables under study. He/she searches for those values of decision variables that maximize the goal variable(s) for the particular problem. These optimal values for the decision variables are determined in the 'model world.' Next, they are translated to the 'real world.' In a sense a management problem is converted into a 'programming problem.' An example of this problem-solving approach is the determination of an optimal allocation of a media budget by optimizing the exposure to advertisements given the audience reach and the costs of various alternative media.

In the *reasoning* mode the decision-maker constructs an internal representation of decision phenomena. This 'mental model' is the basis for reasoning about a problem. It contains variables deemed relevant and the supposed cause-effect relationships. It helps the decision-maker to diagnose and solve a specific problem. Different managers can have different mental models regarding one and the same problem. These mental models may be incomplete, subjective, and possibly (slightly) different from reality. For example, in the case of advertising different managers may use different models to explain why a particular advertising campaign was or will be successful or not.

In the *analogizing* mode the manager, when confronted with a problem, activates his/her memory to find a similar problem, which he/she solved before, or has witnessed being solved. The previous solution is taken as the starting point for solving the present case, and may subsequently be adapted, taking into consideration the differences between the present and the earlier problem. The solution is not constructed from first principles but from past cases. For example, managers can decide to execute the same type of sales promotion for a product in a foreign country as in their home country where this type of promotion proved to be successful. They can also decide to slightly adapt the solution because the situation in the foreign country is different from that in the home country.

Finally, in the *creating* mode the decision-maker is searching for novel and effective ideas and solutions by means of mapping, exploring, and transforming the problem space, expanding the number of possible solutions through divergent thinking and by making connections and associations. Creativity is an important management asset and refers to such things as generating ideas for new products or services, innovative advertising or sales-promotion cam-

paigns, new forms of distribution, and ingenious pricing.

The problem-solving modes as described above are not mutually exclusive in the sense that a decision-maker can use only one mode for the solution of a particular problem. Some decision situations will call for two modes to be employed, sometimes in different phases of the solution process. Here, we look at the dominant mode. This is the mode that describes best what the manager actually does in a particular situation.

## The Supply Side: Management Support Systems

To test our hypothesis that the impact of management support systems depends on the match between the problem-solving mode employed by the decision-maker and the characteristics of the system we conducted a survey among the developers of management support systems. We chose the field of marketing as the empirical setting for our study. In this field we find substantial variation in both the problem-solving modes that are employed and in the functionalities of the marketing management support systems that have been used. We will now classify the management support systems which are available as decision aid (i.e., the supply side of management support systems in our study).

Based on their particular characteristics, eight different marketing management support systems can be distinguished (Wierenga and Van Bruggen, 1997).

1. *Marketing models* are mathematical representations of marketing problems and are used for finding optimal values for marketing instruments. The philosophy underlying these systems is that it is possible to find an objectively best solution.
2. *Marketing information systems* are systems for storage, retrieval, and (statistical) analysis of data. By means of manipulating quantitative information, marketing information systems assist marketers in analyzing what has happened in the market and the possible causes of events.
3. *Marketing decision support systems*. Whereas marketing information systems are relatively passive systems that provide marketers only with the information they are looking for, marketing decision support systems are more active. They provide marketers with the opportunity to answer 'what-if' questions by means of making simulations. Using judgment, marketers will generate ideas for possible courses of action and with the help of the marketing decision support system the outcomes of these actions can be predicted. In the end, the marketer's judgment will be the decisive factor in selecting the final and most appropriate course of action.

4. *Marketing expert systems*. The basic philosophy is to capture the knowledge from a marketing expert in a specific domain and make that knowledge available in a computer program for solving problems in that domain. The goal of an expert system is to replicate the performance levels of a human expert in a computer model (Rangaswamy, 1993). These systems take a normative approach in searching for the 'best' solution for a given problem.
5. *Marketing knowledge-based systems* refer to a broader class of systems than marketing expert systems. They obtain their knowledge from any source, not just from human experts but also from textbooks, cases and so on. Furthermore, knowledge can be represented in multiple forms, i.e., not only by means of rules as in expert systems but also by means of semantic networks and frame-based hierarchies. Contrary to marketing expert systems, knowledge-based systems do not focus on finding a best solution but emphasize the reasoning processes of decision-makers.
6. *Marketing case-based reasoning systems* focus on the support of reasoning by analogies. Analogical reasoning is a way of solving problems in which solutions to similar problems in the past are taken as a starting point for a solution to current problems. Marketing case-based reasoning systems make cases available in a case library and provide tools for retrieving an accessing these.
7. *Marketing neural networks* are systems that model the way human beings attach meaning to a set of incoming stimuli, that is, how people recognize patterns from signals. They were inspired by the actual physical process that takes place in the human brain, where incoming signals are transmitted through a massive network of connections, which are formed by links among neurons in the brain. The first examples of artificial neural networks in marketing have appeared only recently.
8. *Marketing creativity support systems* are computer programs that stimulate and endorse the creativity of marketing decision-makers. Although the number of creativity-enhancement programs developed for marketing problems is still limited, we expect these systems to become more popular in the coming years, given the increasing importance of creativity in marketing, for example for the development of new products.

### The Match between Problem-Solving Modes and Marketing Management Support Systems

We propose that each of the marketing management support systems as described above, will be especially suited for the support of a specific problem-solving mode. In the case of *optimizing*, a best solution exists and the marketing management support system should ensure that this solution is found. Marketing models (Lilien *et al.*, 1992; Eliashberg and Lilien, 1993) provide a mathematical representation

of the marketing problem and are the starting point for finding the objectively best solution for the values of the marketing instruments. Whereas marketing models provide the best *quantitative* solution, marketing expert systems aim at providing the best solution if the problem is described in terms of *qualitative* relationships between variables.

In the *reasoning* mode, the object of support for the decision-maker should not be so much a particular outcome (a precise recommendation on what to do), but rather the manager's decision-making *process*. The system should enable managers to continuously enhance their knowledge and revise their mental models. Marketing information systems and marketing decision support systems can help to achieve a better understanding of the mechanisms in a market. Marketing knowledge-based systems are suited to represent a decision-maker's mental model in a computer and reason with this model.

In the *analogizing* mode the primary object of support is the *process* of finding suitable previous cases and adapting them for the current problem. Marketing case-based reasoning systems are the prime type of marketing management support system that match with the requirements of the analogizing mode.

Finally, to support the *creating* mode, a system should support the creative process and should fulfill a *stimulating* role — that is, generate cues and ideas that trigger the user. Marketing creativity-enhancement programs are systems that can perform this function. In Table 1 we summarize which marketing management support systems match with each of the four marketing problem-solving modes.

### Data Collection

To test our hypothesis that an MSS is more effective if it has a better match with the problem-solving

**Table 1 Marketing Problem-Solving Modes and Appropriate Marketing Management Support Systems**

Marketing problem-solving modes	Marketing management support system
Optimizing	Marketing Models (MM) Marketing Expert Systems (MES)
Reasoning	Marketing Information Systems (MKIS) Marketing Decision Support Systems (MDSS) Marketing Knowledge-Based Systems (MKBS)
Analogizing	Marketing Case-Based Reasoning Systems (MCBR) Marketing Neural Nets (MNN)
Creating	Marketing Creativity-Enhancement Programs (MCEP)

mode we collected data about actual management support systems by means of a survey. For this purpose we looked at the systems that have appeared in the academic *marketing* literature. By scanning this literature (marketing journals and well-known marketing-model books such as Lilien *et al.*, 1992 and Elishberg and Lilien, 1993), we identified 44 marketing management support systems. For each of these systems a questionnaire was sent to the first author of the paper describing the system. In a few cases, when the first author did not respond, the second author was subsequently approached. The questionnaire contained questions with respect to characteristics of the systems, the problems they were developed for, and the impact they had had. Ultimately, 38 questionnaires were returned, implying a response rate of 86 per cent. Table 2 contains the names of the specific systems in our database and of the developers of these systems.<sup>1</sup>

We now describe how the variables of interest in this study were operated and measured.

### Problem-Solving Mode

The core element of our explanatory framework is the match between the problem-solving mode and the type of management support system. We did not have direct observations of the problem-solving mode employed in the situations for which the 38 systems were developed. Therefore, we asked the developers of the systems to judge the extent to which applying each of the four problem-solving modes was appropriate for the decision situations they developed their systems for. The developers of the systems rated on 7-point (impossible/possible) scales the extent to which the problem was suited for (i) finding an *optimal* solution, for (ii) *reasoning*, for (iii) *analogizing*, and for (iv) *creative thinking*.

### Management Support System

The 38 systems were classified into one of eight different specific types of MMSS. Two criteria were used. First, whether a quantitative model (MM, MKIS, MDSS) or qualitative knowledge (MES, MKBS, MCBR) was used. Second, whether the system (i) focused on finding the best solution (MM, MES), (ii) helped the user in developing, adapting and/or using mental models (MKIS, MDSS, MKBS), (iii) made descriptions of similar problem situations in the past available (MCBR) to its user, or (iv) was able to recognize patterns and to learn (MNN). The results of the classification are presented in Table 2.

### The Match between Problem-Solving Mode and System

The match between the problem-solving mode and the management support system depends on the

extent to which the system supports the mode applied by the decision-maker. We distinguish two groups of systems: those with a 'good' match and those with a 'bad' match. A good match occurs if a system is applied to a problem that is rated higher on the applicability-of-the-mode scale than the average of all problems. If the problem rates lower than average on the applicability-of-the-mode scale the system is supposed to support, we call it a bad match. For example, the average score of all problems on the applicability-of-optimizing scale is 4.1 (see Table 3). If a marketing management support system primarily supports optimizing (a marketing model or marketing expert system) and this system is applied to a problem situation that rates higher than 4.1 on the applicability-of-optimizing scale, this was classified as a good match. If such an optimizing system was applied to a problem situation with a score below 4.1 on the applicability-of-optimizing scale it was classified as a system with a bad match. Given the way the concept of match is operated good and bad match should be interpreted as relative measures.

### Perceived Impact

To measure the impact of the systems, the system developers were asked to indicate: (i) the number of companies that implemented the system to support decision-making and (ii) the percentage of companies that originally implemented the system and that still used it. Furthermore, using 7-point scales, the respondents were asked to indicate (iii) the impact on actual decisions, (iv) the success of the implementation, and (v) the satisfaction of the users as perceived by its developers. These five measures can be interpreted as indicators of one underlying construct, i.e., perceived impact of the marketing management support system. Factor analyzing the five measures yielded one factor that accounted for 59.0 per cent of the variance. The Cronbach  $\alpha$  is 0.80, which indicates a sufficiently high internal reliability.

## Results

### Applicability of the Four Marketing Problem-Solving Modes

In Table 3 we present the results for the applicability of each of the four marketing problem-solving modes in the decision situations for which the systems were developed.

In the second column of Table 3 the mean applicability score for each mode is shown. Over all the problems considered it turns out that the reasoning mode is perceived as being most often best applicable. Analogizing immediately follows reasoning. The creating and the optimizing modes are signifi-

**Table 2 Marketing Management Support Systems in the Sample**

Type of MMSS	Systems in the sample
Marketing Models	MEDIAC (Little and Lodish, 1969) SPRINTER (Urban, 1970) GEOLINE (Hess and Samuels, 1971) CALLPLAN (Lodish, 1971) DETAILER (Montgomery <i>et al.</i> , 1971) ADMOD (Aaker, 1975) MODEL FOR ALLOCATING RETAIL OUTLET BUILDING RESOURCES (Lilien and Rao, 1976) STRATPORT (Larréché and Srinivasan, 1981) PRICESTRAT (Simon, 1982) DEFENDER (Hauser and Shugan, 1983) SALES TERRITORY ALIGNMENT MODEL (Zoltners and Sinha, 1983) SH.A.R.P. (Bultez and Naert, 1988) SIMOPT (Green and Krieger, 1989)
Marketing Expert Systems	INNOVATOR (Ram and Ram, 1988) NEGOTEX (Rangaswamy <i>et al.</i> , 1989) ADCAD (Burke <i>et al.</i> , 1990) DEALMAKER (McCann and Gallagher, 1990) PROMOTION DETECTIVE (McCann and Gallagher, 1990) TEXTBOOK PROMOTION ADVISOR (McCann and Gallagher, 1990) ESWA (Neibecker, 1990) SHANEX (Alpar, 1991)
Marketing Decision Support Systems	ADBUDG (Little, 1970) THE SYSTEM OF PROMOTIONAL MODELS (Rao and Lilien, 1972) NEWPROD (Assmuss, 1975) BRANDAID (Little, 1975) THE A/S RESPONSE MODEL (Rao and Miller, 1975) PERCEPTOR (Urban, 1975) MAPLAMOD (Bloom and Stewart, 1977) TRACKER (Blattberg and Golanty, 1978) ADVISOR2 (Lilien, 1979) ASSESSOR (Silk and Urban, 1978) NEWS (Pringle <i>et al.</i> , 1982) SCANPRO (Wittink <i>et al.</i> , 1988)
Marketing Knowledge-Based Systems	PROMOTOR (Abraham and Lodish, 1987) CAAS (Kroeber-Riel, 1990) DATASERVER PARTNERS/COVERSTORY (Schmitz <i>et al.</i> , 1990)
Marketing Case-Based Reasoning Systems	ADDUCE (Burke, 1991) CASE-BASED REASONING SYSTEM FOR FORECASTING PROMOTIONAL SALES (McIntyre <i>et al.</i> , 1993)

**Table 3 The Applicability of the Four Marketing Problem-Solving Modes in the Problem Situations the Marketing Management Support Systems were Developed for**

Marketing problem-solving mode	Mean applicability score (7-point scale) (st. dev. in parentheses)	Number of situations where mode was best applicable
Optimizing	4.1 (2.0)	6
Reasoning	5.6 (1.2)	13
Analogizing	5.4 (1.5)	11
Creating	4.2 (1.6)	4
Total		34 <sup>a</sup>

<sup>a</sup>The results in this table are based on the answers of 34 respondents. Four respondents did not provide the necessary information

**Table 4 Types of Marketing Management Support Systems in the Sample**

Marketing problem-solving modes	Number of systems
Optimizing	13 marketing models (34%) 8 marketing expert systems (21%) 21 systems (55%)
Reasoning	12 marketing decision support systems (32%) 3 marketing knowledge-based systems (8%) 15 systems (40%)
Analogizing	2 marketing case-based reasoning systems (5%) 2 systems (5%)
Creating	No systems

cantly less applicable for the situations for which the systems have been developed. This pattern is confirmed by the third column of Table 3, which gives information about the frequencies that each of the four modes is seen as the best applicable.

#### Characteristics of the Management Support Systems

Five of the eight types of marketing management support systems, as distinguished in Table 1, are represented in our system database. It consists of 13 marketing models, 8 marketing expert systems, 12 marketing decision support systems, 3 marketing knowledge-based systems and 2 marketing case-based reasoning systems. The database does not contain marketing information systems, marketing neural nets, and marketing creativity-enhancement programs. Marketing information systems, although frequently found in companies, are seldom the subject of academic papers, which was the source of the systems in this study. Neural nets and creativity enhancement programs are technologies that emerged only recently in marketing.

By classifying the various types of systems into the

four categories of Table 1, we determine to what extent the systems in our sample support each of the four marketing problem-solving modes. The results in Table 4 show that 21 systems (55 per cent) (primarily) support the optimizing mode, 15 systems (39 per cent) support the reasoning mode, and 2 systems (5 per cent) the analogizing mode.

#### The Match between Problem-Solving Mode and Management Support System

For the problem situations for which each of the systems in our sample was developed we determined which problem-solving mode was the best applicable (see Table 3). Next, we analyzed how often this problem-solving mode was supported by a system that supports the same mode (i.e., a good match). The results of this analysis are presented in Table 5. The columns represent the *demand* side (i.e., the problem-solving mode that is best applicable to the decision situation) and the rows the *supply* side (the problem-solving mode that is actually supported by the system). We illustrate the way Table 5 should be read by discussing the results in the first row. For the 21 problems where optimizing systems were developed, in five cases optimizing was the best applicable mode. For six problems the reasoning mode was the best applicable while the analogizing and the creating mode were best applicable in four and three cases, respectively. For the reasoning and analogizing systems Table 5 can be read in the same way. Since our database did not contain creativity support systems, no data are presented for these systems.

Reading Table 5 column-wise, we observe that when optimizing is the best applicable mode (first column), in five of the six cases a system that supports this mode has actually been applied. In these cases a good match thus exists. However, if we look at all the implementations of systems that support optimizing, in 13 out of 18 cases an optimizing system is applied although optimizing is *not* the best applicable mode.

When reasoning is the most applicable problem-solving mode (second column of Table 5) in the majority of the cases (7 out of 13 times) a system that supports reasoning has actually been applied. Again, in these

**Table 5 The Match between Marketing Problem-Solving Modes (MPSM) and Marketing Management Support Systems (MMSS)**

MPSM most supported by the MMSS (supply side)	Best Applicable MPSM (demand side)				
	Optimizing	Reasoning	Analogizing	Creating	No data
Optimizing ( $n = 21$ )	5	6	4	3	3
Reasoning ( $n = 15$ )	1	7	6	1	
Analogizing ( $n = 2$ )	–	–	1	–	1
Creating ( $n = -$ )	–	–	–	–	
Total	6	13	11	4	4

**Table 6 The Perceived Impact of the Marketing Management Support Systems**

Impact measures	Mean (st. dev.)
Number of companies that implemented the MMSS	46.3 (79.3) (Range: 0–333)
Percentage of companies that still use the MMSS	44.3 (42.2) (Range: 0–100)
Impact of MMSS on actual decisions <sup>a</sup> (small – large)	5.40 (1.33)
Success of implementation of MMSS <sup>a</sup> (not successful – very successful)	5.43 (1.19)
Satisfaction of users <sup>a</sup> (not satisfied – very satisfied)	5.47 (1.07)
<b>Impact Scale</b> (Cronbach $\alpha = 0.80$ )	

<sup>a</sup>For these indicators 7-point scale items were applied

cases a good match exists. However, reasoning systems are also often applied in situations where reasoning is not the best applicable mode (8 out of 15 times). Table 5 also shows that of the 15 situations where analogizing or creating are the best applicable modes, in only one case was a system developed that supports one of these modes. In fact very few systems that support these modes exist in marketing. Overall, of the 34 situations for which data are available, in only 13 cases (38 per cent) a match exists between the demand for support and the support actually offered. (These are the diagonal elements of Table 5). Especially optimizing systems, and to a lesser extent also reasoning systems, were often applied in problem situations that required another type of support. The results thus seem to suggest a relative 'mismatch' between the functionalities of the systems that have been developed and the problem-solving mode which the problems call for. In the field of marketing we see that, whereas for most problems reasoning and analogizing are perceived as being the best possible modes, the majority of the systems support optimizing. This raises the question whether such an imperfect match hampers the impact of management support systems.

### The Perceived Impact of the Management Support Systems in Marketing

Table 6 provides information about the impact of the systems. The practical impact of the systems is considerable and reasonably enduring. The number of companies in which a system was implemented ranges from 0 to 333, with an average of 46 companies. Of the companies that originally implemented a system, 44 per cent, on average, are still using it. The average scores on the scales for impact on actual decisions, success of implementation, and satisfaction of the users (between 5 and 6 on a 7-point scale) also show that the systems have had a substantial impact. Although we concluded that relatively often an imperfect match between problem-solving mode and system existed, we nevertheless find that *on average* the impact figures are relatively good. This raises the question whether the match between problem-solving mode and management support system is an important determinant of system impact.

### The Relationship between Match and Impact

Considerable differences with respect to the impact of the various management support systems exist. We examine to what extent these differences can be explained by the match between the problem-solving mode that the systems actually support and the characteristics of the problem situation.

In Table 7 we present for both the optimizing and the reasoning systems, the correlation coefficients between the applicability of the problem-solving mode and the impact of the system. Only for the systems that support these modes had we enough observations to carry out this analysis. The results confirm our expectations. An optimizing system has a greater impact if the optimizing mode is more applicable to the problem situation where it is applied. The correlation coefficient is 0.39 ( $p = 0.057$ ). On the other hand, the impact of an optimizing system tends to be lower as the problem is more applicable for reasoning ( $r = -0.26$ ). Similarly, systems aimed at supporting reasoning tend to have more impact if the problem is more applicable to reasoning. In a sense, Table 7 can be interpreted as a Multitrait-Multimethod type of approach, showing that the best results are obtained when the right method is applied to the

**Table 7 Pearson Correlation Coefficients between the Applicability of the Marketing Problem-Solving Modes and the Impact of the Marketing Management Support Systems (Two-tailed Significance Within Parentheses)**

	Correlation with impact	
	Applicability of optimizing mode	Applicability of reasoning mode
Optimizing Systems ( $n = 18$ )	0.3857 (0.114)	-0.2566 (0.304)
Reasoning Systems ( $n = 13$ )	0.1109 (0.718)	0.2859 (0.302)

right problem. Since this analysis is carried out per type of management support system, the sample sizes are small. This leads to a low power of the significance test. This probably explains why the correlation coefficients do not always reach significance. Nevertheless, the overall pattern of coefficients is in agreement with what we hypothesized.

Next, we analyze for the whole set of systems whether a relationship exists between the match of the system with the marketing problem and the impact of the system. In Table 8 we present the impact figures of systems that have a good match with the problem situation and systems that have a bad match. The results show that for all impact measures systems with a good match perform better than systems with a bad match. Systems with a good match are implemented in more companies, have a higher endurance rate, have more impact on actual decisions, are more successful, and generate higher user satisfaction. Performing analysis of variance on the overall impact construct shows that this difference is clearly significant ( $F = 7.11$ ,  $P = 0.006$ ). This finding confirms our hypothesis that systems that match well with the problem-solving mode have more impact than systems that do not match.

## Discussion

In this study we have investigated whether a demand-driven approach to the development and implementation of management support systems enhances the impact of these systems on managerial decision-making.

### Major Findings

Since the early 1960s a considerable number of management support systems to support decision-making in marketing have been developed. Mixed observations have been made with respect to the impact of these systems upon marketing management in practice. In this study we investigated the drivers of this impact. We developed a conceptual framework

that relates the requirements for decision support to the type of support that a management support system offers, i.e., the match between the demand and supply of decision support.

By means of a survey among the developers we have collected data about management support systems and their implementation and investigated to what extent these systems have been successful. On average, the impact of the systems has been considerable. Nevertheless, room for improvement exists. We find evidence for an imperfect match between the demand and the supply of management support. In many of the decision situations for which systems were developed, the best applicable problem-solving mode was not the one that was supported by the system. In our empirical setting (i.e., marketing) system development focused especially on normative systems that try to find optimal solutions for problems whereas the nature of decision-making calls for reasoning, finding analogies, and creativity.

Our results provide an empirical confirmation of the appropriateness of the demand-driven approach to management support (Wierenga and Van Bruggen, 1997). The hypothesis derived from this approach, that a system has a bigger impact if a better match exists between the problem-solving mode applicable to the problem and the mode supported by that system, has been confirmed.

### Limitations and Further Research

A study like the one described here has its limitations. First, we realize that the empirical part of this study is limited to *marketing* systems that have appeared in the *academic* literature. With respect to the specific management field we selected to test our hypothesis we acknowledge that the nature of decisions in marketing might be different from those in other fields of management like, for example, finance, operations, and human resources. Especially, the importance of creativity might be larger in marketing than in the other fields. However, we propose that the general principle that management support systems should match problem-solving modes holds

**Table 8 Relationship Between MPSM-MMSS Match and the Impact of the MMSS**

Impact measures	'Bad' match ( $n = 10$ )	'Good' match ( $n = 23$ )	Significance of differences (one-tailed)
Number of companies implementing the MMSS	11.3 (21.4)	67.5 (42.0)	0.034
Percentage of companies still using the MMSS	7.5 (15.0)	52.5 (92.2)	0.026
Impact on actual decision <sup>a</sup>	5.3 (0.8)	5.4 (1.3)	0.400
Success of implementation <sup>a</sup>	5.0 (1.3)	5.7 (1.2)	0.118
Satisfaction of users <sup>a</sup>	5.2 (1.2)	5.7 (0.8)	0.094
<b>Impact factor</b>	-0.44	0.18	0.006

<sup>a</sup>rating on a 7-point scale

for every type of problem-solving mode. Therefore, it is our contention that the hypothesis that was confirmed in the marketing field is also valid for other management areas. Future research in these fields should confirm this.

With respect to the specific sources of the systems in our study, i.e., *academic literature*, we acknowledge that a multiple of the number of systems that we have studied, has actually been developed in companies and marketing research agencies. We cannot claim that the systems in this study provide a representative picture of what is actually used in practice. However for the systems included in our study the relationship between the match of demand and supply and the impact was established and there is no reason to believe that this result does not extend to systems developed in companies and marketing research agencies. It would be interesting to verify this by means of a study of the latter category of systems.

With respect to the subset of systems that have appeared in the academic marketing literature we think that our database is quite complete and representative. One consideration is the high response to the survey (86 per cent). Furthermore, the reader might also judge the completeness and representativeness of the sample from the information about the systems included in the study, as given in Table 2. We think that the most prominent systems from the literature are included.

A final limitation of the study is that we obtained all the information about the marketing management support systems and their implementations from the *developers* of these systems. Using system developers as key-informants might have introduced a bias. A tendency of giving too favorable information may exist about one's own system, in terms of acceptance and use. Therefore, the absolute magnitudes of these variables should be treated with caution. However, the goal of this study was especially to explain the *differences* in performance. These differences are less susceptible to a possible overall upward bias in performance ratings. As follow-up to this research, it might be interesting to conduct a survey among the *users* of the systems in our database to investigate their views about use of and satisfaction with the systems. This way the findings in this study could be corroborated.

### Implications

Our study shows that for the development of truly effective management support systems a *demand orientation* is advisable. Systems should be attuned to the problem-solving modes actually employed. The most effective systems are those that match with the problem-solving mode that is employed in a given problem situation. Illustrative of this idea are the

development of marketing models for problem situations where it was possible to find an optimal solution. Salesforce planning models, for example, have been successful. The problem-solving mode depends on the characteristics of the decision problem, the decision environment, and the decision-maker (Wierenga and Van Bruggen, 1997). Research is needed to determine which problem-solving mode is actually employed in a certain situation. It would be interesting to know how often each of the four problem-solving modes is actually employed in practice. At this point, it seems that in marketing, a good supply of management support systems exists for the support of the optimizing and reasoning modes. However, for the support of analogizing, the first systems are only just emerging, whereas for the support of the creating mode the situation is even less advanced. In this context the marketing community should benefit from the progress computer science (Wierenga and Van Bruggen, 1997). It has already become possible to develop tools that support analogizing and creating. Since these modes occur quite frequently, supporting them is important for companies to gain and maintain a competitive advantage.

We think that the discrepancy between the demand and supply of decision support systems exists in all areas of management. Applying the demand-driven approach presented in this paper can help to obtain a better insight in decision situations and to develop and implement management support systems that have impact.

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### Note

1. A list with the reference details of the systems can be obtained directly from the authors.

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