

An assessment of the theory underpinning the role of information quality in the single-loop decision making model

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Abstract: This paper offers comments on the single-loop decision-making model. The underpinning theoretical bases of such a model are assessed. The role of information quality is hypothesized in relation to customer relationship management decision making in the context of a data warehouse. The importance of learning aspects of decision making is explained. A focus group was set up in order to (1) validate the importance of our research problem from a management perspective (i.e. the interest of practitioners), (2) test the single-loop decision making model parsimony, and (3) get some clues about the potential constructs that would be of relevance in assessing decision performance. The results of this preliminary study support the single-loop decision-making model as a suitable framework for CRM decision making. Specific recommendations are made for further work on this piece of research.

1. Introduction

What is a good decision? [1]. Is it possible to help an inexperienced manager to detect problems? [2]. Is it possible to get some support when stating the facts or describing the situation? [3]. How can a manager be more confident in his/her decisions? [4]. We were interested in applying these questions in a given organization property and context. The organization property is the Customer Relationship Management, CRM in short, process and the organization context is the data warehouse of the firm. Therefore, our research problem consists in understanding the relationships (if any) between personal decision making, problem solving and information in a CRM process supported by a data warehouse. Although decisions are made at all levels in an organization [23] we will focus on decisions in CRM [24] at the individual level.

To the best knowledge of this researcher, the argument that decision effectiveness is a benefit provided by data warehouses has not been empirically validated. As such, our research question is: ***“What is the role of a data warehouse’s information quality in predicting decision effectiveness in CRM”***. This research question belongs to the MIS evaluation category of questions, more specifically to the decision support systems evaluation category of questions which is concerned with “the dependent variable in MIS research” [25]. Dependent variable here means MIS success. Our research is of theory-testing type; therefore empirical research guidelines should be rigorously applied [38]. We have selected the positivist paradigm passive observation for our research methodology. Remenyi et al. [38] recommend the following steps for this type of research: Literature review, assessment of established theoretical frameworks, assessment of ground theory in case of weak theoretical basis, theoretical conjecture and

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hypotheses formulation, evidence collection design, primary and control evidence, testing and analysis, confirmation of theory and development of further/refined theory. As the title suggests, we report our findings after having completed the hypotheses formulation step, including the results of an exploratory research. Specific recommendations are made for working further on this piece of research.

2. The theoretical conjecture

The theoretical background for our research consists of the following two widely accepted theories: (1) The theory of decision making of Cohen, March and Olsen [66], and (2) the theory of problem solving behavior of Simon [5]. The theory of decision making developed by Cohen, March and Olsen [66] describes the links between input exogenous variables, the decision making process (named ‘garbage can’ process) and the output variable (i.e. a decision). Later March [59] emphasized the idea of the impact of preceding decisions, see Figure 1. This theory is applicable for both organizational and managerial decision making [9]. Because we are considering this theory only at the individual level, the exogenous variable “participants” [66] is implicitly considered in each of the decisional activities in the decision making process. In this theory there are the following five links of interest to us: *Decision performance* → *Decision making process*, *Decision making process* → *Decision performance*, *Problems* → *Decision making process*, *Solutions* → *Decision making process*, and *Choice opportunities* → *Decision making process*.

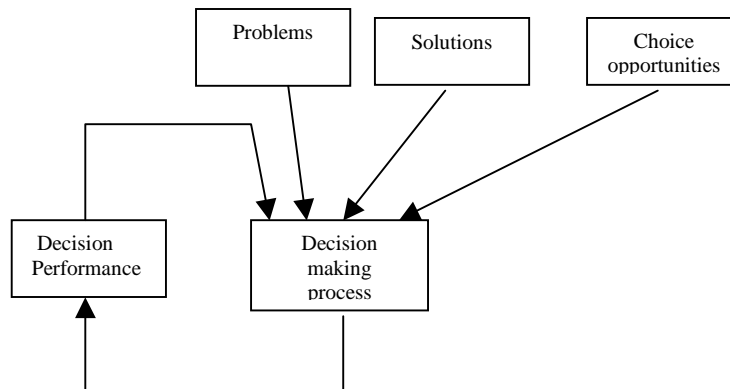


Figure 1. Cohen, March and Olsen’s ‘garbage can’ decision making process.

As Butler commented [9] in relation to this theory “a decision is constrained by the performance of preceding decisions and will, in turn, affect succeeding decisions by its own performance”. Learning is an important aspect in decision making. People learn ways of interpreting and dealing with situations (tasks, problems, and other conditions) by interacting with them [67]. Butler [68] found two dimensions of decision effectiveness. The first, like Marakas in [1], objective attainment, which is the extent to which prior objectives are reached. The second is the extent to which a decision and its associated processes lead to learning. This concept of learning is supported by the feedback of preceding decision performance in the garbage can decision making process.

Decision-making occurs under uncertainty and, potentially, involves subdecisions and concurrent decisions [9]. This theory links decision making to a time frame for the different streams of

decision making activities [9]. The contribution of this theory is twofold: (1) it gives an explanation of the [external view of] managerial decision making process, and (2) it gives a [controversial] explanation of the internal view of a managerial decision making process where this process is seen as a ‘garbage can’. This internal view of the decision making process (i.e. the garbage can decision making process), in simple terms, tells us that *per se* there is not necessarily a causal relationship between problems and solutions. The streams of decision-making activities include detecting new problems, compiling old problems, solutions to old problems and solutions to [potential] future problems. Decision makers “throw” the compiled problems and solutions into the garbage can [their personal ‘repository’] awaiting a choice opportunity (e.g. money spent, responsibilities allocated) when he/she will apply complex mental constructs (e.g. analogies) in order to, for example, map one or several of the available solutions to the problem in a given situation. This model does not prevent the fact that a decision-maker creates an *ad-hoc* solution to a new type of problem or even to an old type of problem. The sequence of streams of activities is entirely up to the decision-maker. Information is central to the process of coping with uncertainty and hence many studies of decision making have investigated the use of information [9]. Also, the fact that, as the garbage can process suggests, decision makers may go about looking for situations where their solutions and problems “fit” – where they make sense- simply means that there are situations that are manageable in terms of the available solutions. It implies nothing about the utility of other solutions [39].

Cohen, March and Olsen [with their input-garbage can process-output model, constructs and causal relationships] created a theory [70] of managerial decision making that has either support or no objections by other researchers [9] [39] [71] [72] [73] [74].

Decision-making can be thought of as a special type of problem solving [1]. Nobel prize-winning scholar Herbert A. Simon stated in his seminal work [5] and other subsequent works [26][51][52][53][54] a theory on decision making behavior contending that (1) as a result of cognitive constraints -i.e. cognitive limits to rationality- and uncertainty, characterized by scarcity of information, a person makes decisions with bounded rationality, (2) unprogrammed decisions will tend to involve problematic searches, with the need for alternatives prompted by a crisis or the availability of a solution and the use of ‘satisficing’ criteria to make a choice, (3) decision making consists of a general three-stage approach for problem-solving including intelligence, design, and choice where choice is a judgmental activity, and (4) in each of the problem solving activities humans are considered information-processing systems [51]. Massey [50] provides additional explanation to these three stages in terms of the following decisional activities: problem identification, problem definition encompassing problem structuring and problem formulation, solution building (named “alternative generation” by Massey), choosing (named evaluation and selection by Massey), and implementing.

Newel and Simon’s theoretical further development on the problem solving behavior theory contends that a problem solver, during the problem-solving process, (1) gets input information on the situation (e.g. a problem, solving task, choice opportunity) and makes an internal representation, (2) makes a problem space where there is information about the problem and about the solution, (3) problem solving takes place within such problem space, and (4) the task instructions and previous experience in solving similar tasks contribute significantly to the determination of the problem space. This view of a problem solver as an information-processing system fits with the garbage can process without entering into contradiction. The bounded rationality pattern of choice is individualistic and therefore judgmental, and context is more

important as a source of information for an interpretation of the decision task, as well as for its performance [39]. Dery [3] comments on this element of Simon's theory arguing that managers do not "normally face a choice situation, but events that call for evaluation and interpretation and that problems do not present themselves as structured or ill-structured, nor do they come as decision problems, complex or simple....To state the facts or describe the situation is to interpret not to copy it. Structured decision problems are structured because we choose to treat them as such". Simon's theory of problem solving behavior is applied to most models of management decision-making [1]. In addition, the literature addresses the application of the problem-solving process in marketing [47][48].

3. Research question and research model

The *problems, solutions and choice opportunities* variables of the garbage can process are [mental] internal representations of the decision maker about situations made after forming information, which means that a construct *Information on situations* that describes such a variables can be used instead. The following three constructs and links in the two referred theories are of interest for our research problem:

- *Information on situations* is the interpretation of problems, solutions and choice opportunities that stem from a specific situation that a decision-maker assigns to data by means of the known conventions used in their representation [60].
- *Decision performance* is (1) the extent to which prior objectives that gave rise to the need for a decision were reached within the boundaries and constraints imposed by the problem's context, and (2) the extent to which a decision and its associated processes lead to learning [9].
- *Decision making process* is the streams of activities that a decision-maker follows in order to cope with uncertainty over time under conditions of bounded rationality [9]. Such streams of decisional activities are problem identification, problem definition encompassing problem structuring and problem formulation, solution building, choosing, and implementing [50].
- The links are: *Information on situations* → *Decision making process*, *Decision performance* → *Decision making process*, and *Decision making process* → *Decision performance*.

Our research question is: "***What is the role of a data warehouse's information quality in predicting decision effectiveness in CRM***". Our unit of analysis is the organizational member working in marketing units performing CRM processes and making decisions. We choose quality as the aspect of *information on situations* and effectiveness as the aspect of the *decision making process* that we will address respectively. We focus on the following constructs:

- *Information quality on situations* (IQ) is the extent to which the data warehouse enables the formation of information on situations that is fit for use by decision-makers in CRM. This definition is a specification of information quality as defined by Huang and colleagues [77]. *Information quality on situations* is an independent variable in our research model.
- *Decision performance* (D) as defined before. *Decision performance* is both a dependent and an independent variable in our research model giving sense to the 'single-loop' denomination.

- *Decision making process effectiveness* (DM) is the extent to which the decisional activities have been performed with effectiveness. That is *problem identification effectiveness*, *problem structuring effectiveness*, *problem formulation effectiveness*, *solution building effectiveness*, *choosing effectiveness*, and *implementing effectiveness* are dependent variables in our research model. This construct can be described as follows $DM = \beta_1PI + \beta_2PS + \beta_3PF + \beta_4SB + \beta_5C + \beta_6Imp$ where *Problem identification effectiveness* (PI) is the extent to which a decision maker perceives symptoms that indicate or anticipate the presence of problems [1], *Problem structuring effectiveness* (PS) is the extent to which a decision maker collects the elements or variables needed to define the problem accurately [50], *Problem formulation effectiveness* (PF) is the extent to which a decision maker identifies and explores the relationships between these variables in order to define the problem [50], *Solution building effectiveness* (SB) is the extent to which a decision maker identifies and plans solution alternatives within the boundaries and constraints imposed by the problem's context, *Choosing effectiveness* (C) is the extent to which a decision maker chooses an acceptable solution plan from a selected set of alternatives, and *Implementing effectiveness* (Imp) is the extent to which a solution plan is realized.

The single-loop decision making model, see figure 2, has been derived from the theory of Cohen, March and Olsen about garbage can decision making and Simon's theory of problem solving considering the aspects of our research question. The denomination 'single-loop' applied to decision making is inspired by the 'single-loop model of learning' denomination [56]. Argyris introduced the 'single-loop' and 'double-loop' models of learning as crucial processes before the decision is made. Argyris explicitly argued the positive impact of such models in relation to the 'garbage can' model. Kolb [78] presented an overlay relating managerial learning styles to problem solving in order to illustrate the similarities and how learning styles affect problem solving success. Kolb concluded that problem solving and learning represent "...the same basic process of adaptation viewed from different perspectives".

There are studies reporting the following factors that can individually or collectively determine the relative difficulty of a pending decision: structure [5] [6], uncertainty [1][7], risk [8], alternatives and multiple objectives [1][9], cognitive limitations [10], contextual limitations [11] [12] [13] [14] environmental limitations [15] [16] [17] [18] and psychological limitations [19] [20] [21] [22]. We have to conclude that all of them are relevant with respect to their impact on managerial decision making. Recognizing the limited specification of the single-loop model to the constructs that we have explained we argue that this model is complete. From our literature review we have not identified any other independent variable, with strong empirical support, that might cause the dependent variables in the single-loop decision-making model.

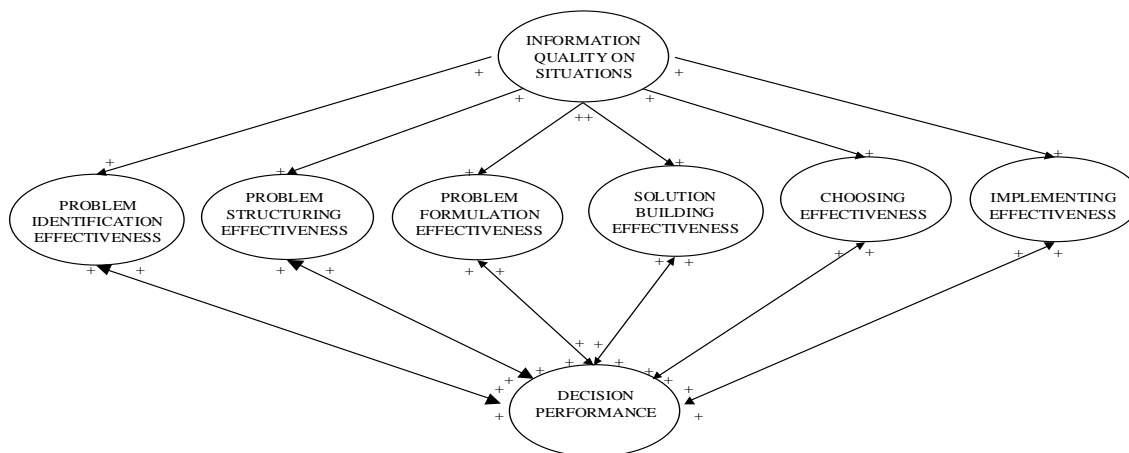


Figure 2. The single-loop decision making model.

With that, our research question can be addressed by testing the following three hypotheses:

Hypothesis 1: $IQ \rightarrow DM$. The greater the *information quality on situations* derived from the data warehouse, the greater the *decision making process effectiveness* in CRM decision-making.

Hypothesis 2: $D \rightarrow DM$. The greater the *decision performance* in CRM decision making, the greater the *decision making process effectiveness* in CRM decision-making.

Hypothesis 3: $DM \rightarrow D$. The greater the *decision-making process effectiveness* in CRM decision-making, the greater the *decision performance* in CRM decision making.

4. Theory assessment

The relevance of the theory of decision making of Cohen, March and Olsen for our research problem is that it gives us (1) a set of links between the variables *decision performance*, *problems*, *solutions*, *choice opportunities* and *decision making process*, and (2) a context of managerial decision making as described by the input-garbage can process-output approach. The relevance of Simon's theory of problem solving to our research is that (1) the *problems*, *solutions* and *choice opportunities* variables of the garbage can process are [mental] internal representations of the decision maker of situations made after forming information, which means that a construct *Information on situations* that describes such a variable can be used instead, (2) the theory provides further detail on the streams of decision making activities in the garbage can process, and (3) scarcity of information and/or cognitive limitations condition the variable *decision making process*.

We see in the literature support for the theory of Cohen, March and Olsen about garbage can decision making together with Simon's theory of problem solving. However, in order to address potential criticisms of this theoretical framework for the single-loop decision-making model as lacking in robustness, we wanted to find evidence in the literature supporting its links.

➤ Hypothesis 1: $IQ \rightarrow DM$

The assertion that information quality is an antecedent of decision performance is common sense and has been the object of many studies (e.g. [30][40][42][43][44][45]). Particularly interesting

for our research are the effects on decision performance of i) integrated data [46] which is a characteristic of data warehouses [31], ii) data accuracy [58], completeness [58][84], and consistency [58], which are critical aspects of data quality in a data warehouse [33] [34], iii) information presentation [69], iv) data load [87], and v) information load [86]. In summary, information reduces uncertainty [75]. However, there are not many field studies giving evidence of a link with the decision making process. From the efficiency point of view, there is evidence supporting that i) knowledge in the problem domain will reduce the time spent on pre-decisional activities [28], ii) integrated data results in faster decision making [46], and iii) information load impacts decision time [86]. From the effectiveness point of view, there is evidence that i) lack of required information is negatively related to procedural rationality [57], ii) information framing has biasing effects on the decision making process [20], iii) information sources providing information of higher perceived quality will be used more frequently than will be those of lower quality [87], and iv) information sources that are more accessible will be used more frequently than will be those that are less accessible, of lower quality. Berthon et al. [85] have found that marketing managers who operate in organizations with more extensively developed repositories of relevant information including rules, policies, etc. will perceive a decision making context composed of higher proportion of structured than unstructured problems. Therefore, although we can conclude that there is enough evidence to support this link, we cannot conclude this at decisional activity level.

➤ **Hypothesis 2: D → DM**

The assertion that [preceding] decision performance is an antecedent of the decision making process either from the effectiveness or efficiency point of view, is postulated in the literature by studies addressing, among other topics, control as a behavioral strategy, learning, experience, and commitment escalation. However, few empirical studies addressing this single-loop, to the best knowledge of this researcher, have been published. The empirical studies supporting this single-loop link that this researcher is aware of had the following focus: i) Mintzberg et al. [27] collected data concerning the extent to which decisional activities were performed in twenty-five decision cases and emphasized the essential circularity of decision-making, and ii) feedback on decision accuracy leads to more normative-like processing of information and improved performance [29].

➤ **Hypothesis 3: DM → D**

Oz et al. [36] state that there are two dominant schools of thought on good decision making: one emphasizes the process, the other the outcome. The assertion that process is an antecedent of process' outcome is overwhelmingly accepted and the central subject in the quality literature. However, in relation to our research problem, there is limited empirical evidence supporting this link. Some remarkable findings from an effectiveness perspective are: i) a match between the information emphasized by the problem-solving tool and by the decisional activity results in superior problem solving [55], ii) comprehensiveness of the decision making process is negatively related to performance in an unstable industry [61] and positively related in a stable industry [76], iii) procedural rationality is positively related to strategic decision effectiveness [57], managers who collect information and use analytical techniques make decisions that are more effective than those who do not [57], quality of implementation is positively related to strategic decision effectiveness [57], iv) computation (e.g. internal rate of return), as a decision making strategy, is a necessary condition for effective investment decisions [68]. From the

efficiency perspective, it is known that time pressure impacts negatively decision effectiveness [83] and decision confidence [81].

The marketing literature has highlighted the significance of CRM. Kotler [62] states that the seller who knows how to build and manage strong relationships with key customers will have plenty of future sales from these customers. Reichheld and Sasser [63] state that companies might boost profits by almost 100% by retaining just 5% of their customers. Companies earn a higher return from getting repeat sales from current customers than from spending money to attract new customers [64]. Yet the nature of marketing strategy implementation and the reason for its success or failure are poorly understood. Furthermore, little is known about the factors influencing managers vested with implementation responsibilities [65]. There are not many empirical works addressing our research problem [65], which from the theory validation point of view represents a good opportunity for research [35]. Therefore, decision performance in CRM decision making becomes a key issue. With respect to IT investments in the marketing function (e.g. data warehouses), Beaumont [41] stated that there is no relationship between the scale of the investment and its benefits. The payoffs are dependent on the quality of the management of the systems and databases rather than the quality of the investment [41]. Industry expectations are that the overall data warehousing market will experience robust growth, at the compound annual growth rate (CAGR) of 28%, through 2004. The CRM-centric data-warehousing segment is expected to have an even higher CAGR of 37%, growing from \$4.2 billion in 1999 to \$20.1 billion by 2004. Consequently, our research question and the (dis)confirmation of our research hypotheses represent a required step in explaining decisional aspects for the success or failure in CRM processes. This has been so far neglected in the literature.

5. Exploratory research

Paradoxically with respect to the academic and economic relevance of data warehouses, industry surveys show that few organizations are measuring tangible or quantifiable returns from their data warehouses. Of those that are, reported returns have been modest. We wanted (1) to validate our perception of the importance of our research problem from a management perspective, (2) test the single-loop decision making model parsimony, and (3) get some clues about the potential constructs that would be relevant when assessing decision performance. Therefore, we conducted an exploratory field intervention by arranging a focus group following the recommended guidelines of Stewart and Shamdasani [82]. This study was conducted during the annual international conference that the user community of NCR's data warehouses organizes addressing data warehouse and CRM subjects. Details of this exploratory research are included in appendix A.

In general, the results from our exploratory research support the managerial significance of our research problem of understanding the relationships (if any) between personal decision making, problem solving and information in a CRM process supported by a data warehouse. As a result of this exploratory research, we found managerial support for a potential extension of our research problem including personal variables such as CRM knowledge competence, and information management competence. Our focus group research, see results #7 and #8 in appendix A, supports the inclusion of *CRM knowledge competence* and *information management competence* as independent variables in the specification of the single-loop decision making model. In order to address this potential weakness in the model (i.e. a potential specification

error [32] missing a critical predictor variable), we have tried to find empirical support for their inclusion. Considering, (1) the lack of strong empirical support for these constructs as predictors of CRM decision making process performance, and (2) our intention of looking for model parsimony [32] avoiding inserting variables indiscriminately [32], we decided not to include these two variables. In relation to the potential constructs that would be of relevance in assessing decision performance, results #2 to #5 (see appendix A) show that organizational performance type of measures is the preferred construct, with decision performance measures being the second preferred type of measures.

6. Next steps: Research methodology, operationalization and analysis

Research methodology

The next steps in our research require (dis)confirmation of our research hypotheses. Our research is of theory-testing type; therefore empirical research guidelines should be rigorously applied [38]. We have selected the positivist paradigm for our research methodology. Field study is our choice of [positivistic] research method. Our choice is based on (1) our literature review, (2) the purpose of our study, and (3) the nature of our research question as explained below.

- Field studies, mainly using a survey questionnaire, have become an increasingly common way of investigating decision making as a way of overcoming lack of generalizability of single cases, and the lack of a real-life feel of laboratory experiments (e.g. with students as surrogates of managers). Some studies create types of decision out of patterns in the associated processes and draw conclusions as to the likely conditions to which each type is best-suited [27] [49] [68]. Other studies test the causal relationship between variables to either create ground theory or support existing theory [30] [36] [40] [42] [43] [44] [45] [46] [58]. Therefore, we find that our choice of large-scale survey has strong support in the literature for our category of research questions.
- The purpose of our research is explanatory and there is a good match with field study as stated in [79]. Also, research will be nomothetic in nature in that it is studying general laws and finding empirical evidence from the research findings supporting such laws [38]. This aspect (i.e. nomothetic) requires evidence collection in such a way that we can generalize research results.
- Our research question is concerned with antecedents of decision effectiveness, which require a quantitative technique to produce quantitative descriptions of the predictors [80].

Therefore, field study is an appropriate choice as our positivist research method.

Operationalization

DeLone's framework [25] is a helpful way of categorizing measures according to ways of assessing information system success. The categories of measures that we find applicable to the single-loop model are IS output quality, user satisfaction, individual impact and organizational impact.

	Technical		Semantic			Effectiveness or Influence	
	← Level	↔ Level	↔ Level	→ Level →			
Variables in our research model	System Quality	IS Output Quality	IS Output Use	User Satisfaction	Individual Impact	Organizational Impact	
- Information quality on situations		✓		✓			
- Decision performance					✓	✓	
- Decision making process effectiveness					✓		

Figure 3. Potential categories of measures applicable to the constructs in the single-loop model.

Testing and analysis

The [theoretical] relationships X-Y in our research model and hypothesized in our research hypotheses could be (dis)confirmed as a logical conclusion of the following two types of validations: Construct validity and causal validity (empirically established). Causation requires a sufficient degree of correlation between the two variables, that one variable is the outcome of the other, and that there are no other reasonable causes for the outcome [32]. In addition, it is required to demonstrate that there are no spurious relationships. The traditional procedure for hypothesis testing should be used. Type I and Type II errors should be avoided. Structural equation modeling is particularly useful when (1) one dependent variable becomes an independent variable in subsequent relationships, and (2) we need to examine a series of causal relationships simultaneously [32].

7. Discussion

From our assessment of the theory underpinning the role of information quality in the single-loop decision making model we conclude that (1) there is enough evidence in the literature supporting information quality on situations as an antecedent of decision making process effectiveness but the role that information quality plays in each of the decisional activities is still not well understood, (2) there is very limited evidence supporting decision performance as an antecedent of decision making process effectiveness and with little detail at decisional activity level, (3) there is very limited evidence supporting decision making process effectiveness as an antecedent of decision performance, and (4) our research question is neglected in the literature. We argue that the single-loop decision making model that we present in this paper represents an innovative and integrative framework suitable for CRM research (i.e. our research question) on the role of a data warehouse’s information quality in predicting decision effectiveness. This can be addressed by testing three hypotheses that we have formulated based on the well respected theory of Cohen, March and Olsen about garbage can decision making and Simon’s theory of problem solving. Recommendations are made about the research methodology (i.e. field study, using a survey questionnaire), operationalization (i.e. DeLone’s framework), testing and analysis (e.g. SEM) that best fit the requirements of the (dis)confirmation of such hypotheses. The single-loop decision-making model supports Beaumont’s point regarding investment in IT for marketing. This author stated that (1) databases and systems do not possess value from their existence per

se, but from their application in different decision making domains, and (2) value should be measured against the productivity of management as it feeds into their decision making.

A remarkable characteristic of the single-loop decision making model is the interesting possibility that the variable *decision performance* as a dependent and independent variable offers for considering decision calibration [37] (i.e. decision confidence vs. decision accuracy).

Appendix A: Focus group

Description

Session Title: Data warehouses in production. Focus group
Context: Partners 2000 conference. Orlando (FL)
Date, time, place: Tuesday, September 26, 2000, 4:30-5:50 P.M., Europe 6 (Dolphin Hotel)
Facilitator/Moderator: Raul M. Abril
Participants: Retail: 1 (Denmark)
Financial : 1 (Israel), 1 (Netherlands), 1(Argentina)
Telecommunications: 1 (Spain), 1-fix line- (Austria), 1-cellular- (Austria)

Method

Potential barriers to open communication were avoided by limiting the group to one participant per industry and country. The fix line provider and the cellular provider of Austria did not regard each other as a competitor. Two invited retail firms were not able to attend. The qualification criteria for participating was: (1) More than one year of data warehouse in production, (2) Responsibility for the usage of the data warehouse either as a user or as a service function. Five questions were sent in advance to the participants. Clarifications were offered over the phone. Answers were provided in a round table discussion with open discussion after each question/round. The questions were: What type of measures do you have for the value contribution of your Data Warehouse?, What measures would you recommend for the value contribution of your Data Warehouse?, What kind of barriers do you find in promoting usage?, What type of queries do you have?, and regarding data warehouse planning, give details about the horizon and kind of financials. The facilitator had a questionnaire ready for recording the answers. The group answers were e-mailed one week later to the participants asking for confirmation. After active follow up we had 3 confirmations out of seven without changing the initial answers. We did not have any (dis)confirmation from the other four.

Focus group results

Legends:

IQ information quality on situations D decision performance DM decision making process effectiveness DWH data warehouse

1. Most of the participants have measures for the value contribution of their DWH.
2. IQ and organizational financial performance are the measures used more frequently.
3. D-measures were reported as the second used more frequently measure by three participants.
4. Organizational financial performance measures were recommended by the majority (five) of the participants for evaluating a DWH.

5. **D**-measures were recommended by three of the participants for evaluating a DWH.
6. **IQ** was recommended by three of the participants for evaluating a DWH.
7. The majority (five) of the participants considered information management competence as a barrier to promoting usage of the information derived from their DWH.
8. Knowledge about the business process (e.g. CRM) was considered by three participants to be the second barrier to promoting usage of the information derived from their DWH.
9. Only one participant considered [lack of] experience as a barrier to promoting usage of the information derived from their DWH.
10. Most of the participants estimated that (1) between 75% and 90% of the queries are of a “What happened” nature (2) between 5% and 20% of the queries are of a “Why did it happen?” nature, and (3) between 0% and 5% of the queries are of a “What will happen?” nature. Two participants reported that they did not have any queries of a “What will happen?” nature.
11. Most of the participants (six) reported planning activities for their DWH with a planning horizon of one to three years based on a budget. All of them reported that they do not make estimates about ROI. They expressed an interest in better understanding end user training expenses.
12. Almost none of the participants expressed an interest in problem complexity, and problem solving skills.

Focus group discussion

Result #11 is consistent with industry surveys in relation to the lack of ROI measures. This result would explain the inconsistency between result #4 (i.e. desired status) and result #2 (i.e. reality). We conclude that the participants experience difficulties implementing organizational performance measures for evaluating the contribution of their data warehouses. Results #2 and #6 reveal a consistent interest by the participants in **IQ** as a factor impacting the contribution of their data warehouses. Therefore, we find practitioners support the inclusion of **IQ** in our research problem. Results #3 and #5 reveal a consistent interest by the participants in decision performance **D** as a factor impacting the contribution of their data warehouses. Therefore, we find practitioners support the inclusion of **D** in our research problem. We only can explain result #12 as a consequence of the utilization (i.e. type of queries) that the participants reported in result #10 indicating that most of the queries are of a reporting nature with low predictive queries. We did not find practitioners support the inclusion of problem solving skills as part of our research problem. However, given that (1) the literature reports that decision making (**DM**) can be thought of as a special type of problem solving, and (2) the application of Simon’s problem solving steps is done for most models of management decision making, then we find theoretical and empirical justification for including decision making (**DM**) as part of our research problem. Results #8 and #7 indicate that lack of competence in information management and lack of knowledge of the business process (e.g. CRM) are barriers to promoting usage of the information derived from their data warehouses. As reported in the literature, for example see [45] in relation indirect users, result #9 indicates that, in the opinion of the practitioners, experience (e.g. number of years) of the business process is not a barrier to

promoting usage of the information derived from their data warehouses. Now, this has to be interpreted with care because the practitioners might have meant that they do not find such barrier because most of their decision-makers actually have experience in the business process.

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