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STRATEGOS: A case-based approach to strategy making in SME

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***Abstract*—Making strategic decisions in an enterprise is one of the most difficult problems of management. It is a result of unstructured character of such decisions which are made in conditions of high uncertainty. This issue is particularly important in case of Small and Medium Enterprises (SME), where Chief Executive Officers (CEO) are lacking support in this area and most often act intuitively, being convinced that their business is unique. Recent researches on decision-making point out the substantial influence of referring to analogies and self-experience in strategic problems. Accordingly it is proposed to use case-based reasoning to build STRATESOS - the strategic decision support system. Then, the system was verified in a survey by dozens of CEOs from SME. The results of the survey are promising and show the remarkable correspondence of the proposed solution with expectations and strategic behavior of CEOs.**

I. Introduction

SMALL and medium enterprises play a key role in the contemporary market economy. Strategic decision making in this kind of companies is one of the crucial issues taken into consideration in management [1]. In order to cope with the uncertainty and complexity, SME decision-makers seem to behave according to bounded rationality theory [2]. They determine certain level of preferences and as soon as the choice which satisfies the set up criteria becomes available, they accept it. In this approach CEOs are looking for satisfactory choices, not for optimal ones. The major challenge of decision making is uncertainty, and the major goal of decision analysis is to reduce this uncertainty [3]. To deal with the increasing complexity of the environment, the SME entrepreneurs create 'shortcuts' in their thinking. In this context there are two possible approaches [4]: routine (habitual and reactive) and intuitive decision making. As we can see developing and formulating the strategy of an enterprise is related to the fundamental questions concerning experience, knowledge and intuition of managers. In case of any new problem, when deductive reasoning is limited, it turns out that appealing to experience is by all means a rational behavior. As Thagard points out, "analogies can be computationally powerful in situations when conceptual and rule-based knowledge is not available" [5]. As strategic management is concerned, the team from Harvard Business School [6] made similar statements: „Reasoning by analogy is a common form of logic among business strategists. Facing a novel opportunity or predicament, strategists think back to some similar situation they have faced or heard about, and they apply the lessons from that previous experience". Using analogies in strategy planning has been thoroughly researched both by means of case study analysis [7] and experimental research with the use of the NK-model [6]. Using the NK-model and referring to the concept of business landscape made possible to conduct formal research on using analogies in complex decision situations. On other the hand this approach has been subject to criticism, which suggested referring to other paradigms and hybrid approaches to reasoning [8].

The use of the mentioned model of CEOs behaviors may be used in creation of information decision support systems. In this context, the Case-Based Reasoning (CBR) seems to be the suitable paradigm for practical usage–vide chapter II. The concept and the prototype of strategic decision support system will be presented in chapter III (implementation issues) and IV (case-based reasoning cycle). The empirical verification is described in chapter V, and final conclusions are presented in chapter VI.

II. CASE-BASED REASONING FRAMEWORK

The research problem mentioned above might be solved, at least partially, by applying the case-based reasoning. It results from the following characteristics of these system [9]. Firstly, a particular case is the basic element of knowledge representation. Subsequently, the acquisition of knowledge consists of analyzing the particular cases from past experience and therefore it is not necessary to establish rules in order to generalize knowledge. Secondly a relatively easy update/expansion of the system through adding new cases, which follows the process of remembering one's experiences. And finally excellent and credible justification for the recommendations (solutions) for business users. These ex-

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ceptionally favorable characteristics result, first of all, from expert knowledge gained through relying on specific, individual cases solved by an expert in the past. Additionally a great opportunity is based on the CBR working cycle described in the figure 1, reflecting reasoning by analogy [10], where: New Case – the new problem, Retrieved Case – the retrieved case that is similar to the New Case , Solved Case – the solution that is adapted from Retrieved Case and is proposed to the New Case, Tested/Repaired Case – verify/test of the Solved Case, Learned Case – retain in the case based Tested/Repaired Case. However, so far there has been no thorough research on applying case-based reasoning to support strategic decision making. There has also been no reliable empirical research conducted to verify this approach and to assess how useful it actually is in the strategy making practice. At the same time global consulting companies have been building systems of databases containing information on the strategy consulting projects they have carried out with a possibility to adapt them for new clients.

III. Strategos Implementation

Based on the case-based reasoning framework, the prototype of strategic decision support system STRATEGOS was created. In order to function, case-based reasoning framework requires three main components: case representation, general knowledge representation, and similarity measure.

Case representation

The case representation should reflect the company itself (company description), its market environment (context description), and one or more strategic decisions taken in this particular situation. In order to establish it properly we conducted several surveys with CEOs of the selected SMEs. Based on those interviews and the research on the case representation for SMEs [11] the following case description was established as the set of the attributes that are taken into account:

1.Company description: market share, location, products/services, number of employees, sales volume (trends in at least two years period), sales volume (export), EBITDA (trends in at least two years period), B2B/B2C.

2.Context description: industry, industry life cycle phase, Porter five forces analysis (threat of substitute products, threat of the entry of new competitors, intensity of competitive rivalry, bargaining power of customers, bargaining power of suppliers).

The act which is chosen as a solution for the current problem, is based on the list of all the combinations of product/market decision based on the Ansoff matrix (product × market) [12], and positioning decision based on the Porter's generic strategies [13]. The complete case representation is representing the case in time T_1 (planned act/decision – after reuse phase) and T_2 (realized act/decision – after revise phase) – see figure 2. Additionally, all information included in the case representation might be enhanced with text, images, files, hyperlinks, etc.

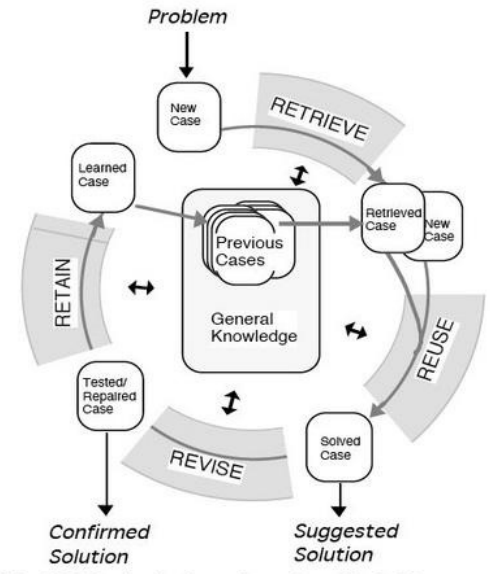

Fig. 1 Case-based reasoning cycle [10]

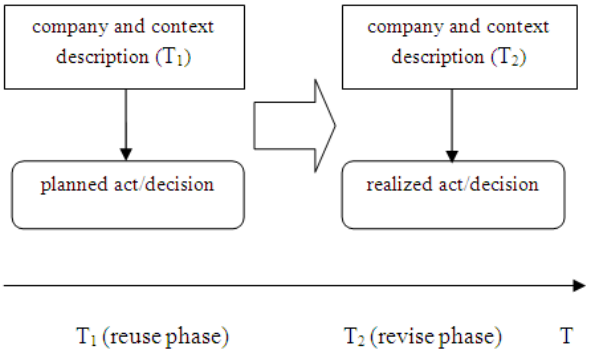

Fig. 2 Case representation in STRATEGOS

Similarity measure

Most of the case-based approaches retrieve a previous case based on the superficial syntactical similarities. The same is true in the STRATEGOS implementation where similarity measure merges the company and context description (in moment T_1 – fig.2) in one vector $a = (a_1, a_2, \ldots, a_n)$ of attribute values. If we denote by A_i the domain of the i-th attribute, then similarity measure is:

$$s: A_1 \times A_2 \times \ldots \times A_n \rightarrow [0,1]$$

and similarity between the input case a^I and retrieved case a^R is:

$$s(a^I, a^R) = 1 - \frac{\sum_{i=1}^{n} distance(a_i^I, a_i^R)}{\sum_{i=1}^{n} w_i}$$

where $w_i \in [0,1]$ is the weight of i-th attribute, and the *distance*$(a^I_i, a^R) \in [0,1]$ equals to the normalized Euclidean distance in the case of numeric attributes and the discrete distance measure (which takes the value 0 if $a^I_i = a^R_i$ and 1 otherwise) in the case of categorical variables [14]. Due to this

similarity measure, it is possible at least to limit "false analogies" [6], cases that are importantly dissimilar and not useful as reference examples.

General knowledge

One of the critical issues is connected with general knowledge (domain ontology) representation. This knowledge is important during the re-use phase of the case-based reasoning cycle. Thanks to this knowledge it is possible to adapt the proposed solution from the retrieved case to the new case. Unfortunately, the strategic decision process is extremely complex, and it is difficult to represent the ontology completely. Despite this, we decided to use general knowledge in our approach as a warning system in situations where the solution proposed is unrealistic for formal reasons. There are the warning examples expressed as the if-then rules:

1. Inappropriate case retrieval based on the rule: "**if** the new case company and the retrieved company are in the different industry life cycle phase **then** the proposed decisions might be wrong**"**

2. Inappropriate proposed solution based on the rule "if the company has just started to penetrate the market with current products **and** proposed decision is: intensive foreign market development **then** this is risky and unrealistic proposal"

IV. STRATEGOS CBR CYCLE

Based on the CBR cycle (see fig.1) and the formal description the entire STRATEGOS decision making functioning will be described. We assume that the specific input problem is given by the CEO. The task is to establish the proper strategic decision (act) for the given problem. The STRATEGOS problem solving cycle consists of 4 phases:

1. **Retrieve:** The solution is retrieved from the case base basing on the similarity between the new case and cases already stored in the case base. The retrieved cases are shown to the user ranked based on the similarity value. Every choice is verified through the general knowledge in order to avoid unrealistic proposals.
2. **Re-use:** After the retrieve phase, it is possible to establish an act for the new case (see figure 3), after that the new case is called a solved case. The main goal of this phase is to give inspiration and/or verification, as well as propose rational choices based on the retrieved cases to the management board. Finally every proposed solution is verified by the general knowledge.
3. **Revise:** The solved case that was established in the previous phase has a planned strategic decision (see figure 2). This is a kind of proposal for the strategic actions plan. The most important goal of the revision phase is to recognize what has actually happened with that company after the strategic decision was taken. It is important to underline that the result does not depend only on described situation and made decision. In reality, there are several factors of different type such as economic trend, customers' behavior, organizational atmosphere in the company etc. that have impact on the final result. Those factors may be provided in documents attached to case description.

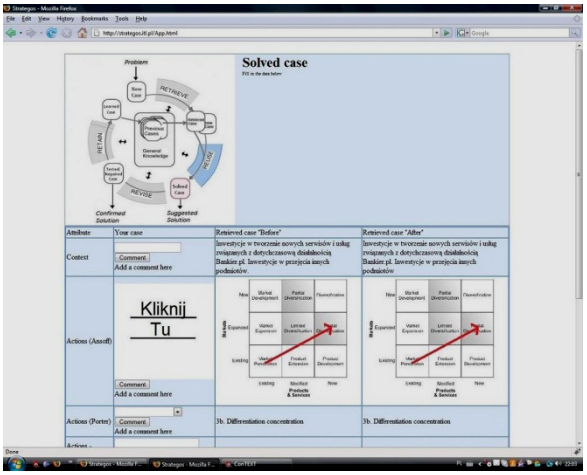

Fig. 3 The view on the STRATEGOS user interface

4. **Retain:** Finally the tested/repaired case is placed into the case base as a lesson learned for the future re-use – a learned case. The quality of learned cases is a crucial problem in the whole CBR cycle, because quality of suggested solution directly depends on this. It should be emphasized that the lessons learned might be negative as well.

As we can see, maturity and quality of STRATEGOS as a decision making tool for supporting real life decisions, does not only depend on technical issues like similarity measure, knowledge representation, etc. The main issue is to gather a valuable set of cases, and this requires long and time consuming co-operation with management boards.

V. EMPIRICAL EVALUATION

First empirical tests of STRATEGOS system were conducted based on pattern cases and real cases. Case base of the system was completed with 454 pattern cases prepared on the basis of standard knowledge in the field of strategic management. Real cases have been prepared basing on 13 IT companies listed on the Warsaw Stock Exchange. The fundamental objective of the tests was to evaluate the quality of recommendations proposed by the system by using the quality measure reflecting similarities between test (real) case and sample case. The results of this technically-oriented test were positive and were already published [15].

The target user of the system is a CEO of a SME. In this context a survey among some CEOs was conducted. They were shown how the Strategos system prototype works. The test group was selected by the target selection and it is composed of 44 CEOs from SMEs operating mainly in TMT (Technology, Media, and Telecommunication) industry. That kind of industry was selected in such a way, to present CEOs functioning in a strongly competitive and innovative market, posing significant strategic challenges. It is important to underline that 14 out of 44 CEOs have analyzed head listed companies, which in turn involves the great level of transparency of that company and the ongoing verification of CEO's activities by the market. All analyzed CEOs were male, average age over 40 years, and in average more than 11 years experience as CEO. Almost everyone admitted lack of formal education in basics of strategic management.

TABLE I.
LIST OF VARIABLES FOR STRATEGOS EVALUATION

Variable	Explanation
Support	Strategos is supporting me in the real strategy decision problems
Education	Strategos is teaching me in strategy management
Decision making	Strategos is generating a final solution for my strategy problems

CEOs were also asked to evaluate the Strategos system after the presentation of entire working cycle simulation, using sample case as illustration. Table I presents variables for registered CEOs evaluations. Accordingly, table II contains the summary of CEOs evaluations in three key matters.

TABLE II.
RESULTS OF STRATEGOS EVALUATION BY CEO'S

Statement	Support	Education	Decision making
Definitely no (1)	0,0%	0,0%	40,9%
No (2)	2,3%	2,3%	56,8%
I do not know (3)	9,1%	4,5%	2,3%
Yes (4)	43,2%	54,5%	0,0 %
Definitely yes (5)	45,5%	38,6%	0,0 %
Summary	**100%**	**100%**	**100%**

As we can see the results of evaluation are positive, i.e. there is almost 90% approval in the context of decisions support, as well as education. To sum up, our system was warmly approved by potential users. The results mirror real CEOs approach, where Strategos is treated as strategic decision support system, and not a system presenting what has to be done. CEOs eagerly commented on the work of the system and stressed their interest in using it in reality, if the conditions of respective quality and cases capacity would be fulfilled, what was underlined in quality assessments.

What is particularly interesting is the analysis of CEOs evaluations concerning the inferences produced by Strategos system i.e. imitation (cases from the same industry) and similarity (cases from the different industries) – vide table III. Table IV presents the evaluations of CEOs in terms of using different inferences in the system.

TABLE III.
LIST OF VARIABLES: IMITATION & SIMILARITY

Variable	Explanation
S Imitation	I find useful cases of companies from my industry in STRATEGOS case base
S Similarity	I find useful cases of companies from other industries in STRATEGOS case base

TABLE IV.
RESULTS OF EVALUATION: IMITATION & SIMILARITY

Statement	S Imitation	S Similarity
Definitely no (1)	0,0%	0,0%
No (2)	0,0%	0,0%
I do not know (3)	6,8%	9,1%
Yes (4)	38,6%	54,5%
Definitely yes (5)	54,6%	36,4%
Summary	100%	100%

The basic question was related to the interest and will to devote time for profound analysis of companies' cases in terms of imitation and similarity. As we can see from the received answers, both aspects generated big interest. Obviously, the interest in competition's cases was the biggest, but results were also high in case of similarity. It shows a great openness of CEOs to business inspirations, some of them were particularly stressing the importance of those inspirations. The attitude of CEOs, which was full of humility towards experience of other companies, is a very positive sign in favor of acceptance of deduction paradigm used in STRATEGOS system. Taking into account received evaluations, we can state that in the studied group of CEOs, the hypothesis that referring to deduction on the basis of cases (through implementation in the described system) is an understandable and acceptable support for strategic decisions making process in management.

VI. FINAL REMARKS

The analyzed CEOs displayed humbleness towards experiences of other companies and many times they interpreted the case base as a sort of their own memory extension. The analyzed CEOs combined acceptance of STRATEGOS with a strong feeling of limitation of reasoning appealing solely to analogies and experience. They treated the system as an inspiration or verification for their actions, being fully aware that every decision-making situation is unique and unrepeatable. It seems that this awareness will not be the same for the entire population of CEOs of SMEs. It also seems probable that CEOs of SMEs would reject STRATEGOS as a theoretical tool or to fall for the opposite tendency, namely accept its suggestions automatically. Such automatic acceptance of the system, lack of knowledge connected with superficial similarities may lead to critical decision-making errors and to huge problems for the company.

The STRATEGOS system will be extended in two directions. The main effort is focused on the proper ontology, where the company can be represented in the case base by a set of cases ordered in time (episode), so we can have the

whole life-time history of the company led by the strategic decision. This is a problem of building dynamics memories called in a literature episodic-based reasoning [16]. Secondly the complete approach in strategy decision making requires deeper semantic similarities based on the object-oriented similarity [17]. The current version of the system is available on the web page: www.strategos.pl [18].

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