Case-based reasoning for supporting strategic decision making in turbulent environments for SMEs

Jerzy Surma
Collegium of Business Administration
Warsaw School of Economics
al. Niepodleglosci 162, 02-554 Warszawa
jerzy.surma@gmail.com

ABSTRACT. The practice of strategic management proves that when the management board is strongly limited in its capacity to take rational actions, specifically in the context of great decision complexity and uncertainty, it is good practice to refer to experience through reasoning by analogy. In this paper we would like to concentrate on supporting strategic decisions for SMEs in turbulent environments. Complexity of analogy-based reasoning has its roots in an attempt to solve new problems basing on past cases from a different domain, while we will focus on case-based approach for a single domain. Therefore we have chosen a case-based reasoning as a suitable decision making paradigm. We present the STRATEGOS case-based reasoning system for supporting strategic decision making by SME management board.

1 Introduction

The practice of strategic management proves that when the management board is strongly limited in its capacity to take rational actions, specifically in the context of great decision complexity and uncertainty, it is good practice to refer to experience through reasoning by analogy (Roberto 2002). As Thagard points out, "analyses can be computationally powerful in situations when conceptual and rule-based knowledge is not available" (Thagard 1996). As regards strategic management, a research team of Harvard and Wharton Business School (Gavetti & Rivkin 2005, Gavetti, Levinthal & Rivkin 2005) made statements in a similar vein: "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". This approach seems to be reasonable especially in turbulent environments. According to Courtney, in situations of true ambiguity (uncertainties are both unknown and unknowable), analogies and reference cases are able to support strategy decisions (Courtney 2001). Using analogies seems to be the golden mean between the positioning school and the evolutionary school of strategic planning. In the case of the positioning school it helps to escape the unrealistic assumptions concerning the rationality of managerial decisions, while in the case of the evolutionary school it helps introduce rational elements in the "reactionary" and ad hoc actions of managers. This issue has been thoroughly discussed by Gavetti and Rivkin, who refer to the concepts of company's plasticity and rationality in its search for the right strategic decisions (Gavetti & Rivkin 2004).

2 Research problems

Using analogies in strategy planning has been thoroughly researched both by means of a case study analysis (Gavetti & Rivkin 2004) and experimental research with the use of the NK-model (Levinthal 1997). Using the NK-model and referring to the concept of business landscape (Ghemawat 2006) made it possible to conduct formal research on using analogies in complex decision situations. This approach has
been subject to criticism, which suggested referring to other paradigms and hybrid approaches to reasoning (Farjoun 2008). The NK-model itself is also problematic, as it simplifies the reality in a significant way. The company and the decision landscape are represented in the form of a binary attribute vector, which by definition restricts the description of the represented fragment of reality. Representing knowledge on a company is a complex issue and it requires considering such elements as description using quantitative attributes, order and hierarchies in the value sets of qualitative attributes, using elements of object representation or semantic networks. It is also crucial to take into consideration the time factor in the context of the company’s life cycle and the changes of its “parameters” in time. A key issue in such a reasoning paradigm is the problem of adapting the solution to the new decision situation. The adaptation requires referring to general knowledge on the company, where knowledge is represented in the form of business rules which make it possible to verify the reliability of the solution and suggest modifications to the proposed solution. In the NK-model approach no reference is made to the ontology of the company, which means that solutions are not adapted. This flaw decreases the value of the discussed solution considerably. Another fundamental drawback of the NK-model is its computational complexity, it is NP-complete (Rivkin 2000), which de facto renders it useless in real-life business situations. In response to this criticism it should be emphasised that the initiators of applying this model in reasoning by analogy did not intend to build a support system for real-life business decisions. The actual aim was to develop an environment for computer simulations confirming or discarding proposed research hypotheses. In this paper we would like to concentrate on supporting strategic decision in a real situation. Complexity of analogy-based reasoning has its roots in an attempt to solve new problems basing on past cases from a different domain, while we will focus on case-based approach for a single domain. For that reason we have chosen a case-based reasoning (CBR) as a suitable decision making paradigm. The domain field in our approach is SME in the new internet/mobile technologies sector. SMEs in this area are mainly governed by a relatively young CEOs, who do not have a deep knowledge and experience in strategy creation. They operate in an uncertain environment. The standard solution to this problem comes from consulting companies, but normally SME sector is not able to afford their fees. In this paper we would like to present STRATEGOS system, based on the case-based reasoning, for supporting strategic decision making. The main user of this system should be a management board of a given SME. The main prototype framework of STRATEGOS was already tested in real-world cases (Surma 2008). In the next section its architecture and functionality is presented.

![The CBR Cycle (Aamodt & Plaza 1993)](image)

**Fig. 1.** The CBR Cycle (Aamodt & Plaza 1993)
3 STRATEGOS case-based reasoning framework

3.1 The main idea

The mentioned research problem might partially be solved by means of applying the case-based reasoning (CBR) approach. It results from the following characteristics of these systems (Kolodner 1993). Firstly a particular case is the basic element of knowledge representation, not a rule as in expert systems. Subsequently, the acquisition of knowledge consists in 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 exceptionally favorable characteristics result, first of all, from expert knowledge gained through relying on specific, individual cases solved by an expert in the past. The great opportunity is based on the CBR working cycle described in the figure 1, reflecting reasoning by analogy (Aamodt & Plaza 1994).

3.2 Knowledge representation

Case-based reasoning framework, as is shown on fig.1, requires the three main components: case representation, general knowledge representation, and similarity measure for its functionality. The case representation should reflect the company itself (company description), its market environment (context description), and one or more strategic decision taken in this particular situation. In order to established it properly we conduct some surveys with CEO’s of the selected SMEs. Based on those interviews and the empirical research on the case representation for SMEs (Surma 2008) the following case structure was established:

Company description: market share, localization, 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).

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).

Strategic decision: context (short description of the subject), product/market decision based on the Ansoff matrix (product × market), positioning decision based on the Porter’s generic strategies, and implementing strategy: strategic initiatives description based on the Kaplan and Norton strategy map concept (Kaplan & Norton 2004).
In the strategic decision section we have chosen the well-known and relatively intuitive strategic tools suitable and easy to use by SME CEOs. Additionally, every information included in the case representation might be enhanced with text, images, files, hyperlinks, etc. In order to represent the strategic decision process, which is time-based, the case representation is divided into two parts: “before” and “after” the strategic action, where the strategic action consists of one or more strategic decisions - see fig. 2. The “before” part describes the situation of the company and the planned strategic decisions as at a specific moment. The “after” part describes the company later, when it is possible to see the results of the strategic decisions actually performed.

The crucial issue is concern with general knowledge (domain ontology) representation. This knowledge is important during reuse phase of the case-based reasoning cycle. Due to this knowledge it is possible to adapt the proposed solution from a retrieved case to the new case. Unfortunately strategic decision process is too complex, and it is impossible to represent the ontology properly (Surma 2009). Despite this in our approach we decided to use general knowledge as a warning system in situation when the solution proposed is unrealistic for formal reasons. There are the warning examples:

- “Inappropriate case retrieval” based on the rule: “if a new case company and a retrieved company are in the different industry life cycle phase then the proposed decisions might be wrong”
- “Inappropriate proposed solution” based on the rule “if the company has just started to penetrate a market with current products and proposed decision is: intensive foreign market development then this is risky and unrealistic proposal”

It is also important to define an appropriate similarity measure for the retrieval phase. Most of the case-based approaches retrieve a previous case based on the superficial syntactical similarities. Successful application in strategy decision making requires deeper semantical similarities. In STRATEGOS we make a fundamental assumption that implemented case retrieval based on the object-oriented syntactic similarity (Bergman 1998) is only for retrieving a potentially interesting cases. The STRATEGIS similarity measure merges similarity of the company and context description. Due to similarity measure it is possible to avoid “false analogies”, cases that are importantly dissimilar and not useful as a reference examples.
3.3 The CBR cycle

Based on the CBR cycle (see fig.1) the whole STRATEGOS decision making functionality will be described. We assume that the specific input problem is given by the SME management board. The task (problem) is to establish a proper strategic decision for their company (new case). The company is described by set of attributes including the current context description, as it was described in section 3.2. The STRATEGOS problem solving cycle consist of 4 phases:

I. Retrieve

The solution is retrieved from the case base basing on the similarity between a new case and cases already stored in the case base. Similarity measure takes into account the 'before' strategic action part of the case description (company and context) – see fig. 2, and informally might be described in the following way:

similarity (new case, retrieved case) = f(company_description(new case, retrieved case), context_description(new case, retrieved case))

The retrieved cases are shown to the user ranked basing on the similarity value. The user might take them into account or decide to use the cases that were searched manually. Due to this user might be more convinced when the retrieved cases are personally chosen. This approach confirms that STRATEGOS is only a decision supporting system. Every choice is verified through the general knowledge, as it was shown in the example “inappropriate case retrieval” warning in order to avoid unrealistic proposals.

II. Reuse

After the retrieve phase it is possible to establish a solution for a new case which is called a solved case. Formally a solved case structure is as follows:

- Solved case (part 'Before'):
  - Company description - new case company description
  - Context description - new case context description
  - Planned decision (suggested solution) = f (decisions(retrieved case (part 'After'), general knowledge, user knowledge & experience))

- Solved case (part 'After'): empty in this phase

It is important to underline that suggested solution (planned decision) is based mainly on strategic decision taken in reality in the retrieved case, as described in the part 'After'. Of course the personal input of the user is extremely important, and he can add his own knowledge and experience. Frankly speaking the main goal of this phase is to give inspiration and to propose rational choices based on the retrieved cases to the management board. Finally every proposed solution is verified by the general knowledge, as it was shown in the example “inappropriate proposed solution” warning.

III. Revise

The solved case that was established in the previous phase has a planned strategic decision placed in the 'Before' part of the case structure. This is kind of proposal for a strategic actions plan. The most important goal of the revision phase is to recognized what actually happened with that company after taken strategic decision. Of course it is needed at least several months up two
years period in order to see any real effects. Formally in the CBR cycle after revision phase a solved case is treated as a tested/repairs case:

- Tested/repairs case (part ‘Before’) - no change, the same as it is in the solved case
- Tested/repairs case (part ‘After’):
  - Company description - current situation after performed strategic decisions
  - Context description - current context description
  - Realized decisions (confirmed solution) = f (planned decisions, real possibilities/budget, current situation, organizational capability to perform planned actions, etc.)

It is crucial to take user remarks concerning the reasons why the proposed approach was successful or unsuccessful. For instance to explain a divergence between the planned and the finally performed decisions. All those remarks are extremely important for a future case re-use by other managers.

IV. Retain

Finally the tested/repairs case is placed into the case base as a lesson learned for the future re-use - a learned case. The case reflects the lesson learned: the ‘before’ part of the case represent the particular situation and the planned solution, and the ‘after’ part represents the real actions and what was the situation of the company after. 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; it means that the company has taken wrong strategic decisions, and this negative case might be retrieved from the case base as a “do not do the same” case. Finally 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 (Sanchez et al. 2005), and is currently under development in STRATEGOS framework.

As we can see, maturity and quality of STRATEGOS as a decision making tool for supporting real life decisions, is not only dependent 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 cooperation with management boards. This might be the largest obstacle, and we will return to this point in the conclusions.

4 Conclusions

Strategic management decisions are rooted in the sphere of emotions, intuition and unconsciousness, rather than the sphere of the rational. Every possible support to managers, which increases rationality of the decision making process, lowers the risk of decisions taken in the conditions of great uncertainty and improves the chance of eventual success. Based on this preliminary research we can ensure that CBR approach might be useful for supporting strategic decision making. Until now we have tested on real life examples retrieve and reuse phase of the CBR cycle (Surma 2009).

Nevertheless this research should be improved by case study research applied in STRATEGOS (using the whole CBR cycle) in real strategic problems, and with a discussion on the feedback from SME CEOs. STRATEGOS might be an excellent tool for educational activities and for supporting strategic decision making. As it was mentioned before the main problem is quantity and quality of the case base. We are...
going to develop the motivation system for SME managers to convince them to use STRATEGOS. We are inspired by ADIRAS (ADIRAS 2008) association – SMEs board proposal where manager-owners participate jointly – through ADIRAS - in the management of their organizations, assisted by an external facilitator. The whole framework will be presented to the management board of SMEs gathered in MCI the European Private Equity group.

Acknowledgement. This research is financially supported by Ministry of Science and Higher Education in budget 2008-2010 as a research project.

References