Strategic Decisions and Intelligent Tools

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Abstract

The success of the strategy formulation process is strictly contingent on the reliability and exhaustiveness of the information a strategist relies on. This paper investigates the Internet as a potential resource of the strategically important information and software intelligent agents as a tool for information retrieval. Though the potential usefulness of the Internet is recognized by the business community, a number of problems, namely effective extraction of the relevant information and its adequate interpretation hinder a productive use of the Internet resources in the strategic formulation process. In this paper we demonstrate that software agent-based systems have a potential to tackle these problems. We argue that the Internet contains potentially important information that, in combination with the intelligent tools for its retrieval and management, may provide the strategist with insights into the trends of the external business environment. Our argumentation is supported by experimental studies conducted in a specific industry context with agent-based software systems.

1. Introduction

The role of information technology in strategic management remains a subject of hard debates (cf. [2], [21]). The major barrier to a wider and more efficient application of information technology in this area is a gap between the ill-structured nature of managerial problems and the well-defined structure of an information system. In strategic management there are two dominating paradigms that vary in a degree of support from information technology. The first paradigm is the conventional strategic planning (cf. [1], [23]) which views a strategy as a set of rather formal decision-making rules. The strategy formulation process identifies the key factors governing its success, evaluates and guides the allocation of these resources. Contemporary information technology possesses strong capabilities to support the strategic planning process through the analytical modeling that aim to formulate the best strategic action program. Second, the evolutionary approach promoted by Mintzberg [21], views the strategies as a continuously evolving concept that adapts to unpredictable changes in the business environment and discards strategies that have become unviable. The fundamental assumption of this concept is that a strategy should be viewed as a vision where qualitative data both from inside and outside of a business organization leverages the formulation of the strategy. It is a challenging task to effectively utilize and make sense of the enormous data sources, which have became available through the Internet (cf. [27]) and to make use of them in strategic management. Recent empirical evidences demonstrate growing capabilities of the information technology to facilitate managing intellectual assets in order to formulate a viable strategy (cf. [10]). In our paper we explore how an intelligent system, namely intelligent software agents can be applied to retrieve data that can have an impact on a strategy the company wants to pursue.

Among numerous emerging information technologies the Internet remains an evident leader. Having emerged from the academic community it has crossed the boundaries and conquered the vast majority of the business world. The growth rate of the Internet remains highly dynamic: the amount of traffic carried over the Internet doubles every 100 days [24]. Scanning the Internet, as well as intelligent search in commercial databases through the Internet services may raise questions, which are substantial for strategy formulation. Moreover, the Internet has already proved its capability to cause drastic changes in the strategy a company strives for (cf. [7]).

An observation of the fact that the Internet is characterized by a large amount of data, the fast growth of the network and an enthusiastic adoption of network technologies by the business community (cf. [4]) motivates research on: (i) the possibility to retrieve data from the Internet which is potentially important for strategy formation and which otherwise would be overlooked; (ii) the use of intelligent software tools to facilitate an effective management of data; (iii) identifying the issues to be resolved in order to provide an effective support for executives .

In the first section we present a summary of the trends that dominate in the field of strategic management. We will discuss the role of information technology in strategic management and present our vision of the possibilities to utilize the continuously growing capabilities of information technology to support the strategy formulation process. In the next section we will give a brief overview of software agents and agent-based systems. This section is followed by a presentation of two experimental studies aiming to demonstrate how the information technology, namely software agents, support a strategic decision-making process.

2. Strategic management theory

The field of strategic management remains highly fragmented and a choice of definition of strategic management is strictly dependent on which set of belief one relies on (cf. [6]). We believe that a company must have an understanding of driving forces both inside of the company and an external environment in order to pursue a specific strategy. To shed light on the theory of strategic management we first review the dominating concepts and identify the processes involved in a strategy formulation and figure out how the software scanning agents may support executives.

The concept of strategic planning that originated in the late sixties still remains in wide use (cf. [1], [23]). The underlying assumption of this concept is to view strategy as a plan. The strategy formulation process as such can be represented as an elaborated process that embodies stages of objective(s) setting, auditing of external/internal factors and an evaluation of the strategies with quantitative methods. The framework, presented by Ohmae [23], represents the process of formulating the set of actions, namely: dissecting the market, weighing the competitors strengths and weaknesses, questioning the prevailing assumptions of an industry, discovery of the actual customer needs and implementing the strategies that may succeed in the market. The initial strategic planning approach is represented by a sophisticated model that requires hard data brought from both inside and outside of business organization. On the basis of the information derived from this data a strategist works out a possible scenario by means of using the quantitative techniques. The analysis precedes and supports the synthesis of a viable strategy by defining the parts that can be combined into a purposeful whole. An endemic attribute of the strategic planning approach is the support provided by techniques aiming to routinize decision-making processes. The formal structure of strategic decision-making rules makes it eligible to employ intelligent software tools to support the strategic planning process. Most of the strategy software enables users to deal with the situation represented by a model that can use both quantitative and qualitative data (cf. [26]). Such an approach provides the executives with functional models. To a certain extent, those models will be lacking in reproducing the high complexity of real world problems, but they will facilitate making the strategic questions explicit and, therefore, will reveal the logic underlying the decision-making process. The fast growing software supports this approach through delivery of the following functionality: modeling processes, developing scenarios, economic and sales forecasting, problem solving, representing decision trees, financial modeling and risk assessment. The major arguments against using information technology for strategy formulation can be summarized by the following points, identified by Mintzberg [21]: (i) hard information is often limited in scope, lacking richness and often failing to encompass non-economic and non-quantitative factors; (ii) much hard information is too aggregated for effective use in strategy making; (iii) much hard information arrives too late to be of use in strategy making; (iv) a surprising amount of hard information is unreliable.

In his turn, Mintzberg [21] promotes a descriptive approach to the strategy formulation process as a decision-making process where deliberate and emergent (not intended) approaches complement each other and facilitate a formulation of the strategy to be realized. This school of thought that is competing with strategic planning considers the strategy formulation as a continuously evolving process of crafting based on the beliefs attitudes and perceptions of those involved into the this process. The factors that affect managers' beliefs are mostly of qualitative nature such as biases, aptitudes, experiences etc. This visionary approach assumes that strategy emerges as a result of entrepreneurial activities based on managers' beliefs. The intelligent tools can support this approach to strategy formulation through bringing into managers' attention the information that can influence, to a certain extent, on their beliefs.

Hamel and Prahalad [9] introduced a view of the strategy as a vision or a foresight. Their claim is that in order to achieve a global leadership in the industry managers must be able to identify weak market signals that may give directions to future market trends and changes in the industry. Having identified those signals and driving forces the company needs to build the correspondent capabilities in order to pre-empt the market. The process of creating a foresight requires a deep insight into trends in technology, demographics, regulation and lifestyles. It is supposed to aid managers to answer the vital questions such as: (i) what kind of customer benefit should the company seek to provide in the long run; (ii) what organizational capabilities should be built in order to deliver this benefit and (iii) how to reconfigure the customer interface in a foreseeable future [9]. These characteristics are rather qualitative which makes it a cumbersome task to take advantage of them by using analytical models without modifying and adapting the data. At its worst, the strategy formulation process is a matter of prediction based on analysis of trends and extrapolation of the past into the future. At its best, the strategists try to answer the profound and key questions of the times [20].

We assume that it is possible to figure out the consequences of those events that have already happened and will create trends in the foreseeable future. A similar point of view is expressed by Drucker (1998). To grasp the weak signals of the external business environment, that may have importance in the long run, we propose to employ the capabilities of intelligent software tools to increase the productivity of managers involved in a strategy formulation process. We define productivity as an amount of output produced per unit of input. Despite its simplicity, there are many issues raised in the process of measuring productivity, since the value in contemporary economy depends on tangible and intangible assets. The growth of productivity comes from working smarter, not from working harder, or from using more capital [3].

Recent appearance of information resources (e.g. World Wide Web) which are publicly available generates an opportunity to make sense of relevant data in a strategy formulation process. It is reasonable to assume that such a large information resource contains the data that can be employed in a model-driven approach such as strategic planning. We also assume that the Internet includes the rich content data items that can contribute to a data-driven visionary approach to strategy formulation.

Another side of using the Internet as an information resource is its overwhelming pace of growth and a very high level of noise in data. To tackle this problem we propose to apply recent developments in the software industry that facilitate the process of information search in a variety of external and internal data sources.

3. Software Agents

The term of “software agent” has been diluted by a growing popularization in recent years. We refer to a software agent as a computational program that can navigate in heterogeneous computing environments and can, either alone or working with other agents, achieve a specified goal [11]. The software agents, acting on behalf of other entities in an autonomous fashion, perform their actions with some level of proactivity and/or reactiveness and exhibit some level of the key attributes of learning, co-operation and mobility (cf. [12], [15], [16], [22]).

In this context, *autonomy* means that the agents operate without any intervention from a human in order to meet the goal that has been set by the user. *Reactiveness* of an agent means that it adapts its behavior to a changing environment in a prompt manner. Finally, the *proactive* agent does not simply act according to the user’s settings but rather possesses the capability to identify further actions and make suggestions to the user [22].

This emerging technology has been rapidly penetrating new areas such as electronic commerce (cf. [18], [19], [25]), simulation in scientific computing (cf. [5]) and applied manufacturing (cf. [13]). In terms of practical applications software agents should possess certain technical capabilities [14]:

- pattern matching capabilities;
- hierarchical and time intelligence;
- sufficient functionality to serve both an individual and the whole organization.

There are three types of agents in a classification presented by Green et al [12]: *filtering agents, retrieval agents and personal digital assistants*. Filtering and retrieval agents are rather similar and can be distinguished by the degree of proactiveness, which is higher for the retrieval agent. A personal digital assistant operates in a limited domain and is usually referred to as an interface agent. That is a system, which helps users to perform their routines in a certain domain and ideally has domain knowledge. The agent provides advice based upon this knowledge as well as the user's current tasks as perceived by the agent.

There are several aspects that make software agents and agent based systems different from conventional systems (cf. [17]) namely:

- the software agents interacts directly with environment while the traditional systems typically involves the user as a middle-man;
- agent-based systems makes it possible to work with the
- problem on higher level of abstraction rather than to give explicit instructions for every detail;
- agent-based system works with marginal user intervention, releases human resources for other work and therefore increase the users’ productivity.

The key attributes of software agents make them attractive for support of managerial activities within business organizations. The major applications areas for agents working in the environments such as Internet include (but are not restricted to) (cf. [8]): workflow management, support for electronic commerce and desktop applications, processing mail and messages, information access and management. There is also room for applications of software agents in meeting scheduling, web browsing and information gathering and filtering.

We aim to bring to light the idea of how the software agents may be exploited in the data acquisition process and more specifically, in the scanning of the external business environment in order to deliver the information that can be used by managers in a strategy formulation process.

4. Using Software Agents for Strategic Management

The rapid development of software agents enabled the usage of both customized and off-the-shelf software for filtering and information obtained from the public resources such as the Internet. The number of commercially produced software agents has been growing for several recent years that have led the users to a possibility to make use of inexpensive software agent with a functionality that is sufficient for an effective retrieval of data from the Internet and other external sources. Typically, the off-the-shelf agents aim to provide functionality of searching, filtering and storing the retrieved information. Obviously, such agent lacks of taking into account the requirement of a specific user. Therefore, in order to provide satisfactory usability it must possess a very flexible interface with easy customization. Such an agent provide the following capabilities:

- autonomously collect data from the different sources on the Internet;
- vary the parameters of the search in order to attain the specific goal;
- launch sophisticated queries that may contain both linguistic and numeric parameters;
- pick out the data based on its content;
- store retrieved data;
- browse the selected data sources on a regular basis;
- be able to trace and extract changes over time;

We have conducted several experimental studies with the off-the-shelf software agent Netattache (by Tympani Development Inc.) that provides the user with a functionality that is similar to the list of capabilities. The context of search is a Finnish company operating in the forest equipment industry. Our goal in this experiment was to figure out if we could obtain substantial information about its closest competitors in the forest machinery market, namely Caterpillar Inc and John Deere Inc. We needed data of quantitative nature such as financial performance of the rivals as well as the qualitative data such as the relative strength of those companies and their strategy in products and markets, dealers and customers. We also aimed to launch the software agent targeting information on the current trends in the forest machinery, research and development and the latest innovations in the forest industry. An interpretation and an assessment of the obtained data bring deeper insight and better understanding of the driving forces that is eventually expected to facilitate developing a viable strategy.

The Netattache is a software agent specifically aiming at web browsing. It is capable of conducting information search and filtering in the Internet according to created profiles. The queries consist of linguistic entities that can be connected by Boolean operators. The data items that match the pattern are collected in a brief and are stored in an archive. This particular software agent is not supposed to have any learning or reasoning capabilities and delivers only the raw data from the Internet sources that is matching the user-defined initial profile.

Monitoring external and internal references the agent deliberately makes the search area wider and increases the plausibility of obtaining the relevant information. The agent searches with the help of filters and retrieves the information on a regular basis so that it is possible to trace the changes over time. We have conducted a set of experiments having launched queries that contain combinations of key linguistic entities.

Figure 1. The result of the search with the Netattache agent.

The search resulted in the list of data items that fits the criterion (cf. fig.1):

- product information such as technical updates, conversion programs, electronic application in the forest equipment ;
- list of forest equipment dealers sorted according location and type of equipment;
- recent information about the competitors' organizational transformations such as mergers and acquisitions;
- latest financial statements and reports (e.g. quarter and annual financial reports);

- innovations and R&D (e.g. ongoing projects in the forest and forestry related industries, case study of John Deere Inc., papers on impact of information technology in forestry, industrial electronics applications and information systems, research papers on forestry in countries with economy in transition, etc.).

Results of the search is represented by the list of data items in hypertext mark-up language format and are organized in briefs around the linguistic parameters (cf. fig. 1). The numerical data retrieved from the Internet such as financial key ratios can be used in the strategic planning to feed the models. The qualitative data items can be widely interpreted by executives in a strategy formulation process. An application of the software agent reduces the executives' time and efforts spent on obtaining the information about competitors for further analysis. The agent retrieved the information fast and efficient enough so that the executives could have delivered rather important information that provides the executives with a better understanding of market driving forces.

The critical issue in using the information retrieved from the Internet is the content and credibility of publicly disclosed data that can be taken into account right away. The lacking reasoning capabilities makes it problematic to obtain any kind of support from the agent in the interpretation of the retrieved data.

We have identified other issues that must be tackled in order to provide an effective information retrieval. The user needs to find a trade-off between the search parameters that will deliver comprehensive results and at the same time would not drastically increase the run time. The run time of the software agent very much depends on the configuration of the search query and load of the network. Automatic scheduling allows the user to launch the search query at a period of low network load (e.g. nighttime) that aims at a minimization of the run time without sacrificing the quality of performance.

The endemic drawback of the off-the-shelf software agents is that the storage and data management capabilities are usually either missing or are ill suited for quick and efficient follow up usage. Sophisticated solutions of the connectivity problem with other, more effective data management systems downgrade the advantages of this kind of software.

In comparison to off-the-shelf software agents the tailor-made agents meet the users' requirements more accurately. The example of such software is an agent-based system that has been specifically developed to support the creation of an industry foresight for an alcoholic beverage industry [28]. This system is expected to provide a broad and comprehensive first approximation of environmental trends and events. In difference to forecasting, industry foresight is not going to be 'true' in all details. However, carrying out a careful examination of the driving forces in the business environment, a strategist may obtain a general picture of what lies ahead. In this case we strive to figure out what kind of capabilities the company should build in order to preempt the market of strong beverages in the future.

Hamel and Prahalad [9] outlined what kind of information a business organization needs to strive for in order to build an industry foresight:

- find material, which can help to enlarge the opportunity horizon;
- develop methods and collect data to find the white spaces in the market;
- find ways to work from functionality thinking rather than collect material on current products only;
- search for material, which will help to challenge price-performance assumptions;
- find material, which can support one in a daylong debate on the following question: "what are the forces already at work in this industry that have the potential to profoundly transform industry structure?"
- find material to trace future trends in the intersection of changes in technology, lifestyles, regulation, demographics and geopolitics;
- find material to describe the prevailing trends. We should also find ways to collect material for working out a contrary approach;
- collect sufficient data and knowledge to trace and describe customer needs in order to look for unexplored opportunities.

The software agents are not limited to hard (quantitative) data, but can also be useful in obtaining soft (qualitative) data about the new trends that may cause unanticipated changes and/or opportunities in markets. Developing an industry foresight requires taking into account a very broad range of qualitative factors. Therefore we intend to delegate the task of information search and retrieval to the software agent.

The multi-agent system developed by IAMSR consists of four agents that vary in their functionality (cf. fig. 1, [28]). The architecture of the system is more sophisticated when compares to the Netattache. The agent-based approach remains the key component in the system. However in compare to the considered off-the -shelf agent-based systems this system has an advanced data management feature that makes it possible to store and fetch the retrieved data more effectively.

The first agent possess functionality similar to the Netattache agent, namely,

- collects raw data from the Internet including password protected sources (e.g. Reuters Business Briefing);
- analyses the data based on its content;
- traces the changes over time;
- has an interface with a data warehouse;
- builds meta-data;

- scans data sources on a regular basis in order to deliver actual data;

The next agent that is yet to be implemented has the following intended functionality:

- analyses and collects the data for the decision support system (DSS) based on user-defined profiles;
- sorts the data according to date, content and profiles;
- provides the data in a pre-specified format to DSS models;

The last two agents retrieve the *product* and *market* oriented data from the raw data delivered by the first agent. These agents:

- analyses and collects data on markets and products based on user-defined profiles;
- sorts the data based on date, content and profiles;
- stores related data together in database;

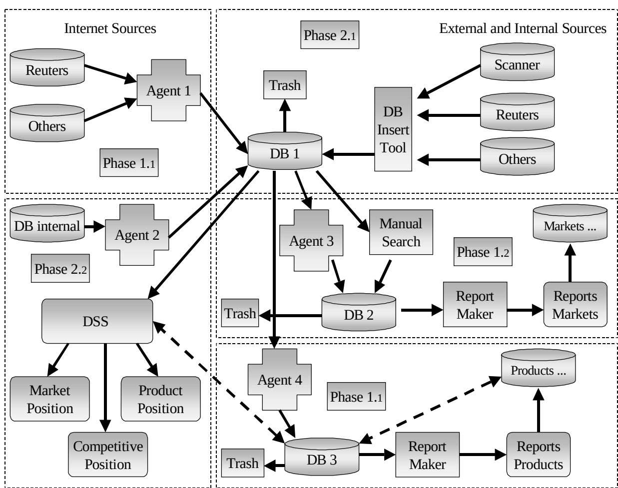

Figure 2. Layout of the agent-based system. Adapted from Walden, Carlsson and Liu [28].

The system was tested in the context of the Finnish alcoholic beverage industry [28]. The tests aimed to retrieve product and market information that can potentially help to create an industry foresight, namely to search for material on actual and potential customers, legislation, dynamic of the beverages consumption and distribution channels. The system provides support in the benchmarking process through delivery of the specific information about competitors such as sales results, investment strategy. A flexible interface allows the user to modify the query in order to meet managers' information needs.

The repetitive test of the agent showed that it retrieves data quickly and efficiently (cf. [28]). However the original idea of using the openness of the Internet data sources was, to a certain extent, undermined by poor content and frequent repetition of the retrieved data.

It is important to notice that the user delegates only search, filtering and retrieval functions to the software agent, while making the ultimate decision about the relevance of the data is the user's responsibility. The problem area of the strategy formulation remains very complex and ill structured and so far, any attempts to give the software agent adaptive or to give it learning capabilities have not been made. Switching to specific, regularly updated sources that can be accessed through Internet services, such as Reuters Business Briefing, improved the results of using the agent, even though the profiles and the pattern of the search remained unchanged. We tend to see the reason for such an improvement in the elimination of low content data items from the search. Both presented studies demonstrate how the productivity of the strategic management processes can be increased with the software agents. The increase of productivity stems from the smarter management of the data that is essential for the strategy formulation process. Moreover, the software agents provide the delivery of information that allows the users to grasp from the environment the weak signals that set trends in an industry for the future.

5. Summary and Conclusions

In our paper we suggested an approach that advocates using software agents to support strategic decision-making. We assumed that such an explosively growing media as the Internet contains information that can be utilized in a strategy formulation process. In order to manage a complicated process of searching the data we proposed to use an approach that employs intelligent software agent. We have tested our approach on two experimental studies that provided insights on the incorporation of the information both from the Internet and from the external data sources for the strategic decision-making process.

The strategy formulation is a very complex process that confines many formal and informal factors. This process requires executives to have a clear understanding of the long-term goals and to stretch the organization's capabilities in order to attain these goals. Management has a need to survey the environment for opportunities and threats to the long-term survival of the company. The companies that successfully employ software agents may benefit from creating a barrier by being able to anticipate the competitors' moves. Software agents coupled with query, reporting and multidimensional analysis tools permit new patterns and relationships to be revealed that makes them eligible support tool for both model driven strategic planning approach and visionary approach, when the strategy is based on qualitative data. Agents can drastically reduce the time and efforts spent on obtaining the information, which is relevant to the strategy formulation process and therefore increases the productivity of executives.

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