An Intelligent Decision Support System for Strategic Planning Processes

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요 지

본논문은 전략적 계획과정에 대한 지능적인 의사결정 지원 시스템의 틀(framework)을 개발하는 것을 목적으로 한다.

전문가 시스템의 능력을 의사결정 지원 시스템에 통합한 지능적인 의사결정 지원 시스템은 사업가나 의사결정자가 전략계획을 효율적이고 효과적으로 분석·수립·평가·통제할 수 있도록 한다.

1. Introduction

Under dynamically turbulent situations, business managers began to be interested in the long-term planning for their firms in order to chart a survival course. Such a long-range planning has been called a strategic planning or corporate planning.

Decision support system (DSS) has been expected to aid decision makers or business managers in straegic planning processes with the advancement of computer technology. But recent studies show that DSSs have been used only by two to three percent of non DP/MIS executives and managers in the U. S. companies, as opposed to the expectation [16].

There could be many reasons why DSSs were not so successful in various aspects, as many scholars have done researches to probe the reasons. In this research, under the assumption that the computer-based DSSs could not have met the requirement of users and decision makers due to the generic weakness of DSS itself, a new framework for the intelligent DSS for the effective and efficient strategic planning processes is proposed.

The intelligent DSS which integrates expert system capabilities into DSS could guide and discipline analysis, formulation, evaluation and control of strategic planning processes for business managers or decision makers.

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2. Strategic planning processes

Overview

Since the 20th century, the pace of change in business environment has dramatically escalated and managers have been faced with the necessity of building long-range plans for their firms in order to chart a survival course through a very dynamically turbulent situation.

As Ansoff[2] describes, since the early 1950's, confronted with growing variability and unpredictability of the business environments, business managers have become increasingly concerned with finding rational and foresightful ways of adjusting to and to exploiting environmental change. This problem has been being increasingly referred to as the strategic problem of the firm.

In the late 60's and 70's, a great deal has been written about the concept of strategy. Given the diversity of opinion, it is generally accepted that business strategies are concerned with fundamental questions as to what kind or kind of business the company is to pursue and how it is to pursue them in cannon's term[3].

In the context, the long-range planning which occurs at the strategic apex of the business firm is

undertaken to compete in a given industry and to position itself among its competitors and to ensure the long-run survival of the firm. It is generally called strategic planning(or corporate planning), or when implementation and evaluation of results is included, sometimes called strategic management.

Since strategic planning researchers began to discuss about building a strategic planning of a specific business firm, there have been many approaches to strategic planning. Any way, strategic planning processes is to develop a strategy for a busines firm to meet a firm's mission and goal, incorporating the strengths and compensating for the weaknesses under the resources and capacities available and the external environment restrictions.

Although there have been many models and approaches to creating the strategic planning processes, Figure-1 shows the common features of the strategic planning processes.

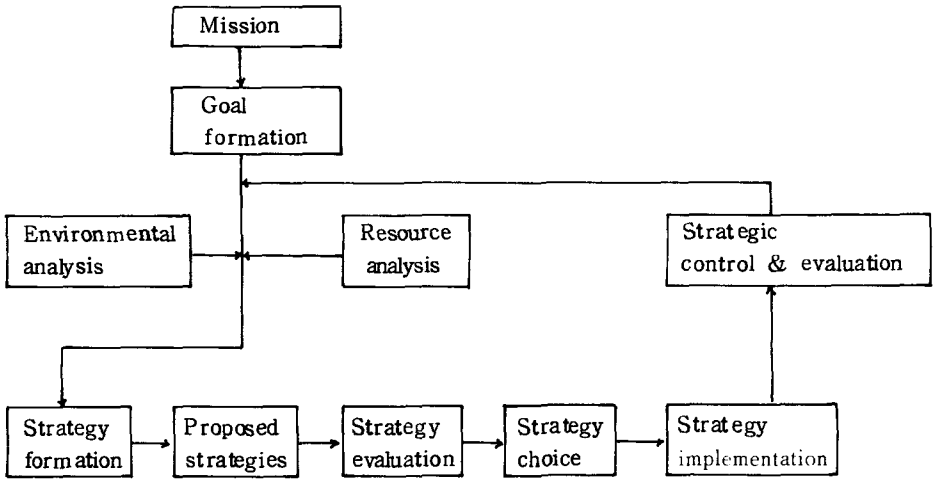

Figure-1. Model for strategic planning processes.

The brief review of the processes is as follows. The firm's mission should be defined with respect to environment and resources. It describes the firm's role and social responsibility in society and industry, defining why the firm exsists and why it competes in certain industry.

The next stage is to formulate the goal which describes what it attempts to accomplish, i. e., to define the end and the direction more in detail. It is very important to consider about the external environment and internal resources and capacities available to be balanced in terms of efficient match between them. The environmental consideration involves economic trends, technological development, social/cultural and political/legal trends, in addition to industry and market condition such as market size, market growth rate, product differentiation, etc.

Then strategy formulation process proceeds, which involves the identification of the factors which comprise an appropriate strategy for the firm, and the specification of alternative strategies for subsequent consideration in the next phase, i. e., evaluation phase.

Strategies being proposed in strategy formulation stage, we must evaluate them to select the most appropriate one. The evaluation phase involves the internal consistency of the firm's goal, the quality of the process and underlying analysis used to formulate the strategy, the content of the strategy, whether the firm can implement or execute the strategy efficiently and effectively.

Evaluation being performed, the best strategy is chosen also in consideration of its acceptability to personal values, goals and risk preferences of the

stakeholders of the firm.

Strategy implementation is to assess whether the strategy can be implemented by the business firm. Such questions should be answered, as follows. Can the firm's members have the will and interest to implement the required by the strategy?, etc. Therefore, the more detailed planning is required to turn the strategy into action and to use somewhat formal planning systems and models. In strategic control and performance evaluation stage, the result of the implementing strategy should be evaluated in light of the level of the goal achievement and control action should be activated if the deviation between the result and planned goal should be significant.

Approaches to strategic planning processes

The effectiveness and efficiency of the strategic planning could be evaluated in terms of the level of accomplishment of the firm's mission and goal. There have been three approaches to build and effective and efficient strategic planning process, i. e. optimization approach, system analysis approach and 'what if' analysis approach.

The brief review of three approaches is as follows

(1) Opstimization approach assumes that the goal of the firm is to maximize with respect to a single objective where the objective is typically expressed as net profit, return on investment, or discounted cash flow. That is, the problem of top management is to select that set of strategies which will yield a maximum return to the stockholders subject to constraints imposed by the availability of production input, production technology, the financial resources, the external economic and social environment.

(2) System analysis approach assumes that top management has assigned a specified numerical value to each important output variable describing the performance of the firm. For example, numerical tatget might be set for ROI, sales growth, market share and cash flow, etc. Given the same set of constraints described in the formulation of the optimization problem, the strategic planning problem is to determine a set of strategies which are consistent with the numerical values assigned to the target variable. This approach is also called simultaneous equations approach.

(3) 'What if' analysis approach is to obtain answers to a number of strategic 'what if' questions. In this approach it is not necessary to assume prior knowledge of the objective function or numerical targets of top management. What if approach can provide top management or decision maker the consequences of proposed managerial strategies. Then top management or decision maker can select the strategies that are most compatible with his long run objectives or goals.

According to the survey of Naylor-Schauland [13], only about four percent of the implementing corporate planning models had been the optimization-based models, and almost seventy-six percent of them were 'what if' style models. One of the main reasons why the optimization-based models were not so popular is that strategic planning proceses were so ill-structured problems that there were too many qualitative aspects not considered in the optimization-based models. Systems analysis approach also suffer from some limitations. That is, if there are fewer strategic decision variables than there are target variables, then a solution to the problem may be mathematically impossible, and if the number of strategy variables exceeds the number of target variables, then an infinite number of solution will be possible. Therefore, the problem of inconsistency in the number of target variables and strategic variables arises in real application.

As in the survey of Naylor-Schauland, what if analysis approach has been widely used in real world situations. This approach has several advantages as follows.

(1) It is not necessary to assume the availability of information about the top management's or decision maker's preference that is either impossible to obtain or extremely difficult to obtain.

(2) The what if approach provides management with the type of information required to make decision.

(3) The what if approach seems to come close to capturing the essence of the way in which corporate

executives actually view strategic decisions

Many of the computerized models([8], [12], [14], [15]), that have been developed for use in strategic or corporate planning models before DSS concept had been introduced were not so realistic in that they presumed the problem to be well-structured… characteristics seldom present in strategic decision problems.

One of the more realistic design approach should be to adopt the approach of decision support systems and expert systems. These days, computer technology could offer a valuable aid in strategic planning processess. In this research, an intelligent decision support systems for strategic planning processes is proposed, which integrate decision support system and expert system, especially well suited for the characteristics of unstructuredness or semistructuredness and what if analysis of the processes, after reviewing decision support system and expert system.

3. Decision support system and expert system

Decision support system(DSS)

Decision support system is a combination of hardware and software that enable users to access and manipulate information from various sources in efficient and effective ways. DSS has great impact on tasks which have enough structure for the computer to be of use, but where manager's judgment is essential(semi-structured), and the desired pay-off will be *in improving the effectiveness of managerial decisions.*

Sprague[17] offers a concise definition of DSS as an interactive computer-based systems that helps decision makers utilize data and models to solve unstructured problems. He used the term 'unstructured problems', as having the meaning that unstructured problems are those which manifest themselves in such vague terms that the human problem solvers must use judgment and intuition to grasp what the problem is before he can proceed.

The strength of a DSS lies in whether it can realistically simulate a decision maker's situation. Most DSS could create multidimensional models for realistic 'what if' analysis.

The formulation of business strategy is the problem solving of the most unstructured or semi-structured sort. Therefore it is desirable to apply DSS which could support those characteristics to the strategic planning processes.

Figure-2 describes the components of DSS[17].

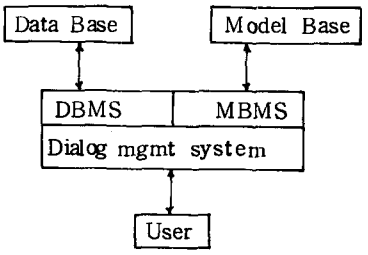

Figure-2. Components of DSS

—DSS has an extensive data base from both internal and external sources

—DSS has a series of models used to analyze and manipulate data. These include optimization model, financial planning model, spreadsheet software and graphic software.

—Data base management systems (DBMS) controls data base and model base management systems (MBMS) controls model base. Dialog management systems povide the user a vehicle to communicate with DBMS and MBMS, which is one of the most powerful characteristics of DSS.

Alter[1] categorized DSS in terms of the generic operations it perform, independent of the type of problem, functional area, decision perspective, etc. after surveying fifty six systems in the sample firms.

(1) File drawer systems-allow immediate access to *data items.*

(2) Data analysis systems-allow the manipulation of data means of operators tailored to the task and setting or operators of a general nature.

(3) Analysis information systems-provide access to a series of data bases and small models.

(4) Accounting models-calculate the consequences of planned actions based on accounting definitions.

(5) Representation models-estimate the consequence of actions based on models which are partially non-definitional.

(6) Optimization models-provide for action by generating the optimal solutions consistent with a series of constraints.

(7) Suggestion models-perform mechanical work leading to a specific suggested decision for a fairly structured task.

Such DSS has the following objectives which represent a set of capabilities that characterize the full value of the DSS concept from the manager/user point of view [17]

(1) A DSS should provide support for decision-making, but with emphasis on semi-structured and unstructured decisions.

(2) A DSS should provide decision-making support for users at all levels, assisting in integration between the levels whenever appropriate.

(3) A DSS should support decisions that are interdependent as well as those that are independent.

(4) A DSS should support all phase of the decision making process of, by H. Simon, intelligence, design and choice.

(5) A DSS should support a variety of decision making processes, but not be independent on any one.

(6) A DSS should be easy to use.

But it is likely that no specific DSS will be required to satisfy all six of the performance requirements given here, because they would be entirely dependent on the task, the organizational environment and the decision maker involved.

Expert system(ES)

Since AI scientists failed to simulate the complicated process of thinking by finding general method for solving broad class of problems in the nineteen sixties, they began to relize that the problem-solving power of a computer program comes from the knowledge it possesses not just from the formalism and inference schemes it employ, i. e, making a program intelligent by providing it with a lot of high-quality specific knowledge about some problem area. This realization led to the development of special-purpose computer programs that were expert in some narrow problem area, which are called expert systems [19].

It is defficult to define expert system clearly because several different groups with different motivations all claim to be working in expert system, and expert system is a new and fast growing area in different discipline and different successful projects have unique characteristics, etc. But Feigenbaum's definition as follows, is more generally accepted. 'An expert system is an intelligent computer program that uses knowledge and inference procedure to solve problems that are different enough to require significant human expertise for their solution.

Expert system (ES) have some major differences from conventional computer programming as follows In ES, which deals with the representation and use of knowledge and easily deal with qualitative data Knowledge base is clearly separated from the control structure (inference engine) and execution is done by using heuristics and logic. Contrastly, in conventional computer programming, which deals with the representation and use of data and easily deal with quantitative data. Knowledge and processing are combined in one sequential program and execution is done on a algorithmic basis.

Figure-3 shows the brief structure of expert system.

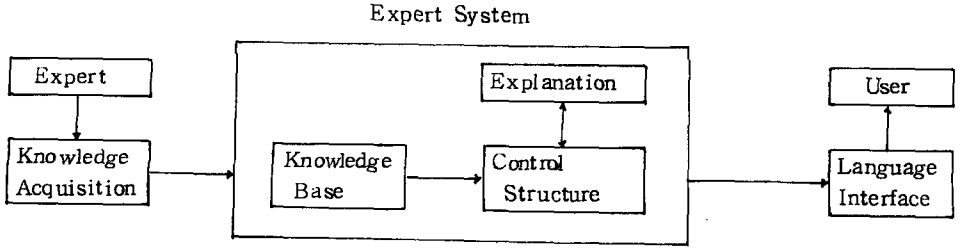

Figure-3. structure of expert system

The brief description of the structure is as follows. Expert system consists mainly of knowledge base and control structure.

Knowledge base is the collection of domain knowledge pertinent to a specific problem domain, which could be represented in terms of facts and rules. Such knowledge is generally acquired from domain expert through the assistance of knowledge engineer or knowledge acquisition systems.

In ES, knowledge base is separated from the rest of the system called control structure or inference engine. The control structure provides a methodology for reasoning about information in the knowledge base and for formulating conclusion.

The explanation ability to trace responsibility for conclusion to their sources is very important in the transfer of expertise and in problem solving. The explanation system could explain how and why a certain conclusion was reached.

Basic characteristics, benefits and limitation of ES

ES has some basic characteristics as follows[19].

(1) An ES must have expertise, which exhibit expert performance, high level of skill, and have adequate robustness.

(2) An ES must have symbolic reasoning, i. e, an ES represents knowledge symbolically and reformulate symbolic knowledge.

(3) An ES must have depth, i. e, an ES must handle difficult problem domain and use complex rules.

(4) An ES must have self-knowledge, i. e, an ES must examine its own reasoning and explain its operation.

Major potential benefits which ES could provide are as follows.

(1) ES could enhance problem solving capabilities by allowing the integration of top expert's judgment into analysis, in addition to enhancing user's understanding through ES explanation capabilities.

(2) ES could solve complicated problems in a narrow domain.

(3) ES could provide flexibility in rendering services.

(4) ES could be built so as to capture scare expertise.

(5) ES could like human experts, work with incomplete information.

The practical limitations of ES are as follows:

(1) ES works well only in a narrow domain.

(2) Knowledge is not always readily available.

(3) The approach of each expert to situation assessment may be different

(4) Most experts have no indepedent means of checking whether their conclusions are reasonable.

(5) Expertise is hard to extract from humans.

4. An Intelligent DSS for strategic planning processes

Intelligent DSS as an integration of DSS and ES

According to Alter's taxonomy of DSS in chapter 3, expert system could be considered to be intelligent DSS which advise users on a specific problem domain as independent computerized systems.

But there are several differences between DSS and ES, as reviewed in the previous chapter. DSS, whose objective is to assist decision maker, emphasizes decision making and deal with ad-hoc, or unique problems, but explanation capabilities are limited. Contrastly, ES, whose objective is to replicate and replace human advisor or expert, emphasizes transfer of expertise, and deal with repetitive problems and explanation capabilities are improtant.

Such differences could provide bases for integrating expert system into DSS for the efficient and effective design of DSS. In this context, intelligent DSS is regarded as an integrated system of DSS and ES rather than exper: system itself.

Most traditional DSS still emphasizes quantitative and mathematical operations so that intelligent DSS should have the capability of supporting qualitative aspects of decision making such as reasoning or inference. ES is certainly well suited for these type of characteristics of intelligent DSS.

ES is generally applied to a narrow domain,

whereas DSS is broader in scope. Therefore, it logically follows that several ES may be need to fully support one DSS[20].

Intelligent DSS for strategic planning processes

As reviewed in the previous chapters, effective and efficient strategic planning would be possible through the appropriate integration of DSS and ES.

Figure-4 describes a framework for the intelligent DSS for strategic planning through the integration of DSS and ES.

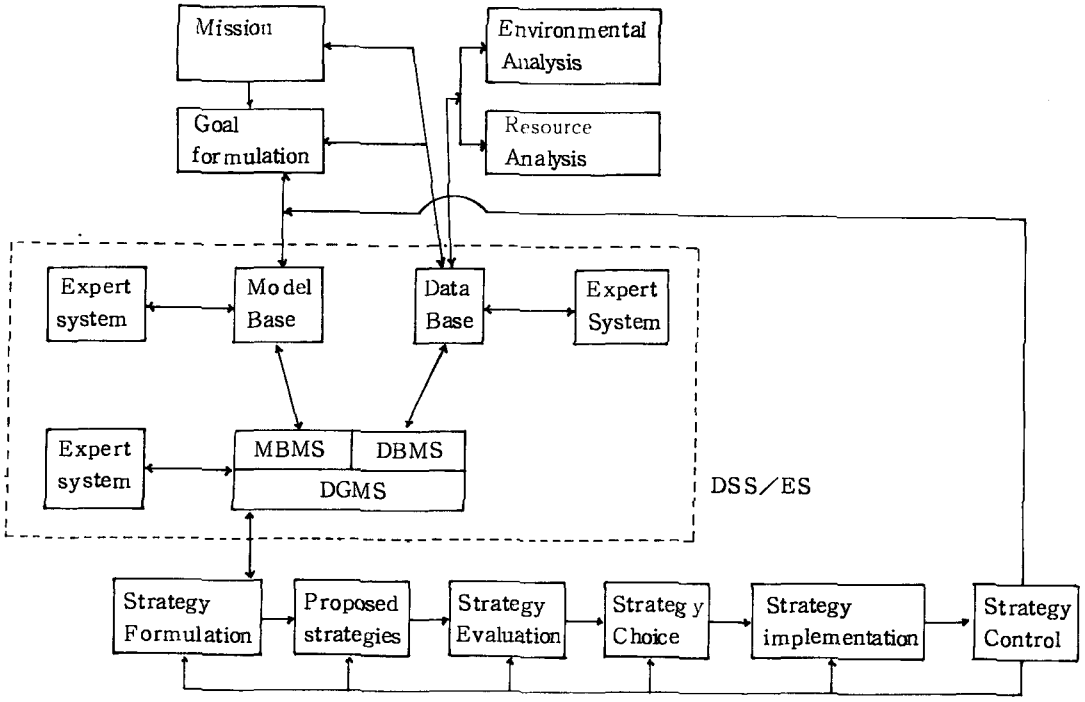

Figure-4. A Framework for the Intelligent DSS for Strategic Planning Process.

The description of the framework is as follows.

The results of the environmental analysis and the resource analysis such as economic trends, technological development, social/cultural and political legal trends, in addition to industry and market size, market growth rate, etc. could be stored in database, which also include historical file, managerial data file, etc. Then, the expert system could be used to help the easy construction, the efficient operation and maintenance of database and database management systems. With the expert system, the user or decision maker can also handle more sophisticated capabilities, such as the ability to perform some reasoning operations on the data of the environmental analysis and the resource analysis.

The expert system could also be able to use the database of DSS to obtain factual knowledge for formulating mission and goal. DSS model base includes a variety of management science models, what if analysis models and spread sheets, like LOTUS and IFPS, as in Alter's classification, for strategic problems. Some pertinent models could be chosen from the model base of DSS under given mission and goal in light of strategy formulation stage. For this, ES queries the decision maker to determine the general category of the problem, then queries to determine the exact nature of the problem and then ES suggests which model to use. In this

phase. ES can improve sensitivity analysis and can provide *judgemental elements* which are needed in case of using certain management science models.

As Carlson[4] studied, one of the main reason why DSS did not have much success in supporting decision-making was a mismatch of DSS designor performance and the requirements of decision makers. ES and natural language processing systems could make a great contribution to mitigate this mismatch. Some possible contributions of ES are as follows.

-ES could add the explanation capabilities to the DSS to allow the user to follow the reasoning behind certain conclusion on management science model selection.

-ES could manipulate symbolic information dealing with the qualitative aspects of strategic information which is not so easy to be included in the traditional DSS or optimization models.

Various outcomes from the decision support subsystem and expert system would be fed to strategy formulation stage. The stages from strategy formulation to strategy control are almost same as described in the previous chapters. Here we would shed light on the aspects of DSS/ES in strategic planning.

Industries could be classified for strategic planning processes as emerging, declining, mature or *fragmented* industries. Within each of these industry-type, various external factors, such as competitor's size buyer and customer strength, the likelihood of *substitute products and new entrants*, could be identified. Different types of company positions, such as dominant company, low-market-share company, could also be identified. Such *information are stored* in DSS database or in ES know ledge base.

Based on such informations, a variety of possible strategic alternatives could be identified[7]. For example, some possible strategies for a declining industry, depending on the company situation, might be liquidate, phased-withdrawal, hold-position, or selective-or niche-investment.

In DSS/ES framework proposed in this research, production system of ES can be used for handling this decision situations. For example, if specific market and company condition are present in a situation, then a certain type of strategy might be suggested.

In strategy evaluation stage, ES which is interfaced *with spread-sheets and some financial models* in decision support subsystems, could potentially provide financial evaluations of recommened stategy.

In strategy control stage, the implementing strategy should be checked if it is being implemented as intended, and remedial actions should be activated in the whole stage of the intelligent DSS, if necessary.

5. Conclusion

In this research, a framework for intelligent decision support system (DSS) for effective and efficient strategic planning processes is suggested. The intelligent DSS which integrates expert system capabilities into DSS could guide and discipline a planner's analysis, formulation, evaluation and control of strategic planning processes.

The intelligent DSS could compensate the weakness of the sole DSS as well as it could provide assistance to decision makers to prepare for the strategic planning problem effectively.

But current ESs are developed in AI languages and AI-type computers, whereas DSSs are developed in conventional computer programming languages on personal computers. Such a technical interface between DSS and ES arises and should be solved for more practical implementation of the integration.

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