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## AN EXPERT SYSTEM FOR SUPPORTING STRATEGIC BUSINESS DECISIONS

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**Abstract:** This study presents a computerized rule based expert system that can be used by managers in the business world to increase their companies’ profitability. Specifically, we examined the profit-centred advices and the strategic business rules given in the “*Profit Patterns*” book written by well-known business thinker *Adrian Slywotzky* and his colleagues. One of our main contributions is that we have extracted advices on strategic management and created a prototype expert system based on this body of knowledge. Another contribution of our work is the

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**visual object oriented methodology that we have followed: We first understood the profit patterns and then turned them into mind maps in an object oriented style. Then we transformed this structure into another object-oriented map, namely the “*domain objects map*” (DOM) that represents the entities in a business environment together with their attributes and attribute values. This map is then used in representing the rules for the expert system, including the advised profit patterns. We created another visual representation of the knowledge base by considering all the decision paths related with each category of decisions. For this, we extensively used the visual programming environment of commercial expert system development software. We came up with a computerized rule based expert system using *Visirule* by considering all decision paths related with each business category. Lastly the end result of the methodology is the rule-based decision support system that formed through *Java*. An important issue related with the book was that ideas explained in the book were limited to only seven categories; namely value chain, channel, customer, knowledge, mega, organization and product. In the future, other related categories concerning the business world (such as finance, marketing, etc.) can also be analyzed and embedded into the existing structure using the same methodology to effectively make suggestions regarding other decision domains in the business world.**

**Keywords: Expert Systems Applications, Decision Support Systems, Visual Framework for Expert System, Business Rules, Profit Patterns, Strategic Management**

## 1 INTRODUCTION

In today's business world, increased competition forces companies to consider profitability as a pivotal goal for survival in the global market. At this point decision support systems that are developed to support strategic decision making in all areas of business have gained importance. The losses due to wrong decisions at tactical or operational levels, may be compensated through various solutions. However, it is much harder to recover the destruction and losses caused by wrong strategic decisions. Business thinkers performed extensive research and thinking based on strategic issues in the real world and have shared their vision in their publications. Profitability is one major business issue, and has been widely investigated. Among the countless business thinkers, some names have received wide appreciation including *C.K. Prahalad, Bill Gates, Michael Porter* and *Adrian Slywotzky*.

In our study, we took the publications of Adrian Slywotzky as the main resource. Slywotzky is a director at *Oliver Wyman*, a global corporate strategy and operations consulting firm. He has authored many books on profitability and on management of strategic risk, including the *The Upside, The Profit Zone, Profit Patterns, How Digital Is Your Business?, The Art of Profitability* and *Value Migration*. The *BusineekWeek* magazine named *The Profit Zone* within the *Top 10 Business Books of 1998*.<sup>1</sup> Slywotzky also won the business information/educational category of *Audio Awards*, honoring excellence in audio publishing, in 2003 with the *The Art of Profitability*.<sup>2</sup> Recently, Slywotzky was listed among the top fifty business thinkers in the world<sup>3</sup> by Suntop Media<sup>4</sup> in 2007.

Among various books of Slywotzky, we concentrated on *Profit Patterns*. In *Profit Patterns* Slywotzky presents thirty one profit patterns<sup>5</sup> and numerous leading scenarios related with central business-oriented objects (such as customer, product, industry, market, organization, etc.). We adopted his strategic advises into our knowledge base in the form of business rules. We realized that the state of business objects, such as market, product and customer, should be specified by the users of our expert system as *facts*. This way, the expert system can operate on these facts and

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<sup>1</sup><http://www.brightsightgroup.com/printContent.asp?action=Biography&speakerID=102>

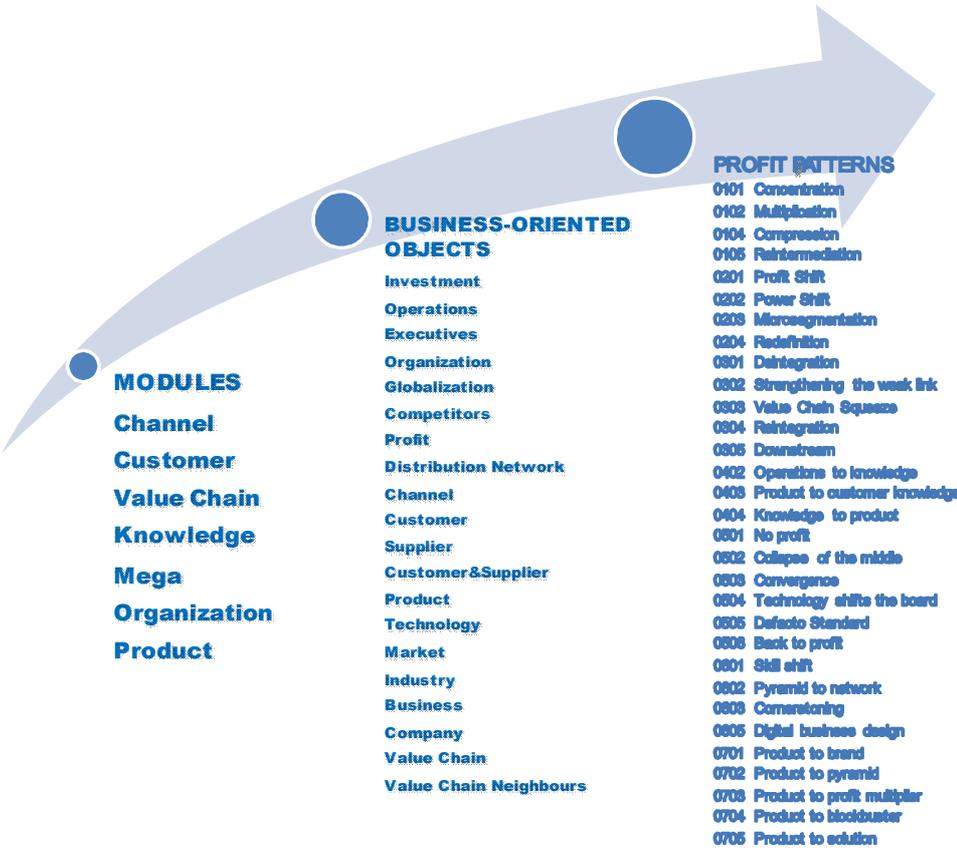
<sup>2</sup> <http://www.audiofilemagazine.com/finalists.html>

<sup>3</sup> <http://www.thinkers50.com>

<sup>4</sup> <http://www.craingerdearlove.com>

<sup>5</sup> *Downstream* has been added after the book was published as the last pattern

provide guidance on the appropriate profitability strategies to be followed. For various categories of business planning, (such as Value Chain, Channel, Customer, etc. ) our expert system gathers facts through convenient questions. Once the system obtains enough facts to reach to conclusions, it displays the suggested profit patterns with a bulleted list of actions to take. Generation process of the concepts used throughout the system is illustrated in Figure 1. We translated the ideas into a rule-based systematic that offers what to do under which condition by using *WinProlog* as our inference engine. Shortly we performed a framework for creating an expert system. We detailed all stages of an expert system that starts with knowledge extraction and ends with Java implementation. Our problem domain was strategic business decision making. As a subset of this domain, knowledge domain was the expert’s knowledge about solving specific problems. In other words, we concentrated on profit patterns in certain fields of business. However, there exists a vast literature on which strategies should be followed under which business environment. Our ultimate goal is to capture the essential insights in this literature within an extensive expert system.



## 2 LITERATURE SURVEY

There are so many expert systems that are used in various platforms of the business world. In this paper we focused on expert system studies related with strategic management. In this context knowledge acquisition, procurement and refinement were the key issues in our study. On the other hand we also inspired by various expert system applications except for strategic management such as risk management, stock investment, etc.

In an expert system development process, *knowledge* is the most critical concept in order to be concentrated on. There are some key studies about knowledge throughout the expert system literature. Wu et al. (2000) claim that a critical factor that affects knowledge-based systems' performance and reliability is the quantity and quality of the knowledge bases. During their study they discuss that many knowledge acquisition tools have been developed to support knowledge base development. However, a weakness that is revealed in these tools is the domain-dependent and complex acquisition process. Similarly, Cheung et al. (2004) presents an agent-oriented and knowledge-based system for strategic e-procurement. The system has been designed to capture and leverage the knowledge of an enterprise to generate dynamic business rules by which an effective procurement strategy can be generated based on enterprise needs and the analysis of relevant market conditions. In addition to these Diamantidis and Giakoumakis (1999) present a tool that combines two main trends of knowledge base refinement. The first is the construction of interactive knowledge acquisition tools and second is the development of machine learning methods that automates this procedure. The procedure they present gives experts to evaluate an expert system.

Among the expert system applications spectrum, risk management and stock investment are hot topics in order to investigate and have some knowledge. Harman and Ayton (1997) describe a decision support system that gives quantitative assessments where appropriate, but which is also able to provide qualitative risk assessments based on arguments for and against the presence of risk. As another expert system application, Liu and Lee (1997) presents an intelligent system to assist small investors to determine stock trend signals for investment in stock business. By using the system skilful investors can explore the various theories for the prediction

by means of adjusting weightings, combinations and even some independent variables allocated by the intelligent system. General users can therefore formulate their investment strategies upon the system recommendations under different investment criteria accordingly.

### **3 THE FRAMEWORK**

#### **3.1 Knowledge Extraction**

*Profit Patterns* provides managers and investors with thirty patterns changing the landscape of every industry. We examined all of these patterns. We extracted all leading indicators that point managers and investors to use those patterns. In other words, we determined most suitable actions for the complex situations in business world by mixing our knowledge with *Slywotzky's* strategic ideas. To give an example in what we did in terms of knowledge extraction, it will be useful to go over *Knowledge to Product* pattern. (Figure 1) The reason why we choose this pattern is that it exactly overlaps with what we did in our study. It is probable that the study we worked on can be extended into a commercial product. Especially it can be commercialized via the internet in points of including modules representing each category of business platform and being updated time to time. So what we did can be considered as generating product from knowledge. The leading indicators of this pattern are related with customer and product characteristics. In order to offer this pattern we are just investigating if there are many or limited number of customer clusters of the firm. On the other hand the ease of use, cost to access, accessibility and many other characteristics of the products of a firm are investigated in order to offer this pattern. There are thirty one profit patterns and numerous leading scenarios related with central business-oriented objects (such as customer, product, industry, market, organization, etc.). Generation process of these concepts throughout the system is illustrated in Figure 2. In the next stage, extracted knowledge is translated into pattern-based schematic form.

“... As knowledge becomes increasingly valuable, more companies will find new ways to turn their embedded **knowledge into products** so that they can profit from making that knowledge more **accessible** and most **cost-effective** for their current and future **customers**... For example, SAP (German software company) ... converted knowledge of these internal business processes and challenges into a **product** that...” (Slywotzky et al., 1999, page 220-221)

Figure 1: Knowledge form of *Knowledge to Product* pattern

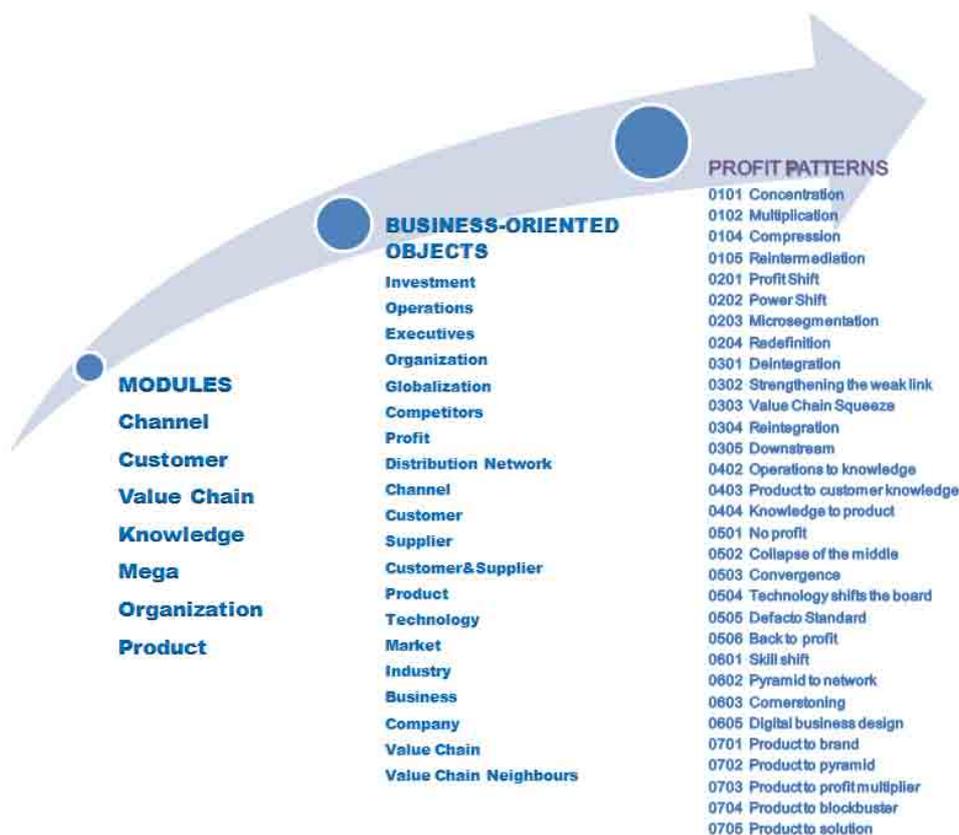


Figure 2: Generation process of these concepts throughout the system

### 3.2 Mind Maps

At this stage, we formed the mind maps of each pattern of each business category, on which the main element (profit pattern) is centred at the root of all nodes and related elements with less importance come at the next level of the hierarchy. Mind maps start from centre with profit patterns and are branched out with business-oriented objects, object attributes and attribute values in order (Figure 3). In order to form these *mind maps*, we used *FreeMind* (software for representing a decision tree). We used standardized symbols (icons) and colouring for each component of the map in terms of standardization (black for objects, blue for object attributes, dark red for attribute values, etc.)

Another important issue is the logic operators. In and relation an individual profit pattern is offered if **both** leading indicators written on the branch of that pattern satisfy with the conditions of the firm. Otherwise it is not offered to use that pattern. However in *or* relation, if **any** of the leading indicator satisfies with the condition of the firm, related profit pattern can be presented as a solution independent from the other leading indicators on that branch. In mind maps these relations are written over the branches just to be differentiated from each other. However they gain importance while forming a visual rule map in terms of linking logic of the nodes by arcs.

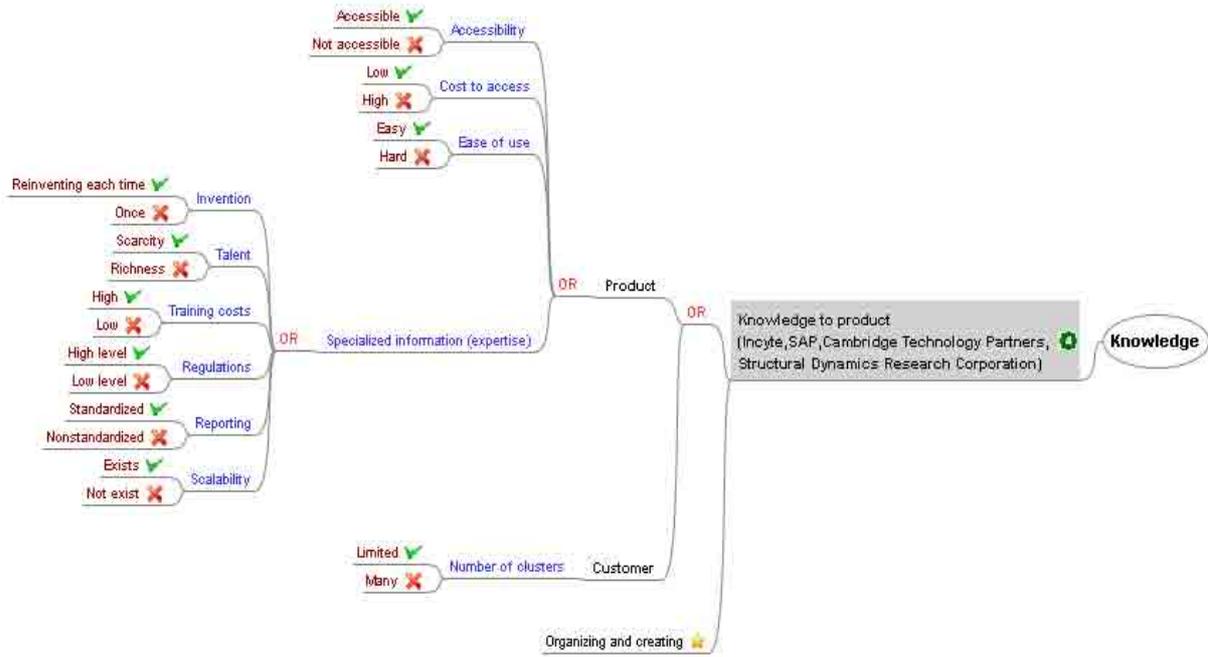


Figure 3: *Decision Tree Representation of Knowledge to Product* pattern by using *FreeMind*

### 3.3 Domain Objects Map

In the third stage, object-oriented representation is taken in hand in order to let managers and investors make object-oriented investigation. We have a transformed mind map with a different structure, which is generated from the module-oriented mind map of the second stage. This new map, named as *Domain Objects Map (DOM)*, places the domain objects (business-oriented objects) at the root node of an object's mind map tree and the suggestions (profit patterns) at the leaf nodes of the tree. The structure of DOM is a special case of the *decision tree diagram*, with the distinction that it strictly follows an object-oriented hierarchy like the mind map of the second stage. DOM is formed manually. Therefore updating the map is difficult, because other related updates in the next stages become difficult to control. This stage can again be independent from the other stages but should be done automatically, relying on a software program. Figure 4 shows the *Knowledge to Product* portion of *product*. Similarly Figure 5 shows the *Knowledge to Product* portion of *customer*.

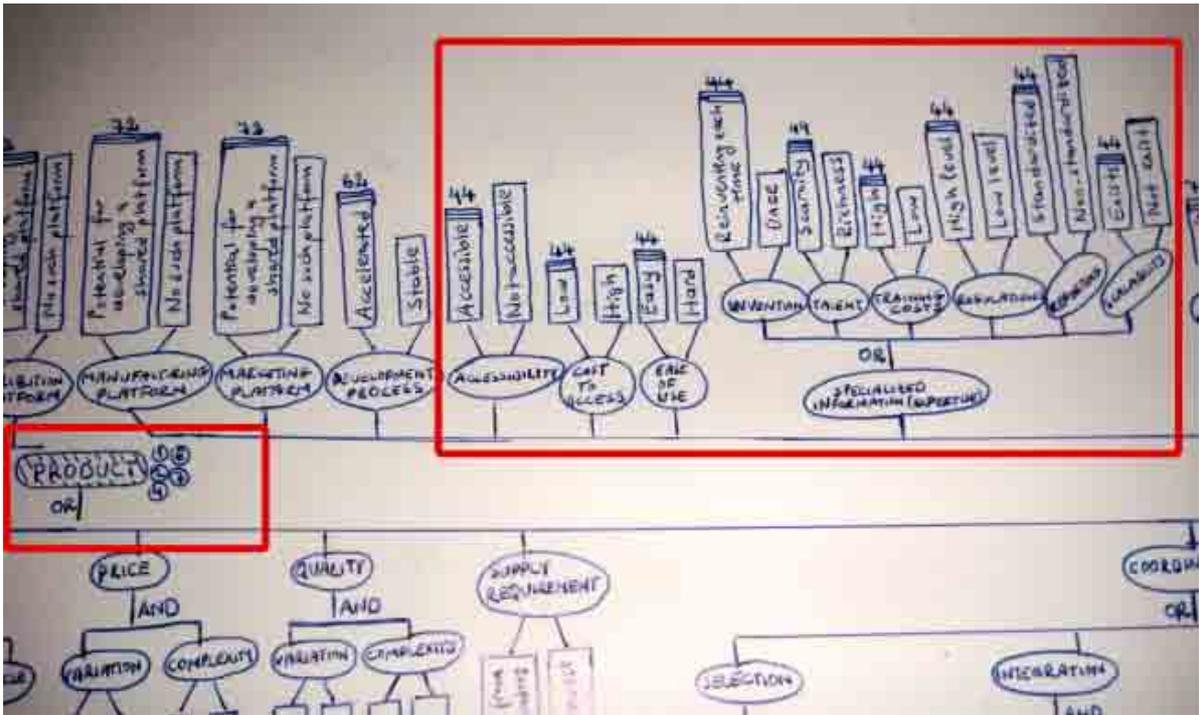


Figure 4: Knowledge to Product portion of product in Domain Objects Map

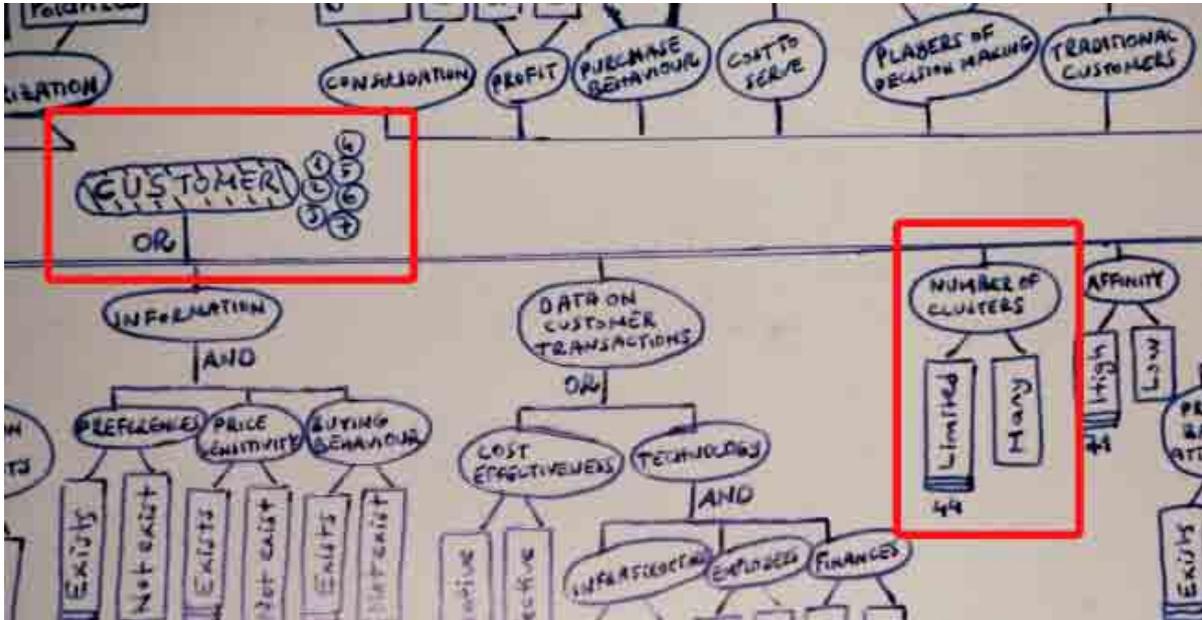


Figure 5: Knowledge to Product portion of customer investigation in Domain Objects Map

### 3.4 Visual Modeling of Production Rules

Before the last step of our expert system framework, we implemented a *Rule Map (RM)*, by using *Visirule* (decision support, knowledge management and knowledge transfer tool for implementing an expert system) which allows programming the rules visually and can generate *Flex* and *Prolog* codes for the decision support. (Figure 6) This software works by drawing some nodes (boxes) and arcs (links), adding some texts (labels, expressions), attaching some optional codes, generating and testing the code and lastly publishing on the internet or PC. Some example usages of *Visirule* are decision tree delivery and execution, dynamic questionnaire production and business rule automation. Our study covers the last use. In terms of concatenating the main functions, *Visirule* has graphical tool for decision logic, drawing and layout of logic flow and code generation for *Flex* and *Prolog*. Moreover it executes code, checks and debugs results and generates and exports code. Lastly related with its intelligent design, it has some useful features such as automatic linking/de-linking of objects, horizontal/vertical alignment, horizontal/vertical spacing, syntax checker for expressions & code and show/don't show information fields. However besides these useful features, shading function is needless. Although shading puts a visual accordance on the graph, this detail decreases the software speed too much.

In RM, we designed each business category apart from each other and then combined them in main menu. At each module, we designed an object-based structure as it was done in DOM, in order to let the managers and investors make object-based investigation. Our model consists of questions and answers linked into each other in a specific logic. (Figure 7)

Each module starts with start box and continues with question boxes as the question form of the object attributes of DOM. Input boxes follow these questions as the answer of these questions. According to these answers, model is directed into the suggestion boxes (related profit patterns) if the answer satisfies with the condition of the pattern. Whether the answers are directed into related profit patterns or not, they are all directed into the next questions as the continuation logic of the model. This process continues until the last question of each module of the system and each

module ends with continue box that provides the transition into the following category to be searched.

Continue boxes have two main functions. They are used for both the transition between each module and each object investigation within an individual module. The reason that we used continue boxes is the slowness problem we faced with at each Visirule document, as we extended the lines through the page down. Also we had a problem with executing the code. By the help of continuation boxes, we eliminated the line excess and reached the modular structure. One other important benefit of modularity will arise in the updating step. We divided all the objects in a single module from each other by continuation boxes. In case of a change on our expert system later, we will not need to analyze every part of the visual model. We will just focus on the object of an individual module we deal with. In case of any change in single object, all related changes throughout the program will be done automatically.

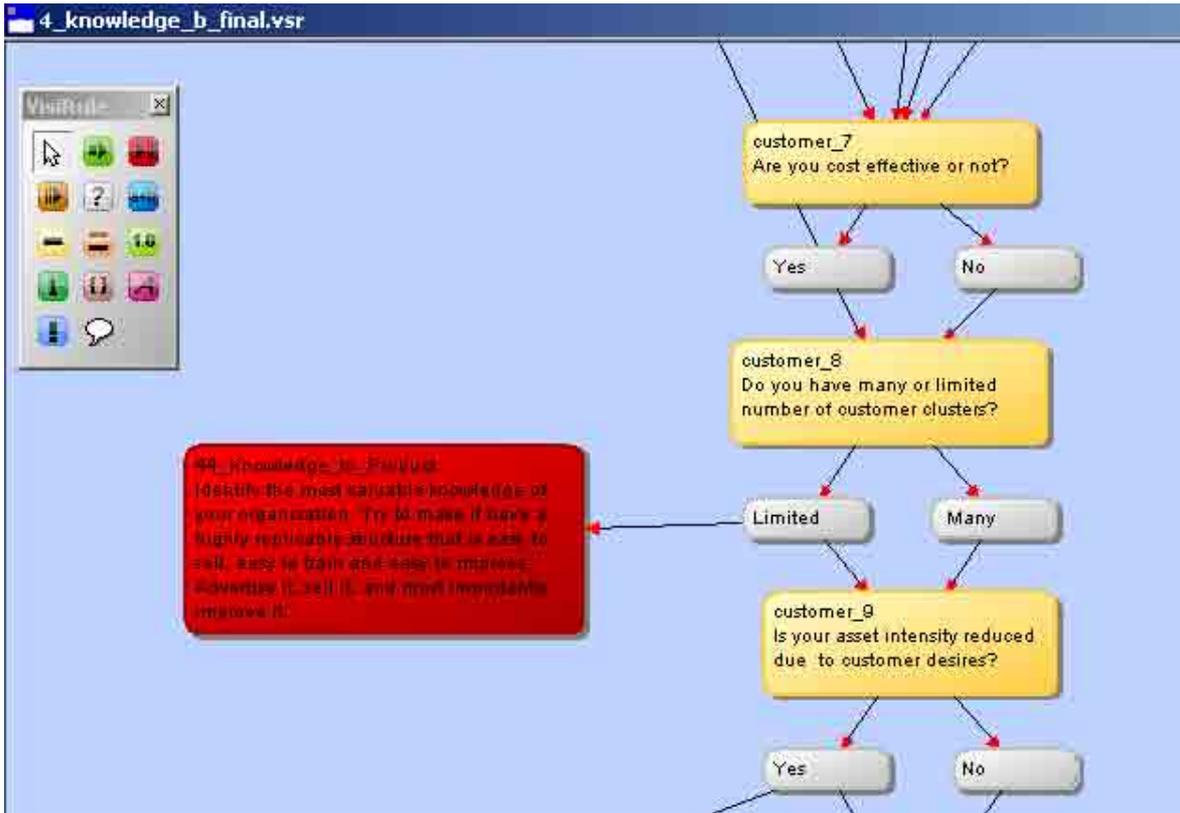


Figure 7: Graphical form of *customer* based investigation resulted with *Knowledge to Product* pattern in *knowledge* category

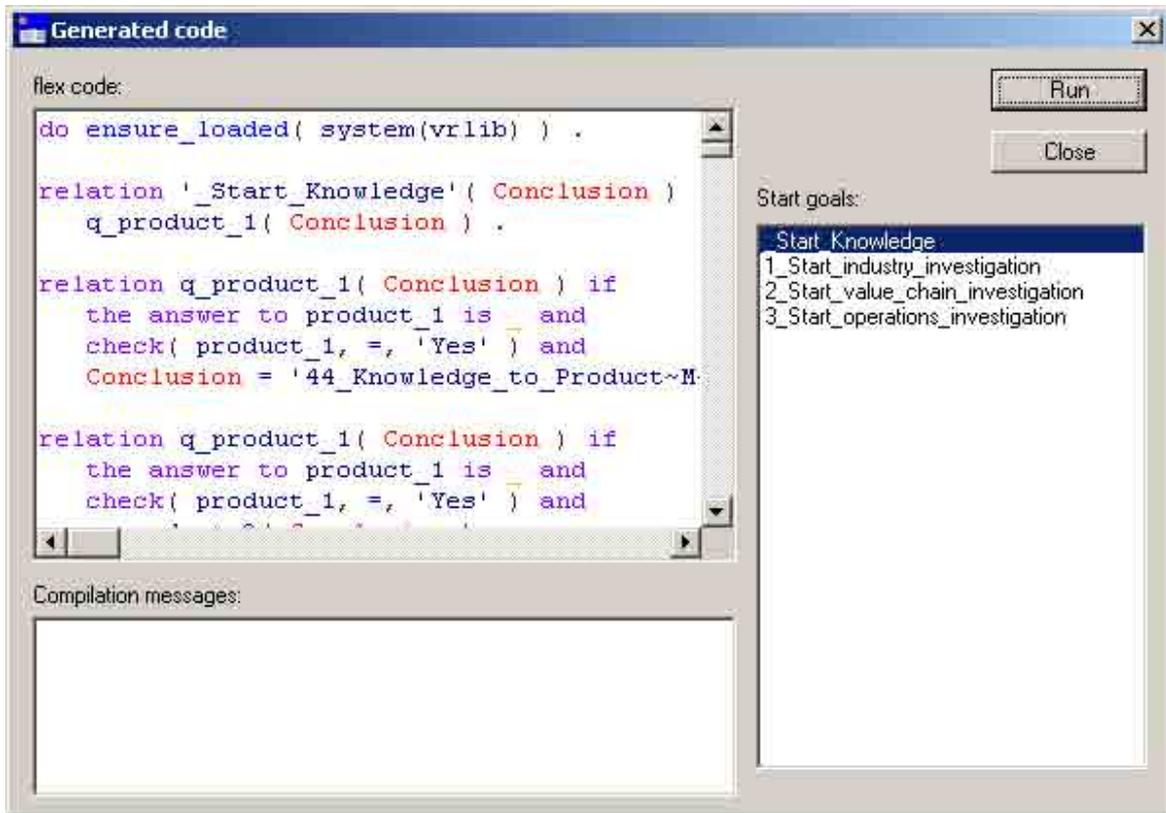


Figure 6: Generated *Flex* code of object based investigation in *knowledge* category

### 3.5 Java Implementation Generated from the Visirule Model

The end result of the methodology is the rule-based decision support system as *Java* application generated from the Visirule map. The user interface of the program consists of three windows which are used easily:

- *Main Window*, representing the menu for category (module) selection (Figure 8)
- *Question Window*, asking questions and getting the answers as input (Figure 9)
- *Suggestion Window*, listing all the suggestions given for individual module (Figure 10)



Figure 8: *Category selection* window of the *Java* application interface



Figure 9: Question window of the Java application interface



Figure 10: Suggestion window of the Java application interface

To put in a nutshell rule-based program initially acquires facts, and then makes suggestions based on these facts. Program starts with category selection in the main menu. User chooses the category he/she will make an object investigation and continues with the first question of the first object. There are seven choices as an answer of any question. Actually all questions are double choiced. First four of seven answer boxes denote the first answer choice, while the other three answer boxes denote the second answer choice of the question. The first group of answers are representing the answers, which are directed into related profit patterns. At each question if the user chooses an answer from the first group, then the system uses this answer in a calculation related with profit pattern suggestion and continues with the following question. In case of choosing an answer from the second group, no calculation is done before getting through the following question. Except these seven answer boxes there are also extra buttons for the questions that the user does not have any idea about the answer or including private information. If these buttons are clicked, program doesn't make any calculations again and continues with the following question.

At the end of each module, program lists all the suggestions given for that module. The logic of deciding to give a suggestion relies on a critical ratio. This ratio is the percentage of the number of directed arcs to any single suggestion (when the answer satisfies the condition) to the number of directed all arcs to that suggestion (whether the answer is directed or not) in Visirule representation. If that ratio is equal to or bigger than 0.6, then the suggestion is offered at the end of the module it falls under. After the suggestions are listed, program continues with the main menu, asking the user the module he/she will choose next.

#### **4 DISCUSSION**

In our expert system development project, there are three key players having critical responsibilities. Manager of the project deals with how the system can be used. Technologist's concern is how the system is implemented in the best way; while the researcher is concentrated on how it can be extended. At the end of implementation, we came up with some remedies for each business category. As an execution example in Visirule part, one of the customer investigations in knowledge

category (Figure 11) resulted with *Knowledge to Product* pattern (Figure 12) that offers useful improvements in terms of increasing profitability.

On the other hand consumer's most important concerns are how the system will help him/her, if it is worth to trouble and expense and how reliable the program is to be tested. At this point we see any business professional as our customer. However managers in small and medium size enterprises (SMEs) are the target audience of the project team. There are many attractive features of our system for SMEs such as increased availability/accessibility, reduced cost and multiple expertise. When Java implementation of our study is published on the internet, access into our system will be easier and will increase. By using our system, people will be free of spending lots of money for consulting firms. Moreover we give our customers a big chance to benefit from world-wide. Our system will both present a remedy and help to gain knowledge about strategic management. Also, users will be able to test their knowledge with the business gurus and business thinkers' strategic ideas. Another issue is that we used symbolic reasoning rather than numerical computation. This is the point that we differ from most of the expert systems. We are just concerned with the situations that might arise in business platform and the action that can be done in these situations.

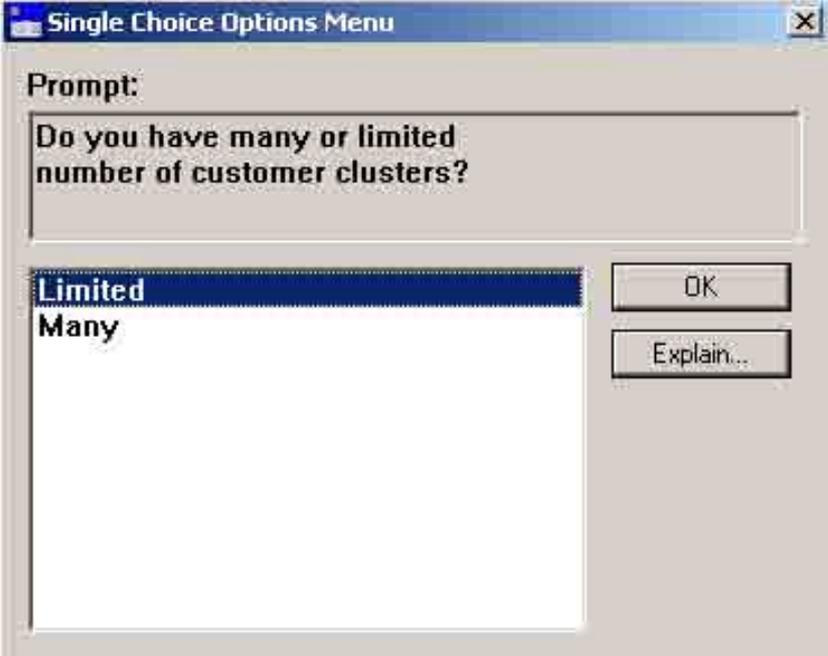


Figure 11: Executed form of one of *customer* based investigations in *knowledge* category

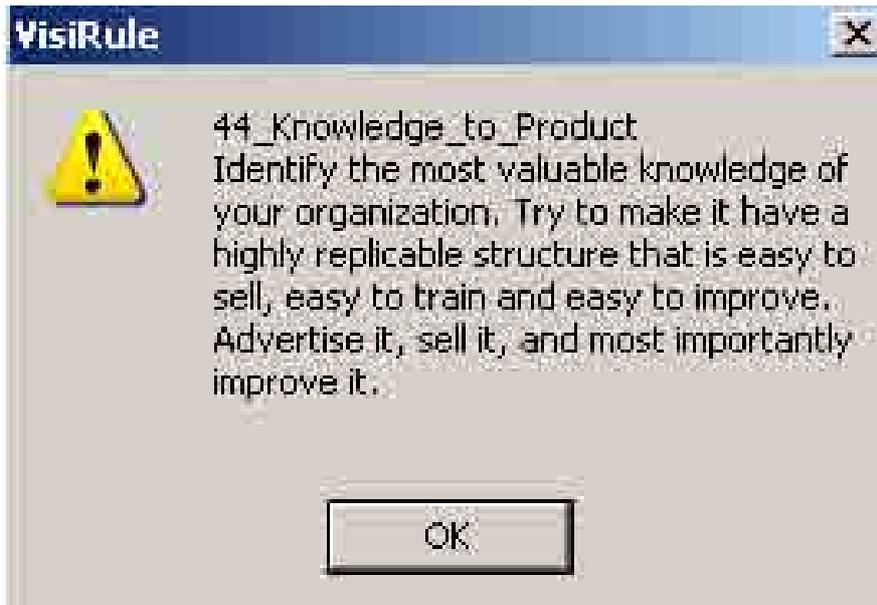


Figure 12: Executed form of *Knowledge to Product* pattern as a solution of one of *customer* based investigations in *knowledge* category

## 5 FUTURE WORK

Our expert system is an easy of access system that people find easy to achieve because of its on-line characteristics. If all answers of our users for each individual use of the system are assembled into a pool, then these answers might be analysed to have some knowledge about how strategic the managers and investors are thinking. This knowledge might be useful for the education of strategic management. Also it might be useful to have information about the market conditions. By this way the user can periodically see both the place of his/her firm in his/her business and the overall situation of the business platform.

Moreover there are many possible categories such as finance, marketing and information technologies which can be added into the system as an extension. While trying to perform these, knowledge should not be limited with a single book or a single business thinker. Ideas of highly important business thinkers and their countless successful publications should be mixed in order to create a beneficial system that reflects all various conditions of business world.

## 6 ACKNOWLEDGEMENTS

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