

Computer aided managerial making and planning in small and medium industrial enterprises

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Abstract

The development of decision support systems for supporting effectively the ill-defined and unstructured enterprise decisions associated with the managerial making and planning both at the strategic & tactical level constitutes a very challenging and at the same time a practically quite useful task. These systems, if properly developed according to the requirements of the users, can be very useful for all kinds of enterprises, and in particular for the small & medium enterprises, which do not have the required specialized personnel and expertise for strategic & tactical planning. In this paper is described the ergonomic development of a decision support system for supporting the managerial, making and the strategic & tactical planning in small & medium industrial enterprises, putting special emphasis on the human factors. The system is based on an extensive knowledge base including more than 500 rules, extracted from structured interviews and planning scenario analyses conducted with managers of small & medium industrial enterprises.

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1. Introduction

It is generally accepted that in most countries the Small and Medium Enterprises (SMEs) are very important for the national economy, the national product and also for maintaining high levels of employment. Critical for the competitiveness, the survival and the development of the SMEs are the adoption of advanced management methods and practices, in combination with appropriate information and communication technologies (ICTs). Modern information systems (IS) can greatly support not only the routine operations of the SMEs (transactional IS), but also their higher management functions, such making critical decisions associated with their strategic and tactical planning (decision support IS) [2, 5, 6, 13, 22, 23, 25, 29, 34]. The present paper focuses on the IS support of these higher management functions in industrial SMEs. Efforts to develop intelligent information systems aiming at supporting critical enterprise decisions have been very intensive [3, 4, 10, 11-14, 18, 28, 37, 38, 40]. A variety of software packages and knowledge - based systems are available, offering some level of support to the basic normative decision making model. However, many of these systems have been designed by decision analysts and knowledge engineers without adequate consideration of user requirements in each particular task domain, which are usually very complicated. Generally the implementation of such systems in real life situations has not been an easy task. Many failures and difficulties have been observed.

Therefore further research is required towards the ergonomic development of effective intelligent information systems, which support critical enterprise decisions. In this research direction the present study attempts to contribute. In the following sections of the paper is described the ergonomic development of a decision support system for supporting decisions associated with the managerial making and the strategic & tactical planning in small & medium industrial enterprises, placing special emphasis on the human factors. In the next section 2 is presented the theoretical background of the study, while in section 3 is described its methodology. In section 4 are described the results of the analysis of the main characteristics of strategic and tactical planning in industrial SMEs, and the requirements that a decision support system should fulfill for effectively supporting these functions. In section 5 is presented the Managerial Planning System (MPS) developed according to these requirements, while in section 6 is described the development of the knowledge base of this system. Finally in section 7 are discussed the results of all previous sections and the final conclusions are reached.

2. Theoretical background

The SMEs differ significantly from the large enterprises concerning the adoption of advanced management methods & practices and also concerning the utilization of ICTs. Extensive research has been conducted to investigate the specificity of the SMEs in comparison with the large enterprises and its consequences. According to Raymond [25] this specificity has the four main dimensions :

- (i) *Organizational specificity* : SMEs are "resource poor" regarding human, financial and material resources. Because of their small size they cannot have the 'economies of scale' that the larger enterprises usually have. This is very important because many modern advanced management methods and practices and many critical ICTs have high fixed costs and therefore high break-even points. Also SMEs because of their size have a much lower control over their external environment (customers, suppliers, etc.) than the large enterprises, which creates to them higher environmental uncertainties.
- (ii) *Decisional specificity* : In the SMEs the decision time frame is much shorter term, and their decisions are much more reactive and less proactive than in the large organizations. Also the decision making is much more intuitive and judgemental, and the decision makers use much less formal decision making techniques and information.
- (iii) *Psycho-sociological specificity* : The managers of the SMEs are very often their owners as well, and have a dominant role in decision making. Usually the owners-managers have a more individualistic ideology and are less willing to share information and delegate important decision making than the managers of the large enterprises.
- (iv) *Information systems specificity* : Most SMEs do not have the required personnel and expertise for planning, organizing, supporting the proper exploitation of ICTs. Their applications portfolio usually includes some transactional applications (e.g. payroll, accounting, inventory control, etc.), aiming mainly at increasing the organizational efficiency, but with very small impact on the organizational effectiveness.

The above multidimensional specificity of the SMEs has a negative impact on ICTs utilisation : the SMEs generally use the ICTs, both

the "traditional" and the modern Internet-based ones, much less (quantitatively and qualitatively) than the large enterprises [2, 6, 9, 17, 22, 23, 25]. Also, because of the above specificity the SMEs tend to be very weak in strategic and tactical planning [1, 16, 36], with negative consequences on their general effectiveness and competitiveness. For this reason government organizations of all levels (e.g. Prefectures, Regions, Central Government, European Commission) design and implement many Programs (e.g. [9]) for assisting SMEs introduce advanced management methods and practices and ICTs.

It is also worth mentioning that the ISs of the SMEs are mainly based on *software packages* [6, 19, 25, 39], which very often is the only feasible solution, because SMEs usually do not have the specialized personnel to develop tailored applications internally, or the required funds to have tailored applications developed externally by software houses. These software packages are mainly of transactional nature (they support to some extent their routine operations) and offer very low level of support for decision making (usually only some standard reports and very rarely some special report generation capabilities). This dominant software packages solution offers to the SMEs some important advantages in comparison with the tailored software solution : lower costs, shorter implementation time and lower implementation risk. However the software packages solution has some disadvantages as well : these packages usually are not very flexible and the user-SME often has to change radically its work procedures and adapt them to the package. Some of these process adaptations may be useful Business Process Reengineering (BPR), but some others may cause big problems. Also the user-SME often becomes highly dependent on the vendor of the software package even for small scale modifications.

From all the above mentioned literature it is also concluded that in the SMEs the use of decision support systems is very low, therefore the great potential and capabilities of IS for supporting decision making is exploited only to a very low extent. As *decision support system (DSS)* is generally defined a computer based system that helps decision makers to confront ill-structured problems through direct interaction and access to data and models [34]. A DSS aiming to support decision making and planning tasks is specially designed to improve the decision making of its user, by extending his/her cognitive decision-making abilities. Its aim is not to substitute the decision maker by making automatic decisions for him/her, but to support and improve his/her decision-making abilities and probably make suggestions and recommendations.

The main objective of developing a DSS is to support to the highest possible extent all the *normative decision making model – cycle*. The main stages of this cycle are [13] :

- problem identification and understanding
- identification of alternative courses of action
- identification of the selection criteria and determination of their weights
- determination of the performance of each alternative course of action with regard to each of the selection criteria
- selection of the optimal alternative with regard to the above criteria
- sensitivity analysis.

Therefore it is required that the DSS offers the decision maker as much support and assistance as possible, with data and calculations/models, in order to identify the problem rapidly in its early stages, to understand it better, to identify and examine more alternative courses of action, to discover existing interactions among various factors, to identify the appropriate selection criteria, to cope with the uncertainty and risk inherent in most enterprise problems and decisions, and finally to select the optimal alternative and to study its sensitivity to various factors.

The development of highly effective DSSs is an important and at the same time difficult and complicated task, and has therefore received much attention by the research and the professional community [3, 4, 10, 7, 8, 11, 12, 14, 15, 24, 26, 26-30, 32-34, 37, 38, 40]. The traditional 'linear' approaches, which are used for the development of transactional IS, have proven inadequate for the DSSs, necessitating the use of more complicated approaches of iterative – evolutionary nature. Also for the design of a DSS it is of critical importance to take into account seriously not only the technological factors, but also the human factors as well. Considering Shackel's anthropocentric model [30], a working situation is determined by *the human, the machine, the system and the environment*. The last three elements constitute the *working system or task environment*. The more the "machine" and the "system" prescribe the goals and the means of achieving them, the more this task is *well-defined*. In contrast, an *ill-defined (or ill-structured)* task is one where the means and goals are mainly determined by the human (person) who performs it, responding to the demands, constraints and changes of the working system. Tasks requiring *non-programmed and unstructured* decisions can be considered as ill-defined. In the structured decisions the "task" and the "tools"

can be determined relatively easily (goals and means of achieving them are clear and well defined). Due to the nature of decision making in real life situations, which often constitute ill-defined complex tasks, the user-centered design for the development of systems supporting decision makers poses challenging problems requiring extensive research.

3. Methodology

The present study was implemented with a four-phases methodology. In the first phase, a detailed task analysis was conducted of managerial planning (strategic and tactical) in the SMEs, based on a first round of case studies, structured interviews and planning scenario analyses conducted with experienced managers of 56 successful Greek small & medium industrial enterprises, all located in the greater area of Athens. The main goals of this task analysis were to identify and understand :

- the main categories of managerial planning decisions that experienced managers of SMEs have to make
- the process followed by them for making these decisions
- the constraints or cognitive difficulties they are facing in this process
- the cognitive skills that these experienced SMEs managers had developed in order to make these decisions and perform managerial planning under the above constraints and cognitive difficulties.

Such a detailed task analysis is considered in the relevant literature as the key for the development of an effective DSS, which supports complex cognitive tasks, such as managerial planning [5, 7, 8, 10, 24, 26-28, 37, 38]. This mapping of the cognitive demands imposed by the task (competence modelling), in combination with the mapping of what the future users actually do at present (performance modelling), allow the design of an effective DSS that matches the mental decision making processes of the users and supports them effectively in order to meet the corresponding cognitive demands and to overcome the cognitive performance bottlenecks.

Based on the above approach and the results of the task analysis of the first phase, in the second phase the managerial planning system (MPS) was designed and implemented. This MPS, in order to offer an effective support for managerial planning, had to be incorporate the relevant knowledge and experience of many successful managers of SMEs. For this purpose in the third phase a knowledge-base was developed, consisting of IF(conditions)-THEN(actions) rules. Each of these rules was

a recommendation of some actions in the case that some conditions exist. In order to develop this critical knowledge-base a second round of case studies, structured interviews and planning scenario analyses was conducted with the managers of the same 56 successful Greek small & medium industrial enterprises. Finally in the fourth phase the whole MPS, incorporating the above knowledge-base, was evaluated in a workshop by industrial SMEs managers, and based on the results of this evaluation some final modifications of the system were made.

4. Main characteristics of managerial planning in SMEs

In this section are described the findings of the task analysis of the managerial planning in the SMEs concerning its main characteristics. As 'managerial planning' is defined the series of mental processes which are followed in order to make important decisions concerning the future course of the enterprise. Managerial planning decisions determine the goals of the enterprise and also the ways the enterprise will act in order to achieve them.

From this task analysis it was found that although there were differences between the investigated SMEs as to their products, their markets, etc., and therefore as to the specific decisions their managers had to make, there were some common categories of managerial planning decisions that could be well distinguished. Some of these common categories of planning decisions are of strategic nature, such as decisions about the main future directions (expansion, stabilization, retrenchment), the basic products or services groups they will offer, the main markets or market segments they will focus on, the sources of their competitive advantage – cost leadership or product differentiation, etc., while some others are of tactical nature, such as decisions about the introduction of new products, purchase of new equipment, advertising, etc. The main factors which are taken into account in the process of making these decisions are the past, present and future states of the external environment of the enterprise, in combination with the past, present and future states of its internal capabilities. In the large enterprises there is a combination of formal and informal processes for making these critical planning decisions, which integrate the views of many departmental managers and planning specialists. However in the SMEs it was clearly concluded that these planning decisions usually made only by the top manager, who is very often the owner of the enterprise as well, without the participation or support of managers or planning specialists. The manager-owner in most cases does not have the required

education and expertise in planning methods and practices, and usually follows an informal intuitive process, which differs significantly among the investigated SMEs, depending very much on the personality and the education of the owner-manager.

The main constraints or cognitive difficulties that the managers of the investigated SMEs have in making these planning decisions are the following :

- *Complexity* : There are numerous, interrelated and therefore interacting factors-dimensions of their environment (both the external and the internal environment) that have to be taken into account for making planning decisions.
- *Dynamism* : Events can occur at any time that change the state of the above factors (especially of the external environment ones), the nature of the problem to be solved and the decisions to be taken.
- *Uncertainty* : The time at which the above events actually occur, the severity of the changes it will cause to the environment, as well as the exact final impact of the decisions taken cannot be predicted.
- *Limited knowledge* : The outcomes of the alternative courses of action are usually predictable with the existing limited knowledge only to a certain extent, mainly qualitatively and very rarely quantitatively.
- *Risk* : The decisions made, the time we make and implement them, or even the absence of decisions, can have negative consequences for the enterprise.
- *Multiple and confliction quantitative and qualitative objectives* : There are many objectives we want to achieve, both quantitative and qualitative ones, which are very often -at least in the short term-conflicting
- *Long response times* : The effects of the decisions may be long-term (they usually appear many years after making and implementing the decision, especially in the case of strategic planning) and they are not easily observable.
- *Novelty* : Many important decisions are unique ventures and therefore there is no concrete past experience as to the best course of action.

The mental processes followed by the managers of the investigated SMEs in order to make these planning decisions under the above mentioned significant constraints and cognitive difficulties present some

interesting characteristics, which should be seriously taken into account in designing an efficient DSS. Associated with these characteristics are corresponding cognitive skills that experienced SMEs managers gradually develop in the course of time. The most important of these characteristics are :

- *Limited search of information* : The managers of the SMEs usually do not expect to find detailed answers to all their questions, and therefore do not attempt to find and process all the information associated with the specific problem/decision they are dealing with. Instead, they base their decisions mainly on the information they have at hand, and only in a few special cases they search of the most important parts of the missing information. This characteristic is probably due to their limited resources (personnel, time, information sources, etc.) and also due to some of the above mentioned constraints and cognitive difficulties (e.g. complex and multidimensional environment, fast changes and uncertainties, etc.). Therefore the managers of the SMEs develop cognitive skills of making optimal or slightly suboptimal decisions with limited and imperfect information [13, 14, 20, 21, 32, 33, 35]. Obviously this characteristic may have many negative consequences : important data for critical planning decisions may be neglected during the decision process, resulting in highly suboptimal or even absolutely wrong decisions.
- *Limited generation of alternatives* : The experienced decision makers of the SMEs usually do not generate extensive sets of possible alternatives, which they would subsequently evaluate in order to select the more appropriate one for the situation at hand. Instead, as soon as they form a basic representation of the situation they define a rather limited set of actions, which they apply immediately preplanned routines. This kind of behaviour could be attributed to the fact that experienced decision makers possess an extensive repertoire of experiences and solutions, which are organized hierarchically in their memories and are accessed more through recognition than conscious search [7, 8, 31-33, 35]. These cognitive skills of the experienced managers allow the rapid solution of many different problems, however they can have many negative consequences as well : application of inappropriate practices for the specific situation (which may have been proved successful in the past in seemingly 'similar' situations, however they are

not appropriate for the specific situation at hand), replication of ineffective practices, delay of required adaptations to environmental changes and therefore of required innovation, etc.

- *Pursuit of qualitative goals* : The managers of the SMEs structure their decision process towards qualitative goals of desired situations or conditions they are trying to bring about. Decision processes are seldom rigid, people adjusting them "on the fly" to keep focus on the goals being pursued. Consequently, although human decision processes can be characterized fairly tightly in terms of various goals being pursued, they can only loosely (at best) be characterized by any strict procedural depiction.
- *Qualitative and heuristic reasoning* : Decision processes involving a heavy load of calculations are usually avoided, and is favored more qualitative and/or heuristic reasoning in the decision process. Consequently mental problem representations that are of quantitative nature are avoided. This characteristic is probably due to some of the above mentioned constraints and cognitive difficulties (e.g. difficulty of predicting quantitatively the exact outcome of various alternative decisions, etc.). In many cases it can result in missing significant opportunities to make better decisions by using quantitative models, which could predict with a good degree of accuracy the outcomes of the various alternative decisions.
- *Multiple thinking/acting cycles* : The managers of the SMEs tend after some initial thinking to make a first limited set of decisions to do some specific actions (though they may lack full information and understanding of the situation), which they immediately apply and wait for the first results. Based on these first results they usually think further and decide some corrective actions, which they apply immediately and wait for their results, etc. and this thinking/acting cycle may be repeated several times. This characteristic is probably due to some of the above mentioned characteristics, constraints, and cognitive difficulties (e.g. complex and multidimensional environment, limited available information, fast changes and uncertainties of the environment, examination of a limited number of alternatives selected from an existing repertoire of past experiences and solutions, difficulty of predicting quantitatively the exact outcome of various alternative decisions, etc.) compensating for them to some extent.

Based on the findings of the task analysis of the managerial planning

in the SMEs, were determined the requirements that a decision support system should fulfill in order to support effectively the managerial planning decisions, and to remove or relax some of the above mentioned constraints, obstacles and difficulties of these decisions. The basic requirements form this DSS are to:

- Enhance the ability of the decision maker to understand and conceptualize the environment they act in, the main environmental factors of interest for the enterprise, the interactions among these factors and their changes resulting due to the occurrence of various events.
- Enhance the ability of the decision maker to consider and evaluate more alternative decisions, given multiple quantitative and qualitative objectives.
- Enrich the repertoire of possible planning decisions stored in the memory of the decision maker, by proposing strategies and tactics relevant to a given situation, e.g. generated by the inference engine using the knowledge base of the system.
- Enhance the ability of the decision maker for each alternative decision to experiment with many possible outcome scenarios in order to cope with the uncertainty and the risk.
- Support the decision maker's working memory during the whole planning process with various kinds of facilities, e.g. spreadsheets, graphics, etc.
- Offer the decision maker the capability of considering more data and models/analyses during the planning process, e.g. by presenting a catalogue of external and internal factors which help the manager to form a global picture of the past, present and the expected future status of the environment, and by providing a list of potential strategies and tactics and a framework for their evaluation.
- Support multiple thinking/acting cycles, by providing a framework with displays presenting the status of external and internal environment factors and the planning decisions made during the previous action/thinking cycles.

Also this DSS should be flexible enough to support various versions of the basic planning process observed in the SMEs of our sample. All these versions include similar steps, however they differ in the sequence of these steps. Also the DSS should be flexible enough to support both the more sophisticated approaches of planning, which

are based on both qualitative and quantitative objectives (followed by the more sophisticated SMEs with well developed formal planning and management information systems), and also the less sophisticated approaches of planning, which are based mainly on qualitative criteria (followed by the less sophisticated SMEs).

5. An operational presentation of Management Planning System (MPS)

The Management Planning System (MPS) offers to the user the following three kinds of screens :

- a. *Planning Status Screens*, which receive and display information on the status of the main internal and external environment factors.
- b. *Planning Decisions Screens*, which receive planning decisions made by the user, and display some proposed strategies and tactics appropriate for the specific situation, which are generated by the inference engine using the knowledge base of the system (which is described in section 6).
- c. *Planning Evaluation Screens*, which present both qualitative and quantitative criteria and support the evaluation of the alternative decisions with these criteria.

The basic planning process proposed by the MPS to the user is based on the conclusions of the above task analysis and the methodologies proposed by the relevant literature [1, 16, 36] and includes the following steps :

- Assessment of the past, present and expected future external and internal environment.
- Setting generic qualitative and even quantitative goals.
- Determination of available alternative strategies and tactics.
- Evaluation of these available strategies and tactics using qualitative and even quantitative criteria and final selection.

However the MPS supports not only the above planning process, but also its various versions followed in many SMEs, which include the above steps as well, but with a different sequence.

In particular the MPS includes the following 13 individual stages of planning, each of them consisting of one or two displays :

STAGE 1 : SETTING OF TIME HORIZON (it can be either short, as it usually happens in most SMEs, or long, between 6 months and 5 years).

STAGE 2 : ASSIGNMENT OF VALUES TO FACTORS OF THE INTERNAL ENVIRONMENT (an extensive list of the most important internal environment factors for the planning, as determined in the task analysis, is displayed, and the user is asked to assign values to them for the case of the specific enterprise).

STAGE 3 : ASSIGNMENT OF STRENGTHS AND WEAKNESSES (the user initially is asked to select those of the above internal environment factors he/she considers as strengths of the enterprise, and also those he/she considers as weaknesses ; then the user is asked to select among these strengths and weaknesses the most important ones, for which some action should be planned to be taken).

STAGE 4 : ASSIGNMENT OF VALUES TO FACTORS OF THE EXTERNAL ENVIRONMENT (an extensive list of the most important external environment factors for the planning, as determined in the task analysis, is displayed, and the user is asked to assign values to them for the case of the specific enterprise).

STAGE 5 : ASSESSMENT OF THREATS AND OPPORTUNITIES (the user initially is asked to select those of the above external environment factors he/she considers as threats for the enterprise, and also those he/she considers as opportunities ; then the user is asked to select among these threats and opportunities the most important ones, for which some action should be planned to be taken).

STAGE 6 : REVIEW OF PAST PERFORMANCE (the user is asked to enter the past economic performance of the enterprise regarding production, sales, turnover, net profits, capital and return of capital).

STAGE 7 : SETTING OF BASIC STRATEGIES AND OBJECTIVES (the user is asked to set the basic strategies and objectives at a qualitative level).

STAGE 8 : SETTING OF QUANTIFIABLE OBJECTIVES (the user is asked to set quantitative objectives for the time horizon set in stage 1, regarding production, sales, turnover, net profits, capital and return of capital).

STAGE 9 : SELECTION OF POSSIBLE TACTICS (an extensive list of tactics, which have been determined during task analysis from the experience of the managers of the examined SMEs, are displayed,

and the user selects the ones he/she considers as appropriate for the specific enterprise).

STAGE 10 : ASSESSMENT OF ALTERNATIVE SETS OF TACTICS (initially in addition to the tactics selected by the user in the previous stage 9, the inference engine of the system using the knowledge base proposes additional tactics that might be appropriate, given the internal and external factors status of the enterprise and also its strategies and objectives ; then the user is asked to group the above selected and proposed tactics into alternative sets of tactics).

STAGE 11 : QUALITATIVE EVALUATION OF ALTERNATIVE SETS OF TACTICS (the user is asked to evaluate each of the above alternative sets of tactics developed in stage 10 according to pre-set qualitative criteria).

STAGE 12 : QUANTITATIVE EVALUATION OF ALTERNATIVE SETS OF TACTICS (the user is asked to evaluate each of the above alternative sets of tactics developed in stage 10 according to pre-set quantitative criteria).

STAGE 13 : ACTIVITIES PLAN (final selection of the optimal set of tactics and development of the corresponding implementation plan).

The user - decision maker can choose to follow the above planning stages either in the order they are presented or in any other order he/she may select to support his/her own version of the basic planning cycle. For this purpose the user can :

- either enter any stage, by ticking the corresponding number in the initial-introductory screen of MPS, and then return to the main menu and enter any other stage, etc., so that the planning process can be fully customized,
- or choose to follow one of the 5 standard routes (= prespecified sequences of the above stages) suggested by the system, which support the most frequent versions of the basic planning cycle observed in the SMEs of our sample.

The user - decision maker can also skip the 'quantitative' stages 6, 8 and 12, in order to follow a qualitative approach.

6. Knowledge base development

MPS does not commit itself to any particular managerial or economic theory ; instead, it is based on the knowledge and experience of successful

SMEs' managers, which is incorporated both in the interface design (screens) and also in the knowledge-base of the system. The main body of the knowledge-base consists of IF(conditions) - THEN(actions) rules : each of these rules is a recommendation of some actions in the case of some conditions. The conditions concern mainly the status of the external and internal environments of the successful SMEs of the sample and also their strategies and objectives, while the actions include the planning decisions made by their managers. This structure is based on the assumption that the planning decisions of the enterprises are directed towards some particular goals (qualitative or quantitative ones) based on the status of certain external and internal environment factors. These rules have been extracted either directly from the scenarios analyses and structured interviews with the SMEs managers (tactics justified by them through reference to the state of external and internal environment factors given the strategy and the targets), or indirectly, through statistical analysis of the data from the structured interviews (statistical correlation of tactics with internal environments of SMEs, external environments and planning decisions).

The statistical analysis of these data has been performed using the SPSS statistical package in a series of phases which are described below :

- (a) First level of statistical analysis of data with various statistical methods, such as frequencies calculations, chi square tests, factor and cluster analyses, etc. The purpose of this first phase was to identify relationships between distinctive states of the internal and external environmental factors and strategies and objectives on one hand and decisions/tactics which have been made in the context of planning process on the other. The number of the statistically significant relationships which have been obtained from this kind of analysis is more than 500.
- (b) A clustering of the SMEs based on common characteristics according to criteria/factors that their managers take into consideration in order to form business plans. The clustering process has shown that certain taxonomic schemes can be developed around generic strategies and the environmental factors as they seem to imply different organizational arrangements.
- (c) Evaluation (refinement) of the statistical findings from the strategic planning point of view.
- (d) Generation of production rules of the "IF (conditions) THEN (actions)", type based on the results of the previous refinement.

In addition rules of other types have also been extracted, such as

directly observed rules and rules which have been extracted from the scenario verbal protocol analysis :

- I. The rules of the first type result from the verbal protocol analysis of the structure interviews. Here, the manager relates the selection of a tactic with values of certain factors. An example of such a rule and the associated managers verbal protocol is shown in Figure 1.

**IF the DEMAND of your product = HIGH
AND the INDUSTRIAL SECTOR = FAST GROWING
AND the MANAGERIAL SUPPORT = SATISFACTORY
THEN you may consider implementing the following
TACTICS in descending order:**

**INCREASE MARKETING EXPENSES
DEVELOP R&D
DIFFERENTIATE YOUR PRODUCTS
IMPROVE DELIVERY
INCREASE VERTICAL INTEGRATION
REDESIGN LAYOUT
USE CAD EQUIPMENT**

Figure 1

- II. The rules of the second type were extracted from the scenario verbal protocol analysis by examining selected tactics and associating them with the described factor values. An example of such a rule is shown in Figure 2.

**'...Initially, we were making metallic kitchen furniture
... Competition on prices gradually increased due to entry
of many small companies with low overheads ... We have
decided to start making wooden furniture (differentiate)
because there was less competition in wooden furniture and
demand was expected to increase due to improvement to
standards of living and changes in consumer behavior...'**

**IF the COMPETITION = HIGH
AND the TYPE OF COMPETITION = LOW QUALITY, LOW PRICE
AND the ECONOMIC ENVIRONMENT = IMPROVES
AND the FLEXIBILITY IN CHANGES OF PRODUCT TYPE = HIGH**

THEN you may consider implementing the following TACTICS

**FOCUS ON HIGH QUALITY PRODUCTS
DIFFERENTIATION OF PRODUCT CHARACTERISTICS**

Figure 2

7. Discussion – conclusions

The above MPS was evaluated in a workshop by industrial SMEs' managers. The time they required to learn it and get familiar with it was very short, and after this first familiarization they had no problem using it. Generally they found MPS very easy and user friendly (as all efforts had been made to minimize typing requirements on behalf of the users - decision makers : the users interact mainly through mouse and menus, and the only typing required is in stages 6, 8 and 12, which however can be omitted if a qualitative approach is to be followed). A few remarks for improving the interface were made ; in response to these remarks some final modifications of the system were made. Also some managers of large SMEs remarked that it would be very useful if MPS could be connected with their financial packages, so that some data from these packages can be shown in some screens of MPS, in order to support more their decision making.

The above industrial SMEs' managers at the end of the workshop were asked which were the most important benefits they believed the MPS was offering. From their the answers it is concluded that the main benefits they perceive are :

- MPS helps them to structure and organize the managerial planning process in discrete, small and better manageable steps.
- It also helps them to locate the most important internal and external environmental factors that should be looked at, and also to exploit and analyze their significant already existing knowledge and experience about these factors and their impact.
- MPS helps them very much to identify and examine more alternative courses of action (many more than the ones they would examine by themselves), both by looking at the screens of possible tactics of stage 9, and also by looking at the proposed tactics for the specific situation (the existing status of the internal and external environmental factors and the chosen strategies and objectives) by the inference engine of the system using the knowledge base.
- Finally it helps them group the alternative courses of action in sets, and evaluate these sets according to well-established qualitative and quantitative criteria, in order to select the optimal set.

References

- [1] J. Argenti, *Corporate planning: a practical guide*, G. Allen & Unwin, 1974.

- [2] J. Ballantine, M. Levy and P. Powell, Evaluating Information Systems in Small and Medium Enterprises : Issues and Evidences , *European Journal of Information Systems*, Vol. 7 (1998) , pp. 241-251.
- [3] N. Blesseos and G. Chondrocoukis, *Task Analysis in a DSS for Small and Medium Enterprises*, EURO X Conference, Beograd,1989.
- [4] N. Blesseos and G. Chondrocoukis, *A Group Decision Support System Design for Small and Medium Enterprises*, Elsevier Science Publishers bB.V., IFIP, 1991.
- [5] Rh. Bonczek, C. W. Holsapple and A. B. Whinston, Computer-based support of organizational decision making, *Decision Sciences*, Vol 10 (1979), pp. 268-291.
- [6] P. B. Cragg and N. Zinatelli, The Evolution of Information Systems in Small Firms, *Information and Management*, Vol. 29 (1) (1995), pp. 1-8.
- [7] V. DeCeyser, Les activites mentales dans les processus de production fortement automatisees, *Le Travail Humain*, Vol. 45 (1982), pp. 331-339.
- [8] V. DeCeyser, De la contingence a la complexite : l' evolution des idees dans l' etude des procesus continus, *Le Travail Humain*, Vol. 51 (1988), pp. 1-17.
- [9] European Commission, *Helping the SMEs to Go Digital*, Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions, COM (2001) 136, Brussels, 13.3.2001.
- [10] B. Fishoff, Human Decision Making, in *Research Needs for Human Factors*, *Community of Human Factors*, National Academy Press, 1983.
- [11] R. B. Gallupe, Experimental research into group decision support systems : Practical issues and problems, in *Proceedings of the Hawaii International Conference on Computerized Systems*, 1986.
- [12] T. P. Gerrity, Design of man-machine decision systems : An application to portfolio management, *Sloan Management Review*, 1971.
- [13] P. Goodwin and G. Wright, *Decision Analysis for Management Judgement*, 2nd ed., John Wiley & Sons, 2000.
- [14] D. J. Isenberg, Thinking and managing : A verbal protocol analysis of managerial problem solving, *Academy of Management Journal*, Vol. 29 (4) (1986), pp. 80-90.
- [15] F. M. Jablin and D. R. Siebolo, Implications for problem-solving groups of empirical research on brainstorming : A critical review of the literature, *Southern Speech Communication Journal*, Vol. 43 (1978), pp. 327-356, .
- [16] G. Johnson and K. Scholes, *Exploring Corporate Strategy*, 5th ed., Prentice Hall Europe, 1999.

- [17] M. Levy, P. Powell and R. Galliers, Assessing Information Systems Strategy Development Frameworks, *Information and Management*, Vol. 36 (1999), pp. 247-261.
- [18] C. E. Lindblom, The Science of Muddling Through, in *Readings in Managerial Psychology*, H. Leavit, L. Pondy and D. Boje (Eds.), University of Chicligo Press, pp. 144-160, 1980.
- [19] H. C. Lucas, E. J. Walton and M. J. Ginzberg, Implementing Packaged Software, *MIS Quarterly*, Vol. 12 (4) (1998), pp. 537-549.
- [20] M. W. McCall and R. E. Kaplan, *Whatever it takes : Decision Makers at Work*, Englewoods Cliffs-Prentice Hall, 1985.
- [21] H. Mintzberg, D. Raisanghani and A. Theoret, The Structure of Unsaturated Decision Processes, *Administrative Sciences Quarterly*, Vol. 21 (1979), pp. 246-275.
- [22] S. Poon and P. Swatman, Internet-based Small Business Communication, *International Journal of Economic Markets*, Vol. 7 (2) (1997), pp. 15-21.
- [23] S. Poon and P. Swatman, An Exploratory Study of Small Business Internet Commerce Issues, *Information and Management*, Vol. 35 (1999), pp. 9-18.
- [24] J. Rasmussen, *Information Processing and Human Machine Interaction : An Approach to Cognitive Engineering*, North Holland, N.Y., 1986.
- [25] L. Raymond, End User Computing in the Small Business Context : Foundations and Directions for Research, *Database*, Winter 1990.
- [26] J. Reason, Cognitive Aids in Process Environments : Prosthesis or Tools, *International Journal of Man-Machine Studies*, Vol. 27 (1987), pp. 463-470.
- [27] E. M. Roth, K. B. Bennett and D. D. Woods, Human Interaction with an Intelligent Machine, *International Journal of Man-Machine Studies*, Vol. 27 (1987), pp. 479-525.
- [28] E. M. Roth and D. D. Woods, Aiding Human Performance I : Cognitive Analysis, *Le Travail Humain*, Vol. 51 (1988), pp. 39-64.
- [29] V. L. Sauter, *Decision Support Systems : An Applied Managerial Support*, John Wiley & Sons Inc., 1997.
- [30] B. Scackel, Human factors and usability, *ACM Gennan Conference on software Ergonomy*, 1985.
- [31] D. Schon, *The Reflective Practitioner*, Basic Books, 1983.
- [32] H. Simon, On how to decide what to do, *Bell Journal of Economics*, Vol. 9 (1978a), pp. 494-507.
- [33] H. Simon, Rationality as process and product of thought, *American Economic Review*, Vol. 68 (1978b), pp. 1-16.

- [34] R. H. Sprague and H. J. Watson (Eds.), *Decision Support Systems - Putting Theory into Practice*, 2nd ed., Prentice Hall International Editions, 1989.
- [35] H. Weick, Managerial Thought in the Context of Action, in *The Executive Mind*, S. Srivastara (Ed.), Jossey Bass Publ., pp. 221-242, 1983.
- [36] T. L. Wheelen and J. D. Hunger, *Strategic Planning & Business Policy-Entering the 21st Century Global Society*, 7th ed., Prentice Hall, 2000.
- [37] D. D. Woods, Coping with Complexity : the Psychology of Human Behaviour in Complex Systems , in *Mental Models, Tasks and Errors: a Collection of Essays to Celebrate Jen Rasmusses's 60th Birthday*, Elsevier Science Publishers, B. W., 1987.
- [38] D. D. Woods and E. Hollnagel, Mapping Cognitive Demands in Complex Problem – Solving Worlds, *International Journal of Man-Machine Studies*, Vol. 26 (1987), pp. 257-275.
- [39] M. S. Wu, Selecting the right Software Package, *Journal* of Systems Management*, Vol. 41 (9) (1990), pp. 28-35.
- [40] D. Zakay, Obstacles in the Utilization of Decision Analysis by Managers, in *Human Factors in Organizational Design and Management*, H. W. Hendrick and O. Brown (Eds.), Elsevier Science Publishers, B.W., pp. 45-49, 1984.

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