USING AN INTELLIGENT DSS FOR CIS IDEA IDENTIFICATION: A SYMBIOTIC APPROACH

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An Intelligent DSS for Competitive Information Systems Identification: A Symbiotic Approach

Abstract:

Competitive Information Systems (CIS) are information systems which help a company to obtain and sustain a competitive edge. Before any such CIS can be implemented, the idea for it has to be formulated. The paper describes a way to systematically stimulate ideas by asking questions. It discusses the question generating mechanism as well as ways to focuses these questions. It shows an implemented DSS, which aids the described process and contains inference mechanisms of expert systems. This DSS uses a symbiotic approach between system and user.

1. Introduction

Competitive Information Systems (CIS) are information systems which help a company obtain and sustain a competitive advantage. Recently, their importance is being recognized due to successful implementations. Ideas to develop CIS can stem from a multitude of areas such as existing applications, different frameworks for reference, systematic procedures, intuition etc. As these CIS become part of the company's overall strategy their identification and selection for implementation resembles the difficulties and challenge of strategy development and implementation. As seen today some of the most known examples of CIS were results of a chance process rather than a planned process [13]. However, with more and more businesses turning to information systems to obtain a competitive edge, systematic ways to find ideas become necessary.

This paper describes a symbiotic approach to the process of finding ideas. An idea in this context is a concept of a concrete information system, which might create a competitive advantage. This idea has to be concrete in the sense that it is applicable to the specific firm that it has been targeted for. Typically the idea will describe how the envisioned system works and not how it will be developed and implemented. Often ideas are formulated in a discussion as a reaction to questions brought forward. We present a Decision Support System (DSS) that systematically triggers the users to find ideas for CIS. In order to reduce the number of questions that are asked, we introduce the inference mechanisms of Expert Systems(ES).

The remainder of this paper is organized as follows. The next section describes the

process of identifying ideas for CIS. Section three analyzes the extent to which DSS or ES could be used to support this process. Based on these arguments we propose a symbiotic approach for idea identification in the realm of competitive information systems. The fourth chapter describes the implemented support system. Finally, we summarize and show some areas for improvement and further development.

2. The process of identifying CIS ideas

Creating ideas for CIS is very much an issue of 'what you know is what you will see'. Creating ideas then means identifying opportunities. One answer to the question of why the competitive possibilities of IST are only now receiving attention, is that 'they have not been seen before' [23]. The conceptual view of the relationship between IST and strategy plays a major role in our ability to influence this relationship and to create ideas or see opportunities. Also, only those applications can be identified in principal which are 'inside' a conceptual framework. This conceptual blindness is inherent to any preformulated process of discovery such as frameworks.

Numerous frameworks have been proposed to develop application ideas. Examples of these approaches are Porter's [16,17] competitive strategy framework and its applications by McFarlan [12] and Porter and Millar [15], Ives and Learmonth's customer resource life cycle [10] and Wiseman's strategy action generator [23,23]. Attention also focuses on organizational issues like creative atmosphere, brain storming and educational sessions [18] and new organizational structures [21]. One concern with most existing research stems from the question addressed. From a firm's perspective the concrete application idea is sought; mechanisms to identify potential areas are just hints in that search. This problem of non-applicability stays, even if a framework confines

itself to a narrow and predefined application area [4]. The gap between the general framework and its application to a business unit exists as long as there is no support for this process.

Whatever new framework gets proposed, it enhances one of the key problems of the area. Looking for CIS ideas is the search for a needle in a haystack. Every new differentiation of contributing factors like information technology, strategy elements or business units increases the number of possibilities, which might contain a CIS. It becomes obvious that a reduction of either the search space in numbers of alternatives or the search effort to scan the same number of alternatives is of extreme importance. Reduction mechanisms work with knowledge other than the one needed for the identification itself. Results of analysis will help to determine which frameworks should be used for identification etc. There is a relationship between analysis and identification which ultimately leads to ideas, which can be evaluated (figure 1).

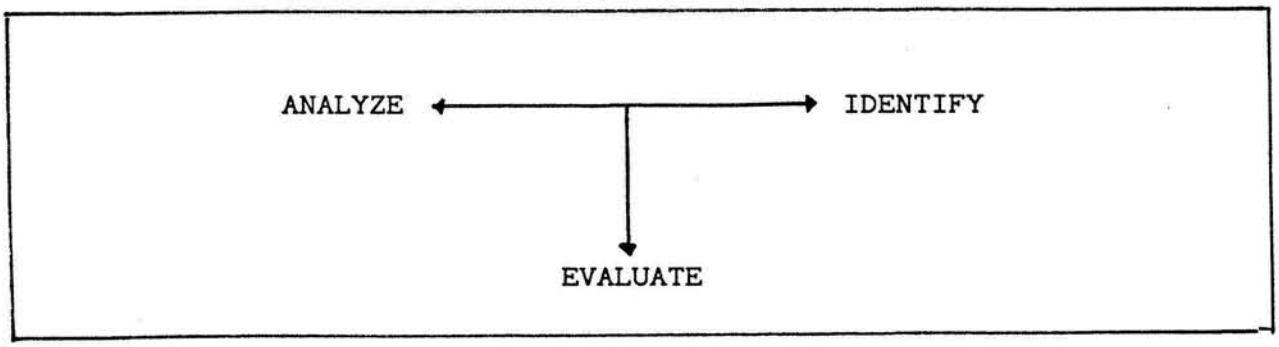

Figure 1: Components of the application identification process

The analysis step is like other strategy oriented analysis. In the area of CIS the work of Michael Porter [16,17] has been extremely influential and gets praise almost like folklore. This step, especially if concerned with competition or value chain analysis will

be performed by business analysts. It provides all necessary information for identification focusing and evaluation. In order to consolidate search space and effort of the identification process the elements of analysis are dependent on the identification mechanisms. Only after we have defined the identification mechanism we can conclude which information we might use to diminish search efforts.

The decision, which application to develop for CIS involves two important steps: the identification of candidates for implementation (the idea), and the evaluation of these ideas. Before any information system with strategic impact can be implemented, and before ideas for such an implementation can be evaluated, the idea for it has to be identified.

For evaluation we are interested in how to justify CIS applications, as they typically can not be cost- justified alone. More than through the typical cost-benefit analysis of any information systems project, CIS will have to be justified as one part of a larger strategic package. The evaluation of CIS will be based on usual criteria for information systems in connection with strategy evaluation. A large part of this evaluation will consist of the screening of the ideas according to different aspects of feasibility, such as economic, technical, organizational and strategic feasibility. We expect that the top echelons of the company are involved in the final decision process.

In this context we understand the process of finding an idea as identifying an opportunities in a given space of opportunities. This space is company specific. It is more important to identify new things for the very company, than to be 'really' creative. Even though that rare and risky type of innovation gets a lot of attention, we

suspect that the more mundane process of systematically searching for opportunities will also result in great competitive improvement for a specific company [7]. We therefore concentrate on idea identification as a search process, which can be systematized and where the process of formulating ideas can by triggered by appropriate questions.

3. Supporting the identification process

DSS can be described as computer-based interactive information systems which use the components data base management system, model base management system and interface to interact with a user[8]. ES are viewed as computer programs which have access to a knowledge base containing an expert's knowledge and data about domain and have access to reasoning mechanisms [5]. ES typically contain explanation mechanisms about the inferences drawn. Even though there is no consensus, on what ES are nor on what constitutes DSS [8], some common and different characteristics have recently been identified [20]. Three differences are important for our purposes:

1. The objectives and behavioral characteristics are different. While an DSS will assist the human decisions maker, ES often take an advising role and make recommendations. Also the active-passive roles are reversed. In a DSS the human queries the machine, with a ES the machine queries the human according to its rules. This means that to use a DSS the user needs to navigate through the methods.

2. Both data manipulation method and contents of the database are different. The prevalent manipulation in DSS is numerical, while the prevalent manipulation in ES is symbolic. The database, or in case of ES knowledge base, contain different types of information. The DSS database contains factual knowledge, whereas the ES knowledge base contains factual and procedural knowledge

3. The ES approach offers limited reasoning ability and only the ES approach offers full explanation capability

We believe it is important to make the differentiation between the concepts behind an

ES or a DSS approach as described and the use of ES techniques for implementation. ES techniques and languages can be used to build DSS tools. Through the ability to represent the knowledge they enforce a consistent and operational description of underlying models. They allow to specifically address and maintainability issues. Also, they allow to combine numeric reasoning (results of analysis) with symbolic reasoning of the representation, logical reasoning of rules and heuristic reasoning to reduce the search space. The user of a system can obtain explanations. Uncertainty and contradictory evidence can be handled with the inference system. Incomplete knowledge could be represented and processed.

We will determine if the three components of the overall identification process are more DSS or ES bound. The three components involve different requirements on the creativity, involve different groups in the company such as business planners, IS planners, IS management and other general management as well as top management. Also different levels and types of knowledge and expertise are involved.

The analysis component of the process seems to be a typical domain for a DSS. A business analyst, well versed will use existing frameworks and data to determine conclusions. As with the analysis stage it is not the purpose to come up with new ways to analyze. Very intelligent DSS might incorporate an ES approach for the selection of the different methods of analysis. In the identification stage the user does not know what to expect. The system cannot - without obtaining expertise - be asked to perform an analysis and then print ideas for CIS. Thereby the user cannot take the lead in this process. We will have to identify a way for the system to take this lead within its given limits. The evaluation component looks like another typical DSS. The user might

choose from different ways to screen and evaluate CIS ideas.

The steps of analysis and evaluation are typical DSS realms; the step of identification is less prone. However, to implement this step as an expert system, which delivers ideas for CIS, seems to be unobtainable. We do not yet know how to encode or even find all the knowledge, humans use to come up with new concrete ideas by looking at a general framework. We therefore present questions to a user as stimuli. The application proposals are the expected responses. Some evidence for the assumption 'questions trigger ideas' was reported in Krcmar [11]. A part of the Information Management System was built to help analyze the possible impact of IST on competitive forces. During its use, a large number of remarks, on what could be done to influence these forces, was typically generated by the participants in trying to answer the questions. Similar results are reported in [19]. We thus model the process of idea identification with two distinct phases : (1) The generation of a stimulus (question), (2) The formulation of an idea (related to that stimulus).

With a symbiotic approach [24] the system contributes its ability to ensure consistency and handle the complex interactions, while the users contribute their judgment and innovative ideas. These questions can be generated systematically and cover a set of issues completely, thus enhancing the users capability to provide concrete application proposals. The issue then is to capture these responses. This leads to a symbiotic relation between a system providing stimuli in the form of questions and the user providing the ideas. As the first phase will be performed by a machine system and the later by the user, we will concentrate on what questions to generate as stimuli. For that purpose we describe a model for question generation.

The reason to look at ideas for CIS could be stated as follows: "Information technology impacts the firm. The firm needs ideas to take advantage of these impacts". Based on this description three variables can be deducted. These are *firm*, *information systems technology* and *impact*. We model the IST involved and the possible impact types as two separate variables. This allows us to employ different conceptual views of impact types and the differentiation of IST. We assume that a firm will have one or more representations to model its reality. It is possible to look at the firm as having generic strategies or as being characterized as a collection of value generating activities.

Ideas to take advantage of the impact of IST on the firm are then concerned with a relation, formed by an instantiation of the variables *representation, impact-type, information-systems-technology*. One can systematically ask questions about *possible* relations to trigger ideas. The assumption is, that for every relation an idea might exist. We call this a simple model for question generation.

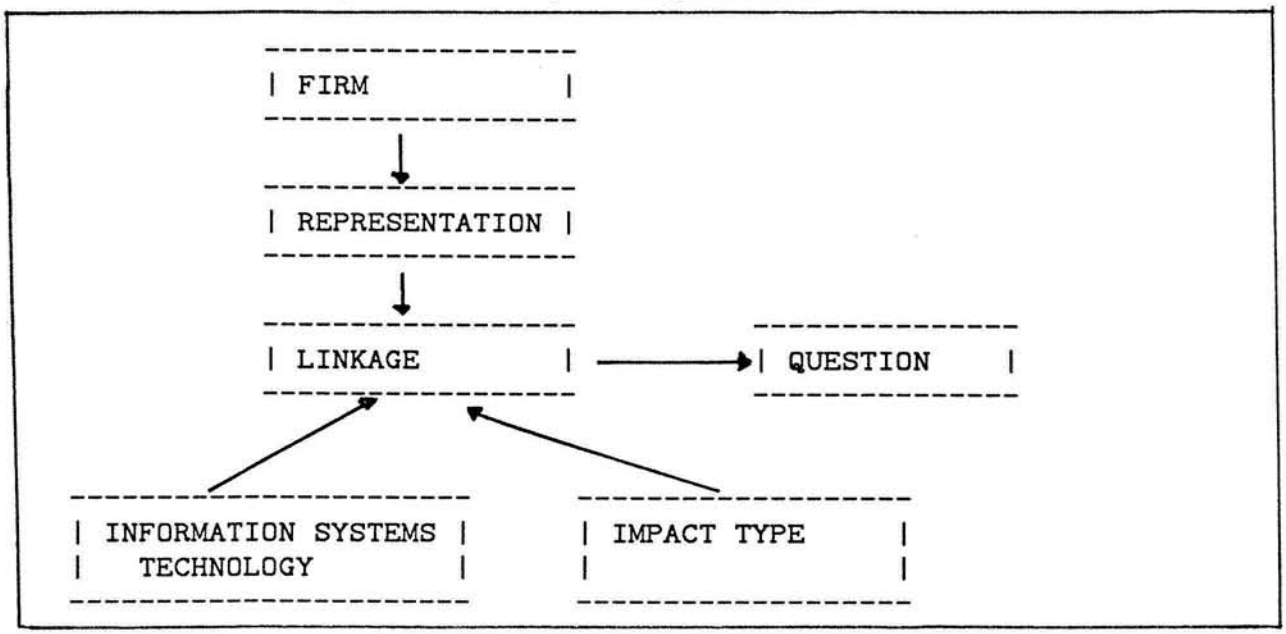

Figure 2: Simple model for question generation

To use this simple model combinatorially leads to a large number of possible questions. We assume, that information about the strength of the prevailing competitive forces, the chosen strategy and the importance of internal activities will help to reduce the number of questions raised. In Figure 3 these additional analysis modules generated have been included.

Figure 3 also indicates the three main phases of the system. They are

1. analysis phase
2. idea identification phase
3. idea evaluation phase

In the analyzes phase business planners will fill the system with the required company specific knowledge. First a combination of conceptual models has to be chosen. Then the different analyses have to be performed.

The idea stimulation phase provides a question session about CIS opportunities. Possibilities to facilitate the idea formulation process besides the asking of questions are familiarization with concepts and showing of possible examples to trigger the phantasy. This could be provided though embedded explanation facilities of the support system. The responses to the questions will be captured.

To capture an idea, the user will type in the text describing the idea. The user will also be asked if the proposal links to any already existing information system, which specific internal and external organizational units will be involved, and a judgment of the expected perceived degree of impact. More than one idea can be entered to any question posed.

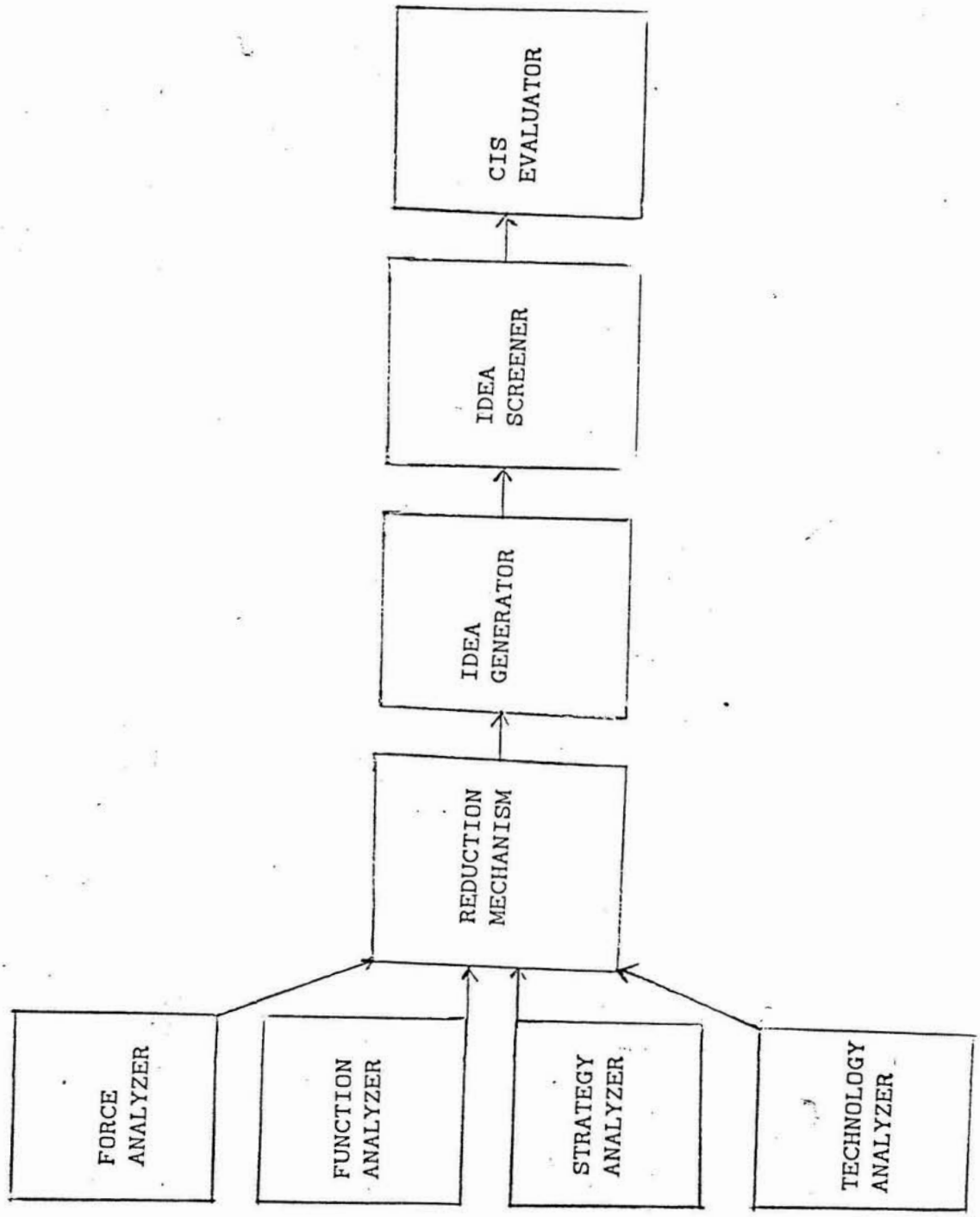

Figure 3: Modules of the implemented system

4. The implemented System

The system is currently implemented in PROLOG, on the DEC-20 system at NYU. The structure consists of three separate modules: (1) the environment analyzer determines the most important aspects to focus the questions upon, (2) the idea generator module triggers ideas for CIS, (3) and the evaluator module assists in evaluating the ideas generated and classifying them into categories.

Each module consists of an *interviewer*, which asks the questions and receives users responses and a *reasoner* which uses rules to evaluate the data entered by the user. Each datum, as it is received from the user is passed to the reasoner essentially using a data-driven approach. The reasoner helps in reducing the number of questions asked and the focusing the ideas generated which match the requirements of the organization. However, the user at every stage is given the opportunity to override the system responses. This agrees with the main line of argument as we want to provide a discussion and decision support environment.

4.1. Analyzer Module

In order to generate focused ideas for CIS, we first perform an analyses of the firm, the environment it currently faces, and the expected future direction. This is typically to be performed by business planners and technology planners, who have a prior understanding of the model used for idea generation. Questions are asked by the system and user responses are in the range of 1 to 10. Questions are asked about: market analysis, function where to implement the MIS, the generic strategy and the technology.

The first set of questions pertains to the market analysis. In the current implementation we have used Porter's [16] model of economic analysis. This model identifies five major competitive forces: threat of new entrants, intensity of rivalry among existing competitors, pressure from substitutes, bargaining power of buyers and bargaining power of suppliers. However, by changing the database of questions we can support other models of representation. To assess the impact of each force on average five questions are asked for each force. A sample of question format is shown in the figure (4). The users responses are passed to the reasoner. The inference rules determines whether on balance IS has the potential of to be critical to the firm's future or whether it is useful but NOT at the core of what has to be done. Only forces, which have some impact, are selected; the best case being one and the worst case being all five of them.

```
Focus of the Question: Strategic Impact of Competitive Forces.
-------------------------------------------------------------

Force: New Entrants

Question: Would new entrants need to enter our market on a large
          scale to achieve parity in production costs?

Response: Your response should be a number between 1 and 10.
          1 for Certainly No, 10 for Certainly Yes, 5 for Medium.

          -> 10.
```

Figure 4: Question format for competitive forces analysis

The second set of questions determines the function in the organization where CIS has

the maximum potential. implementation. Here again we have taken Porter's [17] value chain activities : firm infrastructure, human resource management, technology development, procurement, inbound logistics, operations, outbound logistics, marketing and sales, and service. Questions are directed with examples of the possible implementation in each area and users responses are sent to the reasoner. The reasoner evaluates the most probable functions and selects them.

The third set of questions is aimed at determining the generic strategy that the firm wants to pursue in future. For this module we have used the strategic thrusts [22]: differentiation, cost, innovation, growth and alliance. The business planner indicates the generic strategy. No reasoning mechanism for this part is implemented as of to-day. We are in the process of defining rules that describe the process.

Finally, we question about the technological support the IS organization is most likely to provide. The reasoner uses these responses to categories into three technologies as classified in [3]: the storage, communications and processing. The responses of the reasoner's overall selection are presented to the user to which he is given the option of adding and deleting the selections. the selected components of each areas are used for idea generation.

4.2. Idea Generator Module

The idea generation consists of the *generator*, which poses questions about CIS ideas and captures them, and the *screener* which eliminates duplicates and overlapping ideas. As application ideas can come from personnel at different level of management, this module is presented to junior and senior level management personnel,both in IS and the

functional areas. The users enters the application idea and the target group the system is aimed at. The target groups are: supplier, customer and competitor. A typical question and user response is indicated in figure 5. The responses of users are stored in the database.

```
Indicate your Idea for an Information System.
---------------------------------------------

For the situation described below:

   The Competitive Force to Combat is: New Entrants,
   The IS is to be developed for Function: Inbound_Logistics,
   When the Generic Strategy is: Differentiation,
   The Technology used being: Communications.

Response: You have the following options
            1. To see an existing example (Type example)
            2. To see ideas expressed by others,if they exist
               (Type others)
            3. To indicate your idea (Type idea)

          |: idea.

          |: Place terminals at the users site.

      The idea you have mentioned before is targeted at:

            1. Customers
            2. Suppliers
            3. Competitors

      Indicate the number (1 2 or 3):

           |: 2.
```

Figure 5: Interactive process of questioning and user response

The screening module, collects the responses to the same combination of factors from the users and places them together. A senior DP person is then presented with all the

ideas for a combination. This user then eliminates duplicates and combines overlapping ones. Ideas which are unambiguous are retained. Ideas which are not clear are presently not considered further.

4.3. Evaluator Module

The purpose of this module is to rank the CIS ideas generated. It is based on the evaluation criteria: degree of competitive advantage, support of strengths and weaknesses , feasibility and the risk of undertaking the project. A typical question and the user response is indicated in figure 6.

```
    Focus: Evaluation of ideas generated
    ------------------------------------

In order to combat the Force: new_entrants,
The following CIS idea had been expressed:

Place terminals at the users site.

This CIS is to be developed for the function: inbound_logistics,
Using Technology: communications,

Evaluate on the following Criterion:

Question: Indicate the degree of Competitive Advantage you
          expect to get

Response: Your response should be a number between 1 and 10
          Rest in between the extreme values.

        |: 8.

Question: Indicate the Technical Feasibility of this idea

Response: Your response should be a number between 1 and 10
          10 for very easy to implement, 1 for non feasibility
          Rest in between the extreme values.

        |: 6.

 Question: Indicate the Resource Availability for this idea

 Response: Your response should be a number between 1 and 10
           10 for availability, 1 for non availability.
           Rest in between the extreme values.

        |: 10.


 Question: Indicate the Risk of Undertaking the Project

 Response: Number between 1 and 10
           1 for very risky, 10 for no risk.
           Rest in between the two extremes

        |: 8.
```

Figure 6: Interactive process for idea evaluation.

The user responses are passed to the reasoner which classifies them into three categories: high , medium or no potential. The ones which have been rated poorly are deleted. Finally, the high potential ideas along with the various criteria and the data are put together in a report format which could be presented to senior management for selection.

4.4. Additional Modules

Support is provided to add/delete ideas from the system. The system also contains the capability to modify or choose the representation element, embed different models and change computations of the reasoning mechanism. One feature is that we provide examples for ideas which we know of. This helps the user in identifying the concrete ideas. However, not all the combinations are full. We are in the process of getting examples to complete the database. It is possible to screen other persons ideas. This helps avoiding duplicates and allows to grow ideas.

4.5. Discussion

The modules contain different types of knowledge. These are general knowledge, industry specific knowledge and company specific knowledge. The general knowledge is about the process of systematic questioning, the knowledge of process steps and typical model bank of a DSS in analysis module. The industry specific knowledge are certain assumptions about what are important usages of IST in that industry. The company specific knowledge data in the different analysis results and in the stored ideas.

The reduction mechanism mentioned above helps to focus on important questions so that less than the maximum number of questions will be asked. Several ways to find

"promising" questions can be offered:

1. Ask only for these combinations of variables, when all elements are above a threshold. These thresholds could be separationalistic or combinatoric and on a industry or company level.

2. Ask more questions where successful applications are known. The system might ask, if an example might be imitated.

3. Ask only, if the critical assumptions in a linkage hold The assumptions expressed in a linkage have to be tested if they hold for the specific business unit. The assumptions in the example are "Business unit wants to improve inbound-logistics" and "communication is necessary to improve inbound-logistics ". Thereby assumptions might be surfaced and evaluated [8].

4. Ask, if not enough ideas have been obtained Should the reduction of questions lead to an insufficient number of stimulated ideas, both the reduction rules could be changed. Earlier analysis could also be repeated.

The approach is different from a Delphi approach [6] as it tries to expand the perceived space of opportunities. It thus does not try to produce one coherent view or list of ideas with which all participants agree. This approach is also different from other analysis oriented systems like Situation Analyst [14] and ANSPLAN [2]. Its main premise is not analysis, but rather the triggering of new ideas through questioning. It follows Ackoff's [1] concepts of interactive planning and planning as a continuous process.

The proposed system is advantageous for several reasons. It integrates knowledge from different participants allowing for fruitful combination fostering innovative ideas. It proceeds systematically to uncover concrete possibilities of CIS for a specific company. It thereby collects ideas from different members of the organization. It allows to enhance one idea step by step.

5. Conclusion

We have presented a system to support an important process. The system allows for the creation and collection of ideas about the competitive usage of IST in an organization by active involvement. Stimuli are provided systematically asking questions. The system combines a systematic and symbiotic approach to opportunity identification. It tries to support the ill-structured yet relevant process of idea generation for CIS.

The system can be used for different purposes. The system helps to identify application ideas with greater consistency. In this function, it also works as a tailored checklist. It thus ensures that each individual responds to all relevant questions. By storing the results of previous analysis it can help novices gain insight into the business and its decision process. As the overall framework allows to use different concepts of representation it helps to improve the experts insight by providing alternatives.

Enhancements of the approach are possible in a number of ways. It might lead towards computer conferencing systems or even to a group negotiation support system to help arrive at a consensus about the evaluation of ideas. From an overall perspective, the question capture, even though not at the core of the system might be as important than the ability of the system to stimulate these ideas.

We will evaluate the system along two lines: using the support system, are more ideas uncovered on an individual or group level for a specific firm? and does the system influence the user in satisfaction with the process? From these evaluations we will conclude guidance for the further development of the system.

In itself the approach does not bring out completely new or "break-through" CIS applications. To transcend existing frameworks rests completely on the individual user and for the foreseeable future will not be included into the support environment.

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