MAIN ARTICLES

IMPROVING THE STRATEGIC INVESTMENT DECISIONS: THE ESSENCE OF ACTIVE DECISION SUPPORT SYSTEM

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Abstract

Strategic investment decisions are both important and difficult as they concern very serious issues requiring a lot of investment in terms of finance and manpower which is considered as important and critical in any serious organisation. These strategic investment decisions are more easily understood and controlled than most of the other activities undertaken within the framework of strategic management. Traditional approaches to strategic investment appraisal have been criticised on a number of grounds among which are their narrow organisational perspective, exclusion of non-financial benefits, overemphasis on short-term, faulty assumptions about the status quo alternative, inconsistent treatment of inflation and promotion of non-value adding behaviour. Yet in spite of these apparent flaws with traditional investment appraisal techniques, businesses continue to rely upon them; as a consequence, there is a possibility not only for misguided investment decisions but also the possibility of a perversion of senior manager's business imperative: instead of investing in the company's long-term core business, senior managers become side-tracked and start investing for short-term cash flows. In the light of these criticisms, two basic approaches that can be taken to develop alternative investment appraisal techniques were proposed; with the first approach involving the modification of the traditional investment analysis framework to correct its various technical shortcomings such as inflation inconsistencies, the use of inappropriately high discount factors and its narrow focus expanded to include commonly neglected benefits such as improvements in flexibility, improvements in information quality, timeliness etc. while the second approach involves reliance on analytical framework that represent significant departures from the traditional methods; such as strategic cost management, the multi-attribute decision model, value analysis, the analytical hierarchy method, uncertainty method etc.

Beyond these available alternatives, this paper concludes that since Hyperknowledge, an active support systems have been used as problem solving and decision support environments for strategic management and for strategic decision making in a number of industries in recent years; it appears that the logic of a strategic investment decision is complex enough for a decision maker to benefit from the use of a hyperknowledge environment, and that a hyperknowledge support system could help a management team to control the problems with deciding, launching and following up on strategic investment projects.

1. Introduction

Strategic investment decision making involves the process of identifying, evaluating and selecting among projects that are likely to have a significant impact on the organisation's competitive advantage. More specifically, the decision will influence: what the organisation does —set of products and service attributes that define its offerings; where the organisation does it—the structural characteristics that determine the scope and geographical dispersion of its operations; and how the organisation does it the set of operating process and work practices it uses. The strategic investment decision making process is arguably one of senior management's greatest challenges where there is a critical need to get these decisions right. That is to say if the decision proves successful, the organisation reaps major strategic and operational advantages; but should the decision be wrong, either an important opportunity is forever lost by virtue of the organisation's failure to invest when hindsight it should have, or it has needlessly squandered substantial resources by virtue of making fruitless investment.

This research study found in Carlsson and Walden (1995) that recent development in knowledge based systems technology offer an effective approach to building management support systems for strategic management. The scope of strategic management is broad and the issues involved are ambitious, ambiguous and non-routine. The executives and managers involved should have the ability to break away from the cognitive constraints of their everyday activities and capability to understand the context in which the company is operating. Also, their future strategic context should be outlined and understood, which requires a capability to conceptualize key strategic issues, their corresponding action programs and their expected consequences.

2. Overview of Strategic Investment Decisions and Knowledge-base Systems

In strategic management, it is often necessary to make difficult and important decisions on the basis of imprecise information and incomplete knowledge. In order to cope with the complexities involved the managers need to reduce a context of almost infinite proportions to a manageable personal conceptual framework. Knowledge-based systems have the potential to be very useful in this respect; they can be used to support the building and enhancement of competitive advantages and to help solve complex strategic problems [Mocker (1993)]. There exist several supporting evidence of this in a number of projects from 1993-1998 in which Carlsson et al (1999) have implemented knowledge-based support systems in the forest products, the insurance, the telecommunications, the alcoholic beverage, and the forest machinery industries [see Carlsson & Walden (1997), Walden et al (1996), Walden & Carlsson (1995)].

In the light of this evidence, it will be assumed that there is a reasonable basis for assuming that knowledge based support systems will be useful tools for handling strategic management problems. Butler et al (1993) have studied strategic investment decisions in a wide range of UK and International Companies. Their perspective was one of organizational decision-making theory, which is why they found a number of factors relating to judgment, negotiation and inspiration to be of importance that is more or less qualitative factors. In structured interviews with their senior managers the most important attributes for judging the relevance and potential effectiveness of investments were, nevertheless, quite traditional and in the following order: (i) fit with corporate plan, (ii) (expected) internal rate of return, (iii) Payback Period, (iv) worst case scenarios for internal rate of return and (v) best case scenarios for internal rate of return. Their study focused on important investments, which probably did not have quite the magnitude considered in this case, but the attributes they found are still relevant. The assessment of the relative merits of investment proposals is typically a decision problem built around multiple criteria [Carlsson (1994)]. When you look at the attributes Butler et al identified from this perspective, you can find conflicts between (ii) and (iii), as well as between (iv) and (v); there would probably be a positive mutual support between (i) and (ii), or (i) and (iii), as a corporate plan would

emphasize either a high Internal Rate of Return (IRR), or a short Payback Period. Thus, a possible support system could in this case simply be an implementation of some useful multiple criteria decision making models.

2.1 The Dynamics of Strategic Investment Decision-Making and the Active Support Systems

As strategic investment decision making have all the elements of a classic cost benefit analysis, one expects the process to be supported by a large and thoughtful body of literature. Surprisingly, this is not the case. Shank (1996) points out the four steps involved in making strategic investment decisions as: identifying spending proposals, quantitative analysis of the incremental cash flows, and the assessment of qualitative issues that cannot be fitted into the cash flow analysis and making a yes or no decision. These are poorly covered in the textbooks and receive only marginally better coverage in the journals. Perhaps the poor coverage devoted to the process of strategic investment decisions is part of the reasons why managers are frequently accused of making investment decisions that lack strategic sequence and cohesion. For example, Hayes & Abernathy (1980) and Hays & Garvin (1982) had long ago pointed at and chastised companies for increasingly relying upon quantitative analytical techniques that provide maximal attention to cash flows and minimal recognition to the strategic implications that such decisions can produce. Even today, criticism about managers' strategic investment practices continued to be voiced. Often, Anglo-American managers are the target of this criticism; as Carr & Tomkins (1996) recounted how one German Chief Executive described American managers as mere financial engineers, who had lost any feel or intuition for the products they sell and markets they serve. They also described how a Japanese Senior Manager criticised Anglo-American managers for failing to integrate technology appraisal with strategic formulation and control. From this research study, it is my conviction that, technology is too important to be excluded from corporate strategy which encompassed strategic decisions in the organisations.

In the absence of technological support for the strategic investment decision making, one of the early ideals of the decision support systems was to find a way for human decision makers, and computer-based support systems, to tackle complex problems in interaction, in such a way that the resulting synergy produces new insight. There is not much material in the literature to suggest that this has happened; even if they exist, you could be satisfied with only a few cases. One of the reasons is that senior managers are normally not active users of decision support systems. Instead, the decision support systems are used by those who are hired to get answers for the decision makers. These are, in most cases, junior analysts and staff who do not have the requisite knowledge, experience and overview to fully utilize the potential of decision support systems, making the ideal use of the decision support system become non-standard. When designing a decision support system, it is not always remembered that it is counter productive to give executives tools to carry out tasks they normally do not perform at all. Unless there is a task, which involves the use of a decision support system, they cannot take the time out of their normal overloaded schedule to design any, but will rely on consultants to design the decision support systems for them and charge the organisation several dollars while most of them have the capability to design it themselves. The fact that Strategic Investment Decisions are definitely among the tasks of senior managers can never be over emphasised. This is because senior managers have planned and budgeted time for working on them.

Therefore a decision support system can be helpful if it can be shown to have a few important, supportive properties such that, it could be useful for: (i) getting a quick overview and intuitive understanding of the domain - to provide explanations of key factors and their relationships; (ii) helping with a comprehensive problem formulation - to determine assumptions and to simplify reality; (iii) relating a problem to relevant and effective problem solving methods - to assist with proper problem solver interaction, to advise on proper procedures; and (iv) interpreting and explaining results. These properties are quite easy to describe and a bit harder to build and implement for actual use in practice making senior managers reluctant to design them on their own without hiring consultants to do it [Mili (1990)].

There are a few more interesting approaches to the active decision support system. Manheim (1989) states that an active decision support system should "take the initiative without getting specific orders" and should "respond to non-standard requests and commands"; but Angehrn (1992) argued that an active decision support system could be a conversational, agent-based approach to decision support system in order to "enhance creativity in collaborative human-computer problem solving". Clearly, these approaches show features that are necessary to be co opted into a support system for senior managers. The approach used in this research study has been an alternative support system built around hyperknowledge, which is a cognitive metaphor introduced by Chang et al (1993).

2.2 Alternative Approach to Hyperknowledge Support Systems

Recently, when charged to advise the board of directors as a finance manager of Akuaba Ltd, a Ghanaian wood products company, an alternative support system was developed for the company (woodstrat system) in 2006, but before then hyperknowledge support systems have also been developed and implemented in the telecommunications, the insurance, the forest machinery and the alcoholic beverage industries. The approach used in this study has been fairly straight forward, as is demonstrated in figure 2.2.1 below.
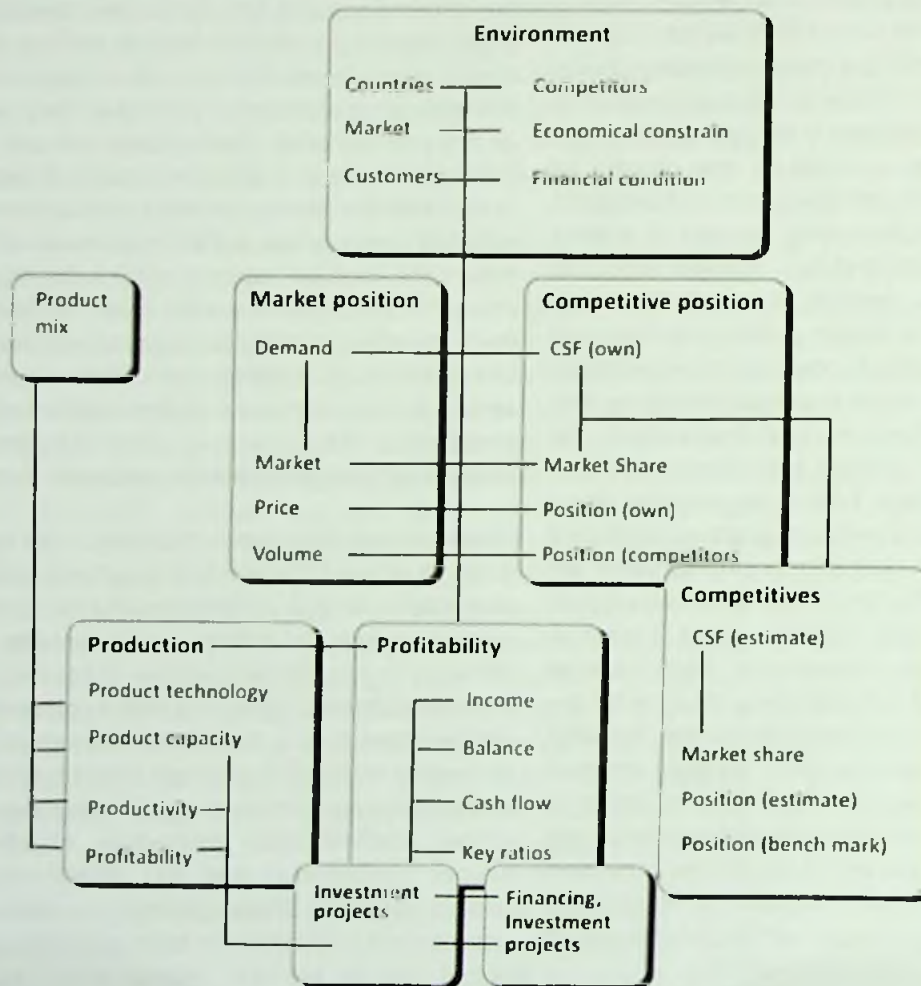

Fig. 2.2.1 Alternative Hyperknowledge Support Environment

Considering the hyperknowledge support environment in fig. 2.2.1, a systems user can start with any module of the system and work his way through it by going from module to module. In this system, one can start with the market position: (i) the demand is a function of (ii) market, (iii) price and (iv) volume, which will decide the coming demand; or (v) Critical Success Factors (CSF) will influence the demand (there is an interaction between the two modules here) and also decide (iv) market share, (vii) our competitive position and (viii) the competitive position of our competitors. A similar network of interactions is played out over all the modules, which allows you to work out interactions among the concepts in the interface.

There are various modules covering key aspects of strategic management, which have been implemented with Visual Basic 5.0 and Java in a Windows NT 4.0 environment. The user interface is designed as a user-friendly platform for senior managers, which is supported with a data warehouse built in Oracle 8.0 and with continuous assessment of the macroeconomic environment, key industrial changes and developments, competitors and their activities and significant changes in key market characteristics. The use of external data sources is supported with software agents.

The hyperknowledge support environment figure 2.2.1 has most of the characteristics described in Chang et al (1993). There are still some unresolved problems both with developing support systems for strategic management and with the conceptual richness of hyperknowledge. This study focused on ways to develop the hyperknowledge environment to combine quantitative with qualitative assessments in the analysing models; and extend it to combine empirical hard facts with knowledge-based estimates and proposals in such a way that one can find a synthesis and new knowledge in an attempt to resolve strategic management problems. In dealing with such complexities one is able to combine interactive and (more or less) intuitive problem solving methods, building on learning processes, with numerical optimization methods, which would help senior managers to tackle complex problems in which part of the complexity is due to

imprecise and incomplete information and knowledge [Carlsson (1997)]. This required additional work to be done, and was fortunately executed in other research programs, whose elements have been discussed in part four (4) of this research paper.

1. Case Study: Shore Resource Group (SRG) Industries (Gh) Ltd

The SRG Industries (Gh) Ltd is a major Free zone company operating in Ghana's free zone enclave at Tema, manufacturing and marketing a wide range of high-quality poly products, exporting 70% to other West African Sub-regional Market; while selling 30% locally in line with the free zone requirement. The turnover for 2007 was Gh¢29.182 million. Exports to Economic Community of West African States (ECOWAS) market and sales by regional subsidiaries represented 76% of the turnover. SRG's basic strategy is to expand and strengthen its market positions in carefully selected core businesses, which are producing Plastic chairs, plastic bowls/cups and polythene bags. In the Annual Report for 2007 Chief Executive, Ali Jabir quite clearly outlined SRG's strategy in six points: (i) Focus on key business, (ii) Strengthen market positions, (iii) Improve competitiveness and efficiency, (iv) Focus on customer service locally and globally, (v) Improving the financial position of the company. SRG is continuously assessing its prospects for expansion and is committed to a strict and constantly enhanced environmental policy. This is a proven way to secure long term competitive ability in the plastic industry. The SRG's profit after financial items was Gha¢1.008 million in 2007; the number of employees was approximately 600, of whom more than 14% worked as expartries.

3.1 A Multi-purpose Poly Mill

One of the SRG's key development projects has been the construction of the new Multi-purpose poly mill at their new site around Tema harbour. The project started in the beginning of 2007 and the new poly machine went into production in August 2008; the new mill is one of the largest in Ghana with a capacity of 150 000 t/a, and a total investment cost of Gh¢137

million. The company's sales network will be handling almost 2 million t/a of polythene bags of different sizes and 2 million plastic chairs & bowls/cups after the new mill has been added. This is one of the significant development projects ever in the history of the SRG and will dominate its operations because the poly mill is the most economical and productive among the poly mills today. Extensive market research, carried out by both the company's own market research department, as well as by external consultants, showed that there were market opportunities for two different plastic qualities: (i) Light Weight Coated (LWC) and Medium Weight Coated (MWC) plastic qualities, with mechanical pulp included, and (ii) Wide Field Channel (WFC) plastic qualities.

A closer look at potential market segments, which appeared to offer a sustainable growth at good product prices, revealed that there was a particular demand for thin (50-95 g /m^2) polythene with good capacity characteristics. There was not much production capacity on offer for this particular polythene quality, even on a global scale, as it obviously is rather difficult to produce a thin polythene with good capacity characteristics. The SRG's research and development department had over the years experimented with a process in which mechanical fibres of cop polymer combined with the-based soft- propylene fibres was a key ingredient, and this process was proved to answer the technical requirements. Two other key factors were advanced coating know-how, which had been developed in cooperation with Valmet, the producer of plastic and poly trimming machines, and the pigmentation process.

The thin polythene was positioned for the Heat-Set Polypropylene Offset (HSPO) segment (heat-set offset polypropylene for producing from reels) in which it offers its users about 20% more galvanising surface per ton than competing poly products in the market. In strategic management terms, the new product had a significant impact in the user's value chains offering savings in the purchase, the storing and the transportation of polymer. The competitors did not have any clearly matching products and will face a 3-5 year catching up struggle if they decide to enter the competition, and as the markets for electronic polythene - the HSPO are taking off, SRG is well positioned with its new plastic product.

3.2 Features of the Multipurpose Poly Mill and the Strategic Investment Decision (SID) Making

The new poly machine is 12000 mm wide, with a process speed of 1600 m/min combined with the coating machine's 1800 m/min. It was built by Valmet and is the most productive and cost effective of its kind in the world. The plastic quality can be guaranteed to be consistently high as the production process is constantly monitored with advanced technology, including several fuzzy logic control systems to make sure that the paste-like substance rushing pastal 1800 m/min over a 12000 mm wide area in a 500 m long polythene machine is kept to preset quality standards. This gives SRG an edge in the fierce competition of the plastic markets in the sub region. Getting all the facts available, the multi-purpose-investment project appears to have been a quick and straight forward process in an attempt to: (1) decide that there is a need for restructuring an existing plastic mill, (2) find growing and profitable market segments for an expansion, (3) invent a new plastic quality for these segments, (4) build the poly machine, (5) restructure and expand the poly mill, (6) get everything ready well ahead of schedule, (7) start up the new poly machine, and (8) make significant profits from the new plastic products positioned in the discovered market segments. Taki and Shangarvi, who were SRG Operations and Production Managers respectively were responsible for the project and pointed out that, the planning, problem solving and decision making that went into the project was not at all that simple, well-informed, rational and straight forward. They found that a support system of the kind implemented elsewhere as a prototype will: (i) Organize data and information, which is fragmented on many data sources, and (ii) Harmonize decision making as everybody has the same facts available.

2. Support Systems for Strategic Investment Decisions.

In 2006 I developed and implemented a support system in Akuaba Ltd while Walden et al developed

and implemented in nine strategic business units from 1992 to 1994 at the Metsa-Serla Corporation in Finland. From experiences gained during the development process, it was not unexpected that the same principles used for the Akuaba woodstrat was also useful for the Strategic Investment Decisions support system in SRG multi-purpose poly mill project. The details studied from Walden et al (1999) present a synthesis of the experience gained and helped me formulate this as key principles for the building of a Strategic Investment Decisions support system in Akuaba woodstrat. In that study, it was found that the real world structure of the Strategic Investment Decision process differs somewhat from the principles described in the literature on Strategic Investment Decisions.

4.1 Real World Structure of Strategic Investment Decision Process

The process starts with a mapping of investment alternatives as a brainstorming process in the project team on the basis of the corporate guidelines. As soon as there is a consensus on the first set of alternatives, this set is run through a first evaluation, which should eliminate those alternatives, which will fail on one or more of the corporate guidelines. This is rather quickly followed by a decision, which is then justified with: (i) data from external and internal sources on markets and competition, (ii) systematic studies on productivity and profitability, and (iii) assessments of customer value and product life cycles.
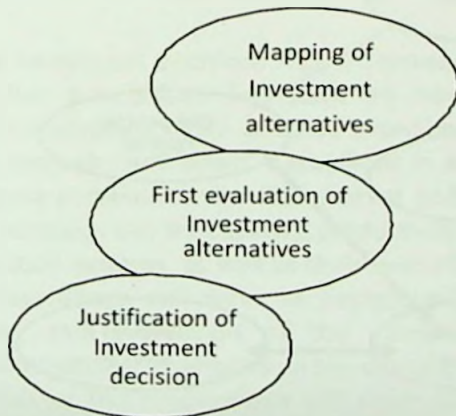
Then it seems justified to propose that a Strategic Investment Decision support system should be built to support this sequence of processes rather than some ideal sequence, which will not be used anyway.

4.2 The first phase of Strategic Investment Decision Process - Mapping of Investment Alternatives

In the first Strategic Investment Decision phase, the guidelines set by the corporate management, market knowledge (tacit or clearly formulated), knowledge about the competition and assessments of the development of production technology are used to build an investor strategy - corporate strategy, which can be either a full-scale document or a few points of the minutes of the first meeting of the Strategic Investment Decision project team. If the Strategic Investment Decision is built on a document, normally there are studies on:

(i) The market position the strategic business unit will have, with and without the Strategic Investment Decisions;

(ii) The competitive position, which will show how strong the strategic business unit will be relative to its competitors, with and without the strategic investment decision, and

(Iii) An assessment of the productivity of the technology used by the strategic business unit with and without the Strategic Investment Decision.

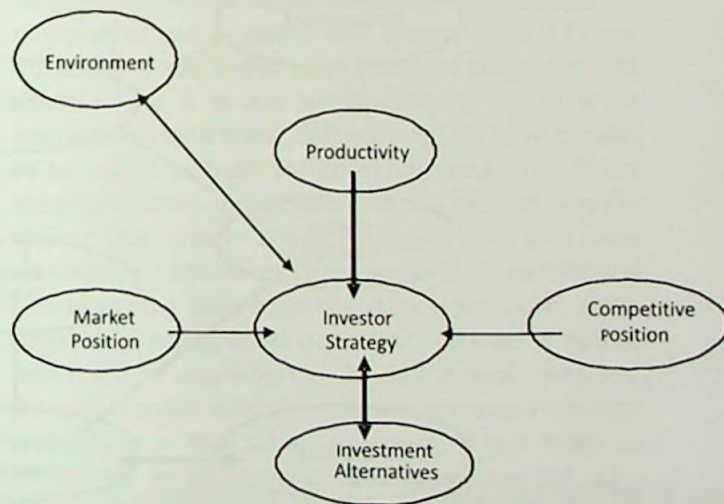Fig. 4.1.1 The Strategic Investment Decisions (SIDs) the real world process

Fig. 4.2.1 The first SID phase - Mapping of investment alternatives.

Several software modules for assessments of market position, competitive position and productivity were implemented in the Woodstrat, and this technology is both useful and motivated for Strategic Investment Decision's of the multi-purpose poly mill investment type. The support system would be used to screen and initially test possible investment alternatives. A more critical factor is to obtain enough facts about the environment and to get good estimates of prevailing trends in product demand and prices. It is important to get material on the relative strengths of competitors and their prevailing strategies in choices of products and markets. Mergers and Acquisitions also need to be followed and to assess what their impacts are on market positions, on logistical alliances, on production technology and on Research and development. There must be a search for good benchmarks on the productivity of the existing production capacity in the market and some facts on the cost effectiveness of the operations.

The cost effectiveness is decided by the cost development of production factors, and one needs to get some factual databases on these, as well as all the odds and ends, which form so-called "weak signals" of changes already starting or about to start, and which can cause significant changes in the markets or among groups of key customers. This material is scattered on many different data sources which are updated at regular or irregular intervals. There are now some feasible technological solutions for handling this type of material, and this will be worked through in part 4.

4.3 The Second phase of Strategic Investment Decision Process - Evaluation of Investment Alternatives

The Strategic Investment Decision process quite quickly focuses on two to three alternatives. Ideally, the evaluation of alternatives should run through many more alternatives but the project teams working on even multi-purpose poly mill investments projects seem always to be pressed for time. As the focus is narrowed, the need for data, information, and knowledge becomes much more concentrated and more precise, and the role of a Strategic Investment Decision support system moves from the support of scanning and screening tasks to the support of mostly numerical evaluation tasks. The investment alternatives, which are being evaluated, have passed the test of fulfilling the investor strategy. But yet still, there may be some need for rating them on how well they fulfil the strategy, which can be done with Analytical Hierarchy Process (AHP) or Virtual Instrument System Architecture (VISA), or some similar tool for combining qualitative and quantitative assessments [Carlsson & Walden (1996)].
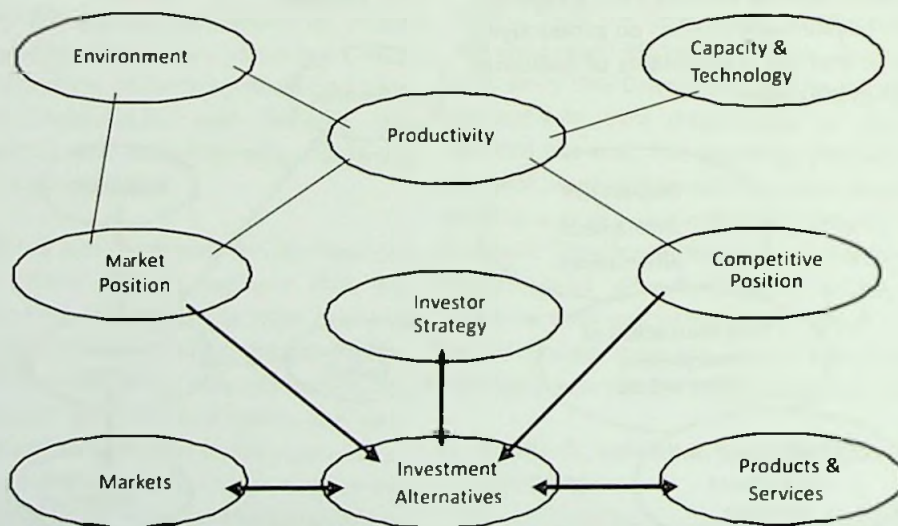

Fig. 4.3.1 The second SID phase - First evaluation of investment alternatives

However, Drucker (1995) argued that a Strategic Investment Decision support system should provide a platform for using this type of tool with the data provided from its modules. The products and services to be produced by the Strategic Investment Decisions need to be evaluated in detail, and be able to trace trends in demand and prices, as well as how well the products and services may succeed in comparison with similar offers by the competition. This requires a fairly detailed database and numerical tools for forecasting and competitive analysis. The Strategic Investment Decision support system should also offer a platform for both, which is not tough in a technological sense, as a normal Windows platform will do. The markets on which the Strategic Investment Decision products and services will be placed should be traced and evaluated. There is the need to get material on what markets there are in which countries, who are the industrial customers you are going to work with and what are their demand and business potential. Senior managers should be able to find and define market segments with specific characteristics, which should be able to identify and pair off with either innovations produced by the strategic investment decision products and services, or with core competencies found with the strategic business units (SBU). Managers should also be able to trace the industrial customer's markets, as the first signals on whether growing or declining demand will come from those markets. There is the need also to get some benchmarks on what prices you can charge and what is the overall cost competitiveness of the customers.

The strategic investment decisions support system needs to offer possibilities for quick ad hoc calculations and graphics, which could be based on getting data through "drill down" capabilities in a data warehouse implementation. The market and competitive positions and the capacity, productivity of the production systems, as well as their level of production technology, will serve as background scenarios for the evaluation of the chosen investment alternatives. Scenarios on the changes and the trends of the environment will serve as drivers of the background scenarios, which will form the basic assumptions for judging the outcomes of a strategic investment decision. There is no doubt that these scenarios are critical for the success of a strategic investment decision. Where these basic assumptions fail, and they mostly do in a negative way, they can turn a profitable and successful investment alternative into a failure. Then there will be four essential requirements on these scenarios: (i)The facts used should be valid and stable (ii)The assessments should be tested for sensitivity (iii)The consequences derived should be tested for precision and validity, and their sensitivity to changes of key factors should be evaluated and tested, and (iv) The methods used for building the scenarios should be quickly adaptable to significant changes.

These types of scenarios have been implemented already in the Akuaba woodstrat support system. In terms of technology they are not hard to build because a good windows platform is sufficient, and most of the functional links needed to link the various scenarios can be done with excel add-on software. It is always useful to have some tools for driving the simulations, and add-on graphics for quick representations of ad hoc scenarios save time. The scenario environments can be tailored to user needs with some support routines in either visual basic 5.0 or java.

Data is a problem for the scenarios, because most of the times you need to draw upon external data sources, many of which have been produced for commercial use at rather stiff prices. Then it is not attractive to stay linked up to them for longer periods of time and it is not worthwhile to try to work interactively with them. Software agents have proved to be useful as tools for collecting data from these external sources, quite often over the internet, and for storing this data in some intelligent way in a data warehouse. Where you have some tools for filtering and retrieving data from the data warehouse, quite often as a background operation, you get a setup, which will be very effective for data driven scenarios. An added bonus with the software agent and the data warehouse is that when designed, it will work as effectively in an intranet and with internal data sources.

4.4 The final phase of Strategic Investment Decision process - Justification of the Investment Decisions.

In real life, a Strategic Investment Decision has to be defended and justified many times to various stakeholder groups. Normally these groups will not appreciate the details and the (often) quite complex reasoning being used in the evaluation of investment alternatives. Thus, you need another type of strategic investment decision support for this phase, scenarios with assumptions on currency fluctuations, interest rates and changes in prices of labour, raw materials, energy, transportations, etc. It is standard practice to allow this proforma income statement to drive changes in equity and the overall capital structure of the strategic business unit, which then can be measured in terms of Return on Capital Employed (ROCE) and similar key ratios. The income statement is also made to run cash flow scenarios and various key ratios on the financial risks with the strategic
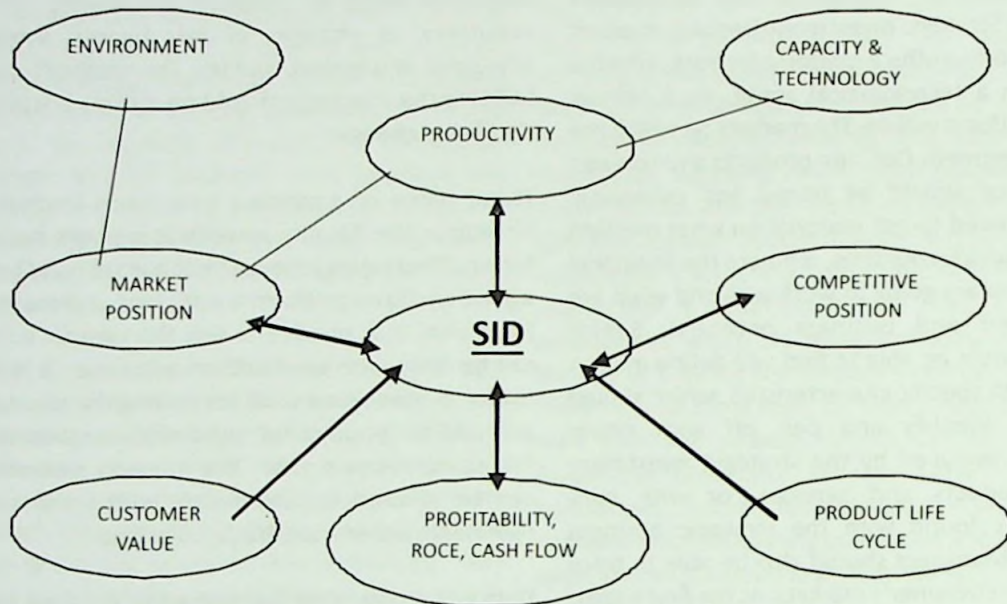

Fig. 4.4.1 The final SID phase - Justification of investment decision.

which should be able to use the same support systems platform as in the previous two phases. The scenario part in this case can be the same as in the previous phase, as you need to be able to show and justify the basic assumptions underlying the strategic investment decision. Possibly, you could build a user support for more animation-like presentations of the scenarios, and need not keep the links to external data sources unless key parameters change as often as you can run the scenarios from the data warehouse.

However, another straightforward part of the setup is the evaluation of estimated profitability of the strategic investment decision over its lifetime. This is a simulated income statement driven by the investment decision. Not surprisingly, all this can be done with excel and the only requirement of the strategic investment decision support systems is that, it provides a good platform for feeding scenario data into the excel application. Then, there would be much use for an effective user interface, which allows the user to quickly switch between scenarios, to print good reports and to produce good graphical representations of the consequences of the chosen scenarios.

Stakeholders may be interested in aspects like customer value and product life cycle assessments of the strategic investment decision, that is to say, they would want to understand how the products and services produced by the strategic investment decision will/may increase the business potential or

the cost effectiveness or the productivity of (industrial) customers. They may also want to be able to find out the possible life cycle changes in demand of the products and services in order to be able to fit these into similar scenarios for supporting or replacing products.

This type of modelling is difficult both in theoretical and technical terms, the causal relations used are not well understood and the data to formulate them is hard to find and use. The strategic investment decision support platform should support the use of advanced modelling tools, which could be used to describe life cycle processes as simulated phase changes on the basis of imprecise and uncertain input, and approximate reasoning to trace the impact of product and service characteristic on (industrial) customer value [see Carlsson (1997) and Carlsson & Walden (1997)].

The next section will illustrate a new technology for a Strategic Investment Decision support system which will allow you to support the type of reasoning that have been described in this study.

1. Hyperknowledge Features

This part illustrates a new technology for a strategic investment decision support system which will allow you to support the type of reasoning described in the real life scenario in part three. The hyperknowledge platform used in woodstrat as discussed was built in visual basic and used access for the supporting database. Later versions of the platform were done in Delphi and used Microsoft Structured Query Language six point five (MS SQL 6.5) as the database, but after a while it became apparent that the support system got in this way is both too complex for senior managers to use, and that the adaptation of the system to changing environments became too cumbersome. These problems were mostly due to the MS SQL. It also turned out that the design was too time consuming to build for fast photocopying. This resulted in the search for alternatives; in which case Java and data warehousing tend to be the available alternatives. However you can have in some applications where Oracle 8.0 was used as both supporting database and as a platform for the data warehouse. In this case the design of the user interface resembles the PointCast platform (PCP), which is a very effective and user-productive interface.

5.1 The Need for a Modified Hyperknowledge Support Systems

There are some modifications introduced as part of a project on fragmentation of working time with four small high-tech companies in Ghana and it was found out that badly designed windows user environments account for a significant portion of the non-productive use of working time traced in these companies. People who try to be highly productive spend many hours per working day with their personal computer applications and reckon that with less than a dozen fairly simple modifications made could save them 15-45 minutes of non-productive time fighting with inflexible applications in attempt to get solutions to their problems. Much of the functionality of this user interface has been made possible with the data warehouse application designed and built for the users; this design is termed as INDY, which is an acronym for an intelligent dynamic data warehouse. Using Oracle 8.0 as a platform, and software agents for data storing and retrieval in this way, it has been possible to include the intelligence already in the links that I have got in the user interface. The overall design of the INDY is shown in figure 5.2.1

5.2 The Intelligent Dynamic Data Warehouse INDY

The data access client of INDY is running a family of software agents, the functionality of which is shown in fig. 8. **Agent 1** is working with selected data sources on the Internet; where there is one version of this agent which accesses and retrieves news items from Reuters Business briefing and stores retrieved data in data base one (DB1). This data is combined with material from other data sources of which scanner data in the form of pictures was almost impossible to store on Oracle 8.0 and is organized and distributed for various applications with the INDY. **Agent 2** is extracting data from internal data sources; **Agent 3** is extracting market data from DB1 and organizes it in a data base two (DB2) for market analysis and reporting; **Agent 4** extracts product data from DB1 and organizes it in data base three (DB3) for further product analysis where DB1 is designed to serve as a database (or a data warehouse) for a decision support system (DSS) application.
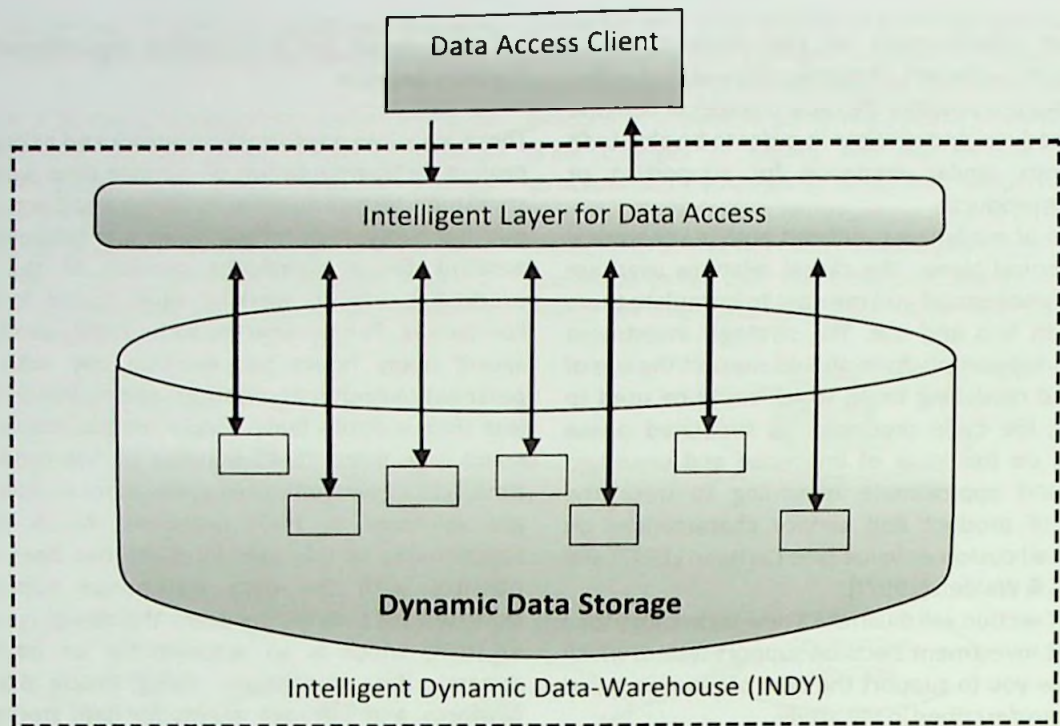
Fig 5.2.1 The INDY data warehouse application source: Turban & Aronson (1998)

The software agents are built to find data according to given search profiles and keywords, they can judge if the material is new or already stored with INDY, and they have some learning properties, so that a user can get relevant material' from data sources he has 'learned to trust' during the process. The software agents have been built in Java and there are already a number of applications in active use and the most promising of these provides a major company in the alcoholic beverage industry with material for industry foresight, that is keeping trace of legislation, structural changes in consumer habits, changes in strategic alliances among its competitors (see figure 5.3.1). These enhancements of the previous hyperknowledge support system built and implemented as the woodstrat system in Akuaba Ltd are aimed at making the system more designed user interface. It is clear that the system will be more effective for the scenario building and evaluation phase than the previous system. It is also much more effective for handling large amounts of data sources and the use of software agents proved of a very effective innovation.

5.3 Importance of Software agents for Data Access, Storage and Retrieval

It is important to note that, modifying a hyperknowledge support system, the modelling environment needs to be enhanced with the new data and user platforms that are made available. A strategic investment decision support system could be strong on forecasting and on a fast analysis of the consequences of a number of alternative numerical scenarios. In recent years there have been some advances in modern financial modelling technology, which allows the use of approximate reasoning on the basis of incomplete and spotty data, and fast, on-line optimization from data in spreadsheet format. The use of Artificial Neural Networks (ANN), Fuzzy Filtering and Fuzzy Logic, Generic Algorithms, Mini-sphere Control for Digital Media (MCDM), Simulation, Animation, etc. are becoming more and more standard for modelling complex phenomena, as the software to enable this modelling is becoming available as windows applications.
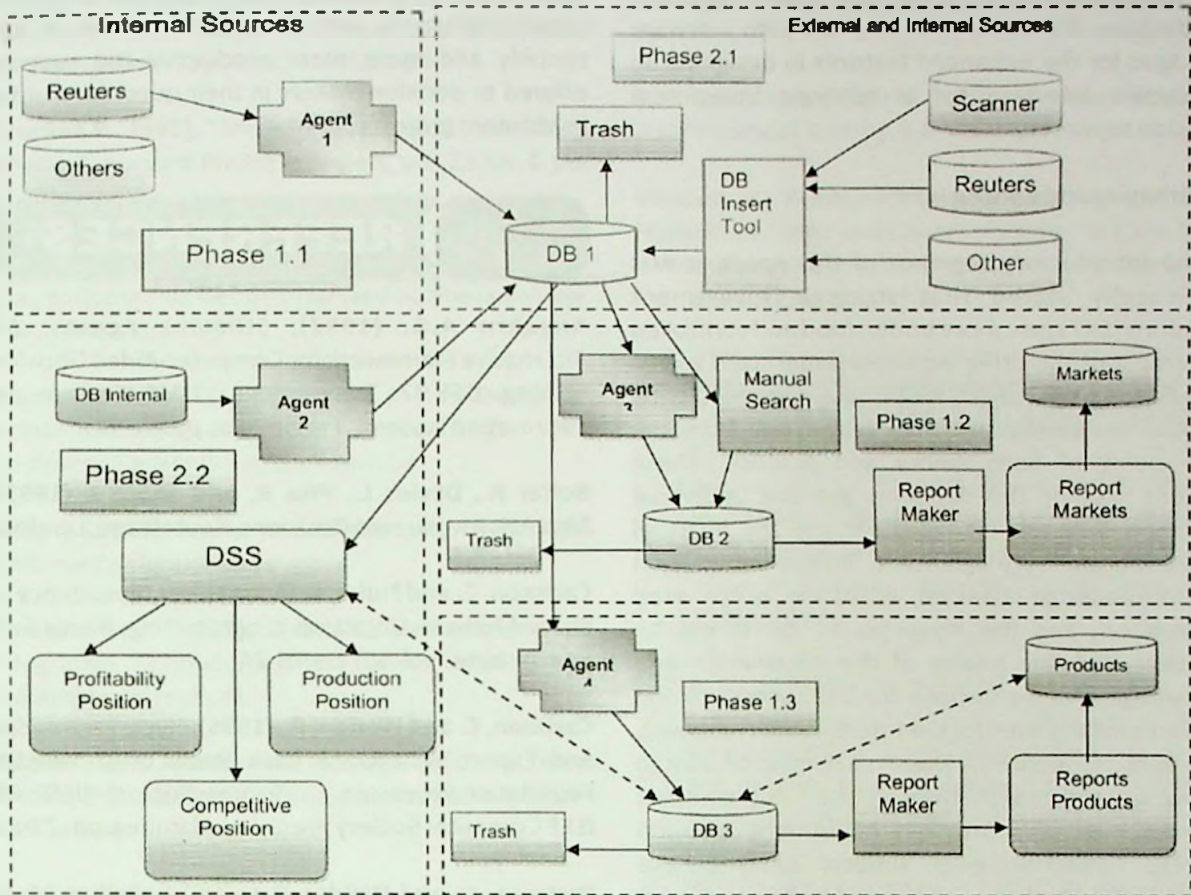
Fig.5.3.1 *Software agents for data access, storage and retrieval*

5.4 The Enhanced Hyperknowledge Platform

It is, important of course to note the problem in which the users should be able to find their way with these tools and that they could make some sense of the results. This requires the enhancements to the hyperknowledge platform developed for SRG Industries(Gh) Ltd and have the following elements as described in figure 5.4.1 below.
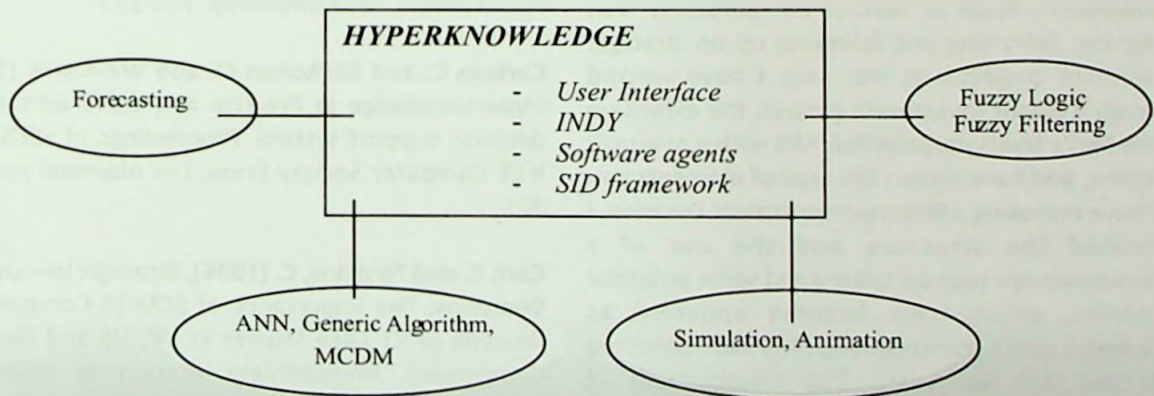

Fig. 5.4.1 Enhanced hyperknowledge platform

The first prototype of this platform is done with Java in Windows NT 4.0, and Oracle 8.0 with software packages for the enhanced features in designing an interactive interface for a strategic investment decision support system.

6. Summary and Conclusions

In the introductory segment of this paper, it was equivocally stated that strategic investment decisions (SID's) are more understood and controlled than most of the other activities undertaken within the framework of strategic management. The reasons are simple and less debateable from the view point of both theory and practice. These reasons are: (i) The decisions get the undivided attention of senior management. (ii) The financial risks undertaken are significant. (iii) The information and knowledge needed is often quite well understood, and the resources to get it will be available. (iv) The quality of the information and knowledge may be decisive for the success of the investment (and even for the future of the company), and as consequence (v) There is a need to be able to follow up and reason through the fairly complex internal logic of a Strategic Investment Decision making. Hyperknowledge support systems have been used as problem solving and decision support environments for strategic management and for strategic decision making in a number of industries in recent years. It appears that the logic of a Strategic Investment Decision is very complex enough for a decision maker to benefit from the use of a hyperknowledge environment because the hyperknowledge support system could help a management team to control the problems with designing, launching and following up on strategic investment projects. In this case I have worked through a Plastic investment project, the extension of the SRG's Multi-purpose Poly Mill with a new poly machine, and have shown the type of elements you can have in making a Strategic Investment Decision. I indicated the structure and the use of a hyperknowledge support system and some potential problems, which have become apparent as experience with hyperknowledge has been collected over the last few years. The development of hyperknowledge, an active support environment is

now in the fifth generation, and this paper exhibited some innovations and enhancements, which will simplify and make more productive the support offered to decision makers in their quest for fruitful investment projects.

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