CHAPTER VIII

SUMMARY
Knowledge based systems (KBS) based upon artificial intelligence (AI) in the form of expert systems (ESs) have been in commercial use for over a decade. The technology has advanced rapidly. However, few companies use ES technology effectively, because the majority are still uncertain of how to apply AI and to what extent it can be useful.¹

As mentioned earlier, these are essentially computer based systems that solve problems generally conceded as being difficult and requiring significant expertise. These systems capture and simulate the behaviour of a human expert in a specialized problem domain and offer intelligent solutions or suggestions based on the expert’s problem solving and inferential methods. Knowledge engineers are the new professionals in this growing field, who build expert systems through three major activities: knowledge acquisition, knowledge representation and knowledge manipulation.

Retail Marketing

Retailing is a significant field of study. Retailing includes all the activities involved in selling goods or services directly to final consumers for their personal, non-business use. Retailing may be studied by using an institutional approach, a functional approach and a strategic approach. The strategic approach needs a greater focus as the underlying principle in this approach is that retail firm needs to plan for and needs to adopt to a complex changing environment.

Situation analysis is the objective evaluation of the opportunities and potential problems facing a retailer. It seeks to determine a retailer's current position and where it should be heading. A company may be interested in one or more of the following objectives: Sales (growth, stability and market share), profit (level, return on investment and efficiency), satisfaction of stakeholders and image (customer and industry perception).

Accurate information is necessary both for developing a new retail strategy and modifying an existing one. And the use of sound marketing research techniques enable a retailer to generate proper information. Marketing research in retailing consists of series of activities: defining the problem to be researched, examining the secondary data, gathering the primary data, analyzing the data, making recommendations and implementing findings. It is not a single act.

An information system can be considered as marketing-oriented in so far as its usage can mirror the marketing activity of the firm and when it can contribute to this very marketing activity too. Information Technology end users are no longer satisfied with information systems which are aimed at relieving them from tedious and repetitive tasks, but they demand that new technologies actually bring added value to their marketing activity and results.

EXPERT SYSTEMS

Managing knowledge is becoming a concern for many firms. Preserving knowledge that otherwise may escape or erode, building knowledge as experience gained and distributing it to the points where it is used are becoming important issues. The only approach to addressing these issues is based on applied Knowledge Based System technology. Knowledge Based Systems (KBS) based upon Artificial Intelligence (
AI in the form of Expert Systems are essentially computer based systems that solve problems generally conceded as being difficult and requiring significant human expertise. Expert System techniques can be used to preserve and disseminate scarce expertise by encoding relevant experience of an expert and making this expertise available as a resource to the less knowledgeable and less experienced person.

HINDUSTAN PETROLEUM CORPORATION LIMITED (HPCL)

Hindustan Petroleum Corporation Ltd. (HPCL) the erstwhile ESSO taken over in 1974 and erstwhile CALTEX taken over in 1976 is now a public sector enterprise engaged in refining and marketing of petroleum products. HPCL is the second largest petroleum company in the country next to IOC. The company meets 20% of the country's petroleum product requirements, operates two fuel refineries at Mumbai and Vishakapatnam with a total capacity of 10 Million Metric Tons Per Annum (MMTPA). Another 3 MMTPA refinery at Mangalore is operating as a joint venture with A.V.Birla group of companies. The Corporation also has the largest lubricating oil refinery at Mumbai with an installed capacity of 3,35,000 TPA constituting over 40% of the country's total capacity. HPCL has a vast marketing and distribution network which has been continuously strengthened over the years.

To catch up with the global trends in management, HPCL appointed Arthur Anderson to carry out the business process re-engineering (BPR) study and based on the recommendations made after the BPR study, HPCL has redesigned its organization structure from pyramid to strategic business units (SBUs) comprising: Retail, Industry and Government sales, Liquefied Petroleum Gas, Lubricants, Aviation and Refinery.
Significance Of The Study:

The management of downstream oil company sales office function offers the industry, a distinct competitive advantage of containing the costs and improving marketing efficiency. Retail sales which account for 63% of the total sales are a major thrust area that offers immense potential for the containment of costs through the effective use of information technology. The management of physical distribution including stocking and distribution involve decisions of critical nature. It is only in recent years that the distribution and wider business philosophy of logistics have come to receive serious attention from both the business and academic worlds. A comprehensive systems thinking rather than a functional tunnel vision is needed for the retail sales management activity.

India’s oil sector is dominated by such government enterprises as Oil and Natural Gas Commission and Oil India Limited in the up-stream (i.e. exploration and production) segment and Indian Oil Corporation, Hindustan Petroleum Corporation Ltd., Bharat Petroleum Corporation Ltd., Indo-Burma Petroleum, Madras Refineries Ltd., Cochin Refineries Ltd. in the downstream (i.e. refining and marketing). The entire oil industry, till now, has been operating under a total regulation through administered pricing mechanism, which is being dismantled. Opening up and deregulation of the industry for the private sector participation pose a challenge to the various aspects of oil industry like quality, price, delivery and service. Consequently, the impact of liberalization would be crucial on the retail sales management function of the public sector undertakings in general and HPCL in particular.

The globalisation process in the oil industry needs the improvement in the productive base of information technology in the oil industry so as to achieve international competitiveness. Against this background, it is viewed that the present
study on “Retail Marketing in HPCL - Expert and Decision Support Systems Approach” assumes immense significance.

The Present Study

A review of the studies on retail marketing revealed that the studies by most of the researchers have centered around pure marketing activity approach rather than an Information Technology (IT) based approach. The issues such as marketing planning, advertising, diversification strategy, pricing forecasting etc., have been the focus of research. The study by Kapoor and Singh was related to marketing planning in Public Sector enterprises. Ramu's study was on diversification strategy and product mix. The study by Shekar and Khandwalla focused on internationalization. Hishhorn and Kaelta attempted to analyze the pricing policies in the Public Enterprises. Tagat's contribution is in the area of analysis of marketing concept and strategy. Murthy has covered the strategic competence of the Public Sector enterprises.

The study by the faculty of the Institute of Public Enterprises, Hyderabad also concentrated on market structure of the public sector enterprises. However, a mention may be made of the contribution of Hasan in the area of research for public enterprises. He concludes that the marketing research as an element in a marketing information systems in public sector ensures free flow of information for effective planning and control and advocates that the top management should believe in the relevance and responsiveness of the marketing research and information system to their managerial needs.

It is evident from the review of the existing literature that Information Technology bases studies or in particular knowledge based systems approach studies have not received the attention they deserve (by virtue of their utility) for research. Hence, an attempt has been made in this study to fill this gap, to an extent.
OBJECTIVES OF THE STUDY

The objectives of the study are:

1. To inquire into the efficiency of the retail marketing activity of HPCL.
2. To examine the decision making practices of managers of HPCL concerning retail marketing activities.
3. To develop an expert and decision support system if necessary to improve the retail marketing activity.

PRESENTATION OF THE STUDY:

The study has been presented in eight chapters. The first chapter describes marketing functions, retail sales function and expert and decision support systems. Chapter two deals with the overview of oil industry in general and HPCL in particular. In chapter three, significance of the study, review of literature, objectives of the study, methodology, scheme of presentation and limitations of the study are presented. Chapter four contains the analysis of marketing activity in HPCL. Chapter five presents sales maximization sub-system, chapter six indent scheduling sub-system, chapter seven deals with the transportation cost minimization sub-system and chapter eight presents the summary.

ANALYSIS OF MARKETING ACTIVITY IN HPCL

The typical public sector oil company sales office has three main departments: Sales, Operations and Finance. Numerous activities are performed by each of them in support of the sales function. Some of the main activities of HPCL sales office include: sales through dealers, customer services, field force management, sales
management services, industry and government customer order fulfillment and general administration.

Retail marketing activity plays a crucial role in the efficient performance of HPCL. An inquiry into the nature of performance of retail marketing activity is carried out by soliciting the responses from the customers and the dealers with the help of separate questionnaires. The quality of the decisions and the speed with which the decisions are made by the managers influences the efficiency of the retail marketing activity of HPCL. Hence a survey on the decision making methods and practices of managers has been carried out soliciting the responses from the officers of HPCL. The officers were asked to comment on the various aspects like the medium of communication for order receipt, criteria used for deciding the order composition, various types of data maintained by purchasing authorities, factors considered in alternative trading area evaluation, factors considered in evaluation of alternative sites for retail outlet location, criteria used by officers in scheduling dealers indents, criteria for supply point determination and LPG refill load indent execution etc. Based on the results of the survey it is felt that there is an acute need for designing expert support system. Three major sub-systems (which have a total of seven applications) have been identified as the potential areas for the development of expert and decision support systems viz.,

1. Sales maximization sub-system
   (a) Trading area and site selection
   (b) Purchase performance and inventory management of dispensing unit spares.
   (c) Order Capture support.
2. Indent Scheduling sub-system
   (a) Petrol and Diesel Tank Truck load indenting
   (b) LPG refill load indent scheduling
3. Transportation cost minimization sub-system
Since the Oil industry forms the backbone of any economy and since an organization which has already adopted substantial amount of information technology is needed for deployment of Expert Systems, HPCL has been chosen for this study. Since Expert systems are developed to cope with decisions of sufficient importance to merit system development, the framework for the following applications (grouped as three sub-systems) has been developed. 1. Sales Maximization subsystem with (a) Retail Outlet trading area and site selection module (b) Purchase Performance Evaluation and Inventory management of Dispensing unit spares module (c) Order capture support system module. 2. Indent scheduling sub-system with (a) Tank truck shipping schedule module and (b) LPG refill load indent scheduling module. 3. Transportation Cost minimization sub-system with (a) Supply point determination module (b) Replacement strategy module for the company owned Tank Trucks.

The study focussed more on the knowledge engineering aspects and less on the knowledge encoding aspects as the unusual aspect of knowledge based systems, which distinguishes this area from other areas of information system development, is that 80% of the work involves understanding and modeling manager’s decision processes used in doing a specific management job.

Sales Maximization Sub-system:
The approach taken for sales maximization in this study is by placing emphasis on decisions that an expert system can handle whether it be a strategic or operative decision. As a result, retail outlet trading area/site selection, inventory management of dispensing unit spares and order capture support have been identified as the applications that merit the Expert System development in HPCL.

(a) Retail outlet trading area and site selection module: One of the crucial strategic decisions a retailing organization makes is the selection of an outlet location. Decision making is complex, costs are high, there is little flexibility once a location has been chosen and the attributes of a location have high impact on the retailer’s sales performance. In HPCL, despite the foregoing facts, the retail outlet site selection decision is made by the Regional Manager or the Sales Manager by making a trip to potential sites along with the sales officers and by taking the Sales Officer’s comparative estimate of the probable amount of sale of MS and HSD and without regard to any other criteria. It has been observed that such an important crucial decision involving huge investment of the company is not done in any systematic manner by majority of the managers.

The above approach having been followed for years has led to the problem of HPCL getting saddled with disadvantaged sites and trading areas having too many outlets. However, there are some managers using logically relevant criteria in the evaluation of potential alternative trading areas and sites. It is felt that an expert system that is capable of providing assistance in selecting the best trading area and the
best retail outlet location considering all the pertinent information, weighing all the relevant variables (gathering the criteria from various experts) will be of immense use.

The domain knowledge has been elicited from the experienced managers using the right selection criteria. Problem has been stated, domain knowledge has been analyzed and model has been formulated for the decision of trading area and site selection. Some of the important criteria identified are: Characteristics of residents, composition of vehicle population with residents, adjoining commercial and office complexes, factories etc. number of the existing outlets i.e. competitors vs. company’s own and their volume and growth projections, present vs. future market potential in the light of the size and capacity of the existing outlets, geographic weaknesses and legal restrictions if any, municipal corporations long term plans of by-pass road and new roads etc.,.

It has been recognised that when multiple objectives that occupy different dimensions co-exist, they can not be combined quantitatively in any simple fashion. The proper method for comparing multiple outcomes which occupy different dimensions developed by Gauss, Buckingham and explained by P.W.Bridgeman in his studies of the dimensional properties of the system,\(^2\) has been used in this model.

(b) Purchase Performance Evaluation and inventory management of Dispensing unit spares:

As stated earlier purchasing and inventory management of dispensing unit spares in a downstream oil company business is viewed not just as cost reduction measure but more as a measure to avoid or reduce the downtime of the dispensing unit and thus avoid the loss of sale of motor fuels. It is from this point of view that the purchase performance and inventory management of dispensing units spares forms a subsidiary sales management function in this real business scenario.

It has been observed that non-availability of a particular spare part can result in the idling of both the equipment (Petrol and Diesel dispensing unit) and fitter/chargman (a person who repairs the Dispensing unit). The idling of equipment (Pumps in retail outlets) in most cases also results in the loss of sale of Motor spirit and High Spied Diesel. In view of the foregoing, the purchase and the management of spare parts inventory plays a crucial role in HPCL.

It has been observed that approach employed by HPCL in controlling inventories of spare parts is not mathematically based. Order quantity and safety stock to be carried of the individual items is at present only a mental arithmetic based on the recent experience of the officer concerned. While all the relevant data required for generating meaningful purchasing reports and evaluation, is maintained and is available, the appropriate mathematical models and computer programs are not in place.

HPCL Purchasing manager needs to retain control over the following critical areas with the help of the Decision support system.: Measure of idle machines (Dispensing units) resulting from a lack of purchased supplies, history of the A class
items vendor-wise, measure of the extent of successful substitutes from local vendors of
spare parts, value of purchase orders subjected to competitive bidding as a percentage
of total orders placed, number of rush orders, quantitative measure of expediting
expenses, ratio of the defective parts to the total purchased parts, measures of vendors
keeping delivery promises.

(c) Order Capture Support System:

Despite the fact that there are over 200 grades of lubricants with varying
amount of profit margins, logical interconnection between products in their sale and
constantly shifting priorities of sale of specific products dictated by their accumulated
stock etc. that the HPCL salesman has to handle, there is no computer assistance
provided to sales man at the time of taking orders.

There is at present no professional approach being followed by the
salesman in deciding the content of the order except that the lube fuel ratio (that is
extracted from the customer sales analysis report - a monthly computer printout from the
Head Quarter's Office) is used in just keeping track of the lube upliftment by dealers in
relation to their fuel upliftment. The monitoring of the dealer's utilization of the sales
incentive scheme is not being done and at the times the dealers are losing huge
incentives by uplifting total annual volumes that are just short of the volumes required to
avail of the incentive.
A framework for expert system application titled "Order capture support system" that is capable of providing assistance to HPCL salesman in the following activities has been developed. The system will provide assistance in - identifying the lines stocked by the customer and omitted from the current order but likely to require replenishment, identifying and estimating the requirement of a particular product because its consumption is logically connected to the consumption of certain other product that the customer has uplifted with supporting sales argument, advising on suitable additional quantities where the customer is likely to benefit by higher order in the form of additional discount or incentive, advising sales staff on which line to push in order to maximize profitability, establishing order priorities on a business advantage basis, advising the order quantity of each product by precisely calculating the EOQ of each lubricant grade and showing the amount of additional profit made by heeding to the Sales man's advice etc.

**Indent scheduling sub-system:**

The introduction of a decision support system for sales maximization brings an increasing emphasis to the area of physical distribution which includes functions of handling shipping orders that result from the sales maximization effort. Motor fuel indent i.e. Tank Truck scheduling and LPG refill load indent scheduling have been identified to be the apt candidates for having expert system support.

(a) **Tank Truck Shipping Scheduling:**
Tank truck shipping scheduling falls in the category of combinatorial explosive problem. The manner in which the Tank Truck load indents are executed has the maximum impact on the total sale. The scheduling of Tank Truck loads to various retail outlets at present is done on first come first serve basis or by sheer discretion of the officers of the Inland Relay Depot or keeping in view the delivery date and time asked for by the dealer. This results in a loss of sale to the corporation when some outlets go dry and this possibly can be avoided by using an operations research mathematical model that can achieve the objective of avoiding or minimizing the total loss of sale to the corporation.

The sequence in which the depot executes the indents on a specific day has an impact on the total sale the corporation makes through its dealers to the endures. This sequence has no effect only in a situation where the tank stocks of all the dealers on the day in question is high enough that they do not go dry even if a load is dispatched either as a first load at the start of the operations in the morning or as a last Tank Truck load at the close of the depot operations in the evening. It has been observed that this is rarely ever the case due to the fact that storage capacity of the dealers of MS and HSD are limited due to various physical (space constraints of the site on which the retail outlet is located), legal (explosive restrictions) and economic constraints (the investment that goes into the tank fabrication/ installation, high amount of working capital required to store large amounts of product). The instances of the high selling dealer's total tank capacity lasting a few hours is not quite uncommon, as the increase of tank capacity is not always a feasible solution for various reasons. Working with the aforementioned
constraints, the HPCL has to ensure avoiding dry-outs at outlets that result in loss of sale and when the dry-out and loss of sale is inevitable, the same should be put at its barest minimum possible.

It has been observed that the above described Tank Truck dispatch activity scheduling in HPCL can be formulated as an Operations Research Assignment problem. We can call this problem relatively determinate because the precision lost by approximating the risk element (time at which the outlet will go dry) as though it behaved with certainty carries a negligible penalty.

The cost matrix has been developed with Retail outlets (which are equivalent of machines in normal Operations research problem) as column headings and loading sequence numbers (1st, 2nd and 3rd which are jobs in the normal OR problem) as row headings. Taking into consideration the average sale per hour, number of hours in which the retail outlet will be dry and the time required for tank truck to fill and reach destination for each of the outlet is put in the form of a table to calculate the actual loss of sale if the sequence of the load for the outlet is varied as 1st, 2nd etc.,... The resultant table is the direct cost matrix on which the assignment problem algorithm can work.

The complexity involved in scheduling makes it a good case for using an expert system. There is almost a one to one correspondence between Expert system and the scheduling problem in the point of view of 1. Problem domain 2. knowledge base 3. Inference mechanism decision making.
Scheduling of LPG refill load indent execution:

Most of the quantitative methods established in scheduling tend to make a lot of assumptions which might at times, be very unrealistic. Scheduling problems as such tend to become very complex. This is because of the combinatorial nature of the number of factors and constraints involved in any real life problem. Sometimes optimal schedule to a problem is impossible due to the constraints imposed. LPG refill load indent scheduling is one such problem for which only a near optimal solution can be obtained by building a special algorithm. The various constraints identified in the analysis of the problem domain are: The product is shipped in a returnable package to dealers and customers, the storage capacity of the dealers are limited due to godown space constraints as well as legal restrictions (explosive rules), the floor stock in majority of the cases is 500 cylinders due to legal restrictions, the filling plants also have their own legal and other constraints of storage.

The problem noted is that, though the monthly refill requirement or consumption of all the dealers is known with certainty and the plant’s capacity of production/ transportation equals or exceeds the total requirements of all dealers, the loss of sale takes place many a time due to HPCL plant’s inability to properly schedule the LPG dealers’ indents.

The following conditions have been identified as the objectives for the proposed LPG refill load indent scheduling Expert system module: 1. No loss of sale should occur. 2. no loss of production should occur. 3 no added transportation costs.
should occur and 4 a truck should not reach a dealer so early that the dealer would not have enough empties and it should at least reach him when his stock is at least equal to his one day's requirement. A special algorithm has been developed which can be built as an expert system that achieves the above objectives despite the special constraints mentioned above.

Transportation Cost Minimization sub-system:

The desired goal of this final sub system was to find the lowest cost method of providing movement services for HPCL products. The two applications identified for accomplishing the aforementioned objective are: the Supply point determination and the Replacement strategy for the company owned Tank Trucks.

(a) Supply Point Determination: Like in many businesses, in the oil industry too, transportation costs represent major expenditures and sizable savings can result from a systematic application of an Operations Research mathematical model. The problem identified here is of considerable complexity owing to the fact that the various retail outlets and LPG dealers can be supplied by any one of the Inland Relay Depots and bottling plants. As the number of IRDs/Plants and dealers increase, the total number of ways of transporting the required amounts to the various retail outlets increases with such rapidity that it quickly becomes impossible to evaluate the total cost associated with each of them. The decision problem for the Expert system application is to meet the requirements of each dealer while remaining with the capacity of each plant and to minimise the transportation cost.
The Vogel's Approximation Method has been used to find the solution. A full-fledged expert system module has been built for this particular application. The module has been built with 26 subroutines, 48 database files, 3 report generator file and one memory file in dBase IV. A minimum saving of Rs. 44,394 will result in transportation costs in Nagpur Regional office alone by altering the way in which the dealers are attached to the plant as recommended by the system.

(b) Replacement strategy for the company owned Tank Trucks:

The application of Operations Research equipment replacement model for the company owned Tank Trucks of HPCL has been considered as the second approach toward minimising the transportation costs. It has been observed that replacement strategy of HPCL is not an optimal one and is not systematic as is evident from the fact that some Tank Trucks have been replaced at 8 lac kilometers and some have not been replaced even after doing 10 lack kilometers.

To keep the maintenance costs at their minimum, it is advisable to replace every Tank Truck after 5 years of operation or after it has traveled a distance of 6 lakh kilometers. A saving of Rs 17,226/ will result per annum if the Tank Truck is replaced after five years as advised by the system in stead of after eight years as is done in majority of the cases.