The approach taken for sales maximization is by placing emphasis on decisions that an expert system can handle whether it be a strategic or an operative decision. However, it should be pointed out that a purchase and inventory management function of dispensing unit spares in an oil company business is viewed not as a cost reduction measure alone but 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 latter point of view that the purchase performance and inventory management of dispensing unit spares module has been included under the general heading "Sales Maximization" along with the order capture support system and trading area/site selection module.

Appropriate mathematical models are investigated from the viewpoint of broadening sales decisions. This enlarged perspective provides a logical framework for designing the following Expert and decision support system sales maximization components of Hindustan Petroleum Corporation.

A. Trading Area and Site Selection

B. Purchase performance and inventory management of dispensing unit spares.

C. Order Capture support System.

The introduction of decision support system for sales maximization brings an increasing emphasis to the area of physical distribution. A physical distribution sub-system includes the functions of handling shipping orders that result from the "sales maximization" effort. The Indent Scheduling discussed in this chapter centers on (i).
Motor Fuel indent scheduling and (ii). LPG refill load indent scheduling, that lend themselves to be formulated as expert system applications.

After the shipping schedules are ready, transpiration is the next logical area for developing expert system applications as the desired goal of this final sub-system is to find the lowest cost method of providing movement services that create a place utility for HPCL products. The two applications identified for accomplishing the aforementioned objective are: (i) Supply Point determination and (ii) Replacement Strategy for company owned Tank Trucks.

PROBLEM IDENTIFICATION / BACKGROUND OF THE PROBLEM:

Retail Outlet Trading Area/Site selection module:

At present the retail outlet site is selected by the Regional Manager/Manager - Sales by making a trip to the alternative sites along with the Sales Officer. A comparative estimate of the probable amount of sale of Ms and HSD is made and the site decision is made almost instantaneously. Such an important crucial decision involving huge investment of the company is not done in any systematic manner.

This approach having been followed for years has lead to the problems of certain companies getting saddled with disadvantaged sites and trading areas having too many outlets. This has also resulted into a situation of certain oil companies using a systematic decision process getting all the advantageous locations selling high volumes. The above has been indicated by the throughput per outlet analysis of the Oil companies.
In the context described above, it is felt that a Decision Support 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 will be of immense value in evaluating the alternate trading areas and alternate locations in a trading area.

A small expert system module developed gathering all the required domain knowledge to make the aforementioned evaluation of alternative trading areas and sites will be of help in disseminating the scarce expert knowledge that only a few experienced people in the company now have.

PROBLEM STATEMENT / SYSTEM PROPOSAL:

The problem or decision to be studied is how to evaluate the various trading areas and the various sites for the location of a Retail Outlet and help the managers decide on the most suitable trading area and site considering the following factors:

- Evaluate the alternative geographic areas in terms of characteristics of residents, composition of vehicle population with the residents, adjoining commercial/office complexes, factories etc.
- Number of the existing retail outlets i.e. competitors vs. company's own and their present volumes 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 roads and new roads etc.

ANALYSIS OF THE PROBLEM OR DOMAIN KNOWLEDGE:

One of the most crucial strategic decisions a retailer makes involves the selection of a store 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 a high impact on the retailer's sales performance. A poor location may be such a liability that even the most able retailer will be unable to overcome it.

The selection of a store location requires extensive decision making by the retailer because of the number of criteria that need to be considered. These include the size, the characteristics of the surrounding population, the level of competition, access to Retail outlet, the attributes of nearby stores, property costs and legal restrictions and other factors.

Retail outlet location usually requires a sizable financial investment and a long term commitment by the retailer. Many of the existing sites which are located on major downtown thoroughfares and highways have been leases for an average period of twenty years.
In choosing a Retail Outlet location, the following steps should be followed.

1. Evaluate alternative geographic areas in terms of the characteristics of residents and existing retailers.
2. Determine whether to locate as an isolated retail outlet.
3. Analyse alternate sites contained in the specified retail location type.

Trading Area Analysis:

A trading area is "the geographical area from which the outlet draws its customers".

The first step in the choice of a retail outlet location consists of describing and evaluating alternative trading areas and then deciding on the most desirable one.

1. The demographic and socio economic characteristics of consumers can be detailed.
2. It can be determined whether a proposed retail outlet will service new customers or take away business from existing ones. Management must also recognise that a competitor may open at the new location. Trading area overlap, if exists must be considered while calculating the potential.
3. The proper number of outlets that can be efficiently and profitably operated in a geographical area can be calculated.
4. Geographic weaknesses are highlighted. For example: in the trading area analysis, it was discovered that a significant number of people residing there were employees of a factory located 10 miles away who commuted regularly.

5. Competition and legal restrictions like (one-way) etc. and projected growth has to be ascertained for the trading area being examined.

The Size and Shape of a Trading Area:

Each trading area comprises three parts: primary, secondary and fringe. The primary trading area encompasses 50 to 70 per cent of the customers. It is the area closest to the Outlet and possesses the highest density of customers to the population and highest per capita sales. There is minimum of overlap with other trading areas.

The secondary trading area contains an additional 20 to 25 per cent of the Outlet's customers. It is located outside the primary area and customers are more widely dispersed. The fringe trading area includes all the remaining customers and they are the most widely dispersed. The size and shape of a trading area are determined by a variety of factors, among them: Retail Outlet size, the location of competitors, travel time and traffic barriers(Poor road) etc., .

One type of store called parasite, does not create its own traffic and has no trading area of its own. The Outlet depends on customers who are drawn into the area for other reasons. Their customers are not drawn to the trading area because of them but patronise these stores while they are in that area.
The location of a retail outlet's competitors has an impact on the size of the trading area. Whenever potential customers are situated between two outlets, the size of the trading area is reduced for each. The size of each outlet's trading area increases as the distance between them increases. On the other hand, when stores are located near each other, the size of the trading area would not be reduced.

Travel or driving time has an influence on the size of a trading area that may not be clear from a study of the geographical distribution of the population. Physical barriers (such as level-crossing, one-way street, poor roads, tunnels etc.) usually affect trading areas and contribute to their odd shapes. Economic barriers (such as differences in sales tax between two towns, octroi etc.) also affect the size and shape of a trading area.

If one town has significantly lower tax than another, it may entice the motorists to travel longer and save more.

**Delineating the Trading Area of an Existing Store:**

The size, shape and characteristics of the trading area for an existing outlet can be delineated quite accurately. Retail outlet records and/or special study can be used to measure the trading area. Retail outlet records can reveal the addresses of both credit and cash customers. Addresses of credit customers can be obtained through the Outlet’s billing department; addresses of cash customers can be acquired from an analysis of Cash Memos on which Vehicle registration numbers/ License plate numbers
are mentioned. By studying the addresses of the customers, an estimate of the Outlet's trading area can be estimated. Primary, secondary, and fringe trading areas can be described on the basis of:

1. The frequency with which customers in a geographic area buy from the Outlet.
2. The average volume of purchase by a customer within a given geographical area.
3. The concentration of Outlet's credit-card holders within a given area.

Regardless of the type of analysis, the retailer should be aware that a time bias may exist. For example, the retail outlet may be patronised by different types of customers during the different periods during the day and week. Therefore an accurate estimate of the size of Outlet's trading area can be obtained only through complete and continuous investigation for at least a week.

**Delineating the Trading Area of a new Outlet:**

Alternate trading areas for a new outlet must be evaluated by an assessment of market opportunities, current vehicular traffic. Trend analysis and/or surveys can be conducted. Trend analysis (estimating the future based on the past) involves the examination of government data concerning automobile registrations, new housing starts, highways, zoning and so on. Consumers surveys can be used to gather information about the time and distance people are willing to travel to retail outlet locations, the features that would attract people to travel to farther locations or to new retail outlets. Either or both of these techniques may provide a basis for delineating
alternate new Retail outlet trading areas. Study of the traffic patterns also may have to carried out to delineate the trading area.

Distance measurement should not be confined to major thoroughfares and it should involve cross streets; people will travel shorter distances along the cross streets. A better measure may be travel time. Second, actual distance may not correspond with the consumer's perception of distance. A retail outlet that offers a few consumer conveniences, few services and crowded aisles is greater perceived distance from the customer than an outlet with a more pleasant environment.

**Characteristics of Trading Areas:**

After the size and shape of each trading area, existing or proposed, has been determined, the characteristics of the area should be examined. Of special interest are the attributes of the residents and how well they match with the retailer's definition of the target market. In this case the automobile registrations and classification by the type of vehicles (Cars vs. two wheelers) etc. may be determined.

The economic base refers to an area's industrial and commercial structure, the companies and industries that residents depend on to earn a living. The dominant industry (company) in an area is very important and drastic decline in the industry may have an adverse effects on a large proportion of the area's residents. An area with a diverse economic base, where residents work for a variety of non-related industries is more secure than an are dependent on the major industry.
All of the criteria mentioned above may not be equally important in all retail location decisions, each should be considered to prevent an oversight. The most important criteria should be viewed as "knockout" factors: if a location does not meet standards on a key criteria, it is immediately knocked out.

**The nature of competition and level of Saturation:**

The retail opportunity in an area cannot be accurately assessed unless the competitive structure is studied. Although a trading area may have residents who match the retail outlet's desired market and may have a strong economic base, it may be a poor location for a new store if competition is extensive. Similarly, an area with a small population and a narrow economic base may be a good location if competition is minimal.

When examining competition, several factors should be analysed: the number of existing Retail Outlets, the volume of sales, their locational advantages and disadvantages, the strengths and weaknesses of the existing retail outlets, short run and long run trends and the level of saturation. These factors have to be evaluated in relation to the total potential of the area and growth possibilities and not in absolute terms.

A trading area can be understored, overstored or saturated. An understored area has too few outlets selling to satisfy the demand of its population. An overstored area has so many stores selling that some retailers are unable to earn an
adequate volume. A saturated area has just enough retail outlets to satisfy the demand of its population.

Measures of retail saturation are based on the premise that any trading area can support only a given number of retail outlets or certain volume of sale.

SITE SELECTION:

After the alternative trading areas are assessed, type of location has to be determined and after the desirable general location is finalised, the specific site should be evaluated on the basis of visibility, placement in the location, size and shape of the plot. The evaluation of each general location and the specific sites contained within them requires extensive analysis.

Visibility is a site's ability to be seen by vehicular traffic. High visibility makes passers-by aware that a gasoline station exists and is open.

Placement in the location refers to a site's relative position in the area. A corner location is often desirable because it is situated at the intersection of two streets and therefore results in "Corner Influence".

An Outlet's compatibility with adjacent or nearby retailers should be weighed. Affinity occurs when various stores are attracted to the same location in order to complement, blend and cooperate with one another and each benefits from the other's presence. An example of this would be the presence of a Famous garage will that attracts
the motorists and the location of a gasoline station nearby would provide the benefit of affinity.

Besides the above, the vehicular traffic counts and analysis as to the number, type etc. has to be made. Some adjustments to the raw count of vehicular traffic should be made. Only homeward-bound traffic may have to be considered at times. Vehicles passing on the other side of the divided highway may have to be excluded. In addition to the above the extent and timing of congestion should also be studied to know its impact on the driving in difficulty. The ownership or lease option of the site and its impact on the economics of the decision to be considered.

The retailer should rate each alternative location (and specific site) on all of the above criteria and develop an overall rating for each alternative. The last step in the selection of a general location and specific site within it is the computation of an overall rating. First each location under consideration is given an overall rating based on its performance on all of the criteria described above. The overall ratings of alternative locations are then compared and the best location is chosen. Second, the same procedure is used to evaluate the alternative sites within the location.

It is often difficult to develop and compare composite evaluations, because some attributes may be positive while others are negative. For example the general location may be good and the specific site may be poor. Therefore the attributes need to weighed according to their importance. An overall rating should include certain knockout factors that would preclude consideration of a site. Possible knockout factors
are a short duration lease, a future bypass is in the plans of the Municipality/Corporation etc.

The above offers several benefits as the above is more objective and systematic than non-quantitative evaluation methods; the above offers insight into the weight of each locational attribute; they are useful in screening of a large number of locations and they can be used to assess management's performance by comparing forecasts with actual results.

Nature of dimensional Soundness: When a number of critical objectives coexist in the model it is not unusual to find that a dilemma arises concerning which objective to maximise. They all seem important to the executive (although perhaps not equally so). Further, as the degree of achievement of any one objective is improved, those of others may deteriorate.

There is only one way in which we can decide what to do, and that is to determine how important each objective is to the decision-maker.

It will be recognised that our quandary stems from multiple objectives that occupy different dimensions. We cannot quantitatively combine these multiple outcomes in any simple fashion. Certainly we cannot add pounds of weight and dollars of cost together and choose the sum we like the best. We cannot do this even if we first rate each outcome in terms of its importance to us and then use an appropriately weighted sum.
To illustrate, let us now consider the problem of the executive who has to decide between two possible locations for a new outlet which the company is planning to commission. To determine the best location, he lists ten different outcomes that result for each strategy. The management considers these ten outcomes as the relevant dimensions of the company's objectives. The executive rates these outcomes in terms of his considered judgment of their relative importance to the final outcome or payoff measure.

### TABLE 5.1

**THE FACTORS TO BE CONSIDERED IN EVALUATION OF ALTERNATIVE SITES**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Dimensional Unit</th>
<th>Importance/Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1: Cost of Land</td>
<td>Rupee Investment</td>
<td>A</td>
</tr>
<tr>
<td>X2: Cost of building</td>
<td>Rupee Investment</td>
<td>B</td>
</tr>
<tr>
<td>X3: Desirability of site in terms of plot size</td>
<td>Preference rating*</td>
<td>C</td>
</tr>
<tr>
<td>X4: Economic base of target market</td>
<td>Preference rating*</td>
<td>D</td>
</tr>
<tr>
<td>X5: Level of competition</td>
<td>Preference rating*</td>
<td>E</td>
</tr>
<tr>
<td>X6: Desirability of site based on traffic count</td>
<td>Preference rating*</td>
<td>F</td>
</tr>
<tr>
<td>X7: Visibility</td>
<td>Preference Rating*</td>
<td>G</td>
</tr>
<tr>
<td>X8: Placement</td>
<td>Preference Rating*</td>
<td>H</td>
</tr>
<tr>
<td>X9: Compatibility</td>
<td>Preference Rating*</td>
<td>I</td>
</tr>
<tr>
<td>X10: Annual Taxes</td>
<td>Expense(Rs)</td>
<td>J</td>
</tr>
</tbody>
</table>

Note: For the asterisked dimensions, it is convenient to use a scale where 10 is the poorest and 1 is best. Data are collected for the alternative strategies and the resulting payoff matrix will have ten outcome values in each box.
Measures taken along the equivalent dimensions should be combined. (If they are not, appropriate weighting factors can be found which accomplish the same objective). In this case, X1 and X2 (being dollar investments) lend themselves to immediate summation without any difficulty. On the other hand, although X10 is a dollar dimension, it is cost experienced over time rather than present worth outlay of total cost. To case X10 in the same dimension as X1 and X2, an appropriate discounting factor must be applied to each year’s expenses so that the stream of costs over time can be converted to a single present worth figure.

In stead of doing this, the executive might prefer to estimate the importance of X10 in the overall scheme of things as compared to X1 and X2 as well as all of the other outcomes. If correct, this importance weight will reflect the size of the
discounting factor acting in conjunction with the other estimates required to transform the X10 dimension to that of X1 and X2. It may also express intangibles that are somehow embodied in it.

Let us assume that the latter course (using weighting factors) has been followed.

**TABLE 5.3**

**EXEMPLARY TABLE SHOWING ALTERNATIVE STRATEGIES AND THE RESULTANT MATRIX WITH WEIGHTING FACTORS**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>S1</th>
<th>S2</th>
<th>Importance</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>(X1 + X2)</td>
<td>100000</td>
<td>150000</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>X3</td>
<td>6</td>
<td>7</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>X4</td>
<td>7</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>X5</td>
<td>9</td>
<td>6</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>X6</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>X7</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>X8</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>X9</td>
<td>9</td>
<td>8</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>X10</td>
<td>1000 p.a.</td>
<td>1500 p.a.</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Note: Importance is assumed to increase as the weighting factor number grows larger.

An Incorrect method that is frequently used: One method of comparing strategies S1 and S2 is to sum the products of the weights and outcomes from each strategy. That is

\[ O(S1) = 3(1, 00, 000) + 4(6) + 5(7) + 1(9) + 3(7) + 2(7) + 3(2) + 4(9) + 1(1000) \]
\[ = 301145 \]

\[ O(S2) = 3(1, 500, 00) + 4(7) + 5(4) + 1(6) + 3(5) + 2(4) + 3(3) + 4(8) + 1(1500) \]
\[ = 451618 \]
By this method, $O(S1)$ is indicated to be the better selection. (Note that this model is based on costs where large numbers are less desirable). The following ratio provides a comparison.

$$O(S2) + O(S1) = 451618 + 301145 \times 1.50$$

Now let us see what happens if we change the scale of $(X1 + X2)$ so that it is read in million dollar units in stead of single dollar units. We know that if the method we are using is dimensionally sound, the exact same ratio should result in spite of the scale transformation.

$$O(S1) = 3(1) + 4(6) + 5(7) + 1(9) + 3(7) + 2(7) + 3(2) + 4(9) + 1(0.01)$$
$$= 148.01$$

$$O(S2) = 3(1.5) + 4(7) + 5(4) + 1(6) + 3(5) + 2(4) + 3(3) + 4(8) + 1(0.015)$$
$$= 122.515$$

And the ratio changes:

$$O(S2) + O(S1) = 122.515 + 148.01 = 0.83$$

This demonstrates that the change in scale introduced dimensional distortion in the ratio.

A dimensionally Correct Method: The proper method for comparing multiple outcomes (which occupy different dimensions) has been developed by Gauss.
Buckinghan and others. It is explained by P.W. Bridgeman in his studies of the dimensional properties of systems. This method uses the product of the outcomes raised to weighted powers. That is, the outcome for any strategy S will be:

\[ O(S) = (X_1)^{A_1} (X_2)^{A_2} (X_3)^{A_3} \cdots X(6)^{A_6} \]

We shall now apply the million-dollar transform of the unit dollar scale to this method.

(X1 is expressed in unit dollars.)

\[ O(S1) = (1,000,000)^3 (6)^4 (7)^5 (9)^6 (7)^3 (2)^3 (9)^4 (1000)^1 \]
\[ = 10^{15} \times 1296 \times 16807 \times 9 \times 343 \times 49 \times 8 \times 6561 \times 10^3 \]
\[ = 1.73 \times 10^{32} \]

\[ O(S2) = (1,500,000)^3 (7)^4 (4)^5 (6)^1 (5)^3 (4)^2 (3)^3 (8)^4 (1500)^1 \]
\[ = 1.65 \times 10^{34} \]

\[ O(S2) + O(S1) = 1.65 \times 10^{34} + 1.73 \times 10^{32} = 95 \]

\[ O(S1) = (1)^3 (6)^4 (7)^5 (9)^1 (7)^3 (2)^3 (9)^4 (1000)^1 \]
\[ = 1 \times 1296 \times 16807 \times 9 \times 343 \times 49 \times 8 \times 6561 \times 10^3 \]
\[ = 10^{17} (1.73) \]

\[ O(S2) = (1.5)^3 (7)^4 (4)^5 (6)^1 (5)^3 (4)^2 (3)^3 (8)^4 (1500)^1 \]
\[ = 10^{19} (1.65) \]

\[ O(S2) + O(S1) = 95 \]
We see that these latter ratios are invariant to the transformation of scale. The is because the multiplicative method produces a pure number ratio i.e. a number without dimensions. To illustrate this fact, let us add some amount of visibility to an amount of placement and derive the ratio (for two strategies S1 and S2) of the combined outcomes:

\[ \text{Ratio} = \frac{(S1 \text{ Visibility} + S1 \text{ Placement})}{(S2 \text{ Visibility} + S2 \text{ Placement})}. \]

Dimensionally, this is equal to:

\[ \text{Ratio} = [S1 \text{ visibility} + (S2 \text{ Visibility} + S2 \text{ Placement})] + [S1 \text{ Placement} + (S2 \text{ Visibility} + S2 \text{ Placement})] \]

There is no utility to be gained from such a ratio. Its dimensionality is meaningless. On the other hand, using multiplication, all of the dimensions cancel and a pure number results. Thus:

\[ \text{Ratio} = (S1 \text{ Visibility} \times S1 \text{ Placement}) + (S2 \text{ Visibility} \times S2 \text{ Placement}) = \text{Pure Number} \]

We observe that in the two cases when an incorrect approach was used the contradictory decisions have been arrived at and in the latter approach the consistency has been achieved. Frequently, the incorrect method will produce a ratio reversal and the executive will be misguided.

Dimensional integrity is an absolute requirement of any sound analysis. When we combine a number of outcomes that occupy various dimensions in an attempt to optimise the overall outcome, the ratio of the outcomes should be a pure number.
The multiplication method will always produce a pure number. This follows from the fact that multiplication generates an area, a volume, and so on which has the property of being common space for the participating outcomes. This common space is proportional to the importance of the values. Addition creates no such common territory and is not properly used when it attempts to combine basically different dimensions as though they were the same. The method of addition should be used only for outcome variables that are characterised by the same dimension.

It is always possible (in theory) to find a unifying transformation that will permit addition to be used. For example, apples and oranges can be added when both are transformed to units of fruit. Similarly, if rupee estimates can be placed on intangibles such as visibility, placement and the desirability of the site, these can be summed. It is not unusual to find that the attempt has been made to find a preference measure for each of the variables. In this case, a single outcome measure is assumed to reflect total preference as the sum of the individual preference contributions of each variable.

The soundness of such utility transformations to a single scale may be more illusory than correct. They are not easily achieved. The dimension of fruit, for example may have no direct bearing on the problem. The dollar estimate of the visibility is known to vary greatly depending on the purpose it is to serve. Knowledge of how to treat these kinds of issues is critical for successful model building.
If some components are to be maximised while others are to be minimised, we can use positive powers to the outcomes to be maximised and negative powers for the outcomes to be minimised.

**PURCHASE PERFORMANCE EVALUATION AND INVENTORY MANAGEMENT OF DISPENSING UNIT SPARES:**

**Problem Identification /Background Of The Problem**

This chapter examines the present method of handling the Dispensing Unit spares purchasing and inventory functions operating in MIS environment for the HPCL. The problems that are being faced or the deficiencies in the present system.

The Dispensing Units (Pumps) at the Retail Outlets (Petrol Pumps) are owned and maintained by the Principals (Oil Companies). Any breakdown or the problem in the Dispensing unit is reported to the Depot/RO by the Dealer/Dealer men and all such complaints are logged in a register. The spare parts required for carrying out the repairs are stored in the Depot and are given to the Chargeman or fitter on request who carries them to the Retail Outlet for replacement and repair. The non-availability of particular spare part can result in the idling of both the equipment (Dispensing Unit) and the Fitter/chargemen. The idling of Equipment (Pumps in Retail Outlets in most cases also results in the loss of sale of MS (Petrol) and HSD (Diesel). In view of the foregoing, the management of spare parts inventory plays a crucial role as a subsidiary function of Sales Management. Due to lack of proper reordering system and non-availability of certain spares with local vendors, the Depot is unable to supply the required spare parts to the
Chargeman and this in turn is giving rise to the Dealer dissatisfaction and dealer complaints in the Dealer Panel Meetings and other such forums.

Since huge sums of money are spent annually in the maintenance and repairs of equipment, the Purchase Performance Evaluation is necessitated to contain the costs.

**Overview of the Purchasing and Inventory Sub-systems - HPCL:**

For the management information system of the HPCL operating in a DDP mode, major purchasing activities are carried out at the Regional Office level. In contrast, the focal point of inventory activities is at the Depot level. The purchasing subsystem, depicted in Figure 5.1 comprises several basic functions: buying and follow-up and vendor, buyer, and purchased-part performance. Also, there is another functional area: reviewing vendor invoices before payment by the accounting section. All of these operational functions are under the supervision of the purchasing management (RO's Operations Department).

The information flow for purchase orders begins when inventory personnel at the Depot level express a need for specific spare parts. Purchase Requisitions are forwarded to the Regional Office who in turn determine the status of the request - that is whether or not the item is already on order. Obviously, there is no need to issue a Purchase Order if the items is on order currently. However, if a Purchase Order is warranted, the Order is made. Copies of the Purchase order are distributed to...
the vendor, receiving and Accounts Section. One copy is retained by the individual who initiated the Purchase Order.

The information flow begins when the receiving report (MRR) is used to update the inventory database. The purchased materials physically flow into the Depot, where the Stock Control clerk updates the database.

MIS PURCHASING AND INVENTORY SUBSYSTEMS

Basically, the purchasing department (Operations Department at RO) locates and determines the suppliers from whom orders to filled. If the desired information is not available, the buyer may send a request for quotation to prospective vendors. Once the outside supplier has been determined, a Purchase Order is typed and mailed to the vendor. It contains the items to be shipped, prices, specifications, terms, and shipping conditions. The original is forwarded to the vendor and duplicate copies are distributed to the purchasing, receiving, stock control, accounting and originating departments.

The approach employed by the HPCL in controlling inventories is not an EOQ calculation for each component part. Basically EOQ formula equates ordering costs and carrying costs in order to obtain the lowest overall inventory costs. The EOQ formula is

\[ Q = \sqrt{\frac{2RS}{CI}} \]

where
- \( Q \) = Economic Ordering Quantity
- \( R \) = annual requirements
- \( S \) = Ordering Costs
- \( C \) = unit price
I = Annual inventory carrying costs, expressed as a percentage of the value of average inventory.

Although the basic EOQ formula does not consider inventory stock-outs, consideration must be given to keeping a certain level of safety stock on hand to meet emergency inventory demand. Safety stock of the individual items to be carried are dictated by the corporation's policy on desired service levels.

**Data Requirements:**

Purchasing and Inventory Data base:

A typical list of purchasing data elements is shown in Fig 1-1. Basically, the corporate data base contains three major files: open purchase orders, vendor master, and inventory master. These data files, together with their detailed elements, comprise the information for making the major purchases on a quarterly basis. In addition, data base elements are necessary at the Depot level (Warehouse) for purchasing specific parts and services as needed.

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Vendor identification number, buyer code, inventory number, quantity ordered, date due, price, and closing date of order

Vendor identification no, vendor name/address, last shipment by vendor, inventory number, price and for price breaks, terms and amount of purchases (lasts 12 months)

Inventory no, avg. daily usage, lead time, stock on hand, stock on order, last four vendor quotations, last four purchases-price, qty, history of deliveries - accepted and rejected, days late last qtr. days late this qtr.
Fig 1.1 : Typical Purchasing Data base elements at the Regional Office level.

The major data elements in the Open Purchase Order file contains vendor identification number, buyer code, quantity ordered, due date, prices and closing date of the order. The main data elements in the Vendor Master file are Vendor identification number, name and address, last shipment date by the vendor, price breaks, terms, summary of deliveries, rejections/defective parts supplied in the past, amount of business given over last 12 months. The inventory master contains parts, average daily usage, lead-time, stock on hand, on-order stock, ordering policy, cost, planned purchases, history of the last four vendor quotations including price and terms and the last four purchases of the item etc.

Buying and Follow-up

The buyer for the HPCL maintain files showing alternative sources of supply for goods they might be called on to purchase. For goods purchased regularly, accurate records on current prices, quantity discounts, shipping terms, cash discounts and comparable items are maintained on the RO data base for purchasing on an optimum basis. Buyers also keep records on past prices and the timeliness of shipments based on periodic computer reports. As prices change, they update their records as well as use these data for changing the data base. In essence the Corporation’s purchasing personnel
have a highly demanding job when attempting to keep overall costs at a minimum whether they be at the RO level or Depot level.

On a regular basis, inventory additions and deductions are made to the database by the Depots and are forwarded to the RO at the end of the month for updating the RO database.

At the Regional Office level, purchase orders are prepared monthly and the EOQ approach is not utilised at the time of placing the Purchase Order. Open Purchase Orders are not kept track of to notify vendors as to late deliveries.

**Buying Performance:**

Purchasing activities do not stop with the placement and follow up of the many purchase orders. They provide management with the information regarding deviations from the purchasing plan, thereby enabling the purchasing department to concentrate on areas in which additional economies are feasible. For an efficient purchasing subsystem, vendor performance must be evaluated.

Vendor evaluation starts with maintaining current purchase order follow up data on the RO database. These data must be used for a quarterly evaluation of vendors on the basis of price. In addition, buyer analyses and orders placed by value are obtainable on a quarterly basis. Although these analyses assist the buyers in performing their assigned functions, improvements are available in terms of the types of information with in the Decision Support System environment.
First all inventory items, together with both their usage and unit cost are listed. Next the unit cost is multiplied by the usage to obtain the total cost estimate. The total costs are arranged in descending order. A close analysis of this inventory usage listing reveals that 80 to 90 per cent of the total inventory cost is associated with 15 to 20 percent of the total items. These items are then designated as A items. The next 60 per cent of the items are called B items, and the remaining percentage, say 20 to 25 per cent are C items.

The database elements consists of approximately 2000 items. These are mainly small component parts. The stock room supplies data concerning the withdrawal of stocks to the system.

**DSS DESIGN CONSIDERATIONS FOR PURCHASING AND INVENTORY:**

The input information for the purchasing subsystem shows the quantity of particular part needed and when it is needed. Design considerations for purchasing revolve around the proper placement of vendor orders that will minimise the overall cost within the corporation. This design approach goes beyond consideration of price. The quality of materials and the reliability of delivery are also brought into play for the proper selection of vendor. It makes no sense to order at the lowest possible price if incoming materials are of low quality. By the same token, late deliveries can cause excessive downtime of the Dispensing Unit. Thus the combination of price, quality and delivery factors must be an integral part of the purchasing subsystem for an effectively designed Decision Support System.
**Purchasing Performance Formulas:**

Before meaningful purchasing reports and evaluation can be obtained for the HPCL, mathematical formulas that reference the Corporations RO data base must be employed. These models are based on the price, quality and delivery which are weighted according to their relative importance. The weights selected are the judgements of the purchasing department. No matter what weights are agreed upon, they form the basis for evaluating the vendor and buyer performance.

**PRICE:** To measure the price variable, past costs provide the best available standard for the present. Current costs that are considerably above those of the previous period is a signal that the purchasing function might be performing poorly. Of course, it is possible that an increase in price is due to a general rise of prices in the economy. But such an all-encompassing movement would tend to affect all prices; in such situations, management should be able to filter out the impact of this general increase. More typically, variation of prices is due to a variety of causes. It is this type of information that management wants isolated and remedied, if possible.

The price index formula for evaluating prices changes for a single product is:

\[
\text{Price index for one product} = \sqrt{\frac{(P_o \times Q_o) + (P_n \times Q_o)}{(P_o \times Q_n) + (P_n \times Q_n)}} \times 100
\]

Where

\- \( P_O \) = average old price (in base period)  
\- \( P_N \) = new price

\[ (1-1) \]
QO = old quantity (in base period)
QN = new quantity.

It compares the price and quantity purchased in the current period with the same data in the base period. Before illustrating Equation (1-1), it is necessary to determine values for the last four purchases prior to the current one. For the data given below, the average price for the last four purchases prior to the current one is 2.30 for 11,000 units, whereas the current price is 2.50 for a quantity of 2000 units.

Last Four Purchases prior to Current One

<table>
<thead>
<tr>
<th>Po</th>
<th>Qo</th>
<th>Po X Qo</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.30</td>
<td>2500</td>
<td>5750</td>
</tr>
<tr>
<td>2.15</td>
<td>4000</td>
<td>8600</td>
</tr>
<tr>
<td>2.50</td>
<td>1500</td>
<td>3750</td>
</tr>
<tr>
<td>2.40</td>
<td>3000</td>
<td>7200</td>
</tr>
<tr>
<td></td>
<td>11000</td>
<td>25,300</td>
</tr>
</tbody>
</table>

Po = 25,300 + 11,000
= 2.30 average price of last four purchases prior to the current one.

Based on the foregoing values, the price index for the purchased item is 92, computed as follows.

Price index for one product

\[
= \sqrt{ \frac{\sum (P_X Q_o) + (P_n X Q_n)}{\sum (P_O X Q_n) + (P_n X Q_n)}} \times 100
\]

\[
= \sqrt{(2.30 \times 11,000) + (2.50 \times 11000)} \times [(2.30 \times 2000) + (2.50 \times 2000)] \times 100
\]

\[
= 92
\]
The value of 92 means that there has been an unfavourable change in prices since the last period. If there has been no change, the price index would be 100. If the index value had been greater than 100, this would have been a favourable price change. In general purchasing management would be pleased with rising indices and displeased with low or falling ones. A rising price index might be due to very effective purchasing, but it might also be due to declining price levels. Similarly, a falling index might indicate inefficiencies or might reflect a general price rise.

QUALITY: Price is not the sole determinant of a "good buy". The firm must also consider the quality of goods it needs before it is possible to evaluate whether it really did get a good buy. The user department must ensure that the parts supplied are not defective and that they have lasted for an acceptable or reasonable period. A measure of the deliveries that actually have had an acceptable life span is useful for measuring the effectiveness of purchasing.

The quality index formula, which depends on a comparison of acceptable or right quality deliveries to the total actual deliveries, is as follows:

\[
\text{Quality index} = \frac{[(\text{Total acceptable deliveries} + \text{Total deliveries}) \times 100]}{\text{(average of last four current acceptance indices)}} \times 100
\]

The quality index can be computed for one product or group of products. All that is needed are data on acceptable deliveries in relation to total deliveries.
or many products and the last four accepted indices for the product or products in question.

The calculation of the quality index can be illustrated for a group of products for which there have been 80 acceptable deliveries out of 88 deliveries during the current quarter. If the average of the last four current accepted indices is 85, the quality index in this case 107, computed as follows.

\[
\text{Quality index} = \left\{\left[\frac{(80 + 88) \times 100}{85}\right] \times 100 \right\}
\]

It should be noted that illustrative index exceeds 100. As mentioned previously, this is a favourable sign - that is the proportion of acceptable deliveries has increased during the period.

**DELIVERY:**

Last deliveries, like poor quality materials and purchased parts can negate a seemingly good buy. At their worst late deliveries may result in idling of D/U and loss of sales. From this viewpoint, it is easy to visualise why a measure of how well vendors meet their specified delivery dates is essential for evaluation purposes. Also, such a measure is useful in evaluating the delivery dependability of particular vendors and in evaluating the buyers/users who choose to purchase regularly from such vendors. The delivery index is a comparison of the number of days late last period compared to this period. Specifically, the delivery index formula is.

\[
\text{delivery index} = \left(\frac{\text{Total late last period}}{\text{Total days late this period}}\right) \times 100
\]
This index can be utilised for comparing the results for specific materials, vendors or purchasing agents.

If the total number of days late last quarter for a particular vendor totalled 50 days, whereas the total days late this period totaled 40 days, the delivery index for this particular vendor is 125.

\[
\text{delivery index} = \left( \frac{50}{40} \right) \times 100 = 125
\]

Again, this index is designed to be greater than 100 if conditions have improved. In the case under the discussion, the total number of days late has declined during this period, resulting in an improvement of the delivery index.

**PURCHASE PERFORMANCE:** The aggregate of the price, quality and delivery indices is a purchase performance index, sometimes called PPI. The Purchase performance index (a single value) summarises the actual performance against the expected performance stated on a quarterly basis or some other time period. It is a composite index, requiring some kind of averaging or weighting process in order to combine these three indices into one. The weights depending on purchasing management's judgment as to the relative importance of each index factor. Common weighting factors are to assign a weight of 50 to the price index and 25 each to the quality and delivery indices.
The purchasing performance index based on the forgoing weighting factors is 104: its price, quality and delivery indices are 92, 107 and 125 respectively.

<table>
<thead>
<tr>
<th>Index</th>
<th>Index Value</th>
<th>Weight</th>
<th>Index Value X weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>92</td>
<td>50</td>
<td>4600</td>
</tr>
<tr>
<td>Quality</td>
<td>107</td>
<td>25</td>
<td>2675</td>
</tr>
<tr>
<td>Delivery</td>
<td>125</td>
<td>25</td>
<td>3125</td>
</tr>
</tbody>
</table>

PPI = \( \frac{10,400 + 100}{100} \)

= 104

This indicates an improvement over the prior period.

Order Point System:

For effective inventory control, there are several mathematical inventory techniques that are available to the systems analyst. One is the Fixed Quantity variable cycle inventory model, often called an "Order point System". This system calls for the use of the EOQ model with the addition of lead-time stock and safety stock.

Determination of the order point, which is related to the lead time stock and the safety stock, proceeds as follows.

\[ OP = (ADU \times LTD) + SS \]

where  
OP = Order Point(units)  
ADU = Average Daily Usage(units)  
LTD = Lead time (days)  
SS = Safety stock
When the inventory level falls to the order point level, the system requires a purchase order to be prepared in the amount of the EOQ. If for some reason the demand exceeds the lead-time stock, the company is protected by the safety stock.

MAD (Mean average Deviation) is a method in which the absolute deviation from the norm for each entry in a time series is averaged. The resulting MAD can be compared against the mean of the series to determine the amount of fluctuating demand. If the MAD is small, the items has rather a stable demand pattern. and large MAD indicates that the item has an unstable demand pattern. The formula for MAD is as follows:

$$\text{MAD} = \frac{1}{N} \sum_{i=1}^{N} (|X_i - \bar{X}|)$$

Where $N =$ number of observations
$X_i =$ individual observations
$\bar{X} =$ average for all observations.

By using the MAD method instead of the Standard Deviation, confidence intervals can be established. (One 1.25) MAD added to the average will give a confidence interval of 78.81(84.13) percent; two (2.5) MADs 94.52(97.72) percent; and three(3.75) MADs 99.18(99.87) percent. Thus equation can be written as

$$\text{OP} = (\text{ADU} + \text{LTD}) + 3 \text{ MAD}$$

for a 99.18 percent assurance of not having a stock-out throughout the year.
Referring to the ABC method of analysis, the A and B items are easily controlled by the order-point system. However, the control differs in that A items have a 99 percent service level and the B items have a 95 percent service level. The order point level for A and B items is determined as follows:

A items:

\[ OP = (ADU \times LTD) + 3 \text{ MAD} \]

B items OP:

\[ OP = (ADU \times LTD) + 2 \text{ MAD} \]

Those items designated as C items are easily controlled by a visual review system.

**DSS PURCHASING AND INVENTORY SUB-SYSTEMS:**

The DSS can produce purchase orders after evaluating the best vendor for the purchase, it can produce the required follow up information and it can evaluate overall performance factors deemed important to purchasing management. It allows the purchasing agents to have the required support over their decision making activities. It allows not only the corporation's purchasing agents to secure a constant flow of reasonably priced supplies, but also have the flexibility to act in response to predicted scarcities, price variations etc.,. From this broader viewpoint, purchasing can lower procurement and overall purchasing costs of goods.
Buying and follow-up:

The actual ordering phase of the purchasing subsystem consists of these separate and distinct phases: buying or purchase order preparation, maintenance of purchase orders and follow up of purchase orders previously issued to the vendors.

Buying:

An efficient purchasing operation in a DSS operating mode goes beyond calculating an Economic Ordering Quantity for a specific purchased part. It involves an evaluation of past vendor performance as a guide to future vendor performance. EOQ is calculated and Purchase Performance Index which is a weighted composite of the price, quality and delivery indices is employed to select the appropriate vendor. The vendor having the highest PPI is selected for the order under consideration.

Purchase Maintenance:

Purchase maintenance involves the updating process of purchasing records. The open purchase orders, vendor master file, and inventory master file must be capable of being updated for the latest vendor additions and deletions, price and price break changes, revised vendor terms and comparable items.

Purchase follow-up:

Purchase order follow-up keeps track of order progress. Prior-issued purchase orders are reviewed weekly by a computer program that references the open
purchase orders and vendor master file. Exception reports are prepared for vendors and
buyers/user departments. Vendor expedite notices are prepared by Regional Office and
reviewed by the user departments before mailing. Price changes, defective parts supplied
and late delivery reports are issued to buyers/user departments with copies of vendor
expedite notices. This approach gives buyers visual control over exceptions occurring in
their areas.

Although the foregoing computer procedures center around weekly
follow-up reports, the purchasing data base can be referenced as needed to obtain
critical information on a particular order.

Critical Purchasing Areas:

Although buying, maintenance and follow up are concerned with merging
together the external and internal purchasing factors for the HPCL, there is need to get
a broader perspective of these factors within a Decision Support System. This can be
accomplished by having purchasing management retain control over these critical areas:
Measure of idle machines (Dispensing Units) resulting from a lack of purchased supplies,
measure of the extent of successful substitutes of materials and parts, value of purchase
orders subjected to competitive bidding, as a percentage of total orders placed, number
of rush orders, quantitative measures of expediting expenses, ratio of defective parts to
the total purchased parts, measures of vendor's keeping delivery promises.
Buying Performance:

The indices explained in the prior section, provide a framework for evaluating the purchasing subsystem. Performance reports in this regard are calculations of price, quality, delivery and purchase performance indices for specific vendors, buyers/user departments and purchased parts. They can be easily prepared by the system because all the appropriate data are stored on the RO's database. Although the reports set forth below are stated on a quarterly basis, more frequent reports can be generated if the corporation so desires.

Vendor:

The vendor quarterly performance report, illustrated below (-) is an evaluation of outside vendors who have supplied materials and parts to the HPCL. A comparison of the total amount purchased last year and this quarter gives an indication as to whether the buyers have been shifting business to or from certain vendors. Normally it would be expected that vendors with indices below 100 would be used less currently than they had been in the past.

VENDOR QUARTERLY PERFORMANCE REPORT FOR 1st QUARTER 98

<table>
<thead>
<tr>
<th>Vendor Name</th>
<th>Total amount Purchased last qtr.</th>
<th>Total amount Purchased this qtr</th>
<th>Price</th>
<th>Index-Quality</th>
<th>Index-delivery</th>
<th>PPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midco</td>
<td>42000</td>
<td>46000</td>
<td>98.25</td>
<td>105.20</td>
<td>115.15</td>
<td>104.21</td>
</tr>
<tr>
<td>L &amp; T</td>
<td>61000</td>
<td>55000</td>
<td>100.50</td>
<td>88.75</td>
<td>100.20</td>
<td>97.49</td>
</tr>
<tr>
<td>Shreenathji</td>
<td>18000</td>
<td>19000</td>
<td>108.15</td>
<td>102.25</td>
<td>95.45</td>
<td>103.50</td>
</tr>
</tbody>
</table>
**Buyer / User Department:**

Just as vendors can be evaluated, so can the corporation’s buyers. From the Management’s purchasing viewpoint, a buyer’s quarterly performance report has great meaning. By evaluating buyers on a comparable basis, management can pinpoint the weaknesses of its buying staff. Those buyers who are price-minded at the expense of quality materials and prompt delivery will be highlighted. An example of this is brought out in Table ( ) in which Asarwa Depot is shown as a buyer with relatively low PPI.

**QUARTERLY BUYER PERFORMANCE REPORT**

<table>
<thead>
<tr>
<th>Buyer’s name</th>
<th>Total amount, purchased last qtr.</th>
<th>Total amount, purchased this qtr.</th>
<th>Price</th>
<th>Index Quality</th>
<th>Index Delivery</th>
<th>PPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asarwa Depot</td>
<td>475200</td>
<td>481275</td>
<td>105.15</td>
<td>100.50</td>
<td>98.25</td>
<td>102.26</td>
</tr>
<tr>
<td>Vapi Depot</td>
<td>445988</td>
<td>450978</td>
<td>120.25</td>
<td>75.15</td>
<td>78.15</td>
<td>98.45</td>
</tr>
<tr>
<td>Nandeshri</td>
<td>501675</td>
<td>471981</td>
<td>99.50</td>
<td>102.50</td>
<td>105.15</td>
<td>101.66</td>
</tr>
</tbody>
</table>

The buyer performance report above can be further refined for more detailed analyses. Specifically, detailed analyses on price, quality, and delivery can be made for buyers (this is also true for vendors and parts). To illustrate, the Figure below depicts a detailed price analysis report for a specific buyer.
Each line on the report summarises all purchases for a particular part from a specific vendor made by one buyer. The most important part of this report is the last column. Quarterly percent variances alert the buyers to deteriorating price conditions especially when two or more buyers are competing for the corporation's business. As noted in the illustration, two suppliers' for part number 1032 should be scrutinised to determine the status quo regarding the prices. In this situation or any other, an extremely high (unfavourable) variance might show up for an item. Similarly, a much lower unfavourable variance might be associated with a much larger total expenditure. From an overall buying viewpoint, it would be more beneficial to the corporation if the purchasing agents spent their time on these items or at least started with these for critical appraisal.

Similar reports can be prepared for each buyer, showing the quality and delivery indices on his purchases of individual parts from specific vendors. Such reports are presented in Figure ( - ) below. The approach for these two reports is the same as above. The data base elements are summarised if there has been more than one purchase of a specific part from a particular vendor. As above, quarterly percent variances are
The quarterly purchased part report, shown below, centers on value analysis - that is whether or not the corporation is receiving value for parts purchased. If the price index is below 100, this might indicate that prices are rising and consideration might be given to replacing this purchased part with another. The delivery index might be critical in terms of attending to the repairs of the Dispensing Unit in time. The purchased part quarterly performance report gives purchasing management an overview of what the buyers are procuring and how effective they are.
PURCHASED-PART QUARTERLY PERFORMANCE REPORT FOR 1st QTR., 97

<table>
<thead>
<tr>
<th>Purchased Part Number</th>
<th>Total amount Purchased last Qtr.</th>
<th>Price</th>
<th>Quality</th>
<th>Delivery</th>
<th>PPI</th>
<th>Total amount purchased This Qtr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1012</td>
<td>18950</td>
<td>98.02</td>
<td>103.50</td>
<td>107.25</td>
<td>101.70</td>
<td>19059</td>
</tr>
<tr>
<td>1045</td>
<td>4975</td>
<td>105.78</td>
<td>98.25</td>
<td>96.54</td>
<td>101.59</td>
<td>6205</td>
</tr>
<tr>
<td>1035</td>
<td>20801</td>
<td>110.90</td>
<td>93.70</td>
<td>105.90</td>
<td>105.35</td>
<td>20221</td>
</tr>
</tbody>
</table>
Chart 5.1

Decision Situation Diagram- Spare Parts inventory management and Purchase Performance Evaluation.

- When to order?
  - Item of A class type
  - Item of B class type
  - Item of C class type

- How much to reorder?
  - Regular Order
  - Rush Order

- Who to buy from?
  - Vendors with Low PPI
  - Vendors with high PPI
PROBLEM IDENTIFICATION/BACKGROUND OF THE PROBLEM:

Order Capture Support System:

An incentive scheme is launched every year to maximise the sales of lubricants by the oil companies. The salient features of the scheme are

1. The incentive scheme is over and above the existing payment terms in which there are Trade and Cash discounts and postdate cheque facility.
2. The scheme is applicable for the upliftment of lubes during the current financial year.
3. The dealers/resellers would be entitled to receive benefits under the scheme only if they exceed the historical total volume of the applicable grades of lubricants.
4. No incentive will be given on volumes up to a certain volume (for example 12 KL) during the year irrespective of historical volume.
5. The payment of incentive will be as per certain slabs.

Each dealer based on their historical sales volumes is given a certain limit of credit by the supplier or the oil company.

There are instances when some Retail Outlet dealers lost incentive amount which is quite a substantial part of the total profit he makes in selling lubes for want of adequate data on historical sales, the knowledge of the grades included in the scheme, ability to calculate an EOQ quantity for a certain grade or all grades etc.
The principal objective of the Order Capture Support system is to maximise revenue by increasing the value of each order placed to the limit of the customer's credit. The ideal is to maximise profit of each Retail Outlet by calculating the EOQ based on historical upliftment of each grade and showing a statement of difference of profit that he makes when he places orders without making precise calculation of EOQ and the profit he makes in preparing his orders taking the professional assistance of the Salesman who calculates EOQ.

The Salesman in the process also gets to the goal of pushing specific items where sales are particularly desirable. The choice of those items is frequently restricted to new products, items which are overstocked, deteriorating or the grades the production of which is discontinued by introducing a superior variety of the same grade.

Since in the long term, customer satisfaction determines order value, a subsidiary objective is to achieve a service which buyer (Retail Outlet Dealer) perceives as being of at least a satisfactory quality.

Order taking process:

Orders at present are being prepared in three different ways. They are:

- produced by the customer and carried personally to the supply point or sent through the dealer's men.
- completed by a traveling salesman at the customer's site.
placed during a telephone conversation with the Salesman or the Supply Location head.

In order to ensure that customer has remembered to replenish his stocks of all those items which he normally buys, the salesman studies previous orders and deduces the likely stock level of each item by examining previous purchases from which he assesses the probable rate of consumption and so estimates the likely amount remaining in stock from the previous order(s). He then bases his suggestions as to what else the customer may need on those estimates.

The calculation is simple but it does take time to do it by hand and it is practically impossible to achieve when in conversation, particularly on telephone when the total period available is short.

A small expert system module which monitors an order as it is built up can provide estimates of consumption, remaining stock, the quantity of order to be economic or to maximise profit keeping the inventory carrying cost and order costs. Here the ability of an expert system to explain its recommendations is particularly valuable as it indicates what the salesman should tell the customer in order to convince him to buy. Such a system, by ensuring that the extra lines suggested are likely to be profitable to the customer and not just an ad hoc sales pitch, will increase his satisfaction with the service offered.
A variant of the above can be used where the products sold are logically interconnected. For example, the purchase of Motor Spirit (Petrol) indicates the approximate requirement of the amount of Super 2 T grade lubricant.

The salesman can point out to the customer that an additional so many units will secure an improved discount. In the long run the customer should find this to be a useful extra service which helps him to avoid stock-out of an item but does not clutter his shelves with slow-moving items. The salesman may also be directed to decide the order content by determining which products should be sold in preference to which others to maximise the profitability.

**PROBLEM STATEMENT:**

The problem or decision to be studied is how to guide the customer (Retail Outlet Dealer) to decide the sales order content that is most profitable to him and have the system make recommendations or provide assistance to the salesman in

- identifying the lines stocked by the customer, 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.
• advising sales staff on which lines to push in order to maximise 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 Salesman’s advice.

ANALYSIS OF THE PROBLEM SITUATION

Order Capture Support System:

The following are some of the important facts turned up in the analysis of the decision problem - Order Capture Support System.

1. At present there is no such computerised system available to offer any kind of assistance to the Salesman at the time of taking orders.

2. There is at present no professional approach being followed by Salesman in deciding the content of the order except that the lube fuel ratio (that is extracted from the Customer Sales Analysis - a monthly computer printout from the HQO) is used in just keeping track of the lube upliftment by Retail Outlet dealers in relation to their fuel upliftment. The historical lube sales volumes are also available in the manually maintained register of the Sales Officer and the same are prone to errors when the dealer makes upliftment from two or more supply points due to non-availability of particular grades or other such reasons.
3. The analysis of product group-wise sales of lubricants is done only at the time Sales Review Meets and the same is not used to capture orders of right mix from the Dealers or Retail Outlets.

4. The monitoring of the Dealers' utilisation of the Sales Incentive Scheme is not being done and at times the dealers are loosing huge incentive by uplifting total annual volumes that are just short of the volumes required to avail of the incentive. This situation is leading to a lot of customer(Dealer) dissatisfaction.

DATA REQUIREMENTS AND DATA SOURCES.

The data requirements for building an Expert & Decision Support system module for Order Capture Support System consists of the following:

1. Dealer-wise Sales of each grade of lubricant, historical, current, monthly and cumulative volumes.
2. Dealer-wise sales of MS and HSD historical, current monthly and cumulative volumes.
3. The details of the incentive scheme like the slab-wise incentive
4. Payment terms and credit limits of each dealer.
5. The cost of carrying inventory.
6. The margins of profit that the company earns on each product group separately.

The data mentioned under point no. 1 & 2 is available on the computer at the Supply location as it is part of the Distributed Data Processing Package.

The data mentioned under point no. 3, 4 and 6 need to be entered into a separate database so that the Order Capture Support System module can access. The data under point no. 4 i.e. the cost of carrying inventory may be uniformly taken as the rate that is equivalent to the Commercial Bank's lending rate.
Chart 5.2

Decision Situation Diagram for Order Analysis

See Fig. 5.5

Acceptable Order
Chart 5.3

Decision Situation Diagram - Improvement required - value.

- Improvement Required in value
  - Credit Limit
    - Type title here
  - Historical Sales
    - Month/Cumulative
  - Average Upliftment
    - Falls Short - yes
    - Falls short-no
    - Comparable
    - Not comparable
    - Value > Avg.Order
    - Value < Avg. order
Chart 5.

Decision Situation Diagram - improvement required in composition.
Chart 5.5
OVERALL DEPENDENCY DIAGRAM FOR ORDER ANALYSIS PROCESS SYSTEM - INITIAL PROTOTYPE.
Chart 5.
DEPENDENCY DIAGRAM FOR ORDER ANALYSIS PROCESS SYSTEM - PROFITABLE
PRODUCT GROUP SEGMENT.

Profitable Product Groups

- Present
  - In the desired composition
  - Not in the desired Composition

- Absent
  - Addition is feasible and recommended
  - Addition is not feasible
DEPENDENCY DIAGRAM FOR ORDER ANALYSIS PROCESS SYSTEM - EOQ OF PRODUCT GRADES SEGMENT.

- EOQ of Prod. grades
  - Comparable
    - Order acceptable with out change
    - Order acceptable with change in prods.
  - Not comparable
    - Qty Change recommended
    - Not recommended since not feasible.
Benefits and Limitations:

The screening or Order analysis process begins upon the receipt of order by the Supply location. These orders are either voluntarily submitted by the Retail Outlet dealer or result from the Sales Force's marketing efforts. The orders normally contain information on the lubricants required, size of package, total quantity required, value of the total order etc.,

An overall outline of the Order Analysis process is presented in Figure 1. As can be seen in the Decision Situation Diagram 1, the orders may require change in composition and/or change in value. Change in composition might be required to include - the profitable product groups that the dealer has not included which he may when suggested, the slow moving items, the products the consumption of which is logically connected with other product(s) and if the EOQ of the products do not parallel the Quantities mentioned in the order in some or all the grades.

The profitable product groups though present, the quantity may not be the acceptable minimum the Salesman wants the dealer to buy and thus may want to advise a change in quantity. The slow moving items too, though present, the quantity may not be the acceptable minimum the Salesman wants the specific dealer to buy keeping in view the dealer's ability as evidenced from the historical sale of similar products, the quantity of the product(s) the consumption of which is logically connected with the other product may not be in the desired proportion to the consumption of the
other product and the salesman on observing this can know if the dealer is using any poor or competitor's substitute.

The value of the order may be exceeding the Credit Limit the Retail Outlet has been granted and the Salesman may wish to take a special approval from the Manager-Concerned in order not to lose the sale, and if the order from a particular dealer is frequently exceeding the Credit Limit in the recent past, the Salesman may wish to recommend an enhancement of the Credit Limit taking the other relevant / pertinent information into consideration. The Salesman may also want to see whether the value of the current month order when compared to the historical order value is more or less, the cumulative value of the current year orders till date to the historical cumulative value for the same period is more or less and if less may wish to use the same as a point in aid to push the sale or revise the Order value upwards and the same logic/approach he might use with the average order size by comparing it with the current order.

User Interface Requirements:

The system accessing the data from the relevant updated files should be capable of displaying the appropriate messages on the screen to help the Salesman advise the change and should also be capable of generating the report of additional benefits derived by comparing the Original Order of the dealer with the revised order accepted. The sample messages associated with various alternative situations or events are provided to serve as examples.
As stated above, the approach adopted and recommended in this study to achieve the objective of sales maximization of both motor fuels and lubricants, is by building a decision support subsystem for the identified three critical functions: Trading Area and site selection, Purchase performance and inventory management of Dispensing Unit spares and order capture support. The design of Trading area/ site selection and Purchase performance/inventory management of dispensing unit spares modules is mathematically based.

From an overall standpoint, the Sales Maximization sub-system supports the decision making at the Regional Office level only. However, the inventory management of dispensing unit spares can be off-loaded from the Regional Office to the Depot level, since Depot is the place where the physical stock of the dispensing unit spares exists. Corrective measures deemed necessary can be effected faster because of immediate feedback.