8.1 INTRODUCTION

Price is one of the most powerful tools which differentiates within the competing product, creates the first image of the product in customers' minds and also generates revenue. According to seller's view, it is a source of revenue, and from consumer's view, it is the value that the customer pays in return of product or service, he receives. The base or lower limit of a price is set by cost and the upper limit set by demand of the product. Low price usually attracts a new customer as lowering the buyer's expectation and it always switches the loyalty of a customer. But, a strong set of value propositions hinders to low price. So, a good pricing strategy should consider price-value equation into its consideration. Hence, price is an indicator, which reflects the financial success of the company and value that is attached with company's product. The price which is charged for company's product/brand means a lot to the customer and to the company itself. It gives signals to competitor about company's plans for the product. Pricing a product or service is one of the most important and difficult areas in the process of marketing decision making. The quality of pricing decision can be an important determinant of the success or failure of a company. The management of pricing is important on both aspects i.e., economic and social standpoints. It is a measure of company's confidence in its product and ability to market it. The pricing decisions are made by marketing executives depending upon various factors taken into consideration viz., price sensitivity of consumers, product segmentation, the size of the company, number of competitors and their unpredictable moves in market segments, the dynamic nature of technology, forecast of demand, cost of the production and geographic segments in which it serves and for societal interests as well as national, etc.

The pricing decision becomes difficult and risky under the pressure of customer and competition and in such a situation, decision-maker's role becomes utmost important in understanding and determining pricing policy as price of the product should not be above, or too far below the perceived values that are to be offered. There is no one perfect solution in pricing, but drawing strategies in planned scientific ways can help to some extent in getting amicable solutions satisfying marketing objectives. While taking critical pricing decision, corporate executive has to take into equal consideration of both profit (corporate goal) and satisfaction (social responsibility). In evaluating pricing structure for a product or service, the decision-maker has to give utmost significance to the decision variables within the prevailing marketing condition.

a) Customers vary in their behaviour viz., abilities, needs, expectations and willingness to pay and purchase a product or service in any market situation. And, the grouping of customers with similar abilities, needs, expectations and willingness to pay and purchase behaviour that are largely common to
form a segment which itself forms a separate market. Price is one of the appropriate basis of grouping the potential customer to form target market segments. The management has to define such target market segments, so as to cater required product or service and appropriate marketing policy to serve it. While doing so, the management can have other benefits from segmentation by price such as reducing the cost of production and to produce the suitable product to that of market segment and in some cases leads to product innovation and new designs. In setting pricing policy for segments, one must consider the value that particular customer attaches to the segment offering. In formulation of pricing strategy, the market segmentation method is considered to be appropriate technique in identifying the problem and preparing required methodology for deciding sound basis of market opportunities. The pricing strategy should be such that it has ability to respond rapidly to changing customer demand and quickly countering competitors action.

In the present study, the management of pricing for milk and its products is highly complex due to its perishability nature. In Keonjhar district of Orissa state (India) milk is mainly produced in rural areas as availability of milch cattle are mostly in rural areas and where consumption of milk and its products are less in comparison to demand in urban areas. Cow's milk is mainly consumed for drinking purposes and buffalo milk for manufacture of products. The major portion of milk production is consumed in form of fluid only and in milk products the ghee is the next most product consumed. The average per capita consumption of milk and its products vary from one part to other due to it's availability, the level of income of the people and the various prices. The co-operative marketing is in developing stage and lack of co-ordination between the producer, collector and distributor is a complicated phenomenon in pricing determination. And also, the uncertainties in this business has cumulated more risks for the rural producers. The collection and assembling of milk, transportation to distant area and processing in large quantities are yet in a undeveloped state in present study area. As a result of which, the maximum consumption of fluid milk is confined to the area of its production only.

Consumers are normally very much price conscious, whether it is consumer durables or food items. The pricing management of milk and its products mainly depends on following points:

a) The prices of fresh milk vary from one area to other due to:
   - type and performance of the milch animals,
   - amount of grazing area available,
   - supply and cost of fodder,
   - cold storage facilities availability, pasteurising and packaging,
   - distance from areas of production and consumption,
   - the cost of transportation,
b) The seasonal price variations are due to:
- calving seasons which are divided into: summer (March to June), monsoon (July to October) and winter (November to February), and/or,
- the non-optimal demand and supply as wholesale prices are generally the highest during summer and lowest during monsoon month. Retail prices undergo variation during fairs and festivals when they may be raised according to the intensity of demand.

c) The prices are fixed according to the classification of milk on gradation basis. Three distinct types of milk are available in market viz., cow, buffalo and goat. Cow’s milk is used for drinking purposes whereas buffalo’s milk, which is richer in fat, is higher priced than cow’s milk and the price of goat’s milk is low in comparison to other two types. The various unfair means normally adopted in this trade forces the price discrimination of milk on gradation basis.

d) The prices are normally fixed after keeping the margin by the two intermediaries between the producer and the consumer, namely, the collector and the distributor.

e) The prices are the result of competitive forces which are fairly well predictable through historical data.

8.2 RESEARCH METHODOLOGY
8.2.1 Research Purpose and Objectives

This research was designed to illustrate the application of segmentation principles into pricing decision. Particularly in focusing on dairy industry, the research was designed to operationalize a generalized market segment framework which would isolate specific market segments for pricing policy of dairy product market. Prices for a particular product in a market are not static; they must be evaluated at regular intervals and adjusted accordingly in different market segments. The product cost is considered to be the lower boundary or floor price to be charged and competitive prices of substitute products are considered as upper boundaries or price ceiling. But right price is that which trade-off between lower and upper boundary as determined by the willingness and ability of customers to buy and also known as optimum price. The market segments selected on the basis of price are appropriate market to be served by a product. And, the management can have other benefits on this basis of market segment viz., reducing the cost of production, to produce the suitable
product to that of market segment and in some cases leads to product innovations and new design.

The pricing objectives depend on each stage of the product life cycle and the market segment being served. In this model, the objective is to determine the prices to be charged in different market segments which would maximise the market share and minimise variation of prices of dairy products.

8.2.2 Information Collected:

1. Milk and milk products available in Keonjhar district.
2. Types and quality of milk and milk products available in Keonjhar district.
3. Demand and supply of the milk and milk product in the area.
4. Number and type of competitors in the area and their product’s prices and sales promotion techniques, etc.
5. Type of prices and price structures for various product lines.
6. Pricing strategy associated with present market condition by different competitors.
7. Prices adopted during specific situations or specific seasons, festivals or other occasions.
8. Types of consumers, their characteristics such as socio-economic, behavioural, psychographic and preferences, liking and habits, etc.
9. Consumer price consciousness and purchasing abilities.
10. Size of dairy industry, trends of sales and factors affecting industry’s sales.
11. Size and characteristics of market and market environment.
12. Market share of currently existing products in the dairy industry.

8.3 MARKET SEGMENTATION BASED ON PRICE - QUALITY DECISION VARIABLES

The price to be charged for each particular product in market segment is to be determined. Each product has its own base price and depending on this appropriate price are set for products in different market segments. A logical sequence of market segmentation for determining a price for a product in a specific segment is to be set. The market can be segmented basing on price for wide range of product lines in different geographic areas. Quality of product can discriminate among heterogeneous consumers. The geographically separated markets have varying price structures depending upon the availability of product, transportation costs or any tax or levy structure in the prevailing market, etc. The present study considers two distinct geographic segments as described above.
In the present study, the seven products considered, are sold to the same customer groups and marketed through the same channels. The seven items in product-line segments are as follows: Fluid milk is classified into three categories depending upon contents of fat and snf via., double tone milk (1.5% fat and 9.0% snf), tone milk (3.0% fat and 5% snf) and whole milk (4.0% fat and 8.0 snf) and milk products considered are ghee, butter, flavoured milk and yogurt. The product-line makes the most sense when each item performs its own sale and profit in its line and compares it with competitors' product-line.

In the present context marketing mixes of milk and milk products greatly vary in rural and urban areas. Marketing channels are considered to be more significant in the marketing mix of milk and milk products and have greater variance in the rural and urban market segments. Most of fluid milk is procured from rural areas and demand for fluid milk and milk products is more in urban market with comparison to rural market. Here the marketing channel levels are considered for segmenting geographic markets for deciding price of dairy products. The marketing channel levels can be direct, single level and multilevel. Also, the market situation based on, demand and supply of the dairy product can separate market segments in deciding the price, which has been depicted in table 8.1. For the application aspect, the construction of the segmentation tree done on a priori segmentation basis for price decision as shown in Fig. 8.1.

8.4 ALGORITHM

STEP 1 : Solve m linear programming problems of maximisation type stated as

$$\text{Max } G_i(X) ; i = 1 \ldots m$$

Subject to

$$A_j(X) \leq b_j$$

$$X \geq 0$$ .................................................. (8.1)

Let $X^1$ be the optimum solution which maximises the $i^{th}$ objective $G_i(X)$ given $g_i$ as its optimal value. The pay-offs on the other objectives at $X^1$ can be denoted by $g_{ij}$ signifying the value of $j^{th}$ objective $G_j(X)$ of the optimal point $X^1$ of the $i^{th}$ objective.

STEP 2 : Construct a pay-off matrix $P_{ij}$ given by

$$P_{ij} = \begin{bmatrix}
g_{11} & g_{12} & \cdots & g_{1j} & \cdots & g_{1m} \\
g_{21} & g_{22} & \cdots & g_{2j} & \cdots & g_{2m} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
g_{m1} & g_{m2} & \cdots & g_{mj} & \cdots & g_{mm} \\
\end{bmatrix} \ldots \ldots \ (8.2)$$
where the matrix can be referred to as decision matrix. The k tuple \((g_{11}, g_{22}, \ldots, g_{mm})\) comprising the diagonal element of the matrix \(P_j\) is the ideal point in the \(m\) dimensional criterion space. Due to the conflicting nature of the objectives, this point usually does not lie in the feasible criterion space. Denote this point by \(g^* = (g^*_1, g^*_2, \ldots, g^*_m)\) after replacing \(g_{ii}\) by \(g^*_i\). The boundary point for the objective \(G_i(X)\) can be obtained by taking the minimum of all \(g_{ij}\) for \(i \neq j, i = 1, \ldots, m\). Hence, for all \(G_i(X)\), their boundary point can be taken as \(g_i\).

**STEP - 3:**

1. Specify \(P_{ii}\) and \(P_i\) for each \(G_i(X) : i = 1, 2, \ldots, m\).
2. Assign the maximum possible overall satisfaction \(\beta_j \in [0, 1]\), such that \(1 = \beta_0 \geq \beta_1 \geq \beta_2 \geq \ldots \geq \beta_n = 0\).

Considering the objective \(G_i(X) > b_i\) with tolerance \(P_i\) for \(G_i(X)\), divide the interval \([P_i, b_i]\) into sub-intervals \([q_{i,j-1}, q_{i,j}]\), \(j = 1, 2, \ldots, N\), such that \(P_i = q_{i,N} \leq q_{i,N-1} \leq \ldots \leq q_{i,0} = b_i\).

Construct a piecewise linear approximation \(\mu_{G_i}(X)\) for the \(i\)th objective such that,

\[
\mu_{G_i}(X) = \begin{cases} 
0 & \text{if } G_i(X) \leq q_{i,N} = P_i \\
\beta_j + [(\beta_j - \beta_{j-1})/(q_{i,j-1} - q_{i,j})](G_i(X) - q_{i,j}) & \text{if } q_{i,j-1} \leq G_i(X) \leq q_{i,j} \\
1 & \text{if } G_i(X) \geq b_i\end{cases} \tag{8.3}
\]

Figure (8.1) depicts the general shape of a piecewise linear and continuous membership function which should be concede over its support.
3. As it is needed to maximise the overall satisfaction using the membership functions, using additive operator for aggregating the objectives; the problem can be modelled as:

\[ \sum_{i=1}^{n} \lambda_i \leq \mu_{G_i}(X), \quad i = 1, 2, \ldots, n \]
\[ \mu_{G_i}(X) \leq \beta_{j-1} \]
\[ A_j(X) \leq b_j, \quad j = 1, 2, \ldots, l \]
\[ X, \lambda \geq 0 \]

(8.4)

4. Determine the outputs using any appropriate algorithm or computer code.

5. The solution vector \( X^* \) associated with this computation stage in the final solution.

**Numerical Example:**

Let the multi-criteria decision system involves 4 objectives which are conflicting and non-commensurable and at the same time they are bounded by 6 rigid constraints. Mathematically it may be stated as:
A. $8x_1 + 9x_2 + 7x_3 + x_4 - 8x_5$
B. $-9x_1 - 8x_2 - 8x_3 + 7x_4 + 7x_5$
C. $-x_1 - 6x_2 + 5x_3 + 9x_4 + 7x_5$
D. $5x_1 + 4x_2 - 2x_3 + 2x_4$

S.t.
1. $4x_1 + 2x_2 + 9x_3 + x_4 \leq 70$
2. $9x_1 + 5x_2 + 4x_3 + 2x_4 + 2x_5 \leq 108$
3. $7x_1 + x_2 + 6x_3 + 6x_4 + 3x_5 \leq 117$
4. $x_1 + x_2 + 6x_4 + 2x_5 \leq 125$
5. $9x_1 + 6x_4 + 2x_5 \leq 98$
6. $4x_1 + 4x_2 + 4x_5 \leq 72$
7. $x_1, x_2, x_3, x_4, x_5 \geq 0$

The maximum and the corresponding minimum for each of the objective can be obtained from $P_{ij}$:

$$P_{ij} = \begin{bmatrix} 152.86 & -133.67 & -132.48 & 11.38 \\ -159.54 & 198.33 & 196.97 & -33.68 \\ -73.41 & 218.97 & 219.83 & 84.86 \\ 10.56 & 15.34 & 16.34 & 76.68 \end{bmatrix}$$

Now, basing on the points, we obtain the following set of piecewise linear membership functions as:

$$\mu_1(Z_1) = \begin{cases} 0.6 & - \frac{0}{38.248 + 133.67} [G_1(x_1) + 133.67] \\ \frac{0}{171.918} \end{cases}$$

$$\mu_{11}(Z_1) = \begin{cases} 1 - 0.6 & \frac{1}{152.86 - 38.248} [G_1(x_1) + 38.248] \\ \frac{0}{114.612} \end{cases}$$

$$\mu_2(Z_2) = \begin{cases} 0.6 & - \frac{0}{55.182 + 159.54} [G_2(x_2) + 159.54] \\ \frac{0}{214.722} \end{cases}$$
\[ \mu_{22}(Z_2) = 0.6 + \frac{1 - 0.6}{198.33 - 55.182} [G_2(x_2) + 55.182] \]
\[ = 0.6 + \frac{0.4}{143.148} [-9x_1 - 8x_2 - 8x_3 + 7x_4 - 7x_5 - 55.182] \]
\[ \mu_3(Z_3) = 0 + \frac{0.6 - 0}{102.534 + 73.41} [G_3(x_3) + 73.41] \]
\[ = 0.6 \frac{-x_1 - 6x_2 + 5x_3 + 9x_4 + 7x_5 + 73.41}{175.944} \]
\[ \mu_{33}(Z_3) = 0.6 + \frac{1 - 0.6}{219.83 - 102.534} [G_3(x_3) + 102.534] \]
\[ = 0.6 + \frac{0.4}{117.296} [-x_1 - 6x_2 + 5x_3 + 9x_4 + 7x_5 - 102.534] \]
\[ \mu_4(Z_4) = 0 + \frac{0.6 - 0}{50.232 - 10.56} [G_4(x_4) + 10.56] \]
\[ = 0.6 \frac{5x_1 + 4x_2 - 2x_3 + 2x_4 - 10.56}{39.672} \]
\[ \mu_{44}(Z_4) = 0.6 + \frac{1 - 0.6}{76.68 - 50.232} [G_4(x_4) + 50.232] \]
\[ = 0.6 + \frac{0.4}{26.448} [5x_1 + 4x_2 - 2x_3 + 2x_4 - 10.56] \]

The problem can be transformed into:
Max \( \lambda = \lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 + \lambda_8 \)
S.t. \( \lambda_1 \leq \mu_1(Z_1), \mu_1(Z_1) \leq 0.6, \)
\( \lambda_2 \leq \mu_1(Z_1), \mu_1(Z_1) \leq 1, \)
\( \lambda_3 \leq \mu_2(Z_2), \mu_2(Z_2) \leq 0.6, \)
\( \lambda_4 \leq \mu_{22}(Z_2), \mu_{22}(Z_2) \leq 1, \)
\( \lambda_5 \leq \mu_3(Z_3), \mu_3(Z_3) \leq 0.6, \)
\( \lambda_6 \leq \mu_{33}(Z_3), \mu_{33}(Z_3) \leq 1, \)
\( \lambda_7 \leq \mu_4(Z_4), \mu_4(Z_4) \leq 0.6, \)
\( \lambda_8 \leq \mu_{44}(Z_4), \mu_{44}(Z_4) \leq 1, \)
\[4x_1 + 2x_2 + 9x_3 + x_4 \leq 70\]
\[9x_1 + 5x_2 + 4x_3 + 2x_4 + 2x_5 \leq 108\]
\[7x_1 + x_2 + 6x_3 + 6x_4 + 3x_5 \leq 117\]
\[x_1 + x_2 + 6x_4 + 2x_5 \leq 125\]
\[9x_1 + 6x_4 + 2x_5 \leq 98\]
\[4x_1 + 4x_2 + 4x_3 \leq 72\]
\[x_1, x_2, x_3, x_4, x_5 \geq 0\]

The final solution is
\[\lambda = 4.8\]
\[X = (1.740457, 4.050686, 0, 12.663490, 2.086742)\]
\[G = (38.250196, 55.18202, 102.53403, 50.232009)\]

8.5 MODEL FORMULATION
8.5.1 Decision Variables, Constants & Symbols:

The model consists of a number of decision variables, constants and symbols. These are discussed below. All values and variables, unless otherwise specified, refer to the particular time period.

\begin{align*}
p & : 1, 2, 3 ..., 5 \text{ for product line segments of dairy products viz., Milk, Ghee, Butter, Flavoured Milk and Yogurt.} \\
g & : 1, 2, 3, 4 \text{ for geographic segments viz., Keonjhar, Barbil, Harichandanpur and Saharpada.} \\
q & : 1, 2, ..., n \text{ for quality of } p^{th} \text{ dairy product.} \\
c & : 1, 2, 3 \text{ types for marketing channel level viz., direct, one level and multi-specific.} \\
m & : 1, 2, ..., n \text{ for specific marketing demand supply condition viz., table 8.1.} \\
(p,q,g,c,m) & : p^{th} \text{ dairy product of } q^{th} \text{ quality type in } g^{th} \text{ geographic segment distributed through } c^{th} \text{ marketing channel level in } m^{th} \text{ marketing demand - supply condition} \\
mc & : \text{Price for variable } (p,q,g,c,m). \\
\text{VX} & : \text{Variation on price for variable } (p,q,g,c,m). \\
\text{M} & : \text{Market share for variable } (p,q,g,c,m). \\
\text{M} & : \text{Minimum levels of market share} \\
\text{D} & : \text{Marketing channel price limit} \\
\text{S} & : \text{Price limit based on specific demand - supply situation.}
\end{align*}
mc : Allowable flexible price percentage in different market FX segments for variable(p,q,g,c,m).
pqg
Q : Quality based price limits.
E : Ethical expectation value of price of product.
G : Geographical area covered.

8.5.2 System Constraints :
(i) Market Share Constraint

Price is typically one of those factors that carries the heaviest responsibility for improving or maintaining market share - a sensitive indicator of customer and trade acceptance. However, with proper pricing policy it is possible to increase the market share considerably. Such a market share can be achieved by market segmentation, where the different market segments are separated, and in each market segment a different price per product prevails. But, at certain time period the market share should be above certain acceptable level than its competitors or substitute products.

\[
\sum_{p} \sum_{q} \sum_{g} \sum_{m} M_{pqg} X_{pqg} \geq M \text{ for all } p, q, g, m, c. 
\]

(ii) Price Restriction Based on Marketing Channel :

Pricing decision depends in the management of marketing channels. The channels adopted and the discount policies practised influence the pricing decisions. Depending on the geographic conditions and the range of market, the marketers should decide on price of product. Where the circumstances require, the marketing channel should be shortened. It would minimise the over-all cost vis-a-vis would maintain economy in the process of price policy and distribution. This variable is fully under the control of a marketing manager. Depending of channel management the price determining decision is affected. So, there is a limiting condition to prices at various market segment under specific marketing channels. Mathematically, it can be put as :

\[
\sum_{p} \sum_{q} \sum_{g} X_{pqg} \geq D \text{ for each } c. 
\]

(iii) Price Restriction due to Demand - Supply Trade Off :

Price is important determinant in economic situation and changing competitive environment. Pricing decision approaches are designed on demand level and to extend the existing demand level. With changing economic situation along with competitive environment, the demand of product vary. Depending on demand - supply situation with economic diversification
situation, the market situation is different and hence, to fix the price of product totally depends on the above factor. There are different market segments available to cater the product with tailor made customised pricing and promotional programmes. So, the price structure is determined on the basis of demand - supply situation of the market segment. Mathematically, it can be put as :

\[ \sum_{m} \sum_{p} \sum_{q} \sum_{g} \sum_{c} X_{pqgmc} \leq S \quad \text{for each } m. \]

(iv) **Variable Pricing Constraint** :

Contrary to the one pricing policy, the flexible or variable pricing policy adopts different prices for the similar quantities of goods sold to the buyers. The variable pricing policy if used under the jurisdiction of marketing legislation, can really generate a lot of profit, sometimes temporarily and on other occasions for long time to come. Price variation can also be done based on various market segments. One can continue doing a discrimination until it sounds unethical or it is below the consumer perception level. This relationship can be mathematically put as :

\[ \sum_{m} \sum_{p} \sum_{q} \sum_{g} \sum_{c} V_{X_{pqgmc}} \geq F_{X_{pqgmc}} \quad \text{for each } p, q, g, m, c. \]

(v) **Geographical Restriction** :

Usually, we find distribution costs of products in different geographic regions to be different. In this respect, the firms adopts pricing policy according to deliver the merchandise to the customer’s market segments. The pricing of product through particular marketing channel depends on geographical regions. Mathematically,

\[ \sum_{m} \sum_{p} \sum_{q} \sum_{c} X_{pqmc} \leq G \quad \text{for each } g. \]

(vi) **Product Quality Restrictions** :

Due to difference in quality of dairy products, the marketers have to discriminate in pricing policy in different market segments. The marketers can identify and separate the markets for straight forward price discrimination, in the basis of product price - quality combination. So, to accept pricing structure according to quality of product, the condition can put mathematically as:
(vii) Ethical Constraint:

It would be right to mention that ethics establishes a close relationship with the pricing decisions. The ethical considerations include rational attitude of the decision maker, particularly while maintaining the quality and optimising the cost. At present days, business ethics are not maintained and we find qualitative degeneration on almost all the fronts and frequent escalation in prices of goods. This will affects firm's image and also brand. Hence, it becomes essential that the consumers at large are offered right goods at reasonable prices. The pricing decisions should mostly be guided by ethical considerations. Ethical expectation value can be calculated by subjective judgement. Mathematically, expected ethical price of product value should be above certain limits.

\[ \sum \sum \sum \sum \sum X \leq E \text{ for all } p, g, q, m, c. \]

8.5.3 System Objective:

I. Market Share Objective:

Market share refers to the segment of a total market controlled by one firm's brand. It is expressed as the sales of a particular firm's product / brand or line of products in relation to total industry sales and computed as percentage. Market share can also be expressed as revenue generated by quantity of firm's product / brand sales in the given market segment to total revenue of industry sales in total market. This can be expressed as:

\[
S = \frac{C_s}{I_s} = \frac{S_c q_c P_c}{I_s} = M P_c
\]

\[ S = \text{Market Share of particular segment.} \]
\[ C_s = \text{Company Sales.} \]
\[ I_s = \text{Industry Sales.} \]
\[ S_c = \text{Number of Customer in a particular segment.} \]
\[ Q_c = \text{Quantity of company product sold in a particular segment.} \]
\[ P_c = \text{Price of company product charged in a particular segment.} \]
\[ M = \frac{S_c Q_c}{I_s} \]
Market share is a demand oriented concept where increasing or maintaining share is considered as key to effective marketing mix. In case of marketing of dairy products based on pricing strategy the efficient management of the pricing in different market segments are key to improve firms profitability further through increasing its market share. Market share objective is a benchmark which represents that portion of a market a company wishes to capture. So, the objective function of this model is to maximise market share based on price in different market segments which can be expressed as:

\[ \text{Max} \sum \sum \sum \sum M^p_q_g_m_c X \text{ for all } p, q, g, m, c. \]

II. Price Variation Over Product Line Objective:

A company can have different products in its product line, which may be highly popular or low image product items and also some fast selling product items and not so fast selling items. A pricing strategy has to consider all these products. Secondly, each segment is presented with a price which is appropriate for the customers in that segment. Prices over product line inn any segment should not vary with change in environmental factors such as economic, political or market demand - cost situations. In order to keep the product/company image and quality of product with standard and stable price over a period of time as customers to a given segment will not ‘drift’ and purchase the product in other / lower price market segment. We can now define price variation over product line is the difference in actual price of product in given segment to the previous price of that product in that segment. Mathematically it can be expressed as:

\[ \Delta P = \text{Variation of price of product in specific time period.} \]
\[ P_a = \text{Actual price of product under certain environmental factors.} \]
\[ P_p = \text{Previous price of product.} \]

Hence, the strategy to achieve maximisation of profits over the product line requires minimisation of variation of price over product line. Mathematically it can be put as:

\[ P = \frac{1}{\Delta P} \]

\[ \text{Min} \sum \sum \sum \sum P^p_q_g_m_c X \text{ for all } p, q, g, m, c. \]
8.6 APPLICATION

8.6.1 Decision variables, constants and symbols:

The decision variables, constants and symbols for the application are discussed below. All values and variables unless otherwise specified refer to the particular time period.

- \( p \) : 1 for product line segments of dairy products i.e., Milk.
- \( g \) : 1, 2 for geographic segments viz., Keonjhar and Barbil respectively.
- \( q \) : 1, 2, 3 quality of milk viz., Whole Milk, Tone Milk and Double Tone Milk respectively.
- \( c \) : 1, 2 types of marketing channel viz., Direct and Multi Level Channel respectively.
- \( m \) : 1, 2 market demand - supply condition viz., High Demand - Average Supply, High Demand - High Supply respectively.

\( (p,q,g,c,m) \) : \( p \)th dairy product of \( q \)th quality type in \( g \)th geographic segment distributed through \( c \)th marketing channel level in \( m \)th marketing demand - supply condition.

- \( \text{mc} \) : Price for variable \((p,q,g,c,m)\).
- \( \text{VX} \) : Price variation for variable \((p,q,g,c,m)\).
- \( \text{X} \) : Price limit based on specific demand - supply situation.
- \( \text{FX} \) : Allowable flexible price percentage in different market segments for variable \((p,q,g,c,m)\).
- \( \text{M} \) : Minimum levels of market share.
- \( \text{D} \) : Marketing channel price limit.
- \( \text{S} \) : Price limit based on specific demand - supply situation.
- \( \text{Mc} \) : Quality based price limits.
- \( \text{E} \) : Ethical expectation value of price of product.
- \( \text{G} \) : Geographical area covered.

8.6.2 System Constraints:

(i) Market Share Constraint

\[
\sum_{p} \sum_{q} \sum_{g} \sum_{m} \sum_{c} \text{mc} \text{mc} \text{X} \geq M \text{ for all } p, q, g, m, c.
\]
(ii) Price Restriction Based on Marketing Channel:

\[ \sum_{p} \sum_{q} \sum_{g} \sum_{m} X_{pqgm} \geq D \text{ for each } c. \]

(iii) Price Restriction due to Demand - Supply Trade Off:

\[ \sum_{p} \sum_{q} \sum_{m} X_{pqm} \leq G \text{ for each } g. \]

(vi) Product Quality Restrictions:

\[ \sum_{p} \sum_{q} \sum_{m} X_{pqm} \leq Q \text{ for each } q. \]

(vii) Ethical Constraint:

\[ \sum_{p} \sum_{q} \sum_{g} \sum_{m} X_{pqgm} \leq E \text{ for all } p, g, q, m, c. \]

8.6.3 System Objective:

(i) Market Share Objective:

\[ \text{Max } \sum_{p} \sum_{q} \sum_{g} \sum_{m} X_{pqgm} \text{ for all } p, g, q, m, c. \]

(ii) Price Variation Over Product Line Objective:

\[ \text{Min } \sum_{p} \sum_{q} \sum_{g} \sum_{m} X_{pqgm} \text{ for all } p, g, q, m, c. \]

8.7 ANALYSIS AND INTERPRETATION OF RESULTS

The problem was solved by the algorithm as described in section 8.4 and by utilising Lindo Software in a Pentium PC at Department of Business Administration, Utkal University, Vani Vihar, Bhubaneswar. The final result obtained in presented in table 8.4 which allocates price to the dairy product (milk) with different qualities in different marketing segments catered by different levels of marketing channels under different demand - supply situation with the optimum value for objectives of price variation and market share.

The original data sheet of price variation and market share with different dairy products with different qualities in specific market segments, marketing
channels under demand - supply situations is presented in table 8.2. The initial price variation minimisation and market share maximisation value are presented in table 8.2. The maximum value for price variation in presence of the other objective is 0.721 and the corresponding minimum value for price variation is 0.382 (table 8.3). Similarly, the maximum and the corresponding minimum value for market share are 2.79 and 2.758 respectively (table 8.3). After construction of piecewise linear membership functions and the final solution obtained in given in table 8.4. The final solution values for price variation and market share are 0.385 and 2.757. The final solution received becomes totally acceptable and within the given limits. As the final solution appropriately assigns prices to various types of dairy product (milk) satisfying the given conditions and market situations, the solution looks perfectly acceptable.

The individual final values of the solution to this model is to assign specific prices to specific dairy product quality (milk) in different market segments - geographic segments, marketing channels and demand - supply situations. So, before analysing the final outcome, these associated variables needs to be defined. There are three types of milk quality depending upon snf and fat combination. Fluid milk classified into categories depending upon contents of fat and snf viz., double tone milk (1.5% fat and 9.0% snf) and whole milk (4.0% fat and 8.0% snf). All these specifically categorised on combination of fat and snf are of requirement for specific market segments. And these milk quality are provided by different level of marketing channels, provided by different level of marketing channels. Some are catered directly, two level and/or multilevel to target market segments. The market situation of demand level of different market segments in a given geographic segments and also simultaneously supply level to these market segment by producers and middle men are important. Price variation or market consumer segment reaction or sensitiveness to the price. Theoretically price is the intersection point of demand and supply curves and also cost of the product is always dependent on the supply of dairy product in the different market segments. The situations considered here are high demand - high supply and high demand - average supply. And marketing channels selected are of direct level and multilevel for two geographic segments i.e., Keonjhar and Barbil. So, now price would be fixed for any given dairy product at only market place based on the segmentation approach of geographic, marketing channels and demand - supply market situations. Extra price sensitiveness of the consumer would eventually affect market share and price variation.

For whole milk quality in Keonjhar town under marketing situation of high demand - average supply with marketing channel level to be direct and multi-level are Rs. 13.50/litre. And for whole milk quality in Keonjhar town under marketing situation of high demand - high supply with marketing channel level to be direct and multi-level are Rs. 13.25/ litre. Whereas, whole milk quality in Barbil town under marketing situation of high demand - average supply with marketing channel level to be direct and multi-level are Rs. 13.00/
litre and Rs. 12.50/ litre respectively. And for whole milk quality in Barbil town under marketing situation of high demand - high supply with marketing channel level to be direct and multi-level are Rs. 13.50/ litre and Rs. 12.50/ litre respectively. This is most probably because different geographic segments with different levels of marketing channels under different market situations yields price differentiation.

For tone milk quality in Keonjhar town under marketing situation of high demand - average supply with marketing channel level to be direct and multi-level are Rs. 11.50/litre. And for tone milk quality in Keonjhar town under marketing situation of high demand - high supply with marketing channel level to be direct and multi-level are Rs. 11.50/litre. Whereas, tone milk quality in Barbil town under marketing situation of high demand - average supply with marketing channel level to be direct and multi-level are Rs. 11.45/litre and Rs. 10.60/litre respectively. And for tone milk quality in Barbil town under marketing situation of high demand - high supply with marketing channel level to be direct and multi-level are Rs. 10.55/litre and 10.40/litre respectively.

For double tone milk quality in Keonjhar town under marketing situation of high demand average supply with marketing channel level to be direct and multi-level are Rs. 10.50/litre and Rs. 10.20/litre respectively. And for double tone milk quality in Keonjhar town under marketing situation of high demand - high supply with marketing channel level to be direct and multi-level are Rs. 10.50/litre and Rs. 10.10/litre respectively. Where as double tone milk quality in Barbil town under marketing situation of high demand - average supply with marketing channel level to be direct and multi-level are Rs. 10.45/litre and Rs. 9.80/ litre respectively. And for double tone milk quality in Barbil town under marketing situation of high demand - high supply with marketing channel level to be direct and multi-level are Rs. 9.85/ litre and Rs. 9.50/litre respectively.

The total price variation value for all the dairy products, their prices and the market segments are just under allowable limits, whereas, the total market share value is less than desired level. The final results of the compromise solution are relatively stable and perfectly fit to the market segments under different marketing situations.
Fig. 8.2: Dairy Product Price - Quality - Geographic Segmentation Tree Plan.

<table>
<thead>
<tr>
<th>Product Milk</th>
<th>Geographic Segment # 1 (Keonjhar)</th>
<th>Geographic Segment # 2 (Barbil)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Quality # 1</strong> (Whole Milk)</td>
<td>Marketing Channel Level # 1 (Direct)</td>
<td>Marketing Channel Level # 1 (Direct)</td>
</tr>
<tr>
<td></td>
<td>Marketing Channel Level # 2 (Multi)</td>
<td>Marketing Channel Level # 2 (Multi)</td>
</tr>
<tr>
<td><strong>Product Quality # 2</strong> (Tone Milk)</td>
<td>Marketing Channel Level # 1 (Direct)</td>
<td>Marketing Channel Level # 1 (Direct)</td>
</tr>
<tr>
<td></td>
<td>Marketing Channel Level # 2 (Multi)</td>
<td>Marketing Channel Level # 2 (Multi)</td>
</tr>
<tr>
<td><strong>Product Quality # 3</strong> (Double Tone Milk)</td>
<td>Marketing Channel Level # 1 (Direct)</td>
<td>Marketing Channel Level # 1 (Direct)</td>
</tr>
<tr>
<td></td>
<td>Marketing Channel Level # 2 (Multi)</td>
<td>Marketing Channel Level # 2 (Multi)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marketing Demand-Supply condition</th>
<th>Marketing Channel Level # 1 (Direct)</th>
<th>Marketing Channel Level # 2 (Multi)</th>
</tr>
</thead>
<tbody>
<tr>
<td># 1</td>
<td>Marketing Demand-Supply condition # 1</td>
<td>Marketing Demand-Supply condition # 1</td>
</tr>
<tr>
<td># 2</td>
<td>Marketing Demand-Supply condition # 2</td>
<td>Marketing Demand-Supply condition # 2</td>
</tr>
</tbody>
</table>


**Product Quality**
- # 1 = Whole Milk
- # 2 = Tone Milk
- # 3 = Double Tone Milk
### Table 8.1

<table>
<thead>
<tr>
<th>↓ M</th>
<th>Demand</th>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>2</td>
<td>High</td>
<td>Average</td>
</tr>
<tr>
<td>3</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>4</td>
<td>Average</td>
<td>High</td>
</tr>
<tr>
<td>5</td>
<td>Average</td>
<td>Average</td>
</tr>
<tr>
<td>6</td>
<td>Average</td>
<td>Low</td>
</tr>
<tr>
<td>7</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>8</td>
<td>Low</td>
<td>Average</td>
</tr>
<tr>
<td>9</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

### Table 8.2

<table>
<thead>
<tr>
<th>Segment type</th>
<th>Price variation</th>
<th>Market share</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_1$</td>
<td>0.00215</td>
<td>0.00168</td>
</tr>
<tr>
<td>$x_2$</td>
<td>0.00105</td>
<td>0.0024</td>
</tr>
<tr>
<td>$x_3$</td>
<td>0.0016</td>
<td>0.00888</td>
</tr>
<tr>
<td>$x_4$</td>
<td>0.00195</td>
<td>0.01584</td>
</tr>
<tr>
<td>$x_5$</td>
<td>0.00145</td>
<td>0.0048</td>
</tr>
<tr>
<td>$x_6$</td>
<td>0.00085</td>
<td>0.01728</td>
</tr>
<tr>
<td>$x_7$</td>
<td>0.0004</td>
<td>0.0096</td>
</tr>
<tr>
<td>$x_8$</td>
<td>0.0009</td>
<td>0.00888</td>
</tr>
<tr>
<td>$x_9$</td>
<td>0.00135</td>
<td>0.00696</td>
</tr>
<tr>
<td>$x_{10}$</td>
<td>0.00155</td>
<td>0.01512</td>
</tr>
<tr>
<td>$x_{11}$</td>
<td>0.00195</td>
<td>0.00456</td>
</tr>
<tr>
<td>$x_{12}$</td>
<td>0.0018</td>
<td>0.00576</td>
</tr>
<tr>
<td>$x_{13}$</td>
<td>0.0003</td>
<td>0.00888</td>
</tr>
<tr>
<td>$x_{14}$</td>
<td>0.0023</td>
<td>0.00936</td>
</tr>
<tr>
<td>$x_{15}$</td>
<td>0.0019</td>
<td>0.00648</td>
</tr>
<tr>
<td>$x_{16}$</td>
<td>0.0006</td>
<td>0.00504</td>
</tr>
<tr>
<td>$x_{17}$</td>
<td>0.00165</td>
<td>0.01752</td>
</tr>
<tr>
<td>$x_{18}$</td>
<td>0.00135</td>
<td>0.0132</td>
</tr>
<tr>
<td>$x_{19}$</td>
<td>0.00165</td>
<td>0.00312</td>
</tr>
<tr>
<td>$x_{20}$</td>
<td>0.00235</td>
<td>0.01392</td>
</tr>
<tr>
<td>$x_{21}$</td>
<td>0.00145</td>
<td>0.01512</td>
</tr>
<tr>
<td>$x_{22}$</td>
<td>0.0011</td>
<td>0.01776</td>
</tr>
<tr>
<td>$x_{23}$</td>
<td>0.00055</td>
<td>0.01896</td>
</tr>
<tr>
<td>$x_{24}$</td>
<td>0.0018</td>
<td>0.01608</td>
</tr>
</tbody>
</table>
### Table 8.3

**Alternate plan**

<table>
<thead>
<tr>
<th></th>
<th>Market Share</th>
<th>Price Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Market</td>
<td>2.789</td>
</tr>
<tr>
<td></td>
<td>Maximisation</td>
<td>0.385</td>
</tr>
<tr>
<td>2</td>
<td>Price</td>
<td>2.75</td>
</tr>
<tr>
<td></td>
<td>Minimisation</td>
<td>2.757</td>
</tr>
</tbody>
</table>

### Table 8.4

<table>
<thead>
<tr>
<th>Segment type</th>
<th>Segment solution</th>
<th>Price variation</th>
<th>Market share</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_1$</td>
<td>13.50</td>
<td>0.029025</td>
<td>0.02268</td>
</tr>
<tr>
<td>$x_2$</td>
<td>13.25</td>
<td>0.013913</td>
<td>0.0318</td>
</tr>
<tr>
<td>$x_3$</td>
<td>13.50</td>
<td>0.0216</td>
<td>0.11988</td>
</tr>
<tr>
<td>$x_4$</td>
<td>13.25</td>
<td>0.025838</td>
<td>0.20988</td>
</tr>
<tr>
<td>$x_5$</td>
<td>13.00</td>
<td>0.01885</td>
<td>0.0624</td>
</tr>
<tr>
<td>$x_6$</td>
<td>13.50</td>
<td>0.011475</td>
<td>0.23328</td>
</tr>
<tr>
<td>$x_7$</td>
<td>12.50</td>
<td>0.0005</td>
<td>0.12</td>
</tr>
<tr>
<td>$x_8$</td>
<td>12.50</td>
<td>0.01125</td>
<td>0.111</td>
</tr>
<tr>
<td>$x_9$</td>
<td>11.50</td>
<td>0.015525</td>
<td>0.08004</td>
</tr>
<tr>
<td>$x_{10}$</td>
<td>11.50</td>
<td>0.017825</td>
<td>0.17388</td>
</tr>
<tr>
<td>$x_{11}$</td>
<td>11.50</td>
<td>0.022425</td>
<td>0.05244</td>
</tr>
<tr>
<td>$x_{12}$</td>
<td>11.50</td>
<td>0.0207</td>
<td>0.06624</td>
</tr>
<tr>
<td>$x_{13}$</td>
<td>11.45</td>
<td>0.003435</td>
<td>0.101676</td>
</tr>
<tr>
<td>$x_{14}$</td>
<td>10.55</td>
<td>0.024265</td>
<td>0.098748</td>
</tr>
<tr>
<td>$x_{15}$</td>
<td>10.60</td>
<td>0.02014</td>
<td>0.068688</td>
</tr>
<tr>
<td>$x_{16}$</td>
<td>10.40</td>
<td>0.00624</td>
<td>0.052416</td>
</tr>
<tr>
<td>$x_{17}$</td>
<td>10.50</td>
<td>0.017325</td>
<td>0.18396</td>
</tr>
<tr>
<td>$x_{18}$</td>
<td>10.50</td>
<td>0.014175</td>
<td>0.1386</td>
</tr>
<tr>
<td>$x_{19}$</td>
<td>10.20</td>
<td>0.01683</td>
<td>0.031824</td>
</tr>
<tr>
<td>$x_{20}$</td>
<td>10.09006</td>
<td>0.023712</td>
<td>0.140454</td>
</tr>
<tr>
<td>$x_{21}$</td>
<td>10.44337</td>
<td>0.015143</td>
<td>0.157904</td>
</tr>
<tr>
<td>$x_{22}$</td>
<td>9.85</td>
<td>0.010835</td>
<td>0.174936</td>
</tr>
<tr>
<td>$x_{23}$</td>
<td>9.793371</td>
<td>0.005386</td>
<td>0.185682</td>
</tr>
<tr>
<td>$x_{24}$</td>
<td>9.50</td>
<td>0.0171</td>
<td>0.15276</td>
</tr>
</tbody>
</table>