7.1 INTRODUCTION

Market segmentation decision system based on specific design of package has to consider the group or segment of buyers who are most receptive to package design and it serves required set of satisfaction. Actually, it is essential to determine what segments of the market should be targeted and once it is known then various objectives of company, customers and intermediary are to be set for these segments based on package design suitability. Any product reaching to the target market segment should be properly packed in order to prevent leakage, flow outs, pilferage's and also convenient in handling. Package design can make success for the product in market. Any good design takes into account the physical aspects of protecting a product and communicating its selling features. Package design acts as a salesman to do marketing itself and also the point of purchase. Packaging is important marketing tool to enhance the brand image, sales appeal and attract new customers. In the marketing mix, the package design is considered to be highly complex decision variable and integral part of all of its elements such as product planning, promotion activities, physical distribution and pricing strategies. Package design enhances the value of the investment in each market mix element such as: for promotion aspect - it favours the product’s sale, in self-service operations as well as encourages impulse buying, sales by description, increase the product visibility and to attract customer; for product planning - it acts as vehicle to extend the product life cycle and to protect product and also to increase the product’s competitive edge and profits; for physical distribution - it plays as a device for the transfer of product safely, conveniently and even with economy from manufacturer to ultimate customer and convince in storage; for pricing - of the product also depends on the design of package so as to create image in market from the competitors.

In the present situation of competitive market condition it is not only essential to produce right things but also it is important that the product has to be presented to the consumers in the right form. The packaging design decisions are most important aspect to any marketing manager. In order to design packages according to the needs of market segments, the decision variable involves package design, size and cost to be considered and to serve the interest of producers as well as consumers. Package design decisions depends on number of factors in segmenting the consumer characteristics such as family size, income, consumption habits, purchase habits and shopping patterns. The package design and branding of the product in different market segment could be so engineered as to enhance the flow of information that might help the segment realise the distinguishably characteristics, costs and attributes of particular product and substitute products. The basic attributes of
package design are cost, size, good flexibility, graphic design, readability and point of sale appeal. The elements of the design are to communicate the visual message of the package design which relates to graphics, illustrations, colour, typeface logo or symbol and brand name, brand image, corporate name, typography, package structure, appetite appeal and shelf visibility.

The products are continuously redesigned from present design in order to enhance market share by entering new market segments. The future of package design decision will be highly influenced by the market segmentation of customers. And the Indian consumer is able to take advantages of good package design and to pay for the price of convenience and protection against adulteration. The new package design allows the company to enter previously closed distribution. In the present study, the decision on package design for milk and milk products is essential due to perishability nature and chances of adulteration.

In Keonjhar district milk is mainly produced in the rural areas as availability of milch cattle is more generally in rural areas and where consumption of milk and its products are less in comparison to demand in urban areas. Cow 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 ghee is next most consumed product. In case of packaging of dairy products flexible packaging design is utmost essential which helps in maintaining good aroma, aesthetic appeal, sales appeal and long shelf life. Dairy products are within time and space constraint’s, so package design should be such that it should provide necessary aid in storage and distribution to particular market segment. The main purposes of flexible package design for dairy products are to: protect it from contamination by macro-organisms and filth; retard or to prevent either losses or gain of moisture; shield it from oxygen and light; facilitate in handling etc.. The packaging of dairy products in Keonjhar district of Orissa (India) are relatively poor in comparison to other packaging industries. The educated population in the major towns in the study area are aware of the role of packaging and to some extent package design in identifying the product. The consumer is willing to pay extra for the convenience and protection against adulteration of dairy products. Consumer in this area are becoming more conscious of packaged goods and attracted to various package designs. Their buying decisions are highly depended on design patterns and encourage to impulsive buying. Now a days stores and shops are without salesman and the real job of salesman is carried out by good package design which is prominently displayed to the customer.
7.2 RESEARCH METHODOLOGY
7.2.1 Research Purpose & Objective:

The present research is to determine which package design will be the best sales tool for dairy product in particular market segment. As consumers are different in their need, want and perception, they can be grouped into certain segments having similar needs, wants and perceptions. Research initially forms certain market segments and then studies effectiveness of this segment (with regard to package design, meet company’s marketing objectives, and increase profit margins. The cost-effective approach to package-design can be developed for target market segment. Research in regard to consumption habits, usage rate and family income pattern enable certain fairly accurate analysis of which particular package design serves the needs of which segment in the market. So, in order to provide clear and actionable package design based on what works with customer segments. Both graphic and structural elements can be researched with particular market segments.

First, define package design objectives, so that all the information gathered through research regarding package design types and market segments could be combined with company’s objectives to arrive at effective design to segment relation resulting in maximum sales. The primary objective of market segmentation decision based on packaging design is to increase the sales of dairy product. And, after taking decision on which packaging design serves best in the market segment, the profit maximisation objective is considered to be important (increase in profits in the market segment based on package design). The second objective for product package design is cost minimisation i.e., to enhance the cost effectiveness of the marketing budget of acquiring the design and serving the market segment. The third objective is to maximise sales appeal package design type in the market segment it serves as design acts to increase the visibility of the product and attract and motivate customers to buy the dairy product.

7.2.2 Information Collected

1. Milk and milk products available in Keonjhar district.
2. Types of package material used for dairy products packaging in Keonjhar district.
3. Types of package design for dairy products in Keonjhar district.
4. Number and type of competitors in the area using their package designs and package materials.
5. Cost associated with acquiring the package design for dairy products.
6. Package design testing for acceptance by different segments including brand equities, packaging equities, type faces, package patterns, package colours and package medallions.
7. Impact of package design on different segments.
8. Types of consumers, their characteristics such as socio-economic and behavioural.
9. Size and characteristics of market and market environment.

7.3 MARKET SEGMENTATION BASED ON PACKAGE DESIGN

This model is to select the package design type alternatives based on usage demographic segments for each dairy product. The selection of package design for dairy products by constructing appropriate market segments is done in logical sequence of segmentation tree plan. The package design type alternatives are considered taking the combination of material type (viz., polypack, bottle, tin, plastic boxes); colour mixture (blue, red, green, black, white and yellow); sizes (250 gms or ¼ litre, 500 gms or ½ litre, 1 kg or 1 litre and 2 kg or 2 litre); and layout design.

In the present study seven item products are considered, which 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 classified into three segments depending upon contents of fat and snf viz., 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). Similarly milk products considered are ghee, butter, flavoured milk and yogurt. Product-line makes the most sense when the each item performs its own sales and profits in their line and compares with competitors' product-lines.

The data collected from district Keonjhar has been divided into two distinct geographic segments i.e., Rural and Urban. In India, marketing mixes of milk and milk products greatly vary in rural and urban areas. As most of fluid milk is procured from rural areas and demand for fluid milk and milk products is largely (in terms of sales) in urban market with comparison to rural market. The geographic segments are selected by judgmental sampling after considering the geographic location, milk potential and transportation facilities.

For this study, further assumption are made regarding income groups in the Indian condition, segmenting the market on basis of level of income of consumers carries an outstanding significance as it varies with change in the regions or places. The income level of the households are assumed as Low Income Group (LIG) whose income is below or equal to Rs. 6000/- per month; Middle Income Group (MIG) whose income is between Rs. 6001/- to Rs. 12000/- per month and Higher Income Group (HIG) whose income is above Rs. 12001/- per month. The household size segment are on the basis of small household size having 1 to 2 persons, medium household size having 7 or more persons. The market segmented according to household usage rate as heavy users, medium users and light users according to average usage rate of household per month depicted in Table:

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Table 7.1: Dimensions of households usage rate segments.

<table>
<thead>
<tr>
<th>Type of household usage segment</th>
<th>Fluid milk (double tone, tone and whole milk)</th>
<th>Ghee</th>
<th>Butter</th>
<th>Flavoured milk</th>
<th>Yogurt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy</td>
<td>50 litres or more</td>
<td>5 kgs or more</td>
<td>2 kgs or more</td>
<td>20 litres or more</td>
<td>10 kgs or more</td>
</tr>
<tr>
<td>Medium</td>
<td>20 to 50 litres</td>
<td>2 to 5 kgs</td>
<td>1 to 2 kgs</td>
<td>10 to 20 litres</td>
<td>5 to 10 kgs</td>
</tr>
<tr>
<td>Light</td>
<td>less than 20 litres</td>
<td>less than 2 kgs</td>
<td>less than 1 kg</td>
<td>less than 10 litres</td>
<td>less than 10 kgs</td>
</tr>
</tbody>
</table>

In this segmentation approach following assumption are considered for marketing of milk and milk products. Raw milk supply in particular geographic segment will strongly be seasonal- there is more production of milk in summer than in winter. The daily orders do not vary much except periodic fluctuations in demand and supply of milk and milk products due to seasonal variation and during fairs and festivals seasons whose effect are easily predictable. The major factor for seasonal variations in milk production is due to incidences of calving of milch animals (Cow’s and buffalo’s) during different months. In present study seasonal variation marketing mix of milk and milk products has considerable effect and a year has been divided into half year and then into four quarters of seasons viz., spring (March to May), summer (June to August), autumn (September to November) and winter (December to February). The study intends to collect data for demand and supply variation in different seasons basing on different geographic segments. For the application aspect construction of the segmentation tree is done on a priori segmentation basis for package design decision as shown in Fig. 7.1.

7.4 ALGORITHM

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

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

Subject to

$A_j (X) \leq b_j$

$X \in \{0,1\}$ ............................................. (5.4)
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 \( g_j \) 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 \( G \) given by

\[
G = \begin{bmatrix}
g_{11} & g_{12} & g_{13} & \cdots & g_{1m} \\
g_{21} & g_{22} & g_{23} & \cdots & g_{2m} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
g_{m1} & g_{m2} & g_{m3} & \cdots & g_{mm}
\end{bmatrix}
\]

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 \( G \) 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 \( g_i \) by \( g_i^* \). The boundary point for the objective \( G_i(X) \) can be obtained by taking the minimum of all \( g_j \) 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 :** This step is known as the decision making stage and involves the determination of a feasible point \( g' = (g'_1, g'_2, \ldots, g'_m) \) nearest to \( g^* \) according to the choice of the DM. This will be accomplished by the following substeps.

**SUBSTEP : I** Determine \( X \)

Such that
\[
\begin{align*}
G_i(X) & \geq g_i^* & i = 1, 2, \ldots, m \\
A_j(X) & \geq b_j & j = 1, 2, \ldots, k \\
X & \in \{0, 1\}
\end{align*}
\]

The fuzzy goal "\( G_i(X) > g_i^* \)" can now be identified as \( \tilde{G}_i \) defined over the set of feasible solutions with the membership function \( \mu_{\tilde{G}_i}(X) \) defined linearly as follows.

\[
\mu_{\tilde{G}_i}(X) = \begin{cases} 
1 & \text{for } G_i(X) \geq g_i^* \\
\frac{(G_i(X) - g_i)}{(g_i^* - g_i)} & \text{for } g_i \leq G_i(X) \leq g_i^* \\
0 & \text{for } G_i(X) \leq g_i 
\end{cases}
\]

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**SUBSTEP II**: Combine all the fuzzy sets $G_i$ using additive operator and solve the model as:

\[
\text{Maximise} \sum_{i=1}^{m} \mu_{Gi}(X)
\]

Such that \( \mu_{Gi}(X) = \frac{(\bar{G}_i(X) - g_i^*)}{(g_i^* - g_i)} \); \( i = 1, \ldots, m \)

\( A_j(X) \leq b_j \); \( j = 1, \ldots, k \)

\( \mu_{Gi}(X) \leq 1 \)

where \( \mu_{Gi}(X) = \frac{1}{2} \lambda_1 + \frac{1}{4} \lambda_2 + \frac{1}{8} \lambda_3 + \frac{1}{16} \lambda_4 + \frac{1}{32} \lambda_5 \)

\( \lambda_K, X \in \{0,1\} \); \( K = 1, 2, \ldots, 5 \)

Let the solution of the model be \( X = X^* \) which yields \( \mu_{Gi}(X) = \lambda_i \) for all \( i \). If the decision yields satisfactorily for all membership values, then it is the final solution. Otherwise go to the next step.

**SUBSTEP III**: The DM is asked whether he can make some concession in the level of any membership function, whose attainment in his opinions is more satisfactory to improve those which are less satisfactory. Suppose the DM is not satisfied with the solution \( X = X^* \) and he can concede \( \Delta \lambda_m \) amount from \( \lambda_m \). Then the following transformation can be made

\( g_i \to G_i(X^*) \) and \( g_i^* \to g_i^* \); \( \forall i \neq h \)

Solve the equivalent problem

\[
\text{Maximise} \sum_{i=1}^{m} \mu_{Gi}(X) \quad ; \quad i \neq h
\]

Such that \( \mu_{Gi}(X) = \frac{(\bar{G}_i(X) - g_i)}{(g_i^* - g_i)} \) \quad for all \( i, i \neq h \)

\( G_h(X) \geq G_h(X') - \Delta \lambda_h (g_h^* - g_i) \)

\( A_j(X) \leq b_j \); \( j = 1, \ldots, k \)

where \( \mu_{Gi}(X) \leq 1 \)

\( \lambda_K, X \in \{0,1\} \); \( K = 1, 2, \ldots, 5 \)
Numerical Example:

Let the Multi-Criteria Decision System involves 3 objectives which are conflicting and non-commensurable and at the same time are bounded by 6 rigid constraints. Mathematically, it may be given as:

Max A. \[ 50x_1 + 70x_2 + 30x_3 + 75x_4 + 65x_5 + 40x_6 + 80x_7 + 70x_8 \]
Max B. \[ 5000x_1 + 5000x_2 + 5000x_3 + 5000x_4 + 7000x_5 + 7000x_6 + 7000x_7 + 7000x_8 \]
Max C. \[ 57.6x_1 + 99x_2 + 243x_3 + 205.8x_4 + 84x_5 + 128.7x_6 + 207.9x_7 + 205.8x_8 \]

S.t.
1. \[ x_1 + x_5 \leq 1 \]
2. \[ x_2 + x_6 \leq 1 \]
3. \[ x_3 + x_7 \leq 1 \]
4. \[ x_4 + x_8 \leq 1 \]
5. \[ x_1 + x_2 + x_3 + x_4 - x_5 - x_6 - x_7 - x_8 \leq 0 \]
6. \[ x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 \geq 0 \]
7. \[ x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8 \in \{0,1\} \]

Now, all these objectives are kept at the same priority level. The maximum and the corresponding minimum for each of the objectives can be obtained from \( G_{ij} \):

\[
G_{ij} = \begin{bmatrix} 290 & 70 & 210 \\ 24000 & 7000 & 24000 \\ 596.7 & 205.8 & 661.5 \end{bmatrix}
\]

Now,

\[
\mu_{G_1}(X) = \frac{G_1(X) - 70}{290 - 70}
\]

\[
\mu_{G_2}(X) = \frac{24000 - G_2(X)}{24000 - 7000}
\]

\[
\mu_{G_3}(X) = \frac{G_3(X) - 205.8}{661.5 - 205.8}
\]

The problem can be formulated as:

Max \( \lambda_1 = .5\lambda_1 + .25\lambda_2 + .125\lambda_3 + .0625\lambda_4 + .03125\lambda_5 + .5\lambda_6 + .25\lambda_7 + .125\lambda_8 + .0625\lambda_9 + .03125\lambda_{10} + .5\lambda_{11} + .25\lambda_{12} + .125\lambda_{13} + .0625\lambda_{14} + .03125\lambda_{15} \)
S.t. $\mu_{G_1}(X) = \frac{G_1(X) - 70}{290 - 70}$

$\mu_{G_2}(X) = \frac{24000 - G_2(X)}{24000 - 7000}$

$\mu_{G_3}(X) = \frac{G_3(X) - 205.8}{661.5 - 205.8}$

$110x_9 + 55x_{10} + 27.5x_{11} + 13.75x_{12} + 6.875x_{13} - (50x_1 + 70x_2 + 30x_3 + 75x_4 + 65x_5 + 40x_6 + 80x_7 + 70x_8) \leq -70$

$8500x_{14} + 4250x_{15} + 2125x_{16} + 1052.5x_{17} + 531.225x_{18} + (5000x_1 + 5000x_2 + 5000x_3 + 7000x_4 + 7000x_5 + 7000x_6 + 7000x_7 + 7000x_8) \leq 24000$

$227.85x_{19} + 113.92x_{20} + 56.96x_{21} + 28.48x_{22} + 14.24x_{23} - (57.6x_1 + 99x_2 + 243x_3 + 205.8x_4 + 84x_5 + 128.7x_6 + 207.9x_7 + 205.8x_8) \leq -205.8$

Solving by 0-1 linear programming approach, the following result is obtained

$\lambda^1 = 1.8578390$

$X^1 = (0, 1, 0, 1, 1, 0, 1, 0)$

$G^1 = (290, 24000, 596.7)$

**Decision Stage**

Suppose in the opinion of the DM, the utility of the objective $G_1(X)$ is not that desirable and he wants to concede an amount 190 or more in the objective value $G_1(X)$.

**Iteration : 1**

The lower threshold values (7000, 205.8) and upper threshold values (24000, 596.7) of the second and third objectives.

The results obtained are as follows:

$\lambda^2 = 1.0327940$

$X^2 = (0, 0, 0, 1, 0, 1, 1, 0)$

$G^2 = (195, 19000, 542.2)$

**Decision Stage**

Suppose the DM desire to concede 450 or more in the objective value $G_3(X)$. 

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Iteration : 3

The upper and lower threshold value (19000, 7000) of the second objective replaced. After construction of the fuzzy membership functions and new problem formulation, it is solved. The result obtained are as follows:

\[ \lambda^3 = 0 \]
\[ X^3 = (0, 0, 0, 1, 1, 0, 1, 0) \]
\[ G^3 = (220, 19000, 497.7) \]

Now no further improvement is possible in the value of G.

7.5 MODEL FORMULATION
7.5.1 Decision variables, constants and symbols:

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

| \( p \) | 1, 2, 3, ..., 7 for product line segments of dairy products viz., Double Tone Milk, Tone Milk, Whole Milk, Ghee, Butter, Flavoured Milk and Yogurt. |
| \( g \) | 1, 2, 3, 4 for geographic segments viz., Keonjhar, Barbil, Harichandanpur and Saharpada. |
| \( i \) | 1, 2, 3 for income level segments viz., Higher income group, Middle income group and Lower income group. |
| \( q \) | 1, 2, 3, 4 for seasonal variation segments viz., Autumn, Summer, Winter and Spring. |
| \( h \) | 1, 2, 3 for household size segments viz., Large, Medium and Small. |
| \( j \) | 1, 2, 3 for product usage segment viz., Heavy, Medium and Light. |
| \( y(f) \) | 1, 2, 3, ..., n referring an ordered set \((p, g, i, q)\) for particular \(p^{th}\) product considered in \(g^{th}\) geographic segment in the \(i^{th}\) income group distributed in \(q^{th}\) Here, \(y(f)\) represents the segment type, viz., 1, 2, ..., n for the set of segments \(Z\), where \(Z = \{z : z = (p, g, i, q) \text{ and } p = 1, 2, 3, ..., 7; g = 1, 2, 3, 4; i = 1, 2, 3; q = 1, 2, 3; \}\) |
| \( m \) | 1, 2, 3, 4 for type of material used for packaging dairy products viz., Polypack, Bottle, Tin, Plastic Boxes. |
\[ r \quad : \quad 1,2,3,\ldots n \text{ for different colour combination used for package design (Colour combination within blue, red, green, black, white and yellow)} \]

\[ z \quad : \quad 1,2,3,4 \text{ for different sizes of packages of dairy products viz., 250 gms or } \frac{1}{4} \text{ litre, 500 gms or } \frac{1}{2} \text{ litre, 1 kg or 1 litre and 2 kg or 2 litre.} \]

\[ l \quad : \quad 1,2,\ldots n \text{ for different types of layout design used on package of dairy product.} \]

\[ t(f) \quad : \quad 1,2,3,\ldots n \text{ referring an ordered set } (m,r,z,l) \text{ for all } T \text{ viz., for package type based on } m^{th} \text{ type of material used for packaging of dairy products using } r^{th} \text{ type of colours combination, } z^{th} \text{ type of package size and } l^{th} \text{ type of layout design. Here } t(f) \text{ represents the package design type, viz., } 1,2,3\ldots n \text{ for the set of design type } T, \text{ where} \]

\[ T = \{ t : t = (m, r, z, l) \text{ and } m = 1, 2, 3, 4; \]
\[ r = 1, 2, \ldots n; \]
\[ z = 1, 2, 3, 4; \]
\[ l = 1, 2, 3, \ldots n; \}

\[ (y(f),h,j,t(f)) \quad : \text{ Type of segment for } p^{th} \text{ product obtained by segmenting the market based on } y(f), h, j \text{ with } t(f)^{th} \text{ type of package design.} \]

\[ hjt(f) \quad : \text{ Type of segment for package design variables for } (y(f), h,j,t(f)). \]

\[ X \quad : \text{ Profit incurred by the type of segment for package design variables for } (y(f), h,j,t(f)). \]

\[ y(f) \quad : \text{ Cost incurred by the type of segment for package design variables for } (y(f), h,j,t(f)). \]

\[ S \quad : \text{ Sales appeal from the type of segment for package design variables for } (y(f), h,j,t(f)). \]

\[ M \quad : \text{ Market share from the type segment for package design variables for } (y(f), h,j,t(f)). \]

\[ Ms \quad : \text{ Minimum accepted market share} \]

\[ B \quad : \text{ Total available budget} \]

\[ N(t) \quad : \text{ Number of design types acceptable.} \]
7.5.2 System Constraints:

(i) Budgetary Constraint:

Budget is a financial plan for the future which involves allocation of resources for each and every activity where some kind of money needs to be utilised. The present study in the study area needs well planned and designed budget to match the product and its package design to the market condition. It is essential that funds are to be controlled in their utilisation as they are limited. That ensures maximum utilisation of funds within a given limit. Mathematically it can be put as:

\[
\sum_{y(f)} \sum_{h} \sum_{j} \sum_{t(f)} C_{hj(t)} X_{y(f)} \leq B \text{ for all } y(f), h, j, t(f).
\]

(ii) Package Design Constraint:

The designing of package is an important aspect which draws the attention of the decision makers. But package design are aimed at a specific objective such as to influence acceptance at the point of purpose and to stimulate impulsive buying or to develop positive impression in the mind of the consumer. But, the specific package design cannot be designed from each and every type of customer market segment. On the whole each type of package design for different dairy products and design pattern combinations such as size, colour, material and layout design can not be made absolute compatible. Hence, choosing every combination at a time while targeting to a specific market segment would not be profitable. This constraint is to ensure that at least one package design type is available for every market segment, mathematically it can be put as:

\[
\sum_{y(f)} \sum_{h} \sum_{j} \sum_{t(f)} C_{hj(t)} \geq 1 \text{ for all } t(f).
\]

(iii) Preferential Constraint:

Preferential constraint determines which specific package design or combination of colour, size, material and layout design is preferred to others in a given market segment. Also, there are so many package designs available. All types of package design are done with combination of colour, size, material and layout design and even though they seem possible, specific market segments may not accept it. Certain package design is expectedly better in performance to other or certain package design satisfies the consumer market segment needs better than the other. Preferential constraints choose one specific combination to be better than the other. Mathematically it can be put as:

\[
\sum_{y(f)} \sum_{h} \sum_{j} \sum_{t(f)} C_{hj(t)} \geq 1 \text{ for all } t(f).
\]
(iv) **Minimum Selectivity and Competitive Advantage Constraint:**

Since, modern developments and technological upgradation in package design, there are certain type of package designs which are accepted by specific market segments. Based on this producer of dairy product has to take advantage of producing certain package design types already accepted in minimum quantity to serve the established market segments. Besides that, what the competitors and current market leaders are manufacturing, are the result of their long drawn experiences, research and innovation activity and not simply a baseless whim. This acceptance of existing package design would not only ensure a competitive parity at present, but also would enhance status and approval of the organisation in future. This constraint ensures that each type of package design has atleast one of market segment to cater and mathematically it can be put as:

\[
\sum_{y(f)} \sum_{h} \sum_{j} \sum_{t(f)} X_{hj(f)} y(f) \geq \sum_{y(f)} \sum_{h} \sum_{j} \sum_{t(f)} X_{hj(f)} y(f) \quad \text{for all } t(f), t(f)' 
\]

(v) **Area Constraint:**

This constraint specifies that the package design created should be convenient in storage, display and convenient in transport as to carry different market areas through various marketing channels. Certain design types are accepted or not accepted based on area coverage and distribution channels. Due to availability or non-availability of particular package design types at certain areas may restrict design to be perform optimally. Mathematically it could be expressed as:

\[
\sum_{y(f)} \sum_{h} \sum_{j} \sum_{t(f)} X_{hj(f)} y(f) \geq 1 \quad \text{for all } y(f)
\]

(vi) **Package Design Non-Compatibility Constraint:**

There has been so many types of design layout and materials along with various product lines. Each product package design cannot be manufactured from every possible combination of material types, layout design, colour or sizes. When used in combination with multiple products and multiple package designs, some combinations remains unacceptable either because of infeasibility in manufacturing process or unsuitable marketing facilities. This constraint avoids all such possibilities and decides on the total number available package design type for each market segment, mathematically it can be put as:
(vii) Market Share Constraint:

Market share refers to that part of a total market controlled by one firm’s brand. Market share of dairy products based on package designs is essential for marketing activity. Certain type of package design share market with comparison to other type. Hence, this model is to decide the products having market share to certain level. So the package design decision variable for particular market segment to be above or equal to certain predefined level of market share, mathematically expressed as:

\[ \sum_{h} \sum_{j} \sum_{t(f)} X_{hjy(f)} \geq N_{(f)} \text{ for all } t(f) \]

7.5.3 System Objectives:

(i) Profit Objective:

A good or effective package design would increase the sales volume and also project the image of an organisation fairly. Profit generated due to sales is a significant marketing objective. Profit contribution is defined as the difference between the total revenue generated by the sales of goods and total cost incurred. The profit equation is expressed as:

\[ P = R - TC \]

where \( P \) = Profit:
\[ R = \text{Revenue}; \]
\[ TC = \text{Total cost}. \]

So, Profit contribution as a model objective should be maximised and it can be expressed as follows:

\[ \text{Max } \sum_{y(f)} \sum_{h} \sum_{j} \sum_{t(f)} P_{hjy(f)} \]

(ii) Cost Objective:

Cost element is given special emphasis while making package designs or while finalising the size by the marketers. To have an effective and impactful packaging designs for dairy products in different market segments, minimisation of all costs affected for procuring good package design is to be maintained. The total cost involves cost of packaging material, research & development of design, labour, processing and other related costs. In this model, the objective is to minimise the costs affected by each package designs.
Mathematically, it can be put as:
\[
\min \sum_{y(f)} \sum_{h,j} \sum_{t(f)} hjt(f) \quad \text{for all } y(f), h, j, t.
\]

(iii) Sales Appeal Objective

The package design is a sales tool that attracts and motivates customers in any segment to buy the product. From consumer viewpoint it is an effective means of recognising the product and distinguishing its characteristics from other competitors products. It motivates customers by seeing the design of package and forming impression of positive product personality. It further helps in repeat purchases in recognising from product package design. Also, good layout always acts as an effective medium of advertising. Hence, it encourages the buyers to impulsive buying.

In evaluating value of sales appeal to establish packaging communication objectives to the target market segment include elements such as:

(a) Reach: Reach is the number of persons or households in a segment visit the store displaying product on shelf at least once during a specific time period.

(b) Display Value: Package design displayed on shelf should be good display value in respect of visibility and readability.

(c) Shelf Impact: This is the qualitative value of a sales appeal through a given store shelf in a given segment.

This can be established by subjective judgement and negotiation on 1-10 scale. Normally, sales appeal of an package design in particular segment in a specific time period is represented as:

\[
S = R \times D \times I
\]

S: Sales appeal
R: Reach
D: Display value
I: Shelf impact.

Most purchasing decisions are made in the store, at the point-of-purchase. So, good package design provide an advantage at this critical point-of-purchase. The basic concept in this model is that degree of effectiveness of package design enhances sales appeal and generates sales over given period of time. Mathematically the objective function can be defined as:

\[
\max \sum_{y(f)} \sum_{h,j} \sum_{t(f)} S^{hjt(f)} \quad \text{for all } y(f), h, j, t(f);
\]
7.5.4 (0,1) Restriction:

Each decision variable has to take 0 or 1 as its solution. Mathematically, it can be represented as:

\[ h_{jt}(f) \]
\[ X_{y} \in \{0, 1\} \text{ for each } y(f), h, j, t(f) \]
\[ y(f) \]

7.6 APPLICATION

7.6.1 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., Ghee.
- **g**: 1, 2 for geographic segments viz., Keonjhar and Harichandanpur respectively.
- **i**: 1, 2 for income level segment i.e., Higher Income Group and Middle Income Group respectively.
- **q**: 1 for seasonal variation segment i.e., Winter.
- **h**: 1, 2 for household size segments viz., Large and Medium respectively.
- **j**: 1, 2 for product usage segment viz., Heavy and Medium respectively.
- **y(f)**: 1, 2, 3...6 referring an ordered set \((p,g,i,q)\) for particular \(p\)th product considered in \(g\)th geographic segment in the \(i\)th income group distributed in \(q\)th. Here, \(y(f)\) represents the segment type, viz., 1,2,...n for the set of segments \(Z\), where

\[
Z = \{z : z = (p,g,i,q) \text{ and } p = 1; \quad g = 1, 2; \quad i = 1, 2; \quad q = 1, 2; \}
\]

- **m**: 1, 2 for type of material used for packaging dairy products viz., Polypack and Plastic Boxes respectively.
- **r**: 1, 2 for different colour combination used for package design viz., blue&white and black&white respectively.
- **z**: 1 for different size of package of dairy products i.e., \(\frac{1}{2}\) litres.
- **l**: 1, 2 for different types of layout design used on package of dairy product.
\( t(f) \) : 1,2 referring an ordered set \((m,r,z,l)\) for all \( T \) viz., for package type based on \( m^{th} \) type of material used for packaging of dairy products using \( r^{th} \) type of colours combination, \( z^{th} \) type of package size and \( l^{th} \) type of layout design. Here \( t(f) \) represents the package design type, viz., 1,2 for the set of design type \( T \), where

\[
T = \{ t : t = (m, r, z, l) \text{ and } m = 1, 2; \quad r = 1, 2; \quad z = 1; \quad l = 1, 2; \}
\]

\[(y(f),h,j,t(f))\] : Type of segment for \( p^{th} \) product obtained by segmenting the market based on \( y(f),h,j \) with \( t(f)^{th} \) type of package design.

\( t(f) \) : 1,2,3...n referring an ordered set \((m,r,z,l)\) for all \( T \) viz., for package type based on \( m^{th} \) type of material used for packaging of dairy products using \( r^{th} \) type of colours combination, \( z^{th} \) type of package size and \( l^{th} \) type of layout design. Here \( t(f) \) represents the package design type, viz., 1,2,3...n for the set of design type \( T \), where

\[
T = \{ t : t = (m, r, z, l) \text{ and } m = 1, 2, 3, 4; \quad r = 1, 2, \ldots n; \quad z = 1, 2, 3, 4; \quad l = 1, 2, 3, \ldots n; \}
\]

\[(y(f),h,j,t(f))\] : Type of segment for \( p^{th} \) product obtained by segmenting the market based on \( y(f),h,j \) with \( t(f)^{th} \) type of package design.

\( hjt(f) \) : Type of segment for package design variables for \((y(f), h,j,t(f))\).

\( X \) : Profit incurred by the type of segment for package design variables for \((y(f), h,j,t(f))\).

\( y(f) \) : Cost incurred by the type of segment for package design variables for \((y(f), h,j,t(f))\).

\( S \) : Sales appeal from the type of segment for package design variables for \((y(f), h,j,t(f))\).

\( M \) : Market share from the type of segment for package design variables for \((y(f), h,j,t(f))\).

\( B \) : Minimum accepted market share

\( M_{\text{nt}} \) : Total available budget

\( N_{\text{nt}} \) : Number of design types acceptable.
7.6.2 System Constraints:

(i) **Budgetary Constraint**:

\[
\sum_{y(f)} \sum_{h(j)} \sum_{t(f)} C_{hjt(f)} \leq B \text{ for all } y(f), h, j, t(f).
\]

(ii) **Package Design Constraint**:

\[
\sum_{y(f)} \sum_{h(j)} \sum_{t(f)} C_{hjt(f)} \geq 1 \text{ for all } t(f)
\]

(iii) **Preferential Constraint**:

\[
\sum_{y(f)} \sum_{h(j)} \sum_{t(f)} X_{hjt(f)} \geq \sum_{y(f)} \sum_{h(j)} \sum_{t(f)} X_{hjt(f)} \text{ for all } t(f), t(f')
\]

(iv) **Minimum Selectivity and Competitive Advantage Constraint**:

\[
\sum_{h(j)} \sum_{t(f)} X_{hjt(f)} \geq 1 \text{ for all } h, j.
\]

(v) **Area Constraint**:

\[
\sum_{h(j)} \sum_{t(f)} X_{hjt(f)} \geq 1 \text{ for all } y(f)
\]

(vi) **Package Design Non-Compatibility Constraint**:

\[
\sum_{h(j)} \sum_{t(f)} X_{hjt(f)} \geq N_{t(f)} \text{ for all } t(f)
\]

(vii) **Market Share Constraint**:

\[
\sum_{y(f)} \sum_{h(j)} \sum_{t(f)} M_{hjt(f)} \text{ for all } y(f), h, j, t(f)
\]

7.6.3 System Objectives:

(i) **Profit Objective**:

\[
\text{Max } \sum_{y(f)} \sum_{h(j)} \sum_{t(f)} P_{hjt(f)} X_{hjt(f)} \text{ for all } y(f), h, j, t
\]
(ii) Cost Objective:
\[
\text{Min } \sum \sum \sum \sum \frac{\omega_{gt}}{E_{gt}} X \frac{\omega_{gt}}{E_{gt}} \text{ for all } y(f), h, j, t.
\]

(iii) Sales Appeal Objective
\[
\text{Max } \sum \sum \sum \sum \frac{\omega_{gt}}{E_{gt}} X \frac{\omega_{gt}}{E_{gt}} \text{ for all } y(f), h, j, t(f);
\]

7.7 ANALYSIS AND INTERPRETATION OF RESULTS

The problem has been solved by the algorithm for a solution in 0-1 format as described in section 7.4 and by utilising Lindo Software in a Pentium PC at Department of Business Administration, Utkal University, Vani Vihar. The final result obtained is presented in table 7.5 which depicts the specific type of package design (for milk selected with material type, colour combination, layout design and size so as to target these package design to specific customer market segments (based on geographic, income, household size, usage rate). This is to design package to cater the needs of target market segments with maximum ability to fulfil the objectives of company & customer segment.

The original data sheet of profit, cost and sales appeal of the package design with the associated dimensions, applications and consumer market segments are given in table 7.2. The initial profit maximisation, cost minimisation and sales appeal maximisation solutions are given in table 7.3. The maximum value of total profit is in the presence of other two objectives determined to be Rs. 19,165/- and the minimum value for total cost is determined to be Rs. 4,157/- (table 7.3). Similarly, the maximum values of total cost is Rs. 1,17,266/- and the corresponding minimum value of cost is Rs. 13,232/- (table 7.3) in the presence of other two objectives. In the same manner, the maximum and minimum values for sales appeal is 1331 and 307 thousands respectively (table 7.3). After construction of membership functions, the compromise solution obtained is given in table 7.4. The compromised total values for profit, cost and sales appeal are Rs. 1,01,144/-, Rs. 11,471/- and 1321 thousands respectively (table 7.4). At this point it was decided to sacrifice profit some more within an adjustable unit of other two objectives, because cost has to be incurred for developing package design and marketing. But profit can be sacrificed within certain limits for better utilisation of resources. By adjusting profit with cost, present profit is ensured and also the sales appeal are enhanced. Here, profit is targeted to a minimum (sacrificed) value of Rs. 16,326/- based on the evaluation of the present market condition. The value of cost is kept in the interval (111471, 13232) and so also for the sales appeal in the interval (1331, 1321) as this is based on the logic that decrease (sacrifice) in profit value leads to increase in sales appeal and better
utilisation of investment. After reconstruction of membership functions, the final solution obtained is presented in table 7.5 and the associated final values of profit, cost and sales appeal are same as previous iteration i.e., Rs. 19,144/-, Rs. 1,11,471/- and 1321 thousands respectively. As, the final solution of profit, cost and sales appeal are within the given limits the final solution received, becomes totally acceptable.

The individual values of the final outcome to MSDS-3 are observed in zero-one format i.e., rejection-selection format. Actually the model accepts or rejects some specific package design with all its associated design types i.e., material, colour, layout and size variables targeted towards a specific consumer market segment. Hence, firstly, the market segments considered on consumer characteristics and package design type dimensions are to be discussed and then the final solution values would be interpreted and analysed.

The consumer groups are selected by segmenting the potential market based on geographic region, seasonal variation and demographic characteristics such as income level, household sizes and usage rate segments. After selecting the market segments with vital geo-demographic characters associated to them with the package design type are determined. Consumer market segment-I is those from Keonjhar town, heavy user of ghee product with package design type-I in winter season and from higher income group with large household size. Similarly, other consumer market segments are formed based on geographic region i.e., Keonjhar or Harichandanpur towns, heavy or medium user of ghee product with package design type-I or II in winter season and from higher income group and middle income group with large and medium household size. The package design type decisions mostly depends on: the convenience of package material; usage rate of products which associated with paying capacity i.e. income level and household size; the seasons also decides, which type of package design to be brought for durability, convenience or re-usage value. The package design material for ghee could be plastic boxes or polypacks. The size of the package is $\frac{1}{2}$ kg. The colour combination of package blue in combination with white and black in combination with white. And the layout design on package selection can be logo of monuments or company.

Considering the individual values of the final outcome table 7.7, it is observed that a combination of zero and one values are obtained indicating the selection and rejection of specific type of package design to the various market segments. Market segments $x_1$ to $x_{16}$ represent the type-I package design, for dairy product - ghee and season to be winter. Market segment $x_1$ to $x_8$ represent to geographic segment - Keonjhar and $x_9$ to $x_{17}$ represent to geographic segment - Harichandanpur. Market segments $x_{17}$ to $x_{32}$ represent the type-II package design, for dairy product - ghee and season to be winter and market segment $x_{17}$ to $x_{24}$ represent to geographic segment - Keonjhar and $x_{25}$ to $x_{32}$ represent geographic segment - Harichandpur.
Type-I package design; consists of $\frac{1}{2}$ kg ghee in plastic boxes with colour combination of black and white with layout design of company logo. $x_1$ to $x_8$ represent for type-I package design in which $x_1$, $x_2$, $x_4$, $x_7$ and $x_8$ market segments from Keonjhar town are selected. Where $x_1$ and $x_2$ reflects market segments with higher income group, large household size and heavy and medium usage customers respectively. $x_4$ depicts market segment with higher income group, medium household size and medium usage customers. $x_7$ and $x_8$ reflects market segments with middle income group, medium household size and heavy and medium usage customers respectively. $x_9$ to $x_{16}$ represent for type-I package design in which $x_9$, $x_{10}$, $x_{11}$, $x_{15}$ and $x_{16}$ are selected market segments from Harichandanpur town. Where $x_9$ and $x_{10}$ reflects market segments with higher income group, large household size and heavy and medium usage customers respectively. $x_{11}$ reflects market segment with higher income group, medium household size and heavy usage customers. $x_{15}$ and $x_{16}$ reflects market segments with middle income group, medium household size and heavy and medium usage customers respectively. From the result it has shown that profit and sales appeal among the market segments of Keonjhar and Harichandanpur towns for type-I package design are more than type-II package design in same geographic region. Type-I package design takes into account the physical aspects of protecting dairy producer and communicates its selling features as well as bilingual (viz., English and Oriya) product information on pack.

Finally, $x_{17}$ to $x_{32}$, the type-II package design consists of $\frac{1}{2}$ kg ghee in polypack with colour combination of blue and white with layout design of monument and company logo. $x_{17}$ to $x_{24}$ represent for type-II package design and for Keonjhar town customers. The market segments selected are $x_{19}$, $x_{21}$ and $x_{22}$ from Keonjhar town for package design, where $x_{19}$ depicts market segments with higher income group, medium household size and heavy usage customers. $x_{21}$ and $x_{22}$ reflects market segments with middle income group, large household size and heavy and medium usage customers respectively. $x_{24}$ to $x_{32}$ represent for type-II package design and for Harichandanpur town customers. The market segments selected are $x_{28}$, $x_{29}$ and $x_{30}$ from Harichandanpur town for package design, where $x_{28}$ depicts market segments with higher income group, medium household size and medium usage customers. $x_{29}$ and $x_{30}$ reflects market segments with middle income group, large household size and heavy and medium usage customers respectively. From the result it has shown that profit and sales appeal among the market segments of Keonjhar and Harichandanpur towns for type-II package design are less effective than type-I package design in same geographic region.

From the above, it is pretty clear that the package design with all its attributes (such as material, colour, size and layout design) are to be targeted to specific market segments. In market segments the customer with all demographic - geographic characters (such as region, income, household size, season, usage rate) are sole deciding factors for particular package design.
It is seen that normally customers prefer package design for dairy products which are perishable or semi-perishable in nature to be well protected and preserved while delivering the product. It should be convenient and easy to use design. The design should have convenient features for the targeted consumers and also cost-effective. So, the package design should be well planned and scientific such that it suits to targeted customer market segments and gives real positive impact on the market place and adapts the latest design or technological innovations.
Fig. 7.1: Dairy product package design and usage-demographic segmentation tree plan.

<table>
<thead>
<tr>
<th>Package Design #1 (Ghee)</th>
<th>Product #1 (Keonjhar)</th>
<th>Geographic Segment #1 (Keonjhar)</th>
<th>Seasonal variation segment #1 (Winter)</th>
<th>Income level segment #1 (HIG)</th>
<th>Household size #1 (Large)</th>
<th>Usage rate #1 (Heavy users)</th>
<th>Usage rate #2 (Medium users)</th>
<th>Usage rate #2 (Medium users)</th>
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<tbody>
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<td></td>
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<td>Geography Segment #2 Harichandanpur</td>
<td>Seasonal variation segment #2 (Winter)</td>
<td>Income level segment #2 (MIG)</td>
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<td>Usage rate #2 (Medium users)</td>
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<td>Household size #2 (Medium)</td>
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<td>Seasonal variation segment #2 (Winter)</td>
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Table 7.2

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<tr>
<th>Segment type</th>
<th>Profit data (Rs.) '00</th>
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<th>Sales appeal data (pts.) '000</th>
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Table 7.3

**Alternate Plan**

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<th>Plan</th>
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### Table 7.4

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<th>Segment type</th>
<th>Profit compromise (Rs. '00)</th>
<th>Cost compromise (Rs. '00)</th>
<th>Sales appeal compromise (pts. '000)</th>
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### Table 7.5

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