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Segmentation based product design using preferred features

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Abstract

Purpose – The purpose of this paper is to present a systematic methodology for segmenting customers based on the preferred product features, its cost and worth, so as to facilitate the designer to develop a product that will simultaneously minimize product cost and maximize customer satisfaction.
Design/methodology/approach – *Post hoc* – non-overlapping – non-hierarchical approach has been used for segmentation based on preferred product features by the customers. Allocation of product features to a particular segment is carried out by considering feature cost and customer worth for that feature. Automobile car has been selected as an example to demonstrate the methodology, where features data were collected from dealers and customer worth data were obtained by random generation method.
Findings – Methodology facilitates creation of n number of homogeneous segments from a heterogeneous customer group based on the cost and worth of product features. Total product cost decreases though product variety increased due to segmentation.
Originality/value – The proposed approach will help designers in segmenting (grouping) heterogeneous customers based on the preferred product features so that a most compatible (matching) product configuration for each segment, especially during product consolidation stage (beginning of the maturity phase of product lifecycle) can be developed to achieve maximum customer satisfaction.

Keywords Customer segmentation, Product design, Product configuration, Customer worth
Paper type Research paper

1. Introduction

New product development (NPD) are strategically important to meet or create customer demands, maintain or increase market share, sales and revenue and hence the competitiveness of an organization. The market success of a product is largely depends on clearly identifying customer needs and providing a product for the same at reasonable cost. The ability to develop new products and/or to improve the existing one governs the growth and market share (Tarasewich and Nair, 2001). For maximizing profits through customer satisfaction, a product line is offered rather than a single product (Ho and Tang, 1998; Fruchter *et al.*, 2006). NPD has been highlighted as a leading driver for revenue, profit and market share growth (Aberdeen survey, 2004). About 70 percent of the product cost is decided by the decisions made during product conceptual stage (Shehab and Addalla, 2001). Therefore, for a product to be successful in the market, it needs to be developed from customer perspective. Customer understands product by its features (attributes). For example, mobile phone product important features include camera, MP3, expandable memory card, FM radio, torch light, mobile tracker, dual sim, 3G etc. Similarly, different products (e.g. car, laptop, home security system) will have different features. Each customer will have different needs that demands different combination of features in a product. Hence, the preference and the importance of each feature in a

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product varies with customers. Customer preferences are flexible and they do not know what exactly they want until they see it (Cao *et al.*, 2011). In addition to feature composition of product their prices also affect the consumer decision. The consumer first decides on his budget for the product class and then he evaluates subsets of features within the product class (Gavish *et al.*, 1983). Similarly, "customer value" (customer worth), i.e. what a product or a service worth to the customer in monetary units, is another important factor that influence the customer product decision making (Haji and Assadi, 2009; Bernstein and Macias, 2002). This needs a problem to be addressed simultaneously from customer, firm and designer point of view.

For customer, the problem is which features to be chosen based on the budget constraint so as to maximize product value. The choice and importance of feature also varies from customer to customer.

For an enterprise, the problem is how to capture and understand these diverse customer requirements and incorporate them into a product to enhance its probability of success.

For a designer, the problem is which features are to be included or excluded in a product so as to create configuration closer to customer expectations. Adding extra feature will increase the cost whereas withdrawing of feature may lead to the customer unhappiness. Customers purchase intension may influence by the factors such as expected price of product, expected benefits from the product as well as their income (i.e. budget constraint). Customers will pay for those features which are connected with their needs. Hence, the market can often be segmented according to the features that are salient to different customer groups.

In this context, customer segmentation (Figure 1) approach is adopted for identifying and grouping customers with common features requirements from a wide range of product features. The approach facilitates the designer to develop a product suitable for a target group of customers.

Customer segmentation is the most commonly used approach in marketing domain to device suitable marketing strategy (Dibb and Simkin, 1997). However, there is scarcity of literature on customer segmentation for developing suitable product configuration design (Yu *et al.*, 1999; Jiao *et al.*, 2007). There are mainly two approaches to segmentation (Wedel and Kamakura, 2000) and these are briefly summarized below:

(1) A priori approach – this segmentation approach is based on known characteristics of the population (respondents) of different segments in advance.

(2) *Post hoc* approach – the segmentation is called as *post hoc* when the segmentation is made after analysis of population. The segments of homogeneous consumers are formed along measured characteristics. The clustering methods generally used for segmentation are:

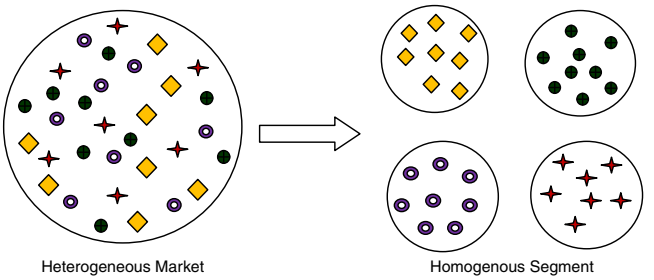

Figure 1.
Segmentation process

- Non-overlapping: each customer belongs to single segment only, i.e. customer belongs to segment A but not to segment B or segment C. Two major types of non-overlapping cluster techniques are:
  - Hierarchical: two customers who are placed in same group at an early stage of the process will remain in same segment up to final clustering solution.
  - Non-hierarchical: this method starts from a random (initial) division of the customers into a predetermined number of clusters and reassign the customers to the clusters until a certain criterion is optimized. Two customers who are placed in the same group at an early stage may end up in different segments.
- Overlapping: customer belongs to multiple segments i.e. consumer belongs to segment A and segment B.

Non-hierarchical methods are superior to hierarchical methods for segmentation (Punj and Stewarts, 1983). However, a general problem of non-hierarchical method is the determination of number of segments (Milligan and Cooper, 1985).

Paper presents a methodology to address the problem of product design configuration by segmenting (grouping) customers based on their preferred product features, cost of the feature and customer feature value. The approach attempts to simultaneously resolve the problem of customer in selecting the features based on worth and designer in developing a product configuration acceptable to a group of customers and hence giving a firm increased probability of product success in the market.

The paper is organized as follows. Section 2 presents the research background on approaches of product design and segmentation. Section 3 describes the *post hoc* methodology for product design and segmentation. Section 4 presents a case example to demonstrate the methodology. Sections 5 and 6 discusses the result and conclusions, respectively.

2. Literature review

Most commonly referred models for designing the products based on customer requirements by considering multiple features includes conjoint analysis (Green and Krieger, 1985), Kano model (Kano *et al.*, 1984), Kansei engineering (Nagamachi, 2002) and quality function deployment (Sullivan, 1986). The main objective of these models is to translate voice of customers (or feelings) to a product features. The conjoint analysis is incapable to capture the complexity of markets (Mahajan and Wind, 1992). QFD technique is cumbersome and errors prone in complex design (Krishnapilla and Zeid, 2006) and time consuming (Mahajan and Wind, 1992). Kano model does not quantify qualitative performance of the attributes (Bhardwaj and Menon, 1997). Kansei engineering measures consumer assessments of product characteristics, but does not assess consumer's actual choice (Gonzalez *et al.*, 2010).

Market segmentation has been studied in the perspective of marketing but very few researchers focussed it in the domain of product design. Kim and Chhaged (2002) suggested the methodology to solve the product line design problem with multiple quality type attributes for a monopolist serving a market with only two customer segments. Kohli and Krishnamurthi (1987) described a dynamic programming heuristic to multi attribute product profile. They tested the heuristic by considering only two segments. Hwang *et al.* (2004) developed customer lifetime value model for analyzing customer value and segmented the customers based on their value such as current value,

potential value and customer loyalty. Mazzoni *et al.* (2007) applied multidimensional segmentation approach and identified three segments based on consumer lifestyles, motivational factors and product attributes. Dzobo *et al.* (2014) proposed segmentation model using a hierarchical clustering technique to cluster electricity customers into customer segments of similar cost characteristics. Three customer parameters economic size, economic activity and energy consumption are considered in the proposed model. Goyat (2011) reviewed and observed that the most of the literature on segmentation is dominated by demographic and psychographic factors. However, Goyat (2011) also concluded that price is one of the influencing factor which affects on purchase of the customers. Hiziroglu (2013) reviewed the current application of soft computing techniques in segmentation problem.

To improve sales or profits, the company can create the models by adding or withdrawing one or more extra features, especially during beginning of the maturity phase of a product lifecycle, as market gets consolidated and cost becoming the order winner criteria in the market. A "Stripped-down Model" or "Bare-Bones" model is a basic model without any extra or additional features. For example, in case of an automobile, the buyer can order for power windows, power steering, automatic transmission, air conditioning, stereo, navigation system, fog lamp and additional safety systems such as air bags and so on. Features are competitive tool for differentiating the company's product from competitor's product (Kotler, 1988).

Product variants are derived from the combination of different modules, subassemblies, components, features and these variants are offered to capture distinct market segments. The features may be grouped in a different product variant as per their worth and preference to the customer. To offer wide variety of products to more number of segments is now the trend and is referred as mass customization, which is a product development approach to minimize tradeoff between the ideal and available product by fulfilling the needs and preferences of individuals functionally, emotionally and anthropologically (Davis, 1987; Piller and Muller, 2004). Increased product variety allows a closer match between customer preferences and offered products, which then has the potential of increasing or maintaining market share. However, decisions (e.g. what product features to be offered and how it will satisfy the customer requirements) have a great impact not only on the product cost, but also on the success of the product. Similarly, decisions "What variants of the product will be offered?" and "which components will be shared across which variants of the product?" are important in product concept stage (Krishnan and Ulrich, 2001). Therefore, there is a need to have a systematic approach that can facilitate an organization to understand segment wise customer product feature requirements and use them to configure a product for that segment.

Literature review reveals that efforts have been made to design a product with preferred customer attributes by considering two (Kim and Chhaged, 2002; Kohli and Krishnamurthi, 1987) and three (Hwang *et al.*, 2004; Mazzoni *et al.*, 2007) segments only. In this view, paper presents a methodology that facilitates creation of n homogeneous segments from a heterogeneous customer group based on the preferred product features, its cost and worth from customer point of view. The methodology with example is discussed in subsequent section.

3. Methodology

The algorithm for the product design and respective segmentation based on the customer worth for minimization of total cost of the product is given below.

3.1 Problem definition

To develop and formulate a systematic methodology to design a product for the particular customer segments based on worth for minimization of total cost of the product by optimum allocation of the features to enhance marketability and profitability.

3.2 Objective function

$$\text{Minimize product cost} = \sum_{k=1}^{K} N_{ck} \left\{ \sum_{j=1}^{J} C_j \right\} \tag{1}$$

$$\text{Subject to } H_{jk} \geqslant H_{jx};\ H_{jk} \in K \tag{2}$$

$$\text{For } x \neq k$$

where N_c is the number of customers in kth segment (size of segment k); k the number of segment, $k = 1, 2, \ldots, K$; j the number of feature, $j = 1, 2, 3, \ldots, J$; C_j the unit cost of feature j. W_{ij} the part worth of feature j for customer i. W_{ij} is the customer worth (customer value) for a particular feature. The customer specifies this worth in monetary units within his budget according to his need and willingness.

H_{jk} is the assigned weight for feature j of segment k. H_{jk} is the weight of feature in a particular segment is obtained on the basis of the sum of the maximum net worth (i.e. preference value) assigned by the customers for a particular feature as per their preference for the feature. This weight of each feature is determined by dividing the preference value of the individual feature by the sum of total preference values of all features in that segment.

i is the customer number, $i = 1, 2, 3, \ldots, N$. The customer in the system is assigned by number i. For example, the first customer in the system is considered as Customer_1, the second customer in the system is considered as Customer_2 and so on.

N is the total number of customers. The total number of customers in the system is represented by N. The system consist of Customer_1, Customer_2, Customer_3, …, Customer_N.

The procedure for the design of product and customer segmentation is as follows:

Step 1: initially, the number of customer in each segment will be number of customers (N) divided by number of segments (k) considered:

$$N_{k_0} = \frac{N}{K} \tag{3}$$

where, N_{kO} is the number of customers in each segments at initial (early) stage.

Step 2: determine net worth (N_w) of ith customer for jth feature using the following equation:

$$N_{wij} = W_{ij} - C_j. \tag{4}$$

Step 3: identify the customers who offered maximum net worth (N_{wjmax}) for a particular feature as compared to other features.

Step 4: measure preference value (P_j) of jth feature using the following equation:

$$P_j = \sum N_{wij}, \quad \text{where,} \quad N_{wij} = N_{wjmax} \tag{5}$$

Step 5: assign weight (H_{jk}) to the feature as per its relative importance in that particular segment using the following equation:

$$H_{jk} = \frac{P_j}{\sum_{j=1}^{J} P_j} \tag{6}$$

Step 6: shift the feature j to segment k and reposition the respective customers who preferred feature j to that segment if the constraint specified by Equation (2) is satisfied.

The feature which has higher weightage (H_{jk}) in one segment (e.g. in segment 1, i.e. H_{j1}, for $k = 1$) than the other segment (H_{jx}, for $x \neq k$, i.e. x may be segment 2 or segment 3 or segment 4, …) remains in original segment, i.e. in segment 1. However, the same feature which has lower weightage in other segments is transferred from that segment to the segment in which it has higher weightage.

Step 7: calculate product cost for the given segment using Equation (1).

The flowchart for the proposed algorithm is shown in Figure 2.

4. Example

Many car manufacturers offer the customer different car variants in an effort to be competitive. To demonstrate the proposed methodology an example of family car is discussed below.

4.1 Product feature evaluation

The car model (variant) with all the features (i.e. top model) is considered to demonstrate the proposed methodology of segmentation. The ex-showroom price of this small family car is Rs. 396,822 with entire features. Some of these features may not available with basic model.

4.1.1 Identify the product features. For this research work, seven important features (Table I) are considered. Only high and medium priced features are considered because many of them are having strong influence on buying decisions.

4.1.2 Set the cost for each feature. The respective costs collected from the dealer are shown below:

- Feature 1: (j_1): air bag – Rs. 21,675 (C_1);
- Feature 2: (j_2): power steering kit – Rs. 16,280 (C_2);
- Feature 3: (j_3): power windows (front and rear) – Rs. 10,665 (C_3);
- Feature 4: (j_4): integrated audio system – Rs. 11,775 (C_4);
- Feature 5: (j_5): air-conditioning kit – Rs. 21,244 (C_5);
- Feature 6: (j_6): security system – Rs. 5,324 (C_6); and
- Feature 7: (j_7): belt assembly (pre-tensioners and force limiters) – Rs. 6,668 (C_7).

The total cost of all these features is Rs. 93,631. If these features mentioned above are not available in the car model i.e. in the basic model, then the price of this basic model

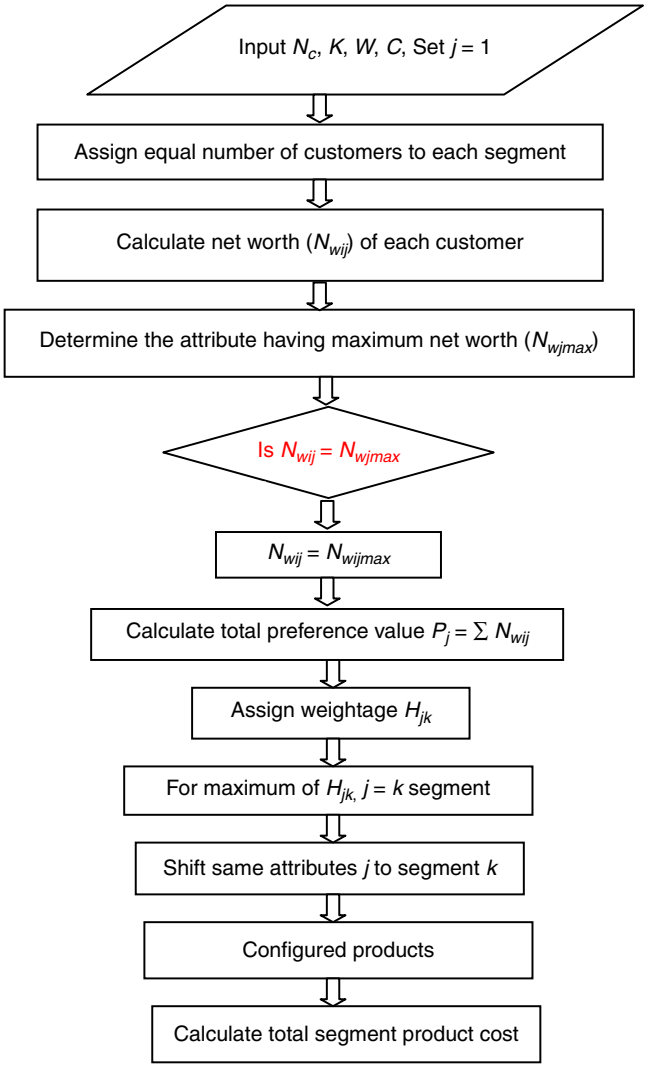

Figure 2.
Algorithm for product design and customer segmentation

Feature no.	Safety	Feature no.	Comfort
1	Air bag	2	Power steering
6	Security system	3	Power (electric) windows
7	Belt assembly	4	Integrated audio system
		5	Air conditioner

Table I.
Feature (attribute) list of car model

("stripped-down model" or "bare-bones" model) is Rs. 303,191 (price of car with all features; Rs. 396,822 – price of basic model; Rs. 93,631).

4.1.3 Obtain customer worth data for each feature. Customer worth data were obtained by using random number generation method because most of the studies (Pullman *et al.*, 2002; Luo *et al.*, 2005; MacDonald *et al.*, 2009) indicated that preferences can change with mood, weather and any number of random factors that a researcher cannot measure. The customer worth is obtained by considering up to ±10 percent random variation in the basic cost of features. The feature cost and worth data of 60 customers is shown in the Appendix. For example, the customer 1 offers the worth (W_{ij}) Rs. 21,285, 17,452, 11,326, 11,492, 22,349, 5,164 and 6,215 for features air bag, power steering, power windows, integrated audio system, air-conditioning kit, security system and belt assembly, respectively.

4.1.4 Determine net worth for each feature. Net worth (N_w) of *i*th customer for *j*th feature is then calculated using Equation (4). For example, net worth (N_{w11}) of 1st customer for air bag (1st feature) is −390 (i.e. 21,285 – 21,675). Similarly, net worth for power steering, power windows, integrated audio system, air-conditioning kit, security system and belt assembly are 1,172, 661, −283, 1,105, −160 and −453 (the Appendix).

4.2 Customer segmentation

The numbers of segments are decided based on judgment (Chakravarti *et al.*, 1987) or directives from upper management (Weatherford and Bodily, 1992). The car company has to decide on number of car models with different features to be launched for different customer segments. To describe the methodology; number of segments considered are two, three and four. However, the number of segments can suitably increase as decided by management.

Increase in number of segments leads to increase in product variety, as each individual has preference for different product variants (Ho and Tang, 1998). Companies are continuously trying to increase market share and profits by increasing customer satisfaction through the variety in the products they offer. Offering a broader product line can lead to increased profitability (Kekre and Srinivasan, 1990; Bayus *et al.*, 2003). The determination of the "optimal" or "appropriate" level of variety is the main challenge for a firm. Larger product variety increases complexity in manufacturing (Alford *et al.*, 2000) as well as operational costs (Lancaster, 1990; Ramdas *et al.*, 2003). It increases the inventory costs (Fisher and Ittner, 1999; Forza and Salvador, 2002), the purchasing costs (Ulrich and Randall, 2001), set-up cost (Fisher and Ittner, 1999) and also the design workload connected to the development of new product variants (Forza and Salvador, 2002). Increased in product diversity may attract new customers, meet the need of individual customer and can be managed effectively through modular design, approach or through design of product families (Song and Kusiak, 2009).

4.2.1 Identify the maximum net worth offered by each customer. The customers have different preference for different features. Some of features are very close to their ideal choice for which they are willing to spend additional amount apart from the cost of feature. These features are "worth" for them. In this paper, this worth (W_{ij}) for a particular feature is considered in monetary value. The net worth, N_{wij} (i.e. $W_{ij} - C_j$) of *i*th customer for *j*th feature will give the actual preference or likeness of the feature. The highest net worth means highest will be the preference for that particular feature. The customers who offered maximum net worth (N_{wjmax}) for the particular

feature as compared to other features are then identified (the Appendix). For example, for customer 1, (N_{wjmax}) identified is 1,172 for power steering (feature 2) and for customer 2, it is 1,302 for the same feature 2. Whereas, for customer 3, the maximum net worth obtained is 942 for integrated audio system (feature 4).

4.2.2 Initial (random) segmentation of customers. Initial segmentation is carried out randomly. The number of customer in each segment will be total number of customers (N) divided by number of segments (k) considered using Equation (3). For example, if total numbers of customers are 60 and two segments are considered then in initial segmentation the first 30 customers are clustered in segment 1 whereas remaining 30 customers are clustered in segment 2 (Table II). However, during segmentation process customers belonging to a particular segment after the initial segmentation stage may remain in the same segment or get transferred in another segment.

Considering two segments (Table II), it is observed that out of first 30 customers allotted in segment 1, eight customers preferred air bag (feature 1) as the most important among all features, five customers preferred air conditioner (feature 5) as the most important feature and so on (the Appendix). Similarly, in segment 2; seven and six customers preferred air bag (feature 1) and air conditioner (feature 5), respectively as the most important feature. The total preference value (P_j) of 1st feature (air bag) in first segment is determined by Equation (5). That is, the preference value (P_j) for air bag feature in segment 1 is given by the sum of all customers in that segments who offered the maximum worth for the air bag feature among all other features. For example, in segment 1; air bag (feature 1) preference value 10,058 is given by the customer 5 (824) + customer 7 (1,214) and so on. Total preference value for a particular segment is given by sum of all preference value in that segment. For example, the total preference values (P_j) of first segment is 31,501 (10,058 + 8,752 + 4,710 + 4,200 + 1,621 + 1,373 + 767). Similarly, total preference value of second segment is 34,657.

Feature in a particular segment is weighted (H_{jk}) on the basis of their relative preference value. The weight of each feature in that particular segment is obtained by dividing the preference value of the feature by the sum of total preference values of all features in that segment (Equation 6). The weight of air bag feature 1 in segment 1 (H_{11}) and segment 2 (H_{12}) is 0.319 (10,058/31,501) and 0.299 (10,360/34,657), respectively. The weights of other features in segments 1 and 2 are shown in Figure 3.

	Segment 1				Segment 2		
Feature, j	No. of customers, N_{ck}	Preference value, P_j	Relative weight, H_j	Feature, j	No. of customers, N_{ck}	Preference value, P_j	Relative weight, H_j
1	8	10,058	0.319	1	7	10,360	0.299
5	5	8,752	0.278	5	6	9,306	0.269
4	5	4,710	0.150	2	5	6,088	0.176
2	4	4,200	0.133	3	5	4,266	0.123
3	2	1,621	0.051	4	5	3,650	0.105
7	3	1,373	0.044	7	2	987	0.028
6	3	767	0.024				

Product cost = $C_1 + C_5 + C_4 + C_2 + C_3 + C_7 + C_6$ = Rs. 93,631 Product cost = $C_1 + C_5 + C_2 + C_3 + C_4 + C_7$ = Rs. 88,307

Note: Total segment product cost = 93,631 × 30 + 88,307 × 30 = Rs. 5,458,140

Table II.
Number of segments 2

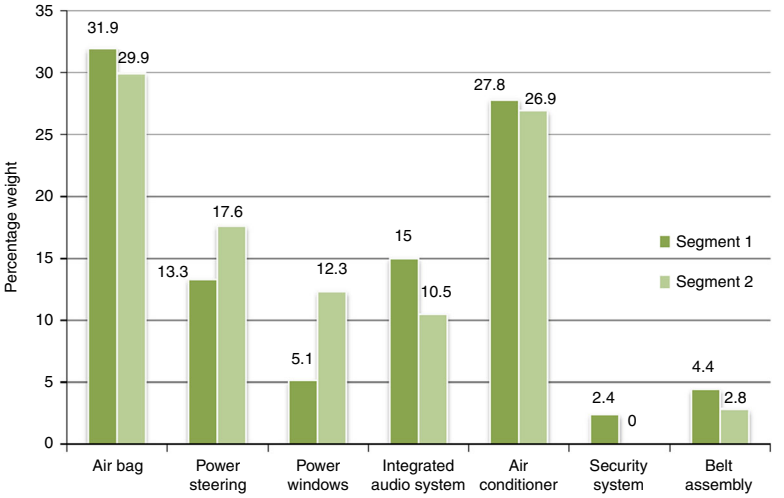

Figure 3.
Weights of the features

4.2.3 Cluster the features based on preference value. To design a product as per customer's requirement and to minimize the cost of the product, the least preferred feature/attributes of one segment are transferred to another segment where it is mostly preferred by applying the steps 2-7 as discussed in Section 3.

From Figure 3, it is observed that feature 5, i.e. air-conditioning kit has higher weightage ($H_{51} = 0.278$) in segment 1 than its weightage ($H_{52} = 0.269$) in segment 2. Whereas, feature 2, i.e. power steering kit has higher weightage ($H_{22} = 0.176$) in segment 2 than its weightage ($H_{21} = 0.133$) in segment 1. The features having higher weights in the particular segment need not to be shifted to other segment, otherwise. It clearly indicates that, air bag, integrated audio system, air-conditioning kit, security system and belt assembly is most preferred by segment 1 and therefore these features must be provided to the customers of segment 1. However, power steering and power windows must to be allotted to the customers of segment 2. It is worth noting that in the initial segmentation (Table II), the feature 6, security system, in segment 2 has not appeared as no customer offered the highest performance value in this group, indicating that customer least preferred this particular feature. The methodology developed in this work facilitates to identify such features of the product which are not in very high demand by the customers. The result after one iteration after shifting features power steering (four customers) and power windows (two customers) from segment 1 to segment 2 and features air bag (seven customers), air conditioner (six customers), integrated audio system (five customers) and belt assembly (two customers) from segment 2 to segment 1 is shown in Table III. Finally, the product for segment 1 is to be configured with features air bag, air conditioner, integrated audio system, belt assembly and security system and for segment 2, power steering and power windows features.

Similar steps are applied when considering 3, 4 or n number of segments. After shifting the most favorable features to the respective segments; the final allotment of the features and respective customers in a single segment, two segments, three segments and four segments is shown in Table IV.

4.2.4 Determine total product cost. After allotment of the features the respective total segment product cost is then calculated using Equation (1). The respective total segment product cost is shown in Table IV. It is observed that the total segment product cost is minimized by satisfying each customer of all the segments with the preferred features. For the given illustration, considering number of segment only one, i.e. all the seven features are clustered only in one segment. It means that the customer has to purchase the product and will have to pay for those features for which they may have least or no preference. As limited numbers of preferred features are allotted to segments, the segment product cost decreases which may lead to satisfy the customers.

5. Result analysis

Four different product configurations for four different segments are proposed with the respective features and model costs are as given below:

Segment 1 – Model 1: Rs. 314,966, i.e. Rs. 303,191 (basic model price) + Rs. 11,775 (cost of feature j_4).
Segment 2 – Model 2: Rs. 336,427, i.e. Rs. 303,191 + Rs. 33,236 (cost of feature $j_5 + j_6 + j_7$).
Segment 3 – Model 3: Rs. 324,866, i.e. Rs. 303,191 + Rs. 21,675 (cost of feature j_1).
Segment 4 – Model 4: Rs 330,136, i.e. Rs. 303, 191 + Rs. 26,945 (cost of feature $j_2 + j_3$).

Table III. Product configuration for two segments

Segment 1			Segment 2		
Feature, j	No. of customers, N_{ck}	Cost of feature, C_j	Feature, j	No. of customers, N_{ck}	Cost of feature, C_j
1	15	21,675	2	9	16,280
5	11	21,244	3	7	10,665
4	10	11,775			
7	5	6,668			
6	3	5,324			
Total number of customers = 44			Total number of customers = 16		
Product cost = $C_1 + C_5 + C_4 + C_7 + C_6$ = Rs. 66,686			Product cost = $C_2 + C_3$ = Rs. 26,945		

Note: Total segment product cost = $66{,}686 \times 44 + 26{,}945 \times 16$ = Rs. 3,365,304

Table IV. Result of the proposed methodology

Number of segments	Segment, k	Number of customers, N_{ck}	Features	Product cost (Rs.)	Total segment product cost (Rs.)
One	1	60	$j_1, j_2, j_3, j_4, j_5, j_6, j_7$	93,631	$93{,}631 \times 60 = 5{,}617{,}860$
Two	1	44	j_1, j_5, j_4, j_7, j_6	66,686	$66{,}686 \times 44 + 26{,}945 \times 16 = 3{,}365{,}304$
	2	16	j_2, j_3	26,945	
Three	1	10	j_4	11,775	$11{,}775 \times 10 + 48{,}243 \times 29$
	2	29	j_1, j_5, j_6	48,243	$+ 33{,}613 \times 21 = 2{,}222{,}670$
	3	21	j_2, j_3, j_7	33,613	
Four	1	10	j_4	11,775	$11{,}775 \times 10 + 33{,}236 \times 19 + 21{,}675 \times 15$
	2	19	j_5, j_6, j_7	33,236	$+ 26{,}945 \times 16 = 1{,}505{,}479$
	3	15	j_1	21,675	
	4	16	j_2, j_3	26,945	

Allocation of the features to different segments based on 60 customer data were shown in Figure 4. It is observed that feature j_4 is the most preferred by ten customers (16.67 percent) in first segment, features j_5, j_6, j_7 are the most preferred by 19 customers (31.67 percent) in second segment, feature j_1 is preferred by 15 customers (25 percent) in third segment and features j_2, j_3 are preferred by 16 customers (26.67 percent) in fourth segment.

In this example, two, three and four segments are obtained by allocating customers based on their highest preferred product features. In case of single segment, the customer has no choice; the customer will not pay for those features, which are not required for him. However, the cost of the product is so high that few customers may afford to purchase that product which ultimately results in loss of sale and profit. Methodology facilitates the generation of customer segments based on their most preferred product features, i.e. each segment created is associated with a set of product features that can be used to configure a product for that segment. In this situation the overall product cost decreases with increased number of segments (Figure 5) which can increase the probability of purchasing the product by all customers.

6. Conclusion

Increased product variety allows a closer match between customer preferences and offered products. It has become an important strategy to increase market share, sales

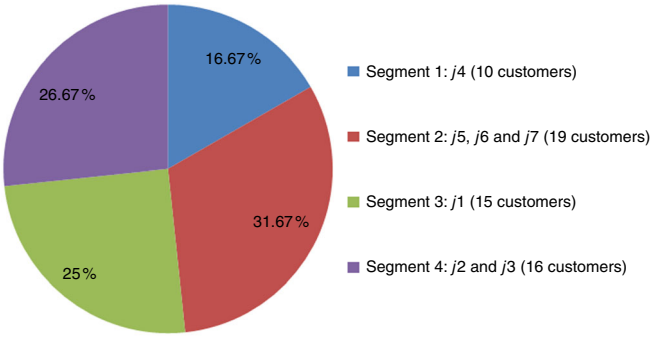

Figure 4.
Allocation of features for different segments

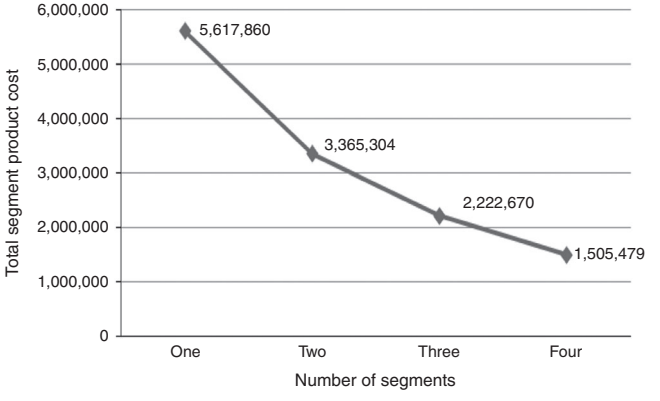

Figure 5.
Segment product cost

and profits. A company can have multiple variants of the same product so as to create customer value. The main challenge to a firm is to find out which features offered by their product matters most to the customers. Companies can alter the features offered by their products based on customer value analysis study, such that they acquire more customers and retain their existing ones.

The paper presents a systematic approach for designing a product by allocating the preferred features to different customer segments to minimize the product cost. The approach is developed to group the customers in n number of segments based on their worth to most preferred feature. As the number of segment increases; the total segment product cost significantly reduces. If only two segments are considered, the reduction in total segment product cost is 40.09 percent (i.e. (Rs. 5,617,860 – Rs. 3,365,304)/Rs. 5,617,860). Similarly, if three or four segments are considered, the total segment product cost is reduced by 60.43 percent ((Rs. 5,617,860 – Rs. 2,222,670)/ Rs. 5,617,860) and 72.20 percent ((Rs. 5,617,860 – Rs. 1,505,479)/Rs. 5,617,860), respectively. If four segments are proposed, and comparing its total segment cost with the total segment cost of two segments and three segments, then the percent reduction in the total segment product cost is 55.26 percent (i.e. (Rs. 3,365,304 – Rs. 1,505,479)/ Rs. 3,365,304) and 33.95 percent (i.e. (Rs. 3,365,304 – Rs. 2,222,670)/Rs. 3,365,304) to that of obtained by using two segments and three segments, respectively. This clearly justifies the importance and application of proposed methodology for the customer segmentation and product design.

The work focusses on the cost of the feature, its worth and segmentation. By offering only preferred features to certain segments which minimizes inventory carrying cost as well as assembly time, labor cost and thus overall cost of production due to limited number of features. The proposed methodology is applicable for any number of customers, any number of features and any number of segments. However, the decisions about number of segments should address the tradeoff between benefits and cost. The research work can further be extended by considering the second and or third preference of the customer simultaneously.

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Customer No.	Feature 1, air bag $C_1 = 21{,}675$		Feature 2, power steering $C_2 = 16{,}280$		Feature 3, power windows $C_3 = 10{,}665$		Feature 4, audio system $C_4 = 11{,}775$		Feature 5, air conditioner $C_5 = 21{,}244$		Feature 6, security system $C_6 = 5{,}324$		Feature 7, belt assembly $C_7 = 6{,}668$		Max net worth
	W_{ij}	N_{wij}	W_{ij}	N_{wij}	W_{ij}	N_{wij}	W_{ij}	N_{wij}	W_{ij}	N_{wi}	W_{ij}	N_{wij}	W_{ij}	N_{wij}	N_{wijmax}
1	21,285	−390	17,452	1,172	11,326	661	11,492	−283	22,349	1,105	5,164	−160	6,215	−453	1,172
2	22,412	737	17,582	1,302	10,324	−341	12,458	683	20,352	−892	5,324	0	6,468	−200	1,302
3	20,981	−694	16,638	358	10,729	64	12,717	942	22,009	765	5,569	245	7,201	533	942
4	19,508	−2,168	15,824	−456	11,710	1,045	11,940	165	23,028	1,784	5,494	170	6,561	−107	1,784
5	22,499	824	16,443	163	9,982	−683	11,963	188	20,182	−1,062	5,260	−64	7,175	507	824
6	20,548	−1,127	16,834	554	10,409	−256	12,741	966	21,456	212	5,420	96	6,081	−587	966
7	22,889	1,214	16,443	163	9,599	−1,067	10,951	−824	20,564	−680	5,771	447	6,535	−133	1,214
8	22,022	347	17,061	781	11,476	811	12,670	895	21,202	−42	5,207	−117	6,561	−107	895
9	22,195	520	15,661	−619	10,174	−491	11,916	141	20,862	−382	5,356	32	6,855	187	520
10	22,282	607	16,345	65	11,028	363	10,857	−918	19,629	−1,615	5,047	−277	6,641	−27	607
11	19,724	−1,951	16,280	0	10,196	−469	10,645	−1,130	21,032	−212	5,367	43	6,615	−53	43
12	21,458	−217	16,280	0	11,582	917	11,398	−377	21,669	425	4,898	−426	6,068	−600	917
13	23,019	1,344	15,987	−293	10,622	−43	12,293	518	19,884	−1,360	5,271	−53	7,201	533	1,344
14	20,678	−997	15,433	−847	11,369	704	11,893	118	21,371	127	5,313	−11	6,388	−280	704
15	22,152	477	16,801	521	9,748	−917	11,257	−518	20,777	−467	5,707	383	6,935	267	521
16	22,585	910	14,847	−1,433	10,537	−128	12,764	989	21,456	212	5,558	234	6,348	−320	989
17	21,155	−520	15,629	−651	9,790	−875	12,693	918	19,099	−2,145	5,420	96	6,308	−360	918
18	21,328	−347	17,615	1,335	9,961	−704	12,623	848	23,198	1,954	5,026	−298	6,015	−653	1,954
19	20,678	−997	14,880	−1,400	9,876	−789	12,364	589	22,816	1,572	5,516	192	6,641	−27	1,572
20	21,068	−607	15,857	−423	9,897	−768	11,375	−400	20,352	−892	4,983	−341	7,241	573	573
21	23,452	1,777	16,508	228	9,790	−875	12,222	447	21,202	−42	5,718	394	6,388	−280	1,777
22	19,681	−1,994	17,485	1,205	9,940	−725	11,587	−188	21,924	680	4,845	−479	6,308	−360	1,205
23	19,594	−2,081	16,378	98	10,345	−320	11,634	−141	20,692	−552	5,409	85	7,121	453	453
24	21,805	130	16,117	−163	10,686	21	10,974	−801	21,202	−42	5,761	437	6,721	53	437

(*continued*)

Table AI.
Net worth data sheet

Table AI.

Customer No.	Feature 1, air bag $C_1 = 21{,}675$ W_{ij}	N_{wij}	Feature 2, power steering $C_2 = 16{,}280$ W_{ij}	N_{wij}	Feature 3, power windows $C_3 = 10{,}665$ W_{ij}	N_{wij}	Feature 4, audio system $C_4 = 11{,}775$ W_{ij}	N_{wij}	Feature 5, air conditioner $C_5 = 21{,}244$ W_{ij}	N_{wi}	Feature 6, security system $C_6 = 5{,}324$ W_{ij}	N_{wij}	Feature 7, belt assembly $C_7 = 6{,}668$ W_{ij}	N_{wij}	Max net worth N_{wijmax}
25	23,496	1,821	17,354	1,074	9,599	−1,067	12,505	730	23,064	1,820	4,813	−511	6,748	80	1,821
26	23,062	1,387	14,945	−1,335	10,644	−21	12,905	1,130	23,156	1,912	5,058	−266	6,535	−133	1,912
27	20,418	−1,257	14,945	−1,335	10,004	−661	11,116	−659	19,799	−1,445	5,611	287	6,881	213	287
28	20,201	−1,474	16,540	260	10,793	128	11,799	24	20,564	−680	4,941	−383	7,015	347	347
29	20,288	−1,387	15,336	−944	11,689	1,024	11,092	−683	22,774	1,530	4,941	−383	6,415	−253	1,530
30	23,626	1,951	17,517	1,237	9,662	−1,003	12,929	1,154	19,332	−1,912	5,047	−277	6,108	−560	1,951
31	21,545	−130	15,368	−912	10,110	−555	11,940	165	22,859	1,615	5,154	−170	6,588	−80	1,615
32	20,635	−1,040	16,150	−130	9,769	−896	12,387	612	22,604	1,360	5,580	256	6,521	−147	1,360
33	23,452	1,777	15,629	−651	10,046	−619	11,681	−94	20,097	−1,147	4,930	−394	6,668	0	1,777
34	23,626	1,951	14,880	−1,400	9,812	−853	12,058	283	22,476	1,232	5,580	256	6,081	−587	1,951
35	22,499	824	15,075	−1,205	11,497	832	12,364	589	19,714	−1,530	5,143	−181	6,495	−173	832
36	20,028	−1,647	16,866	586	9,641	−1,024	10,880	−895	19,162	−2,082	5,537	213	6,508	−160	586
37	22,412	737	14,652	−1,628	11,625	960	10,598	−1,178	19,799	−1,445	5,718	394	6,241	−427	960
38	23,799	2,124	17,615	1,335	11,412	747	10,833	−942	22,136	892	5,824	500	7,095	427	2,124
39	21,025	−650	16,671	391	11,582	917	10,668	−1,107	22,774	1,530	4,983	−341	6,388	−280	1,530
40	23,582	1,907	17,745	1,465	10,516	−149	12,222	447	21,796	552	5,611	287	6,548	−120	1,907
41	19,638	−2,037	14,978	−1,302	10,089	−576	12,034	259	19,672	−1,572	5,569	245	6,441	−227	259
42	19,984	−1,691	16,573	293	11,454	789	12,670	895	21,456	212	5,537	213	6,201	−467	895
43	20,461	−1,214	15,433	−847	9,897	−768	10,621	−1,154	22,731	1,487	5,462	138	6,521	−147	1,487
44	20,938	−737	15,857	−423	9,662	−1,003	12,693	918	21,371	127	5,516	192	6,775	107	918
45	22,672	997	16,215	−65	10,622	−43	11,893	118	19,629	−1,615	5,771	447	6,055	−613	997
46	22,282	607	17,354	1,074	9,599	−1,067	11,139	−636	19,460	−1,784	5,697	373	6,401	−267	1,074
47	21,285	−390	16,443	163	10,836	171	10,645	−1,130	20,479	−765	4,813	−511	7,028	360	360
48	19,984	−1,691	15,987	−293	9,982	−683	12,599	824	21,032	−212	5,643	319	6,081	−587	824

(*continued*)

Table AI.

Customer No.	Feature 1, air bag $C_1 = 21{,}675$ W_{ij}	N_{wij}	Feature 2, power steering $C_2 = 16{,}280$ W_{ij}	N_{wij}	Feature 3, power windows $C_3 = 10{,}665$ W_{ij}	N_{wij}	Feature 4, audio system $C_4 = 11{,}775$ W_{ij}	N_{wij}	Feature 5, air conditioner $C_5 = 21{,}244$ W_{ij}	N_{wi}	Feature 6, security system $C_6 = 5{,}324$ W_{ij}	N_{wij}	Feature 7, belt assembly $C_7 = 6{,}668$ W_{ij}	N_{wij}	Max net worth N_{wijmax}
49	21,805	130	14,717	−1,563	11,305	640	12,529	754	19,672	−1,572	4,930	−394	6,975	307	754
50	22,455	780	16,280	0	11,646	981	12,599	824	21,499	255	5,079	−245	7,148	480	981
51	21,545	−130	17,615	1,335	11,689	1,024	12,670	895	20,012	−1,232	4,813	−511	6,281	−387	1,335
52	21,415	−260	15,824	−456	11,326	661	11,210	−565	21,584	340	5,846	522	6,601	−67	661
53	22,195	520	17,061	781	11,497	832	10,998	−777	21,074	−170	5,079	−245	6,321	−347	832
54	21,978	303	15,303	−977	11,689	1,024	11,940	165	22,604	1,360	5,058	−266	6,961	293	1,360
55	21,111	−564	17,778	1,498	9,790	−875	11,351	−424	22,561	1,317	5,249	−75	6,935	267	1,498
56	22,065	390	15,336	−944	10,814	149	11,351	−424	20,989	−255	5,047	−277	6,388	−280	390
57	20,505	−1,170	16,215	−65	11,134	469	12,222	447	23,198	1,954	5,037	−287	7,028	360	1,954
58	21,285	−390	17,875	1,595	10,068	−597	11,869	94	20,054	−1,190	5,558	234	6,975	307	1,595
59	20,765	−910	16,866	586	10,409	−256	11,092	−683	20,352	−892	5,441	117	7,295	627	627
60	22,889	1,214	17,387	1,107	11,561	896	12,693	918	21,711	467	5,654	330	6,161	−507	1,214

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