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BLENDING MULTI-OBJECTIVE OPTIMIZATIONAND QUALITY FUNCTION DEPLOYMENT FOR DETERMINING COST AND QUALITY

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Abstract

The Blending problem is one of the oldest and best known optimization problems. It is generally formulated as a linear program and has been applied in many fields. However, the mixing problem encountered in the industry requires much more than direct linear programming formulation. Indeed, the classic blending model would almost always be impossible due to the problem of blending in the industry. Indeed, it is often not possible to combine the characteristics of the mixtures as desired, which leads decision makers to seek solutions as close as possible to specific solutions. In this article, we develop and solve a versatile optimization model for the problem of blending, in which we minimize the total cost of the raw materials to be used, as well as violations of the desired characteristic scores of the final blends. We also present a parametric model which is used as a reference point to compare the multi-objective optimization model.

Keywords: MOO, QFD, Mobile Handsets.

I. Introduction

This Paper highlight the issue of decision making based on the customer Segmentation and the impact in term of Cost which will be finalized on incorporation of those features. The paper discusses about applying Quality Function Deployment

to establish correlation between "WHAT and "HOW" and then applying various schemes of the Optimization[VI]for developing an optimized solution forthe Manufacturer prospective as well as buyer's prospective.

II. Quality Function Deployment in Multi Criteria Decision Making

Perks that come equipped with Evolutionary Multi-Objective Optimization for the selection of mobile handsets. Does it shed light upon the cost and quality parameters?

The Definition of Optimization under Various Terms

To start off with, since the very beginning of the 20th century, optimization has been referred to as being somewhat close to the literal meaning of "finding the best of something". However, if one comes to take the following aspect into a different light, say, mathematically, things might turn out to be a little different than what they actually mean in the dictionary.

Speaking of numbers, the term "optimization" actually refers to the process of finding the maximum or minimum value of a function which is under one or the other set of constrains.

The History

It's been said, that 'war brings out the best and worst of all'. And true to the nature of this phrase, this technique actually saw its genesis amidst the greatest human conflict ever, The Second World War. A gentleman going by the name of George Dantizig devised a set of mathematical formulae in 1940.

The usage of such a tool was nothing but obvious for the war effort. And thanks to the genius of his efforts, the method has now become synonymous with a ton of applications. Some of these applications can be listed down as follows:-

1. Control systems[V,X]
2. Classification problems[XI]
3. Medical applications
4. Economic applications[VIII]

III. The Various Aspects of Optimization Techniques

Optimization techniques are actually divided into two parts. These parts can be listed down as follows:-

Single Objective Optimization Technique

This optimization technique involves the application of the best viable option for a single object. In simpler words, the optimization technique that involves finding the best/optimal solution for a single object is better known as the single object optimization technique.

Multi-Objective Optimization Technique

As the name defines itself, this optimization technique involves finding the best/optimal set of solutions for a number of objects. This technique can better be explained via the following example:-

A car manufacturer aims to produce a given number of units. Now, these units are tasked with achieving two major goals. One being the final product's cost effectiveness and the other being a good rating on the comfort spectrum of things.

These two problems cannot be solved by applying a single logical solution. The different demands require different set of solutions as well. Cost effectiveness and comfort cannot be achieved with a single stroke of luck. It will definitely need a set of solutions that could easily cater towards the problems at hand.

The Darwin's Approach

As Darwin's famous "survival of the fittest" quote shines light upon the basic idea of evolution. The mathematical application towards the same has also been supplemented by a logic that stands on the same ground as the theory of Darwin himself. Evolutionary [I,IV] Multi-Objective Optimization technique is also applied for finding the best set of solutions to fuzzy problems.

Let us consider a fuzzy system that is supposed to deliver upon the following two aspects: -

a) Easy interpretability
b) Accuracy

The problem is, one attribute can be achieved while sacrificing either a fraction or a whole unit of the other attribute. A fuzzy system which is facing some complexity regarding the delivery of the best set of solutions for the aforementioned attributes, will definitely fail to exhibit the desired results.

Such a condition that creates a paradoxical situation of gaining one attribute over the loss of the other is known as "Interpretability-Accuracy Trade-off."

Non-dominated solutions

Let us consider another case which involves getting a set of solutions defined by:

$$(x_1^*, x_2^*, \ldots\ldots\ldots\ldots\ldots\ldots\ldots x_n^*)$$

This set of solutions actually produces the optimal values for all the designated objective functions. Now this set is considered to be the set of Non-dominated solutions.

IV.Algorithms based on the MOEA to Deal with Multi-Objective Optimization Problem

A few set of algorithms were the need of the hour when multi-objective optimization problems were quite rampant. In order to deal with these problems, the

following algorithms saw their genesis in order to cure the ongoing ailments. These algorithms can be listed down as follows:-

1. NSGA- It was basically developed around the concept of Goldberg. It emphasized upon the relevance of classification layers for each and every individual.
2. NPGA- This algorithm focuses upon the tournament selection mechanism. It is also concerned with the Pareto Dominance.
3. MOGA- It ranks the individuals on the basis of the number of chromosomes present in them. Furthermore it also assigns the maximum fitness value for all non-dominated individuals.

The aforementioned algorithms were developed as a part of the first generation of such algorithms, the second generation of such algorithms came to life shortly after. These algorithms are listed down as follows:-

1. SPEA- When a number of MOEAs merge together, they form this kind of an algorithmic structure. It computes strength value by using an external non-dominated set.
2. SPEA2- It can better be described as a refined version of the former. Some basic yet major improvements upon the former version are the addition of fine-grained fitness assignment strategy. This algorithm also uses the nearest neighbour density estimation.
3. PAES- It follows the (1+1) evolution strategy. The storage of non-dominated solutions is performed as well.
4. NSGA-II- It is the updated or improved version of the algorithm sharing the same name from the first generation. It basically uses the crowding distance concept.

V. Implementation of the Given Parameters

Now that the problems have been discussed with their appropriate solutions, it would be better to understand the number of factors that come into play. The selection of a mobile handset depends upon the following factors:-

The built quality of the phone.

1. The operating system installed and the degree to which it can be used.
2. The reduction of price.
3. Ease of access to the user.

Usually, these are the most relevant options that come into the minds of people before they choose a particular handset for themselves. However, the problem lies in finding the solutions to all these problems while doing each aspect the justice it needs at the same time.

In order to achieve this, the client/the organization shall conduct an opinion poll among the common folk. Their results shall be registered and processed to an extent when the satisfaction of the customer as well as the cost is present at the same time.

VI. QFD Quality Function Deployment

Quantity Function Development was initiated in 1972. Its popularity gradually increased after first implementation by TOYOTA for its mini vans. QFD[VIII] is a systematic approach of finding out the bridge between actual consumer's requirement and what the company can off the focus on the area like:

- Production Planning
- Part development
- Process Planning
- Production planning
- Service industries

It is a team based management tool in which customer's expectation are used to device the product development process. The basic idea to use QFD is to formalize the requirement engineering process with high quality standards.

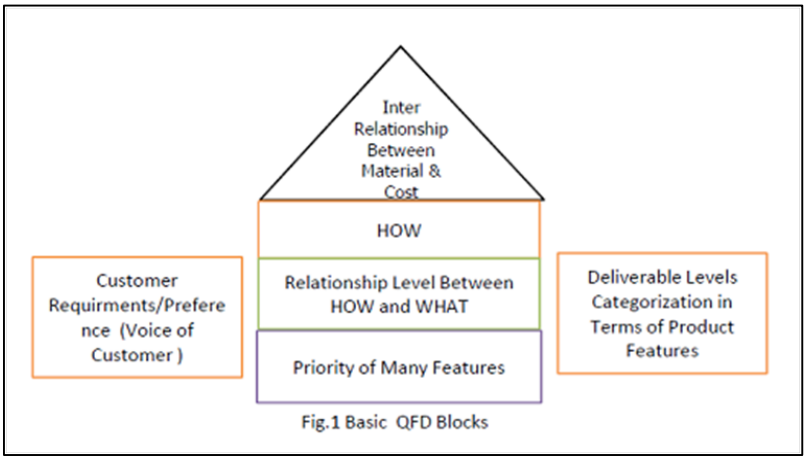

Fig.1 Basic QFD Blocks

VII. Customer Aspect of Design

The basic principle of any Mobile design lies on the features and the complexity in design. A trade –off has to be managed between the design and implementation of the basic features and the impact on the production it will value provided that cost is also being managed by the company. We have broadly classified the Handset criteria into

i) RAM ii) Camera front & back iii) Battery Life iv) Processing Capabilities

All the parameter lives with the Cost factor a Relation can be established under different broad categories: Relationship between Parameters vs. cost impact and finally to customer segmentation.

Table I : Relationship Between Features, Cost Impact and Customer Segmentation.

S.No	Features Incorporated	Cost Impact%	Customer Segmentation
1	RAM	Very High	Business Segment
2	Camera – Front Camera - Back	Moderate = 10% High =20%	Student Class Housewife
3	Battery Life	Significant=40%	Business Student
4	Processing Capability	Very Very High= 60%	Business Segment

Author have surveyed various websites and found certain relationship being established. Figure 2 shows various mobiles being selected/Arranged according to the price and features further study has been revealed in this paper showing the impact of feature on Quality of the Mobile and the cost impact which the company will in adding those functionalities.

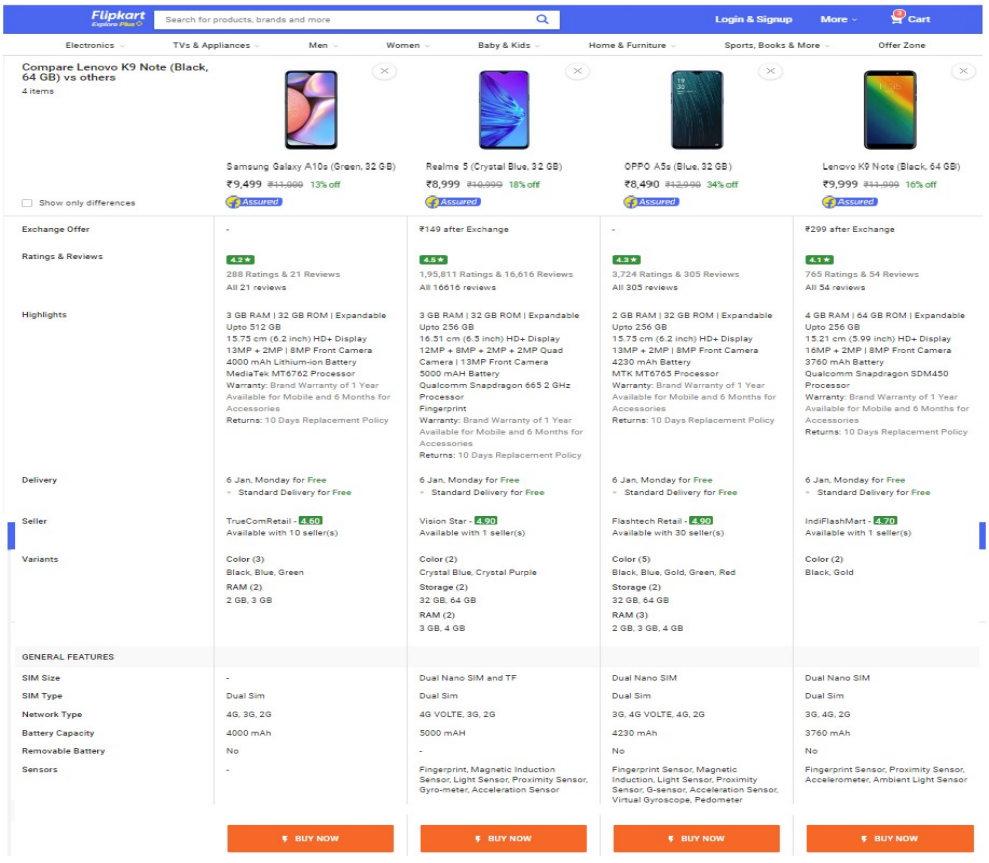

Fig. 2: Various Variables are Shown for Online Purchase

On Analyzing the Website it was found that Screen Size and battery has significant weight age in Cost of the Mobile handsets (Figure 3). Secondly, if we categories[IV] it amongst various segments then we majorly get four basic segments Business man, Housewife, Student and Senior Citizens as shown in main focus is on the variability we are able to establish through our Mobile Shop and Customer surveys.

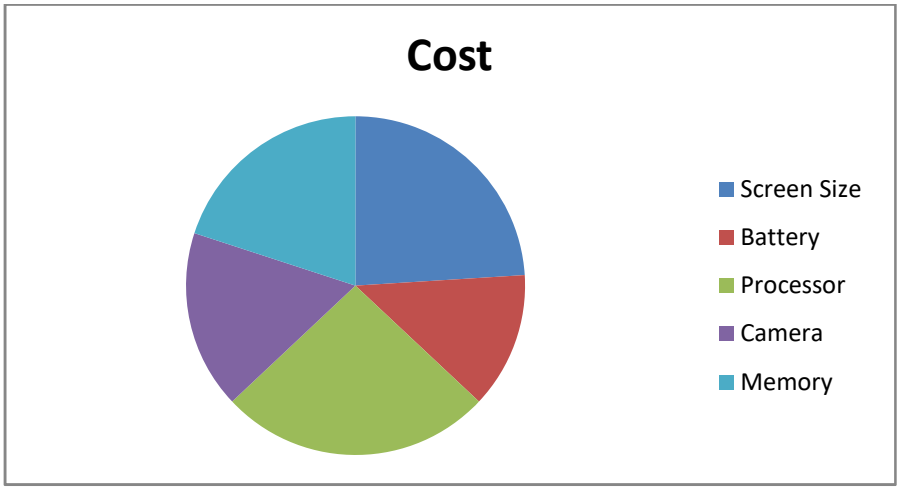

Fig.3: Pie Chart Showing the Cost Component in Mobile Handset.

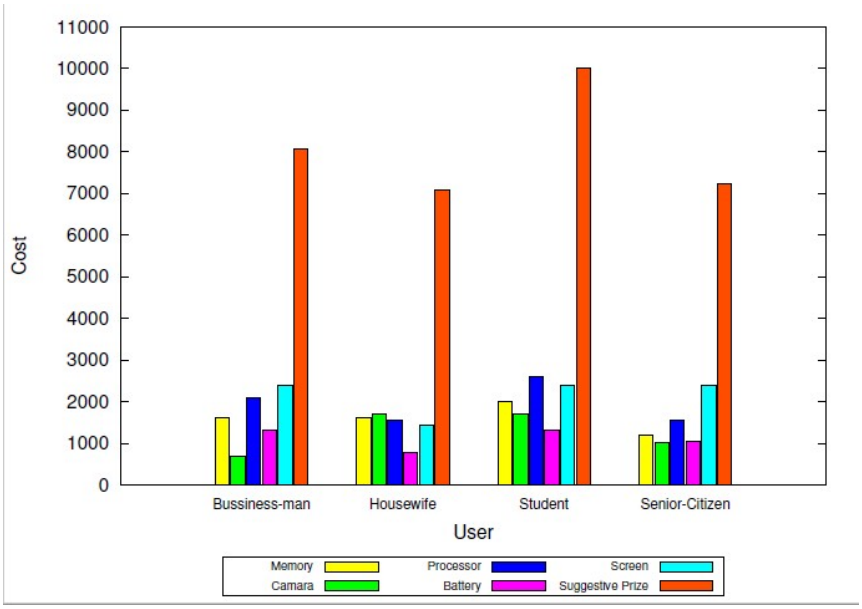

Fig.4: User Segment with Cost and Features Expected

A Relationship matrix between customer requirements priorities like frozen requirements are identified and is directly correlated with process and people at the middle of QFD a direct relationship needs to be established at the middle of QFD showing the relationship between "HOW" the company to achieve the target and "WHAT" the customer wants, is shown by Solid circle, Single Circle, triangular Symbol and a blank box shown in figure 4.

In this list of customers requirements are analyzed in "WHAT" field like RAM ,Camera, Battery life and Processing Capabilities then we have Technical Descriptors showing how it will be achieved by the company in it cost magnitudes .In order to fit the variable in the relationship part we have to derive it using optimization technique .

Prioritized Customer Requirement

It contains the column for importance to customer, target value; scale up factor sale point and Absolute weight.

Importance to the Customers

In Customer requirements the requirements are ranked with members 1 to 10 ie: the more important to the customer requirements; the higher rating.

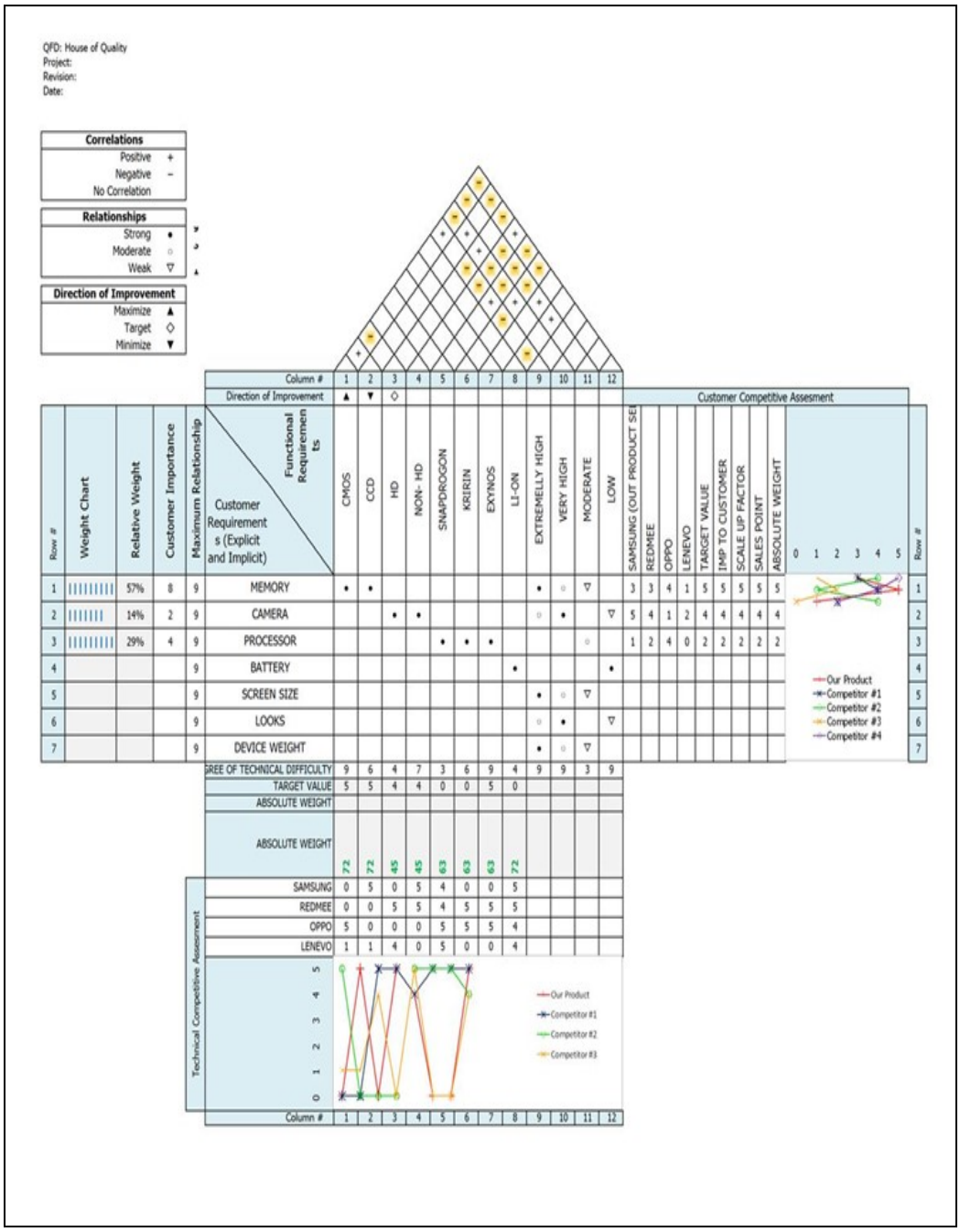

Fig.5: A QFD Showing Relationship between HOW and WHAT.

Target Value

It shows the degree of technical values of WHAT ranging from 1 to 5 i.e.: Worst to Best.

Absolute Weight (AW)

Absolute weight is calculated based on the formula given as:

Absolute Weight = (Importance of Customer)(Scale up Factor) (Sales point)

Scale Up Factor

It is defined as the Ratio of Target Value to the product rating given in the customer. Competitiveassessment. As the output rises more effort is applied to complete the task.

Sales Point

It tells the QFD team how well a customer requirement will be master table in the current scenario. It ranges from 1.0 to 2.0 being the top most value.

Absolute Weight

It is given by the formulae

Absolute Weight = (Importance to Customer)(Scale up Factor)(Sales Point)

Degree of Difficulty

It deals with the technical descriptors make up a block of rows corresponding to each technical descriptor in House of Quality. The degree of difficulty is determined by rating each technical descriptor from 1 to 10.

Target Value

The target value for each technical descriptor included below the degree of technical difficulty & it determines how much effort is needed.

Finally the calculate **Absolute weight** shown as the prioritized technical description it is calculated by the formula: A Dot product of the column in the relationship matrix and the column for importance to customer. The greater the Absolute weight the more is focus on HOW.

One an example is a dot product of Relationship Matrix and the column for importance to customer.

VIII. Analysis

We derive a relationship between "WHAT" and "HOW" related to cost impact using Interactive multi-objective programming which balances the trade–offbetween various factors. This multi objective programming searches a solution in an interactive way. The objective function for our problem can be written as:

$$f = f1(ScreenSize) + \frac{f2(Camera)}{Cost} + f3(Batterylife) + f4(Processing) + f5\left(\frac{Processing}{cost}\right)$$

We have used Naleayama and Yun method to balance the trade off activity using μ - ν- SVR and found the Parents optimal solution nearest to the given aspirants level. General Pareto front is being calculated and is replicated by MOGA by normalizing the following set of out course of values which are generated from QFD. Various Pareto Fronts are generated after obtaining the Target value, Scale up factor and Sales Points from QFD, a perfect correlation is established between Cost and Features as QFD tells about the HOW difficult it is to establish these features in terms of manufacturing these items.

Plotting the Results

The results from the tests conducted above can deliver a number of varying results and it is probably the best way to get a better picture of the current situation would be to plot a graph that involves the presence of both the attributes that were taken into consideration in the first place.

IX. The Inference

It can be rightly said that after conducting the given algorithmic tests and other evaluations, the generation of a set of multiple solutions for a plethora of problems is feasible.

The complexity can be managed by working upon the rate of trade-off in between the available attributes. The aforementioned algorithmic processes as well as the results throw light upon the usefulness of the Evolutionary model.

In the upcoming future, it might be possible for us to see a better version of the algorithms that are currently in usage. These efficient algorithms will blur the line between losing a fraction or no units from the attributes at all. The handset selection problem can now be solved easily while giving an insight regarding the fulfillment of both the desired outputs.

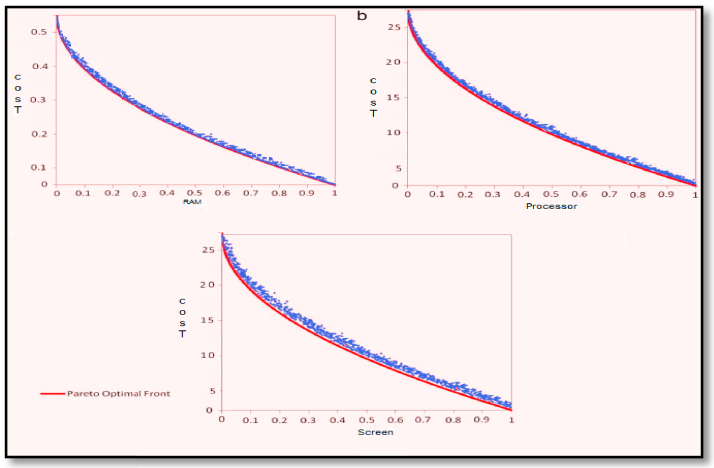

Fig. 6: Pareto Diagram for cost Vs Various Features of the above Objective Function

X. Conclusion

In this paper we are able to calculate and inference about the Customers segment [II,V] and their categorized requirements in terms of various factor. By the help of QFD we are able to highlight the specific factors which are important to customers and how the company is able to deliver then using combination of functionalities/features and how to do it. Cost factors can be adjusted by the features which are to be incorporated in the Handset. The adjustment of input variables is done by the help of the Multi- objective optimization technique. By this way we are able to find out the exact relationship in three main factors Requirement of the customer based on their segmentation, Quality of Achieving it as a part of Material requirements and finally the cost imprecation which the company has to be bear on embedding these features.

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