'Quality & Popularity' Prediction Modeling of TV Programme through Fuzzy QFD Approach

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***Abstract*—In this paper we tried to dwell on to the problem of identifying the most important 'Quality and Popularity contributing factors', which plays an important role in deciding the 'Popularity' of a TV production.**

We first tried to identify correctly the most important 'Quality and popularity' contributing factors of a TV programme which makes the TV programme more popular and successful, and then applied the knowledge of a most suitable scientific technique i.e. Fuzzy QFD in our situation, which would successfully incorporate these identified factors by establishing a proper correlation between these factors and the relative engineering requirements which used to effects these factors mostly if not considered at the time of production of the TV programme, and lastly we analyze our findings by simulating a most approximate 'fuzzy inference rule' based 'Quality and Popularity' prediction model.

Our model would rather help in deciding the best combination of identified characteristic, for which 'Quality & popularity' of the said TV programme will be predictable on a suitable linguistic scale, and could be kept high by maintaining the minimum required threshold of different identified characteristics.

***Index Terms*—Fuzzy Quality Function Deployment (FQFD), House of Quality (HOQ), Fuzzy Inference mechanism (FIM), TV Production (Television program production)**

I. INTRODUCTION

In TV entertainment industries where millions of money are being invested in producing variety of T V programmes on regular basis and after finishing the production, producers of the programme, start search for sponsorship of their production through various commercial agencies or directly with TV channel owners, to get some good return on their investment, these agencies in return provide them a platform to telecast their programme for the viewers and depending upon the response of the viewers in terms of popularity of the said programme the return on the investment of the producers could be decided, though every producer has invested his money by thinking a good return on the investment but only a few of them encounter a positive response from its viewer and thus could become success in term of monetary returns, but majority of others could not even get back their investment or just equalize it and some more unfortunates get totally loss as they even do not get any commercial sponsorship for their production.

A. Motivation

Though most of the producers of the TV industry used to concern about the latest way of incorporating the current trend and technicality of the production industries rather, in a blind manner to prove that their production incorporating the latest feature of the industry, even then their programme does not taste the success on real ground. There exist a number of cases of drastic failure of hugely invested projects which incorporates the entire latest technicality and invested millions of rupee in the projects, why it is so?

A general trend in a TV programme making is the concern about a good script, a well trained director, shooting technicians, camera persons, good sound recordist and vision mixer engineers and for post production a well establish non linear editing facility with some good editors for audio and video effect generation and mixing for final presentation of the programme, is been taken as a sufficient resource to produce a good quality programme, is it enough to contribute well in a success of the production? Does not the heterogeneous background of the viewers play any role in the success of a programme? Does only the above mentioned resources are enough to cross the benchmark of viewer's expectations? These and several other questions often come in producers mind when a well invested project faces a drastic failure. The purpose of this research is oriented towards answering these queries on a well structured scientific background and thereby designing a computational prediction model of 'TV programme popularity' based on our scientific finding of related data.

B. Problem statement and objectives

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The problem motivation stated above suggest us that it is only the viewer of a programme who is responsible for its popularity or failure and if we any how can identify the most common features of a programme which, the viewers want most, and through some effective scientific methodology could insert these requirements in the proposed TV programme well at the time of production, only then we might be able to make it popular among the viewers, but the heterogeneous background of Television viewers and their responses about a popular TV programme is so scattered that selecting and organizing them in a two or three sub groups of most rated requirements is difficult to interpret accurately, as the responses are in linguistic terms and thus difficult to judge on crisp scale.

Since the identification of 'popularity ingredients' of the TV programme will be based upon these findings therefore in case of wrong judgment of linguistic terms on crisp scale will cause the wrong prediction of the success metrics ingredients and this in result will produce a wrong result. Hence in this scenario we identify our problem statement as:

- To identify correctly the most important common popularity factors of a TV programme which makes a programme more popular and successful, through its viewers (audience) point of view and judge them accurately in linguistic term by some appropriate technique.
- To find and apply a most suitable scientific technique which will successfully incorporate these popularity factors and interpret them on a suitable linguistic scale.
- To establish a proper correlation between these identified factors and the relative engineering requirements which used to effects these factors mostly if not considered at the time of production of the TV programme.
- To propose a basic popularity prediction model based on our findings of the above popularity ingredients and its simulation for prediction study purposes.

C. Contribution and adopted methodology

Since the viewers requirements were expressed in linguistic term therefore to initiate our work correctly we applied fuzzy logic concepts (because fuzzy theory is a well proven methodology of Soft computing in dealing with linguistic variables effectively) to weight the requirements on a suitable linguistic scale and then we correlate the identified attributes more accurately in accordance with the voice of viewers. we did a lot of literature survey to find the most suitable correlating technique which in our scenario seems to fit correctly when applied correctly to correlate viewers requirements to the design attributes of the production, we find QFD (Quality function deployment) in combination with fuzzy i.e. Fuzzy QFD most suitable to fulfill our criteria of application. We then ranked them in accordance to their importance ranking (find out on linguistic scale), for the respective improvements i.e. which one is needed to improve most so that the viewers requirements relating to that particular attribute could almost get fulfilled and thus contribute most to make the proposed TV production 'Popular and Success'. After suitably ranking these identified improvement factors contributing more towards popularity and success of the TV programme we rigorously prepared a related rule base depending upon our findings to simulate the most approximate 'fuzzy inference model of popularity prediction' by utilizing Fuzzy toolbox of MAT Lab environment to relate the 'popularity' of the programme in relation with the above identified attributes and then discuss the result.

D. Organization of the paper

Apart from this introduction rest of the paper is explained in three major parts, in section-2 a brief overview of fuzzy logic, fuzzy inference mechanism, introduction of the traditional QFD (Quality Function Deployment) and building up of HOQ (House of Quality) is given. Section-3 explains our proposed fuzzyQFD based 'TV programme 'popularity factor identification'; we explained our work thoroughly with the help of both the approaches i.e. crisp and fuzzy in relation to our gathered data. Section-4 presents the result analysis and decision on the identified important production metrics, we correlate the different metrics that has been identified above through simulation by utilizing the fuzzy tool box of MAT lab, an exhaustive exercise is been done while preparing the rule base in accordance with our findings for the fuzzy inference system, to simulate a more accurate model for prediction after suitably scaling the linguistic variables and their respective membership functions.

We conclude this research work with a discussion about future work scope. Appendix 'A' and 'B' explain the necessary calculation steps involved in our work and Appendix 'C explains the necessary parameters and the applied fuzzy rule base which we prepared for simulation work.

II. FUZZY LOGIC & QUALITY FUNCTION DEPLOYMENT(QFD)

A. Fuzzy Logic

Use of Fuzzy sets in logical expression is known as Fuzzy Logic. Fuzzy Logic is a superset of a Boolean logic and that has been extended to take care of the partially truth values. It is a mathematical technique for dealing with imprecise data and problems that have many solutions rather than one. Fuzzy logic works with ranges of values, solving problems in a way that more resembles human logic. Fuzzy logic is a logical system which is an extension of multi valued logic. Fuzzy logic starts with and builds on a set of user supplied human language rules. The fuzzy system converts these rules to their mathematical equivalents. Fuzzy logic can handle problems with imprecise, vague and incomplete data. In Fuzzy Logic a proposition may be true or false or have an intermediate truth value, such as may be true. Fuzzy systems try to emulate cognitive process of the brain with a rule base. The basic concept is inspired by the human process, where the decisional criteria are not clear cut but blurred and is difficult to find objective to make decision more precise and clear [1].

B. Fuzzy inference mechanism (FIM)

To get a better understanding of fuzzy inference mechanism we will start with Generalized Modus Ponens (GMP) which is analogue of the ‘Modus Ponens’ rule of the classical logic[14]. Its format is given by:

R: If p then q (Rule)

F: p’ (premise)

C: ⇒ q’ (conclusion)

In general if R will be interpreted as a fuzzy relation on U x V and F will be interpreted as a fuzzy set on U, so that C = RoF (composition of F and R) is a fuzzy set on V where U = domain of x and V = domain of y in other words , we have

$$C(y) = \max \{\min [F(x), R(x, y)]\}$$

Where max is taken over all x in U. The given process by which the conclusion is derived is called *fuzzy inference* [5].

The general format of fuzzy inference mechanism (FIM) is as follows:

- It consists of several rules (several R’s) each R consisting of one or more antecedents (one or more F) and only one consequent C. The collection of such rules is called the *rule base* or *fuzzy rule base* (FRB).
- One or more given facts (matching the total number of antecedents) in the form of fuzzy propositions.
- The objective is to arrive at the appropriate conclusion(s) via the interpretations described above and the Generalized Modus Ponens (GMP).

We now explain the actual details of FIM procedure. Let the total number of linguistic rules be K and let the kth rule be given by

R (k): if < x1 is A1k > and <x2 is A2k > and …and < xN is ANk>
Then < z is Bk >

Where x1, x2,…xN are the input variables with domains U1,U2,…,UN and z is the output variable with domain V. Aik and Bk (i = 1, 2,…,N) are linguistic values characterized by fuzzy sets with membership function also denoted by the same symbols. We are also given N number of facts : < x1 is A1>, < x2 is A2>… < xN is AN>.

C. QFD and House of quality (HoQ)

Generally a four phase approach is accomplished by using a series of matrixes that guides the product or service team’s activities by providing standard documentation during product and/ or process development (Figure 2.1).

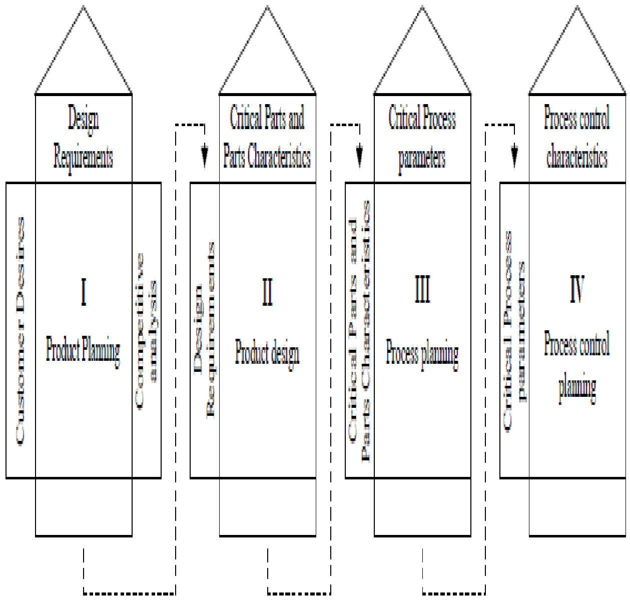

Figure 2.1 The four phases of traditional QFD

As shown in figure 2.1 each phase has a matrix consisting of a vertical column of “What’s” and a horizontal row of “How’s”. “What’s” are CR; “How’s” are the ways of achieving them (CRs). At each stage, the “How’s” are carried to the next phase as “What’s”. As a result, the House of Quality can be built in many shapes and forms. The general purpose of QFD model includes the components is shown in Figure 2.2.

Customers requirements (CR) - Also known as "Voice of Customer" or VoC, they are the "what’s" the customers want from the product to be developed. They contain customers’ wishes, expectations and requirements for the product.

Customer importance ratings - Once these "what’s" are in place, the customer needs to provide numerical ratings to these "what’s" items in terms of their importance to the customer. A numerical rating of 1 to 5 is often used, in which the number 5 represents the most important and 1 the least.

Customer market competitive evaluations - In this block, a comparison is made between a company's product/service and similar competitive products/services on the market by the customer. The comparison results will help the developer position the product on the market as well as find out how the customer is satisfied now. For each product, the customer gives 1 to 5 ratings against each CR, 5 being best satisfied and 1 the worst.

Technical specifications - They are the technical specifications that are to be built into a product with the intention to satisfy the CR. They are sometimes referred as "hows" because they are the answers to CR: how can the requirements be addressed or satisfied. They are the engineers' understanding in technical terms what customers really want. The technical specifications must be quantifiable or measurable so that they can be used for design.

Relationship matrix - Relationship matrix is used to maintain the relationship between CR and design requirements. In other words, the matrix corresponds to the "what's" vs. "how's". It is the center part of HoQ and must be completed by technical team. A weight of 1-3-9 or 1-3-5 is often used for internal representation of relationship, 1 being the weak and the biggest number being the strong relationship.

Correlation matrix - It is the triangular part in the HoQ (the "roof"). The correlation matrix is used to identify which "how's" items support one another and which are in conflict. Positive correlation help identify "how's" items that are closely related and avoid duplication of efforts. Negative correlation represents conditions that will probably require trade-offs. The positive and negative ratings are usually quantified using 2, 1, -1, and -2 ratings, with 2 being the two "how's" items are strongly supportive to each other and -2 being the conflicting. Sometimes only 1 and -1 are used.

Target goals - Completed by technical team, these are the "how much's" of the technical "how's" items. They provide designers with specific technical guidance for what have to be achieved as well as objectively measuring the progress. The goals have to be quantified in order to be specific and measurable.

Technical difficulty assessment - Technical team conducts the assessment. It helps to establish the feasibility and reliability of each "how's" item. 1 to 5 ratings are used to quantify technical difficulty with 5 being the most difficult and 1 being the easiest.

Technical competitive evaluation - It is used for comparing the new product with competitor's products to find out if these technical requirements are better or worse than competitors. Again, 1 to 5 ratings are used with 5 being the fully realized each particular "how's" item and 1 being the worst realized.

Overall importance ratings – This is the final step of finishing HoQ for phase 1. For each column, sum all the row numbers each of which is equal to the production of relationship rating and customer's important rating. The results help identify critical product requirements and assist in the trade-off decision making process.

III. PROPOSED WORK

In order to identify most common incorporable factors which will make a programme more popular and successful among its viewer the various important feedbacks of the viewers must be ranked first as per the decreasing or increasing order of importance of a particular factor in viewers mind and then finding what most of the viewers want to see in a particular programme. The task of listing and identifying these factors is so complicated that the audience research unit of the production house becomes unable to sort out the factors correctly and in orderly fashion, to do so we here proposed a novel practical application of fuzzy QFD

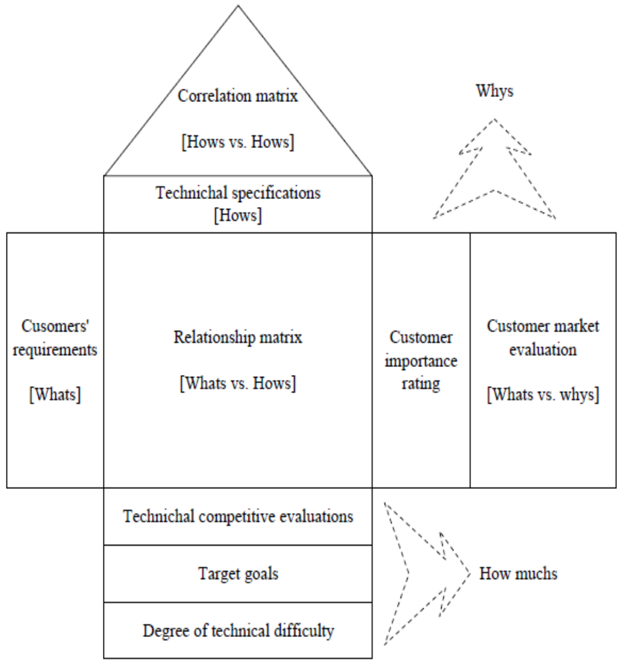

Figure 2.2 House of Quality (HoQ) in QFD

method which is been derived through the fusion of computer science and management science discipline. Through this approach we try to resolve the issue of identifying the most important incorporable factor among the various almost same looking important factors by suitably deciding the ranking as per their importance in viewers mind and then discarding those factors which are less important or less relevant to accommodate in the proposed production. We start making a suitable HOQ (QFD process) as explained in previous section through the following stages:

A. Determining the Viewers Demand

The initial and most critical step of the QFD process in our case is, the identification of 'what' TV viewer want and expect from a good TV programme. In this step, viewers' demands, expectations, and complaints are determined. Identified data contain current viewer's expectations that are critical to success and potential expectations that would excite viewers. Several methods can be used to establish the viewers' requirements, including: viewer's panels; focused group discussions; structured or unstructured viewers interviews; self-completing questionnaires; in-depth viewers observation; viewers' complaint and compliment database; viewers' service inquiries database; front-line staff feedback. The list of viewer demand was identified with literature search, and focusing on group brainstorming in the concerned audience research unit, which was applied in this study. In the brainstorming process, group considered the complaints that were received from viewers as an input. In addition that small viewer group was chosen for the pilot study. In this study an open question was asked to the respondent to gather data. After collecting data, this list was obtained.

The list of the viewer's concerns is shown below:

1. Cost of production of the programme
2. Production house brand name
3. Sufficient well advance promotion
4. Contents of programme
5. Ease in understanding
6. Confined to specific group of viewer
7. Able to convey the hidden message
8. Provides entertainment
9. Repeat telecast of the programme (time slot)
10. Avoids vulgarity in programme
11. Related to viewers environment
12. Related to social environment
13. Appealing (presentation)
14. Characterization
15. Duration of program
16. avoids excessive mid breaks
17. Appropriate theme for family viewing

At any one time it is unlikely that TV organization can satisfy all of its viewers' requirements. Therefore it is necessary to prioritize the needs that are to be met within a planning cycle systematically. Using a structured questionnaire, 300 viewers were asked to rate the importance of the programme features identified and to compare the performance of the many existing popular TV programmes with their "ideal programme" In this way it was possible to see which quality characteristics are more important for meeting or exceeding viewers' expectations. The *rate of importance* is a rating of the viewer demands on a scale of 1 to 5. On this scale 5 denotes most important and 1 denotes relatively low importance. The viewers should assign these ratings. Mean and standard deviation of the attributes is depicted in table 3.1

Table 3.1: Mean and standard deviations of viewers preferred attributes

Attribute Variables	Mean	Standard deviation
Cost of production	2.71	1.25
Production house brand name	3.05	1.23
Sufficient well advance promotions	3.09	1.26
Contents of programme	4.26	1.03
Ease in understanding	4.05	1.20
Confined to a specific group of viewers	3.70	0.99
Able to convey the hidden message	4.23	1.06
Provide entertainment	4.31	1.02
Repeat telecast of the programme (time slot allotment)	4.34	1.02
Avoids vulgarity in programme	4.61	0.97
Related to viewers environment	3.83	1.05
Related to social environment	3.95	0.99
Appealing (presentation)	3.91	0.92
Characterization	3.09	0.91
Duration of programme	4.25	0.64
Avoids excessive mid breaks	4.55	0.78
Appropriate theme for family viewing	4.51	0.81

Further refining among these attributes led us to suitably categories them into three broad factors which are of relevancy from the production point of view, we grouped them as explained below:

- Popularity factor
- Entertainment factor
- Regional factor

Only the below given attributes are compatible on these three factors and based on the items loading on each factor. These twelve attributes are shown as items in the Table 3.2. Therefore rest of the attributes was not considered further.

Table 3.2 attributes categorization in three factors

Popularity factor ⇩	Entertainment factor ⇩	Regional factor ⇩
Time slot allotment	Ease in understanding	Related to viewers environment
Duration of the program	Content of program	Related to social environment
Provide entertainment	Appropriate for family viewing	-------
Presentation	Avoids vulgarity	------
Avoid excessive mid breaks	-------	------
Able to convince meaning	--------	------

B. Viewers competitive evaluation

Viewer's competitive evaluation is conducted according to the result of the survey is given in Table 3.3. This table consists of ten columns. Every column is explained below.

Column 1: consist of Viewer's rate of importance of identified preferred attributes.

Column 2: This column represents the current performance of the programme in question i.e. programme 'A', considering the quality characteristics. The viewer performance evaluation of the surveying TV organization (producer of programme 'A') provides a listing of the satisfaction degree for the each of the quality characteristics. A scale of 1 to 5 was used.

Columns 3, 4, 5: The viewer evaluation of the performance of the competitors' programme of the surveying TV organization was determined using a scale of 1 to 5. In this case three competitors TV organization (name could not be disclosed due to legal reasons) were examined for comparing and benchmarking process.

Column 6: This column shows the planning phase of the organization. This is determined by looking at where the viewer programme is today, and what the competitors are doing with respect to the viewer demands. It also takes into account the organization's strategic plan and policy deployment.

Column 7: Column 7 contains the factor by which actual improvements must be adjusted to reach the levels that organization in question i.e. A wants to achieve. These were calculated by dividing the planned quality target levels by the current quality levels. It is called the rate of improvement. The value of the rate of improvement 1.00 would signify that no improvement was necessary.

Table 3.3: Viewer competitive evaluation matrix

Level of attributes	*Column*	*1*	*2*	*3 …..*	*…4*	*5*	*6*	*7*	*8*	*9*	*10*
Primary Level	*Secondary Level (Attributes)*	*Rate of Import-ance*	*Compe-titor X Progr-amme*	*Our Progra-mme 'A'*	*Compe-titor Y Progr-amme*	*Compe-titor Z Progr-Mme*	*Goal*	*Impo-vment Ratio*	*Sales Point*	*Row Weight*	*Demand Weight*
Popularity Factor	*Time slot allotment*	*4.34*	*3.2*	*3.59*	*3.52*	*3.14*	*4.34*	*1.21*	*1.5*	*7.87*	*10.37*
	Duration of program	*4.25*	*3.24*	*3.36*	*3.17*	*2.85*	*4.25*	*1.26*	*1.2*	*6.45*	*8.50*
	Provide entertainment	*4.31*	*3.4*	*3.44*	*3.43*	*3.25*	*4.31*	*1.25*	*1.5*	*8.10*	*10.67*
	Presentation	*3.91*	*3.16*	*3.67*	*3.43*	*3.14*	*3.91*	*1.07*	*1.0*	*4.17*	*5.49*
	Avoids excess mid breaks	*4.55*	*3.36*	*3.79*	*3.61*	*3.15*	*4.55*	*1.20*	*1.5*	*8.19*	*10.79*
	Able to convince meantime	*4.23*	*3.2*	*3.26*	*3.43*	*2.99*	*3.45*	*1.06*	*1.2*	*5.37*	*7.08*
Entertain-ment Factor	*Ease in understanding*	*4.05*	*3.16*	*3.21*	*2.83*	*2.81*	*4.05*	*1.26*	*1.2*	*6.13*	*8.08*
	Content of Programme	*4.26*	*3.2*	*3.31*	*3.52*	*3.1*	*3.52*	*1.06*	*1.0*	*4.53*	*5.97*
	Appropriate to family Viewing	*4.51*	*3.48*	*3.74*	*3.52*	*3.01*	*4.51*	*1.21*	*1.5*	*8.16*	*10.75*
	Avoids Vulgarity	*4.61*	*3.32*	*3.36*	*3.52*	*2.83*	*3.52*	*1.05*	*1.5*	*7.24*	*9.54*
Regional Factor	*Related to viewers Environment*	*3.83*	*3.4*	*3.56*	*3.43*	*3.04*	*3.83*	*1.08*	*1.0*	*4.12*	*5.43*
	Related to social Environment	*3.95*	*3.12*	*3.36*	*3.39*	*2.96*	*3.95*	*1.18*	*1.2*	*5.57*	*7.34*
										75.91	*100.0*

Column 8: This column that is named as sales point shows which of viewer demands or attributes of programme have more important effect on marketing and image of the programme. In other words which attributes of the programme ensure competitive advantage for the TV organization against its rivals? In this case the organization in question can improve this competitive edge. In this study sales point scores were determined using brain storming process among the experts who works at the programme production department in the organization, which was applied to this study. A score of 1.5 is used to indicate a strong sales point. A score of 1.2 is used for a lesser sales point and a blank or 1.0 is used for items, which are not sales point. It is impractical to make every customer demand a sales point. A weight, which was determined by experts can be assigned to the presence of a sales point and used in calculation of the quality weight [8].

Column 9: This column is named as row weight or absolute weight. Row weight is determined by multiplying the rate of importance (column 1) by the rate of improvement (column 7) and multiplying the result by the sales point (column 8). Row weight = (column 1) x (column 7) x (column 8) (1)

Column 10: Final column is determined by converting the absolute weight to the percentage.

C. Determining the Technical Requirements

In this stage, determined viewers demands were translated into technical requirements. The objective is to translate each viewer's voice into one or more technical requirements. Each technical requirement should be measurable and global in nature and should satisfy the voice of the viewer. Table 3.4 has addressed the "what" question by identifying viewers' requirements. This third stage addresses the "how" question by identifying the measurable and definable design features of the viewers programme. In this study, eight important quality characteristics, which were defined by Garvin, were considered to meet and related to viewers requirements. These are *performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality.* All of these quality characteristics were explained below [9].

Performance refers to the primary operating characteristics of the product or service. They are usually measurable. For a TV programme these characteristics would relate to the regional factor such as, related to viewers environment or related to social environment. *Features* are additional characteristics that enhance the product/service appeal to the user. Adding prize distribution to the viewers and encouraging them to participate through SMS in between the programme can be given as an example. *Reliability* of a product is the likelihood that a product will not fail within a specific time period. An example is the inclusion of some local announcements, or some informative educative content in between the proposed show. Although Garvin states that reliability is more relevant to durable goods there are many examples of reliability as a key element of a service and fast moving product.

Table 3.4: Relationship matrix between how's and what's

What's	How's	Performance	Features	Reliability	Conformance	Durability	Serviceability	Aesthetics
Primary Level (factors)	Secondary level (attributes)							
Popularity Factor	Time slot Allotment	1	9	9	9	1	3	9
	Duration of Programme	1	9	9	9	3	3	9
	Provide entertainment	1	9	9	9	3	3	9
	Presentation		3	3	9	9	3	9
	Avoids excess Mid breaks	9	9	9	9		3	9
	Able to convince meaning	1	9	9	9	1	3	9
Entertainment Factor	Ease in understanding	9	3	9	9	1	3	9
	Contents of Programme	3	3	9	9		1	1
	Appropriate for family viewing	3	9	9	9	1	3	3
	Avoids vulgarity	9	3	9	9	1	3	3
Regional Factor	Related to viewer environment	9	9	9	9	3	3	
	Related to social environment	9	9	9	9	3	3	
	Weight of column's	457.4	867.15	725.61	900.09	191.05	288.09	615.66
		5	2	3	1	7	6	4

Conformance is precision with which the product or service meets the specified standards. In our case it relates to the technical aspect of production and post production features like non linear editing, special audio and visual effects etc. *Durability* measures the length of a product's life. For TV programme, it measures how long the popularity of the show will keep its viewers stuck to their Television sets. *Serviceability* is the speed with which the product can be put into service when it breaks down. In our scenario of TV programme we relate it to the adaptability of the show i.e. flexibility in script to accommodate any future changes to make it continuously more interesting as it progresses. *Aesthetics* is the subjective dimension indicating the kind of response a user has to a product. It represents the individual's personal preferences. It reflects the ways of individual's responds to the look, feel, sound, taste, and smell. A person judging the content of the programme would say it is of higher quality but other can judge exactly opposite of this person.

D. Relationship matrix between how's and what's

After establishing what's and how's, construction of house of quality continues with establishing the relationships between the customer voices and the technical requirements [10]. To build the relationship matrix between how's and what's, it is necessary to establish if relationships exist between every *what* and every *how*. All relationships are categorized such as either strong, medium, or weak. A score of 9 is used to indicate a strong relationship between what's and how's. A score of 3 signifies a moderate relationship and a square or 1 signifies a weak relationship between them. The matrix in Table 3.4 shows all relationship between customer requirements and technical requirements.

E. Column weights

Weights were calculated for each technical requirement that represent a combination of both the viewers' level of importance and the strength of the relationships. This is accomplished by multiplying the relationship strength and the importance. Thus, in column 1, row 1, in Table 3.3, the viewers' importance level (demand weight) is 10.37 and weight for the weak relationship is 1; their product is 10.37. At the intersection of column 1 and row 2, the product is 8.50. This calculation process is continued wherever there is a relationship in the column. For the column 1, the sum of these products is 457.40. Using the same calculation all of the column weights have been determined and shown at the bottom line of the Table 3.4

F. Fuzzy Quality Function Deployment Approach

As we described above in our work that various inputs, in the form of judgments and evaluations are needed in the QFD charts. Normally, these inputs are gathered through questionnaires, deep interviews, and focus groups. This gives rise to uncertainties when trying to quantify the information. Therefore we also investigate the same problem through Fuzzy logic, in order to reduce the uncertainty of the collected data, and then we investigate the result obtained through both methods to analyze which of one will resolve the issue more appropriately.

1. Integrating Fuzzy Logic with QFD

In FQFD approach, we translate the crisp values into fuzzy numbers, which can be considered as probability distribution [65] and used to test the significance of the coefficients. Mathematically,

$$A_{ij} = [\alpha_{1ij}, \alpha_{2ij}] \qquad (3.1)$$

Where Aij is a symmetrical triangular fuzzy number (TFN) which is defined by the interval [α1ij, α2ij]. Using the same notation, a typical membership function for a symmetrical TFN Aij can be expressed by:

$$\mu_{Aij}(a_{ij}) = 1 - \frac{\left| a_{ij} - \frac{\alpha_{2ij} - \alpha_{1ij}}{2} \right|}{\frac{\alpha_{2ij} - \alpha_{1ij}}{2}}, a_{ij} \in A_{ij} \qquad (3.2)$$

The scalar multiplication of TFN and the sum of two symmetrical TFNs can be represented as follows:

$$\lambda \circ [\alpha_1, \alpha_2] = [\lambda \cdot \alpha_1, \lambda \cdot \alpha_2] \qquad (3.3)$$

$$[\alpha_1, \alpha_2] \circ [\beta_1, \beta_2] = [\alpha_1 \times \beta_1, \alpha_2 \times \beta_2] \qquad (3.4)$$

Where λ denotes the scalar quantity and [α1, α2] and [β1, β2] are the intervals of the two symmetrical TFNs respectively.
In this study, individual rating equations can be generalized as:

$$\textbf{Individual rating} = \sum_{j}^{n} A_{ij} X_j$$

Where Aij and Xj denote the relative importance of the *ith* characteristic with respect to the *jth* viewers need in the relationship matrix and importance of the *jth* viewer need perceived by the viewer, which are customer rating respectively. In this study, to compare between crisp individual ratings and fuzzy individual ratings, we used normalized individual ratings. The normalized individual rating for each characteristic can be determined as:

$$Normalized\ Individual\ Rating_i = \frac{Individual\ Rating_i}{Maximum\ Individual\ Rating} \qquad (3.5)$$

The relative importance and the customer rating can be linguistic or crisp variable. As mentioned, linguistic variables such as *strong relation, (s) moderate relation, (m)* and *weak relation, (w)* are used to describe the relative importance instead of 9, 3 and 1. These linguistic variables first translated into TFNs numbers (Table 3.5)

Table 3.5: Definition of linguistic variables

Linguistic variables	Fuzzy Number
Strong Relation (s)	[0.6-1.0]
Moderate Relation (m)	[0.3-0.7]
Weak Relation (w)	[0.0-0.4]

Table 3.6 shows viewers rating and relative importance using linguistic variables. The ranges of linguistic values for quantifying the relationship were pre-determined by intuition. The ranges of ratings were then derived from calculated rating and pre-determined uncertainty value. In this study, uncertainty value was fixed ±0.1. For example *demand weight* was calculated at a score of 10.37 for *providing 'time slot' attribute* in the traditional QFD approach. In the FQFD approach, demand weight was calculated as a range which is 10.27 – 10.47. For other attributes, demand weights were calculated in the same method and it is shown in the rating column in Table 3.6 using FQFD approach, individual ratings were calculated using the above given equation, and then translated into normalized individual ratings.

The result obtained through the calculations formed the table 3.6 (below) which is the viewers rating and relative importance using linguistic variables as explained through table 3.5(above)

Table 3.6: Viewer Ratings and Relative Importance Using Fuzzy approach

	Ratings	Performance	Reliability	Feature ....
Time slot Allotment	10.27 - 10.47	W	S	S
Duration of program	08.40 – 08.60	W	S	S
Provide Entertainment	10.57 – 10.77	W	S	S
Presentation	05.39 – 05.59		W	W
Avoids excess mid Breaks	10.69 – 10.89	S	S	S
Able to convey meaning	06.98 – 07.18	W	S	S
Ease in Under standing	07.98 – 08.18	S	W	S
Content of programme	05.87 – 06.07	M	W	S
Appropriate for family viewing	10.65 – 10.85	M	S	S
Avoids vulgarity	09.44 – 09.64	S	W	S
Related to viewer's Environment	05.33 – 05.53	S	S	S
Related to social environment	07.24– 07.44	S	S	S
	Individual Ratings	31.59 76.98	48.81 86.97	65.01 98.99
	Normalized Individual Ratings	0.31 0.76	0.48 0.85	0.64 0.97

…..Conformance	Durability	Serviceability	Aesthetics
S	W	M	S
S	M	M	S
S	M	M	S
S	S	M	S
S		M	S
S	W	M	S
S	W	M	S
S		W	W
S	W	M	M
S	W	M	M
S	M	M	
S	M	M	
68.75	10.01	18.48	45.95
101.8	63.49	79.61	88.10
0.68	0.10	0.18	0.45
1.0	0.62	0.78	0.87

IV. ANALYSIS, SIMULATION & RESULT

In this section we will analyze our findings of previous section to conclude the topic and discuss the result; to start with we will prepare a table which is the summary of our findings through the two mentioned approaches i.e. crisp and fuzzy. This will facilitate us in comparison of the two methodology and in deciding the improvement if any.

Table 4.1 Results generated by the FQFD approach and the crisp approach

Design requirement	Through fuzzy approach	Through crisp approach
Performance	0.31 – 0.76	0.51
Feature	0.64 – 0.97	0.96
Reliability	0.48 – 0.85	0.81
Conformance	0.68 – 1.00	1.00
Durability	0.10 – 0.62	0.21
Serviceability	0.18 – 0.78	0.32
Aesthetics	0.45 – 0.87	0.68

The ratings related with the crisp approach are also normalized using the maximum ratings obtained. As it was mentioned before, normalized individual rating is calculated by dividing individual rating by the maximum rating. Maximum individual rating for the crisp approach is determined as a score of 900.09. This rating value shows that the conformance attribute has a maximum rating and the highest score. For each attribute of the 'TV programme in question' normalized value for crisp approaches (as mentioned in above table 4.1) is also calculated as shown in 'appendix B', in order for better comparison and analysis.

A. Decision on relative ranking of attributes

Now we will consider each attribute separately or collectively and analyze the scope of improvement (needed or not needed) depending upon its relative ranking of importance (needed to make the TV programme success and popular) through normalized viewers requirement ratings, and make important decision on the attribute ranking.

1 'Performance' vs. 'Serviceability'

For a TV programme these characteristics relate to the regional factor such as, 'related to viewers environment' or 'related to social environment', and *Serviceability* in our scenario of 'TV programme' is the adaptability of the TV show i.e. flexibility in script to accommodate any future changes to make it continuously more interesting as it progresses.

Now we observe that 'Performance' has a score of 0.51 while considering crisp methodology and 'Serviceability' has a score of 0.32 ,which is quite low in terms of importance ranking if compared with 'Performance', therefore if we consider crisp approach we would put 'Serviceability' in lower ranking in respect to 'Performance, but the fuzzy methodology consideration imply a rating of 0.31 – 0.76 for performance and 0.18 – 0.78 for serviceability which is almost same for both quality attributes thus put them at the same ranking of quality requirements. Since 'serviceability', in our case is the capability of the 'T V programme in question' for future adaptation to keep it popular, and through fuzzy approach we found its ranking same as the rating of 'Performance' i.e. of equal importance, but this important attribute would have not been considered had we considered only crisp rating methodology and would have lost it for equal consideration for improvement. Therefore we conclude about 'performance' and 'serviceability that they are of the same importance and should be considered equally for improvement i.e. the TV programme 'A' must have provision to be related to its viewers environment as well as to its social environment and the provision of future adaptability (i.e. flexibility in script, characters and shoot locations etc to kept it popular in long run) at the same level.

2 'Feature' vs. 'Conformance'

Feature in our case is, adding prize distribution through lottery to the participating viewers and encouraging them to participate through SMS in between the programme or after the programme etc. while *Conformance* in our case of TV programme is the technical aspect of production shoot and post production engineering features like non linear editing, special audio and visual effects etc.

Now considering the outcome of importance rating through crisp methodology, it is 0.96 for the quality attribute 'Feature' while for 'Conformance' it is 1.0 which keep it at the top of ranking while 'Feature' comes next to conformance , now so far as fuzzy methodology is concerned quality attribute 'Feature' having a rating in the range 0.64 – 0.97 and 'conformity' obtain a reading of 0.68 – 1.0 which obviously put quality characteristic 'Conformance' at the top of ranking but to the quality characteristic ‘Feature’ it also give the same level of importance.

Therefore through the above discussion we conclude to put both of them i.e. ‘Feature and Conformance’ at the same level thus enhancing the feature by introducing viewers participation either through prizes or through SMS participation and well take care of shooting technicality such as proper lighting to shoot correctly, proper camera control, proper audio balancing and vision mixing, proper after shoot editing and audio mixing etc should be taken with equal care and with top priority to make the launching programme a quality success.

3 ‘Reliability’ vs. ‘Aesthetics’

As we explain previously that *Reliability* of a product is the likelihood that a product will not fail within a specific time period. This is the key element for users who need the product to work without fail, in our scenario of TV programme it will be like the inclusion of some local regional employment or administrative announcements, or some informative educative content in between the proposed show by which viewers shall feel connected to it on regular basis, *Aesthetics* is the subjective dimension indicating the kind of response a user has to a product. It represents the individual’s personal preferences. It reflects the ways of individual’s responds to the look, feel, sound, taste, and smell. A person judging the content of the programme would say it is of higher quality but other viewer can judge exactly opposite of this person.

Now considering them on crisp rating scale we have 0.81 score for quality requirement ‘Reliability’ while ‘Aesthetics obtain 0.68 which is far below than ‘Reliability’, so through crisp approach we put ‘Reliability’ far head than ‘Aesthetics’, but is it proper to consider ? Let’s have a look on fuzzy methodology! Which suggest the rating of 0.45 – 0.87 for both of them and thus judge them at equal rank. Therefore we would have been wrong had we considered crisp approach only.

4 ‘Durability’

Durability measures the length of a product’s life which in our scenario of TV programme, it measures how long (time period) the popularity of the show will remain same and keep its viewers stuck to their Television set on regular basis.

Now considering the outcome of importance rating through crisp methodology, for ‘Durability’ it is 0.21 which indicates the lowest ranking, while through fuzzy methodology it is 0.10 – 0.62 which is also lowest among other attribute but indicates moderate consideration if consider upper bound.

B. Investigating additive influence of identified factors and their contribution towards ‘Quality and Popularity’ of TV programme

We shall now graduate to the next step of analysis which is co relational analysis part, to do so we need to consider the table 3.6 of previous section which identifies the applicable correlation among the viewer’s requirement and the quality engineering requirement or feasibility of incorporating.

As per our relational ranking analyzed above ‘Conformance’ tops the list now we will analyze the viewers requirement dependency on it, by examining the table 3.6 we observe that all the twelve selected requirements of the viewers have ‘Strong’ correlation with ‘conformance’ and thus make it more relevant to improve upon. Next on ranking is the quality attribute ‘Feature’ , which also has strong correlation with all the viewers requirements except one that is ‘Presentation’ which indicates that by improving upon the ‘Feature quality attribute of programme production we would marginally improve the ‘Presentation’ requirements of the viewers.

Next on our list are ‘Reliability and ‘Aesthetics’ quality attribute which by looking on table 3.6 indicates that ‘Reliability has four ‘weak’ correlation among the viewers requirement ‘Presentation’, ‘Ease in understanding’, ‘Content of programme’ and ‘Avoids vulgarity’, therefore improving upon the ‘Reliability’ quality attribute of programme, will marginally satisfied these four requirements of the viewers. Now coming to ‘Aesthetics’ quality attribute we observe that it does not have any correlation with factor 3 viewers requirements namely,’ Related to viewers environment’ and ‘Related to social environment’ and has medium correlation with ‘Appropriate for family viewing’ and ‘Avoids vulgarity’ and with ‘Content of the programme’ requirements of viewers it has a weak correlation, except these other remaining requirements are strongly correlated with ‘Aesthetics’ quality attribute, similarly we make consideration for ‘Performance’ and ‘Serviceability’ quality attributes through the table and find that ‘Performance’ attribute is not related to the ‘Presentation’ requirement of viewer thus only this requirements would be left out even if improving upon this quality attribute ‘Time slot allotment’, ‘duration of programme’, ‘Provide entertainment’ and ‘Able to convey meaning’ requirements of viewers are weakly correlated with this attribute and ‘content of programme’ and ‘Appropriate for family viewing’ is having medium correlation with this attribute. So far as ‘Serviceability’ quality attribute is concerned only ‘content of programme’ requirement is weakly correlated with it and all other requirements are medium correlated.

C. Simulation work

Based on our above analysis we arranged a test bed by utilizing fuzzy tool box of MATLAB 7.0 set up, to further investigate our findings on Quality contributing factors and their additive influence on the ‘quality and popularity’ of the TV programme, to do so we redefine the above found ‘quality and popularity’ affecting attributes on a suitable linguistic scale and defined them through triangular fuzzy membership functions and kept them under a suitable range for modeling purpose and then we exhaustively prepared a rule base considering all the combinations of the above found ‘Quality and popularity’ affecting attributes by keeping their rank of contribution as per the above done analysis, the results are shown below in the screen shots taken from the model and parameters of test set up is shown in Annexure ‘C’ at the end of this dissertation. Linguistic variable term and their corresponding values of the above found Quality attributes are taken at three level of contribution in TV Programme, for minimum contribution of any attribute we define linguistic term “Insufficient” through triangular fuzzy function similarly for moderate contribution we defined the term “Sufficient”, and for higher level of contribution we used the term “High”, and to depict the “Quality and Popularity” in term of linguistic term we took help of the words.”Less” for lower level of Quality & Popularity level, “Normal” for below moderate level of Quality & Popularity, “Above normal” term is used for explaining the level in the above moderate range and lastly we used the term “High” for higher level of popularity.

Through this simulation work we tried to identify the most balanced suitable combination of Quality and Popularity contributing factors which collectively seems to provide the best result with intelligent contribution towards the ‘Quality and Popularity’ of the TV programme and thus is more influential when applied collectively, which would otherwise have been more costlier affair if applied in isolation to each other, in this prediction simulation ‘Quality and Popularity’ of the TV programme is shown as output on Z axis in relation with the varying attributes taken on X and Y axis as mentioned below the respective figures.

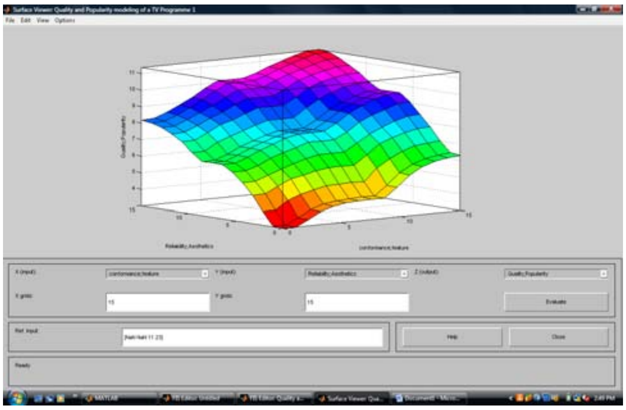

Figure 4.1 “[Conformance & Features]” vs. “[Reliability & Aesthetics]”With [Serviceability & Performance] and [Durability] are in the linguistic range of “sufficient”

The above depicted screen shot of fig.4.1 models the variation among ‘Conformance & Features’ (on X axis) and ‘Reliability & Aesthetics’ (on Y axis) while we keep ‘Serviceability & Performance’ and Durability in the linguistic range “Sufficient”, we observe that the ‘Quality & Popularity’ of the programme could maintain higher range i.e. ‘Above normal’ to ‘High’ for almost all upper half ranges of variables

Similarly other two interesting cases that we observed through simulating the various scenario, for which ‘Quality & Popularity’ of the TV programme could easily be maintained in the upper ranges with optimize balancing of the variables are self explanatory and depicted in below given screen shots in fig.4.2 and 4.3.

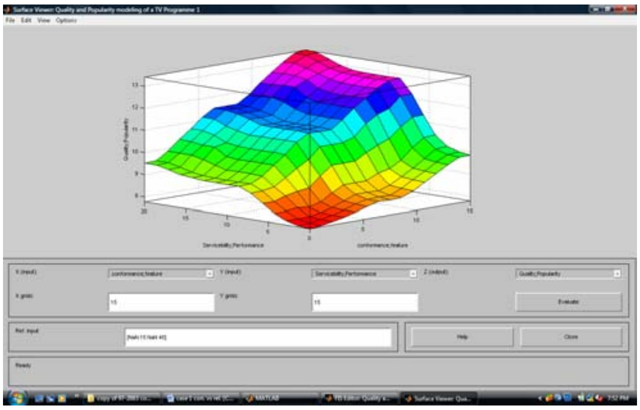

Figure 4.2 “[Conformance & Features]”vs. “[Serviceability &Performance]” *With* [Reliability & Aesthetics] and [Durability] are in the linguistic range of “high”

The above depicted screen shot of fig.4.2 models the variation among ‘Conformance & Features’ (on X axis) and ‘Serviceability & Performance’ (on Y axis) while we keep ‘Reliability & Aesthetics’ and Durability in the linguistic range “High”, we observe that the ‘Quality & Popularity’ of the programme could be kept in higher ranges with comparatively less efforts i.e. for almost entire two third upper range of ‘serviceability and performance’ gradual increase in the ‘Conformance & Feature’ from threshold value would keep the ‘Quality & Popularity’ almost in “Above normal” to “High” ranges.

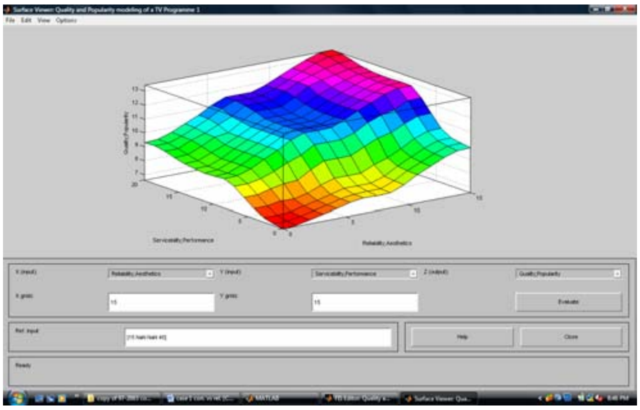

Figure 4.3 “[Reliability & Aesthetics]” vs.” [Serviceability & Performance]” With [Conformance & Feature] and [Durability] in linguistic range of “High” (Quality & Popularity just reaches the “high” linguistic range for extremes)

Similarly, above depicted screen shot of fig.4.3 models the variation among ‘Reliability & Aesthetics’ (on X axis) and ‘Serviceability & Performance’ (on Y axis) while we keep ‘Conformance and Feature’ and ‘Durability’ in the linguistic range “High”, we observe that the 'Quality & Popularity' of the programme could maintain higher range i.e. 'Above normal' to 'High' for almost all upper two third ranges of 'Serviceability & Performance' if we maintain 'Reliability & Aesthetics' towards extreme.

D. Conclusion and future scope

In this research work, we have explained, how a quality plan can be determined for a proposed TV programme 'A' by using Fuzzy QFD technique, QFD links viewer requirements or "what's" with the technical quality requirements or "how's", so the voice of the viewer is translated into Quality engineering plan. Study was conducted in the six stages as explained in chapter 4. The first and the most important part of the study are to determine the viewer's wants and needs accurately. These viewers' demands were grouped under three factors, which were labeled as: popularity factor, Entertainment factor, and Regional factor. These three factors include most quality and popularity effecting attributes. At the second stage of the study, 'TV programme in question' i.e. 'A' was evaluated with its three competitors. This evaluation was conducted by considering crisp and fuzzy approaches. According to the crisp approach, *avoid excess mid breaks* in the popularity factor was found out the most important attribute to be improved. The second important attribute was determined in the Entertainment factor that is *appropriate for family viewing*. The third one is *provides entertainment*, which is in the popularity factor. Popularity and entertainment factors are more important than regional factors according to the viewer evaluation.

In the fuzzy approach, requirement weights have been determined as a range rather than a crisp value. According to fuzzy approach, the range of ratings of the requirements derived from calculated rating. Thus, *avoids excessive mid breaks* has a range of 10.69 – 10.89. It has the highest upper limit. *Appropriate for family viewing* has a range of 10.65 – 10.85 if these two viewer requirements are compared with each other it can be seen that there is a small difference between these two attributes. The next important viewer requirements is *provide entertainment,* which has a range of 10.57 – 10.77. At the third step, these requirements were translated into the seven technical requirements. These characteristics, which were taken from Garvin's study, are performance, features, reliability, conformance, durability, serviceability, and aesthetics. After determining relationship between how's and what's, the weights of each technical requirement were calculated. Considering this calculation, quality plan of TV programme 'A' was determined. Conformance was found the first factor to be improved by both approaches. Then, in the crisp approach, features, reliability, and aesthetics were determined as essential technical requirements. Performance, serviceability and durability were found as the final improvement characteristics. On the other hand, in the fuzzy approach, result was slightly different than crisp approach. Conformance was also the most important attribute in the fuzzy approach, the features was ranked to be second factor affecting the consumer preference. Reliability and aesthetics have the same range, which is different in the crisp approach. After conformance and features, rest of the quality requirements have different priority in both approaches.

Since our research work is novel in nature and we have not seen any related research on "TV programme popularity factor identification and their additive influencing nature in success of a TV programme, therefore this exploitation of the subject could further be expanded in all dimensions to the fulfillment of various unseen possibilities and also by including some of the unresolved issues of Quality and Popularity of TV prograame, also in this research we tried to explore the topic through Fuzzy QFD and investigated the influence further through Fuzzy inference modeling, as Fuzzy inference modeling is a rule based modeling approach therefore the additive influence is considered here strictly in accordance with the rule base and does not include the uncertain or stochastic processes which may or may not affect the Quality and popularity of the programme, hence The main challenge lies in our proposed work are:

- Discriminating Quality contributing factors when there are a large number of legitimate factors affecting a particular kind of TV programme.
- Generally 'Quality and Popularity' depends on the above identified attributes but is there any other stochastic process or processes involve which play challenging role in the said determination.
- Identification and determination of good threshold Values of attributes collectively is very difficult and that should be dynamic or adaptable to be more effecting.

Depending upon the current situation, stochastic nature of influence is one additional possibility to be explored in further research on the topic, we tried to write our work in a self content manner so that the necessity of further references could be reduced and the research work may be proved to be complete in all manners.

APPENDIX 'A'

(i) Calculation of 'Individual Ratings' mentioned in Table 3.6 using FQFD Approach:

a) Performance Rating

$\sum_{j}^{12} A_{ij} X_j =$ (10.27x 0.0; 10.47 x 0.4)+(8.4 x 0.0; 8.6 x 0.4)+(10.57 x 0.0; 10.77 x 0.4)+(5.39 x 0.0; 5.59 x 0.0)+(10.69 x 0.6; 10.89 x 1.0)+(6.98 x 0.0; 7.18 x 0,4)+(7.98 x 0.6; 8.18 x 1.0)+(5.87 x 0.3; 6.07 x 0.7)+(10.65 x 0.3; 10.85 x 0.7)+(9.44 x 0.6; 9.64 x 1.0)+(5.33 x 0.6; 5.53 x 1.0)+(7.24 x 0.6; 7.44 x 1.0) = (31.59; 76.98)

All of the other ratings were calculated using the same notation above

b) Feature rating = (65.01; 98.99)
c) Reliability = (48.81; 86.97)
d) Conformance = (68.75; 101.81)
e) Durability = (10.01; 63.49)
f) Serviceability = (18.48; 79.61)
g) Aesthetics = (45.95; 88.10)

Therefore we get the 'Maximum Individual Rating' =101. 81

(ii) Calculation of 'Normalized Individual Ratings' mentioned in Table 3.6 using FQFD Approach:

By using the equation 3.5 we calculate the following normalized individual ratings:

Normalized Individual Rating for Performance: = (31.59/101.81; 76.98/101.81) = (0.31; 0.76)
Normalized Individual Rating for Features: = (65.01/101.81; 98.99/101.81) = (0.64; 0.97)
Normalized Individual Rating for Reliability = (48.81/101.81; 86.97/101.81) = (0.48; 0.85)
Normalized Individual Rating for Conformance = (68.75/101.81; 101.81/101.81) = (0.68; 1.00)
Normalized Individual Rating for Durability = (10.01/101.81; 63.49/101.81) = (0.10; 0.62)
Normalized Individual Rating for Serviceability = (18.48/101.81; 79.61/101.81) = (0.18; 0.78)
Normalized Individual Rating for Aesthetics = (45.95/101.81; 88.10/101.81) = (0.45; 0.87)

APPENDIX 'B'

Calculation of Normalized Individual Ratings mentioned in Table 4.1 using the Crisp Approach:

Normalized Individual Rating for Performance: = (457.40/900.09) = 0.51
Normalized Individual Rating for Features: = (867.15/900.09) = 0.96
Normalized Individual Rating for Reliability = (725.61/900.09) = 0.81
Normalized Individual Rating for Conformance = (900.09/900.09) = 1.00
Normalized Individual Rating for Durability = (191.05/900.09) = 0.21
Normalized Individual Rating for Serviceability = (288.09/900.09) = 0.32
Normalized Individual Rating for Aesthetics = (615.66/900.09) = 0. 68

APPENDIX 'C'

Relative parameters and inference rule base, used for MATLAB simulation:

```
[System]
Name='Quality and Popularity modeling of a TV Programme'
Type='mamdani'
Version=2.0
NumInputs=4
NumOutputs=1
NumRules=239
AndMethod='min'
OrMethod='max'
ImpMethod='min'
AggMethod='sum'
DefuzzMethod='centroid'

[Input1]
Name='conformance; feature'
Range= [0 15]
NumMFs=3
MF1='insufficient':'trimf', [0 0 6]
MF2='sufficient':'trimf', [1.5 7.5 13.5]
MF3='high':'trimf', [9 15 15]

[Input2]
Name='Reliability; Aesthetics'
Range= [0 15]
NumMFs=3
MF1='insufficient':'trimf', [0 0 6]
MF2='sufficient':'trimf', [1.5 7.5 13.5]
MF3='high':'trimf', [9 15 15]

[Input3]
Name='Servicebility; Performance'
Range= [0 20]
NumMFs=3
MF1='insufficient':'trimf', [0 0 8]
MF2='sufficient':'trimf', [4 11 18]
MF3='high':'trimf', [14 20 20]

[Input4]
Name='Durability'
Range= [0 45]
NumMFs=3
MF1='insufficient':'trimf', [0 0 18]
MF2='sufficient':'trimf', [5 23 41]
MF3='high':'trimf', [27 45 45]

[Output1]
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Range= [0 20]
NumMFs=4
MF1='less':'trimf', [0 0 6]
MF2='normal':'trimf', [2 7 12]
MF3='above_normal':'trimf', [9 14 19]
MF4='high':'trimf', [12 20 20]
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