# A Study of Solving Decision Making Problem Using Soft Set

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*Abstract:* **The process of selecting the best from the list of alternatives available for selection is called decision making. Decision either is a day-to-day decision or a sensitive one which has greater impact to the organization or society. The decision making method requires a systematic procedure to define parameters which are necessary to take final decision as well as focused on how to bringing accuracy for collecting data for different parameters. Sometimes predefined parameters are not sufficient to take accurate decisions in solving general or real time problems, hence there may be provisions to add more parameters to the existing set that may comes either as a new or generated from processing of existing ones. The decision required by the people for purchasing a house in a particular area always being a difficult task. Because such decision parameters carries different importance to different people. For example an employee needs a house very close to his office because the person is staying only with his wife but another employee of same designation and salary choose a house in remote location because he is staying with his father, mother, children and all children are studying in the schools which located in that area. To solve such problem is a difficult task, which needed an efficient mathematical analysis. The present study is focused on fuzzy soft set and how it will helpful in effective & efficient decision making of the people in a short time.**

***Keywords: Decision Making, Fuzzy Soft Set, Sensitive Decision, Selection***

## I. INTRODUCTION

Decision making is a daily activity in today's first moving world. It takes significant role in the field of selection of best fit in different alternatives. Different parameters and their values help decision makers to take right decision at right time. The decision making process involves series of activities to draw final conclusion from listed data available for analysis. Sometimes a preplanned decision process might not help to conclude an analysis. In such situation other parameters to be added in the existing analysis process to derive an effective solution to a specific problem. The inherent problem of decision making is related to vagueness and uncertainty aspects due to partial definition, lack of information, having less time to think, etc. Therefore classical mathematics is not very effective in dealing with such problems.

The theories like probability, fuzzy set, rough set have tried to resolve the problems by using it expanded tools. But all these techniques do not consider parameterization tools; therefore the above concepts are unable to solve the problems of uncertainties. The soft set concept overcome all these problems and posses rich potential of solving certain decision making problems like customers preference for product selection, fund sources problem, man power recruitment problem etc.

In this paper author is defining fuzzy soft set and applying different methods to solve decision making problems. The practical aspects used in decision making of selecting of houses to make the selection process more comfortable, accepting low cost and consuming less time are discussed in the study. Because most of the people would also find difficulties in selecting good houses based on certain circumstances due to too many characteristics and involvement of various parameters for continuous living. In addition, not all houses would be satisfied all requirement and also people have their own expectation for their own houses.

## II. PRELIMINARIES

Soft set theory is a generalization of fuzzy set theory that was proposed by Molodtsov in 1999 to deal with uncertainty in a non-parametric manner. A soft set is a parameterized family of sets - intuitively, this is "soft" because the boundary of the set depends on the parameters. Formally, a soft set, over a universal set X and set of parameters E is a pair (f, A) where A is a subset of E, and f is a function from A to the power set of X. For each e in A, the set f(e) is called the value set of e in (f, A).

The basic notion of all soft theory and some useful definition from Maji et al. (2002;2003) are discussed here, where U to be an initial universal set and E to be a set of parameters of $A,B \subset E$.

*Definition 2.1 (Soft Set)*

A pair of (E,f) is called a soft set over if and only if F is a mapping of E into the set of all subsets of the set U. In order words, the soft set is a parameterized family of subsets of the set U. Every set F(e), $e \in E$, from this family may be considered as the set of e-approximate elements of the soft set. Let us consider the following example.

Example 2.1: A soft set (F,e) describes the attr4activeness of the bikes which Mr. X is going to buy [Pal & Mondal, 2011].

U is the set of bikes under consideration. E is the set of parameters. Each parameter is a word or a sentence.

E=(e1=stylish; e2=heavy duty; e3=light, e4=steel body; e5=cheap; e6=good mileage; e7=easily started; e8=long driven; e9=costly; e10=fibre body).

In this case, to define a soft set means to point out stylish bikes, heavy duty bikes and so on.

*Definition 2.2 (Operation with Soft Sets)*

Suppose a binary operation denoted by *, is defined for all subsets of the set U. Let (F, A) and (G, B) be two soft sets over U. Then the operation * for the soft sets is defined in the following way: (F, A) * (G, B) = (H, A x B), where H (α, β) = F (α) * G (β), α ϵ A, β ϵ B and A x B is the Cartesian product of the sets A and B.

*Definition 2.3 (NOT Set of a Set of Parameters)*

Let E= {e1,e2,e3……en} be a set of parameters . The Not set of E denoted by ˥E and is defined by ˥E={e1,e2,e3…..en}, where ˥$e_i$ =not $e_i$ for all i. It may be noted that ˥ and ˥ are two different operations.

*Definition 2.4 (Complement of a Soft Set)*

The complement of a soft set (F, A) is denoted by $(F, A)^c$ and is defined by $(F, A)^c = (F^c, ˥A)$, where $F^c$: ˥A→P(U) is a mapping which is defined by $F^c(\alpha)$ = U-F(˥α), for all αϵA.

*Definition 2.5 (Relative Complement of a Soft Set)*

The relative complement of a soft set (F, A) denoted by $(F, A)^r$ and is defined by $(F,A)^r=(F^r,A)$, where $F^r$:A→P(U) is a mapping given by Fr(α)=U-F(α), for all αϵA.

*Definition 2.6 (NULL Soft Set)*

A soft set (F, A) over U is said to be a NULL soft set denoted by ϕ, if for all εϵA, F(ε)=ϕ (null set).

*Definition 2.7 (Relative NULL Soft Set)*

A soft set (F, A) over U is said to be a NULL soft set with respect to parameters set A denoted by ϕ A, if ε ϵ A, F(ε)=ϕ (null set).

*Definition 2.8 (Relative Whole Soft Set)*

A soft set (F, A) over U is said to be a relative whole soft set with respect to parameters set A denoted by UA, if for all ε ϵ A, F(ε)=U.

*Definition 2.9 (Absolute Soft Set)*

The relative whole soft set U(E) with respect to the universe parameters E is called the absolute soft set over U.

*Definition 2.10 (AND Operation on Two Soft Sets)*

If (F, A) and (G, B) be two soft set then (F, A) AND (G, B) denoted by (F, A) ∧ (G, B) and is defined by (F, A)(G, B)=(H, A x B), where H(α, β) = F(α) , ∩ G(β) for all (α, β) ϵ A x B.

*Definition 2.11 (OR Operation on Two Soft Sets)*

If (F, A) and (G, B) be two soft set then (F, A) OR (G, B) denoted by (F, A) ∨ (G, B) and is defined by (F, A)(G, B)=(O, A x B), where O(α, β) = F(α) ,∩ G(β) for all (α, β) ϵ A x B.

## III. LITERATURE REVIEW OF SOFT SET THEORY

Firstly, Zadeh in 1965 proposed Fuzzy set theory, which become a very important tool to solve problems and provides an appropriate framework for representing vague concepts by allowing partial membership. Fuzzy set theory has been studied by both mathematicians and computer scientists and may applications of fuzzy set theory have arisen over the years, such as fuzzy control systems, fuzzy automata, fuzzy logic, fuzzy topology etc. Beside this theory, there are also theories of probability, rough set theory, which deal with to solve these problems. Each of these theories has its inherent difficulties as pointed out in 1999 by Molodtsov who introduced the concept of soft set theory which is completely new approach for modeling uncertainty.

The origin of soft set theory could be traced to the work of Pawlak [1982; 1982A] in 1993 titled Hard sets and soft sets [Pawlak, 1994]. His notion of soft sets is a unified view of classical, rough and fuzzy sets. This motivated by Molodtsov in 1999 titled soft set theory; first result, thee in, the basic notions of the theory of soft sets and some of its possible applications were presented.

Maji et al., (2001) presented the combination of fuzzy and soft set theories, fuzzy soft set theory is a more general soft set model which makes descriptions of the objective world more general, realistic, practical and accurate in some cases of decision making. In 2003 again presented soft set theory with some implementation in their work. Roy & Maji (2007) presented a novel method of object recognition from an imprecise multi observer data in decision making problem. Pei & Miao (2005) have discussed the relationship between soft sets and information systems. It is showed that soft sets are a class of special information systems. After soft sets are extended to several classes of general cases, the more general results also show that partition type soft sets and information systems have the same formal structures, and that fuzzy soft set and fuzzy information systems are equivalent. Xiao et al., (2005) in his paper, an appropriate definition and method is establishing the information table based on soft sets theory and at the same time the solutions are proposed corresponding to the different recognition vectors.

In Mushrif et al., (2006) studied the texture classification via Soft Set Theory based in a classification Algorithm. In Aktas & Cagman (2007) have int5roduces the basis properties of soft sets and compare soft sets to the related concepts of fuzzy sets and rough sets. In the same year, Kovkov et al., have presented the stability of sets given by constraints is considered within the context of the theory of soft sets.

Yao et al., (2008) presented the concept of soft fuzy set and its properties. Xiao et al., (2008) in this paperdata analysis approaches of soft sets under incomplete information is calculated by weighted average of all possible choice values of the object and the weight of each possible choice value is decided by the distribution of other objects. In Ali et al.,(2009) gives some new notion such as the restricted intersection, the restricted union, the restricted difference and the extended intersection of two soft sets. Herawan et al.,(2009) proposed an approach for visualizing soft maximal association rules which contains for main steps, including discovering, visualizing maximal supported sets, capturing and finally visualizing the maximal rules under soft set theory.

Theories that been proposed for dealing with such housing selection problems in an efficient way (Behzadian, 2010). However, all the theories that associated with limitation of inherent which possibly due the inadequacy of the parameterization associated tools with them (Maji, 2002). The concept of soft set as new mathematical tool for dealing with the uncertainties which is free from the above difficulties (Molodtsov, 1999). As a practical problem is faced for a particular property, whether all the parameters in the parameters set is always necessary to preserve this property (Maji, 2002). By using the entire parameters set for describing the property which is consuming the time and the constructed rules may be finding difficult to understand, apply or verify. To deal with this problem, reduction of attribute required. Reduction objectives are to reduce the number of attributes, and at the same time, preserve the property of the information. Mapping from parameter to crisp subset of universe is the soft set (Herawan, 2010). Data analysis and decision support systems we may see it structured of a soft set.

## IV. ANALYSIS

### *4.1. Housing and its type*

A house can be represented as building or structure that has the ability to be occupied for dwelling by human beings. The types of houses available for man living are ranging from cottage to Bungalow or dwellings. Houses can be built in a large variety of configurations. Particularly houses are divided into free-standing or detached dwellings and attached or multi-user dwellings. Both sorts may vary greatly in scale and amount. The types of houses available in Bhubaneswar are HIG House, MIG House, Apartment, Duplex, LIG House, Bungalow, situated in the town (urban area), semi urban area, rural area and market places. One of the types of house in Bhubaneswar is terraced house. It is available in HIG & MIG form but they are different in area, no. of rooms and also in structural form but located in urban area and city capital. It is lies in a row of identical or mirror-image houses share side walls. Each row may consist of 10 to 12 units depending on the width of the house, as it have to comply with regulations of the Bhubaneswar Development Authority that each house has a fixed construction area and also a specific are to be used for plantation.

Next is semi-detached house (LIG House) or often called as “Semi- D” consists of pairs of house built side by side as units separated by a wall. Each house’s layout is normally a mirror image of the other one. Semi-D house have front, rear and any one side open spaces. Another type of houses in Bhubaneswar is bungalow. A bungalow is a type of standalone building. It is also known as detached house. These detached houses have open spaces on all sides. Besides, there are apartments used for accommodation in Bhubaneswar. An apartment is a self-contained housing unit that occupied only part of a building or a section in the building. The occupied share a common area like lobby, car park, lifts and so on. An apartment normally consist basic facilities like swimming pool and guarded.

Not only that, duplex (As per size of HIG even more) also one type accommodation in Bhubaneswar. It is usually bought by wealth person. Commonly it is two stored and located at semi urban area with facilities such as walkways, recreational facilities are jointly owned by the unit’s owners. The line of duplexes provided with full facilities like swimming pool, gym equipment, club horse, CCTV, inter-com, guards which distinguished it from apartment type of living.

Some of residents in Bhubaneswar also like to build their own house. They convert the building as they like to fulfill their satisfaction. There is also orchard house, which is normally comes with a land of plot size of not less than an acre. Orchard house is an exciting lifestyle development offering with fruit orchard together with a village style house.

### *4.2. Price*

To promote the capital and it’s surrounding as special attraction for industrialists, software developers, foreign touristers etc., the government initiate or introduced various housing schemes for people of the state in low, medium and high cost. Since its inception, the provision of low cost housing has become a priority of the government in the Five Years National Plans and various urban development agencies. At present ceiling price for low cost housing was fixed at Rs. 10,000, 00/- per unit for people with house hold income of less than Rs. 1, 00,00/- per month.

Research shows that the house price movements are influenced by economic, household's purchasing power and borrowing capacity, bank interest rate and payback capacity and sub sectors related to housing market such as furniture and household accessories etc.

*4.3. Data set used for selection of House*

The following types of houses are used for decision making to select the best possible house as per need of customers.

*a. HIG House (T), b. MIG House (D), c. Apartment (A), d. Duplex (B), e. LIG House (C), f. Bungalow (L)*

The details of parameters are as follows.

a. Location, where city = 1 and non-city = 0

b. Price, where Rs. 20,000,00/ - Lakh – Rs. 35,000,00/ - Lakh = 1 and Rs. 36,000,00/ - Lakh – Rs. 65,000,00/ - Lakh = 0

c. Size, where small size less than 1000 square feet = 0 and big size more than 1000 square feet = 1

d. Garden, where yes = 1 and no = 0

e. Garage, where yes = 1 and no = 0

f. Store, where yes = 1 and no = 0

g. Include furniture, where yes = 1 and no = 0

h. Good structure, where yes = 1 and no = 0

The below analysis uses soft set theory for decision making problem with rough approach to select efficient house as per requirement of customers.

Let U={h1,h2,h3,h4,h5,h6} be a set of six houses, E={location, price, size, garden, garage, store, include furniture, good structure} be a set of parameters.

Consider the soft set (F,E) which describes the attractiveness of the houses, given by (F,E)={location=Φ, price={h1,h2,h3,h4,h5,h6}, size={h1,h2,h6}, garden={h1,h2,h6}, garage={h2,h4,h5}, store={h1,h2,h3,h4,h5,h6}, include furniture ={h1,h3,h6}, good structure ={h1,h2,h3h4,h6}}.

Suppose anybody (Mr. A) interested to buy a house on the basis of parameters like "location", 'price', 'size', 'garden', 'garage', 'good structure' etc., which constitute the subset P={ location, price, size, garden, garage, store, include furniture, good structure } of the set E. That means out of available houses in U, he selects that house which qualifies with all or maximum number of parameters of the soft set P.

Suppose that, another person Mr. B wants to buy a house on the basis of the sets of choice parameters $Q \subset E$, where Q={ location, price, size, garden }, and Mr. C wants to buy a house on the basis of another set of parameters $R \subset E$.

Mr. A has chosen the best parameters for his house. The house which is most suitable for Mr. A need not be same for Mr. B or Mr. C as the selection is dependent upon the set of choice parameters of each buyer. To solve the above problem theoretical characterization of the soft set theory of Molodtsov, which analyze below?

*4.4. Tabular Presentation of a Soft Set*

The tabular representation presents an almost similar representation in the form of a binary table. The soft set (F, P) on the basis of the set P of choice parameters of Mr. A and it can be represented in following tabular form. The style of representation will be useful for storing a soft set data for analysis. If $h_i \in F(e)$ then $h_{ij}$=1, otherwise $h_{ij}$=0 where $h_{ij}$ are the entries in the table.

| U | $e_1$ | $e_2$ | $e_3$ | $e_4$ | $e_5$ |
|---|---|---|---|---|---|
| $h_1$ | 1 | 1 | 1 | 1 | 1 |
| $h_2$ | 1 | 1 | 1 | 1 | 0 |
| $h_3$ | 1 | 0 | 1 | 1 | 1 |
| $h_4$ | 1 | 0 | 1 | 1 | 0 |
| $h_5$ | 1 | 0 | 1 | 0 | 0 |
| $h_6$ | 1 | 1 | 1 | 1 | 1 |

**Table 2.1 Tabular Presentation of Soft Set**

*4.5. Reduct Table of a Soft Set*

Consider the soft set (F, E). Clearly for any $P \subset E$, (F, P) is a soft subset of (F, E). The tabular representation of the soft set (F, P). When Q is a reduct of P, then the soft set (F, Q) is called the reduct soft set of the soft set (F, P).

Intuitively, a reduct soft set (F, Q) of the soft set (F, P) is the essential part, which suffices to describe all basis approximate descriptions of the soft set (F, P). The core soft set of (F, P) is the soft set (F, C), where C is the core (P).

*Choice Value of an Object $h_i$*

The choice value of an object $h_i \in U$ is $c_i$, given by

$$c_i=\sum_j h_{ij}$$

where $h_{ij}$ are the entries in the table of the reduct soft set.

*4.6 Algorithm for Selection of the House*

The following algorithm may be followed by Mr. A to select the house what he wished to buy.

- Input the soft set (F, E).
- Input the set P of choice parameters of Mr. A which is a subset of E.

- Find all reduct soft sets of (F, P).
- Choose one reduct soft set say (|F Q) of (F, P),
- Find k, for which $c_k$=max $c_i$.

Then $h_k$ is the optimal choice object. If k has more than one value, then any one of them could be chosen by Mr. A by using the options.

The decision problem for selection of house can be solved in using the above algorithm as follows

Clearly, from the table it is identified that {e1, e2, e4, e5}, {e2, e3, e4, e5} are the two reduces of P={e1,e2,e3,e4,e5}. Choose any one say, Q={e1, e2, e4,e5}.

Incorporating the choice values, the reduce soft set can be represented as

| U | $e_1$ | $e_2$ | $e_4$ | $e_5$ | Choice value |
|---|---|---|---|---|---|
| $h_1$ | 1 | 1 | 1 | 1 | C1=4 |
| $h_2$ | 1 | 1 | 1 | 0 | C2=3 |
| $h_3$ | 1 | 0 | 1 | 1 | C3=3 |
| $h_4$ | 1 | 0 | 1 | 0 | C4=2 |
| $h_5$ | 1 | 0 | 0 | 0 | C5=1 |
| h6 | 1 | 1 | 1 | 1 | C6=4 |

Table 2.2 Tabular Presentation of reduce Soft Set

Here max ci=$c_1$ or $c_6$.

Decision: Mr. A can buy either the house $h_1$ or the house $h_6$.

It may happen that for buying a house, all the parameters belonging to P are not of equal importance to Mr. A. He likes to impose weights on his choice parameters, i.e. corresponding to each element $p_i \in P$, there is a weight $w_i \in [0,1]$

*4.7. Weighted Table of a Soft Set*

Lin[13] defined a new theory of mathematical analysis which is "theory of W-softset" to know about the concept whether a membership function be regarded as the only characteristic function of a fuzzy set. "W-softset" means weighted soft sets. Following Lin's style, the reduct-soft set (F,Q) will have entries $d_{ij}=w_j$ x $h_{ij}$, instead of 0 and 1, where $h_{ij}$ are the entries in the table of the reduct soft set(F,Q).

*Choice Value of an Object $h_i$*

The weighted choice value of an object $h_i \in U$ is $c_i$, given by

$$c_i=\sum_j d_{ij}$$

where $d_{ij}$ =$w_j$ x $h_{ij}$ . Imposing weights on his choice parameters Mr. A now could use the following revised algorithm for arriving at his final decision.

*Weighted Algorithm for Selection of the House*

The following algorithm may be followed by Mr. A to select the house what he wished to buy.

- Input the soft set (F, E).
- Input the set P of choice parameters of Mr. A which is a subset of E.
- Find all reduct soft sets of (F, P).
- Choose one reduct soft set say (F, Q) of (F, P), according to the weights decided by Mr. A
- Find k, for which $c_k$=max $c_i$.

Then $h_k$ is the optimal choice object. If k has more than one value, then any one of them could be chosen by Mr. A by using the options.

If we solve the original problem with the help of Weighted Algorithm then the solution shall be drawn in the following manner. Suppose that Mr. A sets the following weights for the parameters of Q; for the parameter "location" weight is 0.7 (w1=0.7), 0.4 is the weight for the parameter "price" (w2=0.4), the parameter "garden" carries weight 0.9 (w4=0.9) and 0.8 is the weight of the parameter "garage" (w5=0.8).

From the below table it is seen that Mr. A will select the house h1 or h6 for buying according to the choice parameters in P.

| U | $e_{1;}$ w1=0.7 | $e_{2,}$ w2=0.2 | $e_{4,\ w4=0.9}$ | $e_{5,}$ w5=0.8 | Choice Value |
|---|---|---|---|---|---|
| $h_1$ | 1 | 1 | 1 | 1 | C1=2.6 |
| $h_2$ | 1 | 1 | 1 | 0 | C2=1.8 |
| $h_3$ | 1 | 0 | 1 | 1 | C3=2.4 |
| $h_4$ | 1 | 0 | 1 | 0 | C4=1.6 |
| $h_5$ | 1 | 0 | 0 | 0 | C5=0.7 |
| $h_6$ | 1 | 1 | 1 | 1 | C6=2.6 |

Table 2.3 Tabular Presentation of weighted value

The weighted algorithm shows what values to be assigned for parameters, so that the selection provides best possible solution to the people. Sometimes the algorithm generated weight which are same for two or more houses. In such situation customer has to choose the convenient one as per suitability of parameters.

*4.8. Mixed Weighted Table of a Soft Set*

Whenever any customer wants to specify the fixed criteria for certain parameters i.e. the values of parameters remain unchanged and used different weight for remaining parameters as situation demands; in such situation mixed weighted analysis is used. This will reduce the unnecessary calculations for selection of best possible decision and helps to get the result in short time. This method is also suitable when decision making is difficult to analyze when it needs lot of parameters.

The proposed method uses fixed binary values and weighted values as given for different parameters. The reduct-soft set (F,Q) will have entries $d_{ij}$= $h_{ij}$ + $w_j$ x $h_{ij}$, where $h_{ij}$ are the binary entries in the table of the reduct soft set(F,Q), which are represented as 0 and 1and $w_{ij}$ represents weight assigned for parameters.

*Mixed Weighted Algorithm for Selection of the House*

The following algorithm may be followed by Mr. A to select the house what he wished to buy using mixed weighted approach.

- Input the soft set (F, E).
- Input the set P of choice parameters of Mr. A which is a subset of E.
- Find all reduct soft sets of (F, P).
- Choose one reduct soft set say (F, Q) of (F, P), according to actual values of fixed parameters i.e. 0 and 1 and the weights as decided by Mr. A.
- Find k, for which $c_k$=max (actual values of fixed parameters + $c_i$)

If Mr. A selects a house on fixed parameter like Garden and Garage then it must be treated as 1. The remaining parameters used for selection may be varied and that can be weighted as per prime choice or best weight available for said parameters.

| U | $e_{1\ w1=0.5}$ | $e_{2,\ w2=0.7}$ | $e_4$ | $e_5$ | Choice Value |
|---|---|---|---|---|---|
| $h_1$ | 1 | 1 | 1 | 1 | C1=3.2 |
| $h_2$ | 1 | 1 | 1 | 0 | C2=2.2 |
| $h_3$ | 1 | 0 | 1 | 1 | C3=2.5 |
| $h_4$ | 1 | 0 | 1 | 0 | C4=1.5 |
| $h_5$ | 1 | 0 | 0 | 0 | C5=1 |
| $h_6$ | 1 | 1 | 1 | 1 | C6=3.2 |

Table 2.3 Tabular Presentation of Mixed weighted value

## V. CONCLUSION

The research provides different parameters to solve decision making problems using soft set. The accuracy in the parameters, the parameters used fixed weight and weighted values assigned to the parameters always played a key role for actual selection. Sometimes it creates confusion in some situation where the mixed weighted values are same for different houses; in such situation new fuzzy soft set concepts are to be added to get the best and perfect one from list of alternatives. Hence the study can be further extended to enhance the existing work in fuzzy soft set as well as create platforms for everyone to select the best as per parameters available to the customers.

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