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On the Construction of Statistical Quality Control Chart Using Fuzzy Probabilistic Approach

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ABSTRACT

The fuzzy statistical quality control charts play an important role for smart control of air pollutions. The world health organization is estimates that 4.6 million people die each year from causes directly attributable to air pollution. Air pollution damages people, environment, animals, and other components of natural life. It has a high risk priority for the world. Recent studies focus on and other risks for humanity. They propose different solutions to prevent air pollution. In this paper, develop a new methodology for construction of statistical quality control chart using fuzzy probability approach. Application of this method has been established through the air pollution control causes illustration with consumer's demographic characters on a hedonic rule.

Keywords: Fuzzy Logic, Capability Process, and Air Pollution.

I. INTRODUCTION

Air pollution is a chemical, physical (e.g., particulate matter) or biological agent that modifies the natural characteristics of the atmosphere. The U.S. Environmental Protection Agency (USEPA) has set national air quality standards for six common pollutants (also referred to as criteria pollutants). These are O_3, CO, Sulfur dioxide (SO_2), particulate matter (PM), NO_2, and Pb.

SO_2 belongs to the family of sulfur oxide gases (SOx). These gases dissolve easily in water. Sulfur is prevalent in all raw materials, including crude oil, coal, and ore that contains common metals like aluminum, copper, zinc, lead, and iron. SOx gases are formed when fuel containing sulfur, such as coal and oil, is burned, and when gasoline is extracted from oil or metals are extracted from ore. SO_2 dissolves in water vapor to form acid, and interacts with other gases and particles in the air to form sulfates and other products that can be harmful to people and their environment. PM is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. These particles can affect the heart and lungs and cause serious health effects (USEPA 2007).

These gases irritate the airways of the lungs, increasing the symptoms of those suffering from lung diseases. Particles can be carried deep into the lungs where they can cause inflammation and a worsening of heart and lung diseases. The World Health Organization estimates that 4.6 million people die each year from causes directly attributable to air pollution. Many of these mortalities are attributable to indoor air pollution. Worldwide more deaths per year are linked to air pollution than to automobile accidents. Research published in 2005 suggests that 310,000 Europeans die from air pollution annually. Direct causes of air pollution related deaths include aggravated asthma, bronchitis, emphysema, lung and heart diseases, and respiratory allergies. The USEPA estimates that a proposed set of changes in diesel engine technology (Tier 2) could result in 12,000 is less premature mortality 15,000 fewer heart attacks and 6,000 fewer emergency room visits by children with asthma, and 8,900 fewer respiratory-related hospital admissions each year in the United States (USEPA 2007). Therefore, air pollution is an important risk for humanity and the world.

Risk, as defined by Gray and Larson (2003), "is the chance that an undesirable event will occur and the consequences of all its possible outcomes." Risk analysis is the process of examining each identified risk issue to estimate the likelihood of a risk and predict the impact on the project. Fuzzy sets are an extension of classical set theory and are used in fuzzy logic. In classical set theory the membership of elements in relation to a set is assessed in binary terms. According to a crisp condition an element either belongs or does not belong to the set. By contrast, fuzzy set theory permits the gradual assessment of the membership of elements in relation to a set; this is described with the aid of a membership function $\mu \rightarrow [0, 1]$. The techniques of risk analysis are powerful tools to help people manage uncertainty. There are many risk analysis techniques currently in use that attempt to evaluate and estimate risk. These techniques can be either qualitative or quantitative depending on the information available and the level of detail that is required (Bennet et al. 1996). Quantitative techniques rely heavily on statistical approaches, which include Monte Carlo Simulation (Bennet et al. 1996), Fault and Event Tree Analysis (Bennet et al. 1996; White 1995), Sensitivity Analysis (White 1995), Annual Loss Expectancy (Rainer et al. 1991), Risk Exposure (Boehm 1989), Failure Mode and Effects Analysis (White 1995), and so on. On the other hand, qualitative techniques rely more on judgment than on statistical calculations such as Scenario Analysis (Rainer et al. 1991), FST (Rainer et al. 1991), and so on. Quantitative and qualitative techniques have their own advantages and disadvantages. Among these techniques, the application of fuzzy set Theory to risk analysis seems appropriate; as such analysis is highly subjective and related to inexact and vague information. In this paper construction of statistical quality control charts using fuzzy probabilistic approach through air pollution affects control the data for has been collected for Salem District, Tamil Nadu, India.

II. AIR POLLUTION CONTROL USING PROCESS CAPABILITY INDICES

Air pollution is one of the main topics handled by some works in the literature. Some of them are briefly explained as follows: Jensen (1998) has developed a prototype air quality model system based on the GIS (geographic information system), namely Air GIS, to support local authorities in air quality management for big Danish cities. The system integrated digital maps, administrative databases, an Operational Street Pollution Model (OSPM), an urban landscape model, and Arc View GIS for air quality and exposure estimation at the street address level. Tah and Carr (2000) have created a hierarchical risk breakdown structure representation used to develop a formal model for qualitative risk assessment. Elbir et al. (2000) have intended to shed light on air quality in Turkey and compare air pollutant emissions on a national scale with that of the European countries. They also evaluated levels of air pollution in some of the big cities in Turkey using available national monitoring data for SO_2 and PM_{10}. They found that Turkish air quality limits must be revised. Demirci and Cuhadarolu (2000) have statistically analyzed the relationship between air pollution and wind speeds of different directions, using the SPSS. They emphasized that there was a weak relationship between the air pollution concentrations and wind speeds in urban Trabzon. Mahant (2004) has presented a novel approach to overcome the fuzziness in traditional risk assessment, and created a risk assessment model using fuzzy logic. Al-Shehab et al. (2005) have provided a cause and effect diagram that allowed project managers to have a better comprehension of the effects risks have on a project. They developed a Casual and Cognitive Map containing risks pertinent to their case study and their interrelationships. Onder and Dursun (2006) have measured contents of heavy metal accumulated by air pollution in the cedar tree needles from the green area of Konya city center. They also used the results of SO_2 and PM analyses for measurement of air pollution effects on accumulation of heavy metals in the vegetation. The results from their study showed that accumulations of heavy metals in the old trees were generally higher than that of young trees.

Skarek et al. 2007 have investigated usage of chemical analyses (PAHs analyses) and toxicity testing (genotoxicity testing with a screening bacterial genotoxicity test-SOS chromotest), for the evaluation of organic air pollution and its genotoxic activity. They performed it in two important industrial cities, Sarajevo and Tuzla, in Bosnia and Herzegovina, respectively. They also compared PAHs analyses and SOS chromotest to confirm the practicability of the SOS chromotest for the evaluation of air pollution and identification of localities with increased health risks. Barratt et al. (2007) have used a CUSUM procedure to assess changes in ambient mean air pollution levels following the introduction of a traffic management scheme at Marylebone Road, Central London. Kaya and Kahraman (2008a) have analyzed the risk assessment of air pollution in Istanbul. The process capability indices (PCIs), which are very effective statistics to summarize the performance of a process, were used in that paper. A process capability index (PCIs) was used to determine the levels of the air pollutants that were measured in different nine stations in Istanbul. Robust PCIs (RBCIs) were used when air pollutants had a correlation. Fuzzy set theory was applied for both PCIs and RPCIs to obtain more sensitive results. Kahraman and Kaya (2008b) have proposed a methodology based on PCIs to control the levels of pH, dissolved oxygen, and temperature in dam's water for irrigation. PCIs were constructed for this purpose.

Six-sigma is both a philosophy and a methodology that improves quality by analyzing data with statistics to find the root cause of quality problems and to implement controls. In this study PCIs have been analyzed based on the six-sigma approach and their membership functions have been obtained.

III. PROCESS CAPABILITY ANALYSIS

Process capability is broadly defined as the ability of a process to satisfy customer expectations. Some processes do a good job of meeting customer requirements and therefore are considered "capable," whereas others do not and are designated "not capable" (Bothe 1997). Measure of process capability summarizes some aspects of a process's ability to satisfy customer requirements. Some PCIs are used to measure the ability of process. A PCI is a number that summarizes the behavior of a product or process characteristic relative to specifications. Generally, this comparison is made by forming the ratio of the width between the process specification limits to the width of the natural tolerance limits. These indices help us to decide how well the process meets the specification limits (Montgomery 2005). Several PCIs, such as C_p, C_{pk} and C_{pm} are used to estimate the capability of a process (Kotz and Johnson 2002). C_p is defined as the ratio of specification width over the process spread. The specification width represents customer and/or product requirements. The process variations are represented by the specification width. If the process variation is very large, the C_p value is small and it represents a low process capability.

$$C_p = \frac{Specification\,Width}{Process\ Spread} = \frac{Allowable\ process\ spread}{Actual\ process\ spread} = \frac{USL - LSL}{6\sigma} = \frac{\omega}{6\sigma} \quad (1)$$

Where σ is the standard deviation of the process.

C_p is usually estimated by the following equation:

$$C_p = \frac{USL - LSL}{6S} = \frac{\omega}{6S} \quad (2)$$

Where S denotes the sample standard deviation.

Air Pollution Control Using Process Capability Indices

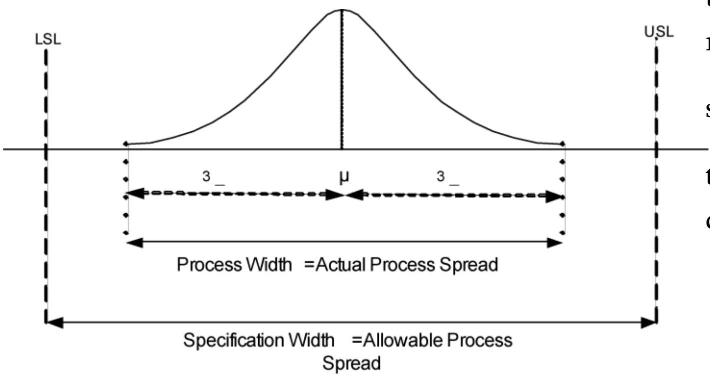

Figure 3.1. Centered process

C_p indicates how well the process fits within the two specification limits. It never considers any process shift as indicated by equation (1), and presented in Figure 3.1. C_p simply measures the spread of the specifications relative to the six-sigma spread in the process. If the process average is not centered near the midpoint of specifications limits, the C_p index gives misleading results [see Kane (1986), Bothe (1997), Kotz and Johnson (2002), and Montgomery (2005)] for more details). The six quality conditions and the corresponding C_p values are summarized in Table 1 (Tsai and Chen 2006).

The process capability ratio C_p does not take into account where the process mean is located relative to specifications (Montgomery 2005). C_p focuses the dispersion of the studied process and does not take into account the centering of the process. To overcome this problem, Kane (1986) introduced C_{pk}.

The C_{pk} index is used to provide an indication of the variability associated with a process. It shows how a process confirms to its specification. The index is usually used to relate the "natural tolerance (3σ)" to the specification limits. C_{pk} describes how well the process fits within the specification limits, taking into account the location of the process mean. Process target is a point within the specification width. It reflects the best value of the customer satisfaction, as shown in Figure 3.3 Generally, $T = \frac{USL + LSL}{2}$. If the mean of the process is equal to target value, customers gain the best satisfaction.

Table 3.2 Quality Conditions and C_p Values

Quality Condition	C_p **Value**
Super Excellent	$2.00 \le C_p$
Excellent	$1.67 \le C_p \le 2.00$
Satisfactory	$1.33 \le C_p \le 1.67$
Capable	$1.00 \le C_p \le 1.33$
Inadequate	$0.67 \le C_p \le 1.00$
Poor	$C_p < 0.67$

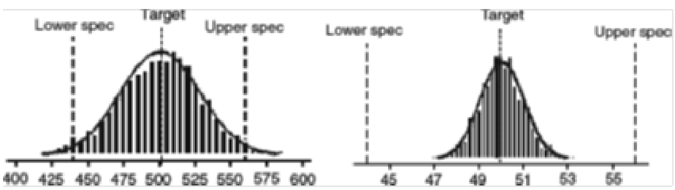

Figure 3.3 Centered three-sigma and six-sigma processes (Markarian 2004).

C_{pk} measures this real capability when the process is the off-center. The variation factor k is defined as

$$k = \frac{|T - \mu|}{0.5(USL - LSL)} \quad (3)$$

$$C_{pk} = C_p\ (1 - \text{k}) \quad (4)$$

If the process is centered, k = 0 and $C_{pk} = C_p$.

If the process target is not determined, C_{pk} should be calculated differently based on equations (5) – (7). See Kane (1986), Bothe (1997), Kotz and Johnson (2002), and Montgomery (2005)), for more details.

$$C_{pk} = min\{C_{pl},\, C_{pu}\} = \frac{min\ \{USL - \mu, \mu - LSL\}}{3\sigma} \quad (5)$$

$$C_{pl} = \frac{(\mu - LSL)}{3\sigma} \quad (6)$$

$$C_{pu} = \frac{(USL - \mu)}{3\sigma}$$

C_{pk} is usually estimated by the following equation

$$C_{pk} = \frac{min\ \{USL - \bar{x},\, \bar{x} - LSL\}}{3S} \quad (7)$$

IV. SIX - SIGMA APPROACH AND PROCESS CAPABILITY INDICES

Motorola originally developed the six-sigma, which was a quality improvement program that aimed to reduce the number of defects to as low as 3.4 parts per million in 1987. It uses the normal distribution and the strong relationship between product nonconformities, or defects, and product yield, reliability, cycle time, inventory, schedule, and so on. Statistically, six-sigma refers to a process in which the range between the mean of a process quality measurement and the nearest specification limit is at least six times the standard deviation of the process (see Figure 3.3). The statistical objectives of six-sigma are to centre the process on the target and reduce process variation. A six-sigma process will approach "zero defects" with only 3.4 defects per million opportunities (dpmo) whereas the four-sigma width has 6210 dpmo (see Figure 5.1).

V. AIR POLLUTION CONTROL USING PROCESS CAPABILITY INDICES

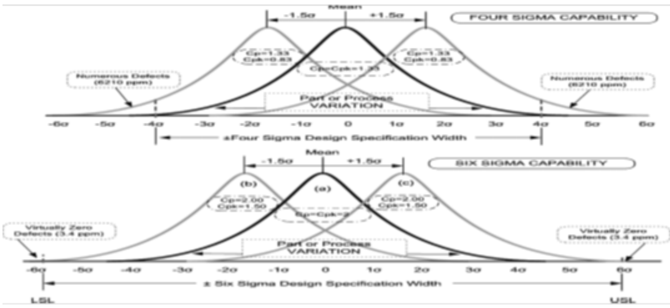

Figure 5.1 Shift of process means (Six - Sigma 2007).

In comparison, the goal of many quality initiatives throughout the 1980s and early 1990s was to obtain a process capability index (C_{pk}) of at least 1.0, which roughly translates to three - sigma. However, this level of quality still produces a defect rate of 66,810 dpmo (Markarian 2004). In the six-sigma approach, the commonly recognized PCIs can be formulated as follows:

$$C_p = \frac{USL - LSL}{6\sigma} = \frac{12\sigma}{6\sigma} = 2 \quad (8)$$

Where σ is the standard deviation of the process. This situation is shown in Figure 5.1(a).

C_{pk} can be calculated based on Equation (9) for the six-sigma approach.

$$C_{pk} = \frac{min\ \{USL - \mu, \mu - LSL\}}{3\sigma} \quad (9)$$

In the first case (a) shown in Figure 5.1, C_{pk} can be calculated as follows:

$$C_{pk} = \frac{min\ \{USL - \mu, \mu - LSL\}}{3\sigma} = \frac{min(6\sigma,\ 6\sigma)}{3\sigma} = \frac{6\sigma}{3\sigma} = 2.00$$

In the second case (b) shown in Figure 5.1, C_{pk} can be calculated as follows:

$$C_{pk} = \frac{min\ \{USL - \mu, \mu - LSL\}}{3\sigma} = \frac{min(7.5\sigma,\ 4.5\sigma)}{3\sigma} = \frac{4.5\sigma}{3\sigma} = 1.50$$

In the third case (c) shown in Figure 5.1, C_{pk} can be calculated as follows:

$$C_{pk} = \frac{min\ \{USL - \mu, \mu - LSL\}}{3\sigma} = \frac{min(4.5\sigma,\ 7.5\sigma)}{3\sigma} = \frac{4.5\sigma}{3\sigma} = 1.50$$

It is clear that the minimum value of C_p must be 2.0 in the six-sigma approach to reduce nonconforming. Also the minimum value of C_{pk} must be 1.50 in the six sigma approach.

C_p = C_{pk} = 2.00 is the ideal position of the process for the six-sigma approach.

VI. CONSTRUCTION OF CONTROL CHART USING FUZZY PROBABILISTIC APPROACH

Step 1: Identify the linguistic variables the attributes in a production process and also define appropriate membership function of each variable.

Step 2: Constructing the attributes into membership values in order to assess the intermediate values lying between each variables, one can be divided in the interval $[0,1]$ to homogeneous or non – homogeneous intervals with respect to the number of attributes which are proposed to study,

$[0, R_1]\ [R_1, R_2], ..., [R_{K-1}, 1]$.

Step 3: To calculate the fuzzy membership value

$$m_{ij} = \int_{R_{j-1}}^{R_j} \mu_{L_j}(x_j)\,dx_j; i = 1, 2, \ldots, n; j = 1, 2, \ldots, k.$$

Where $\mu_{L_j}(x_j)$ is the membership function of the j^{th} attribute.

Step 4: Calculate the total fuzzy response quality value and the value is equal to one.

$$\sum_{i=1}^{n} m_{ij} = 1; j = 1, 2, ..., k.$$

Step 5: Let $L_1, L_2, ..., L_j$ are the linguistic values. The fuzzy set is denoted by F_i, and described by the membership function $\mu_{L_j}(x_j)$, where x_j, is a subset of the standard basic variable.

Step 6: The Control Limits are based on membership functions. For n samples of each size $n_1, n_2, ..., n_i; (n_i = 1, 2, ..., n)$

$$CL = \overline{M} = \frac{\sum_{j=1}^{k} \overline{M_i}}{n}; i = 1, 2, ..., n.$$

Where $\overline{M_i} = \frac{\sum_{j=1}^{k} n_{ij} r_j}{n_i}; i = 1, 2, ..., n$ the sample is mean of i^{th} sample; n_{ij} is the number of observations categorized with j^{th} linguistic term in the i^{th} sample; r_j is the fuzzy representative value of the j^{th} linguistic term and n_i is the size of the i^{th} sample.

Step 7: The control limits of central line at distance expressed on multiples of the mean deviation are given below.

Membership UCL $= Max\{0, (CL + k\delta(GMF))\}$

Membership LCL $= Min\{1, (CL - k\delta(GMF))\}$

Where $k = \left(\frac{2}{3}\right)$, since the mean deviation of the normal distribution is $\left(\frac{2}{3}\right)\sigma$ and $\sigma = \delta(A)$.

Step 8: Construction of control chart using Fuzzy probabilistic approach we take Fuzzy set F_i

associated with the linguistic terms L_j are transformed into their respective representative values r_j. The sample mean is calculated on the average of the sample linguistic representative values r_j. For each sample i the standard deviation SD_i is calculated as the standard deviation of the representative values of the observations of the sample.

VII. APPLICATIONS

The data are collected from Salem District in Tamil Nadu and classification as 20, 40, 60, 80 and 100 counts. We classify the air pollution into six categories: Good, Satisfactory, Moderate, Very Poor, Poor and Severe and also collected 366 samples of sizes are shown in Table 7.1.

Table 7.1 Attributes of Air Pollution

S. No	Good	Satisfactory	Moderate	Very Poor	Poor	Severe	No. of items
1	2	5	8	12	13	10	50
2	4	6	9	11	12	8	50
3	3	4	7	12	13	11	50
4	5	4	8	10	11	12	50
5	3	3	7	11	13	13	50
6	5	6	5	11	12	11	50
7	3	5	6	12	11	13	50
8	2	3	7	11	13	14	50
9	3	2	7	12	13	13	50
10	2	4	5	12	13	14	50
11	3	6	8	9	11	13	50
12	2	4	7	12	13	12	50
13	4	5	6	10	11	14	50
14	3	4	8	11	12	12	50
15	4	4	7	10	11	14	50
16	3	5	6	11	12	13	50
17	1	3	7	12	13	14	50
18	5	4	8	10	11	12	50
19	3	6	5	11	12	13	50
20	3	5	7	12	12	11	50
21	4	6	5	10	11	14	50
22	3	4	8	11	11	13	50
23	3	7	9	9	10	12	50
24	5	8	8	10	9	10	50
25	5	5	7	10	11	12	50
26	2	6	9	11	10	12	50
27	2	7	8	9	11	13	50
28	1	5	9	12	11	12	50
29	5	7	8	9	10	11	50

30	3	6	9	9	12	11	50
31	2	5	8	12	11	12	50
32	5	7	8	9	10	11	50
33	4	8	9	11	8	10	50
34	3	7	8	10	10	12	50
35	2	6	9	10	11	12	50
36	1	8	7	11	12	11	50
37	3	7	8	9	10	13	50
38	2	8	9	10	11	10	50
39	3	7	8	9	11	12	50
40	2	6	9	10	12	11	50
41	3	4	8	11	11	13	50
42	4	5	9	10	10	12	50
43	2	7	8	11	10	12	50
44	6	4	7	11	9	13	50
45	5	8	10	9	8	10	50
46	2	6	9	11	10	12	50
47	4	8	9	10	8	11	50
48	5	5	8	9	10	13	50
49	4	7	9	10	9	11	50
50	4	7	8	9	10	12	50
51	3	8	9	10	9	11	50
52	2	7	7	10	11	13	50
53	3	8	10	9	10	10	50
54	2	7	9	12	9	11	50
55	4	6	8	9	11	12	50
56	2	5	9	11	10	13	50
57	3	8	9	10	9	11	50
58	2	6	8	11	10	13	50
59	4	9	8	10	9	10	50
60	3	7	8	9	11	12	50
61	2	8	9	11	10	10	50
62	5	3	8	10	11	13	50
63	6	9	8	9	8	10	50
64	5	5	7	11	10	12	50
65	4	8	9	10	9	10	50
66	2	6	8	9	12	13	50
67	3	7	9	10	11	10	50
68	5	6	7	9	11	12	50
69	4	8	9	11	9	9	50
70	5	7	8	9	10	11	50
71	4	6	8	5	15	12	50
72	2	6	8	12	10	12	50
73	2	8	9	10	10	11	50
74	2	6	8	11	9	14	50

75	4	9	8	8	9	12	50
76	3	7	8	9	11	12	50
77	3	8	7	10	12	10	50
78	5	3	8	10	11	13	50
79	6	9	8	9	7	11	50
80	5	5	6	11	11	12	50
81	4	8	6	10	9	13	50
82	1	6	8	9	12	14	50
83	3	7	9	10	10	11	50
84	5	6	7	9	12	11	50
85	4	8	9	11	9	9	50
86	5	7	8	10	10	10	50
87	2	8	9	10	9	12	50
88	2	6	8	11	12	11	50
89	4	9	8	10	9	10	50
90	3	7	8	8	11	13	50
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92	5	3	8	9	11	14	50
93	6	6	8	10	9	11	50
94	5	5	7	11	10	12	50
95	4	8	9	10	9	10	50
96	2	6	8	8	14	12	50
97	3	7	6	10	13	11	50
98	5	6	6	8	13	12	50
99	4	8	8	11	10	9	50
100	5	6	8	7	10	14	50
101	3	5	7	10	13	12	50
102	3	4	7	13	12	11	50
103	3	7	9	9	10	12	50
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105	5	5	7	10	10	13	50
106	2	8	5	11	13	11	50
107	2	7	8	9	11	13	50
108	1	5	9	12	11	12	50
109	5	7	8	9	10	11	50
110	3	6	9	8	13	11	50
111	2	5	8	11	14	10	50
112	5	7	7	9	11	11	50
113	4	8	9	11	9	9	50
114	3	7	8	9	11	12	50
115	2	6	9	10	12	11	50
116	1	7	8	11	12	11	50
117	5	7	8	9	10	11	50
118	2	8	9	10	11	10	50
119	4	5	9	9	12	11	50

120	2	5	7	12	11	13	50
121	5	7	8	8	10	12	50
122	4	8	9	10	9	10	50
123	3	7	10	10	9	11	50
124	2	6	5	11	14	12	50
125	3	9	5	11	13	9	50
126	3	8	8	9	8	14	50
127	2	8	10	9	11	10	50
128	3	7	8	9	11	12	50
129	1	7	8	10	13	11	50
130	3	4	7	11	11	14	50
131	4	5	9	9	11	12	50
132	1	8	9	11	10	11	50
133	6	5	7	10	9	13	50
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161	3	5	7	9	12	14	50
162	2	6	8	10	11	13	50
163	4	5	8	11	10	12	50
164	2	4	9	10	11	14	50

165	1	5	8	11	13	12	50
166	4	4	7	10	12	13	50
167	5	7	8	9	11	10	50
168	2	4	9	11	10	14	50
169	4	6	9	10	10	11	50
170	3	5	8	9	12	13	50
171	2	7	9	10	11	11	50
172	5	7	6	8	10	14	50
173	3	6	9	8	12	12	50
174	4	7	6	9	10	14	50
175	2	8	9	7	11	13	50
176	2	6	9	12	10	11	50
177	5	5	7	11	10	12	50
178	2	4	10	11	9	14	50
179	3	8	9	8	10	12	50
180	2	5	8	12	9	14	50
181	4	7	6	10	11	12	50
182	3	6	5	11	12	13	50
183	2	8	10	9	10	11	50
184	5	6	5	10	11	13	50
185	4	8	6	7	12	13	50
186	3	6	10	8	12	11	50
187	2	7	9	11	10	11	50
188	4	6	8	9	11	12	50
189	2	5	7	11	12	13	50
190	3	7	9	10	10	11	50
191	2	4	8	11	11	14	50
192	4	6	6	10	12	12	50
193	3	7	7	9	10	14	50
194	2	8	5	12	11	12	50
195	5	4	8	10	10	13	50
196	6	7	8	9	9	11	50
197	4	5	7	11	10	13	50
198	3	6	8	10	11	12	50
199	2	5	6	11	12	14	50
200	4	6	7	10	11	12	50
201	5	5	7	8	12	13	50
202	4	8	8	10	9	11	50
203	5	7	6	9	10	13	50
204	4	6	9	7	13	11	50
205	3	5	7	11	10	14	50
206	2	5	8	10	13	12	50
207	3	4	7	11	12	13	50
208	5	6	9	9	10	11	50
209	5	7	8	11	9	10	50

210	5	5	7	10	11	12	50
211	3	8	5	10	13	11	50
212	2	7	6	10	11	14	50
213	1	4	8	12	14	11	50
214	4	7	7	10	10	12	50
215	3	4	9	10	13	11	50
216	1	5	6	11	14	13	50
217	5	6	7	9	11	12	50
218	4	7	8	10	10	11	50
219	3	7	8	8	11	13	50
220	2	5	9	10	12	12	50
221	1	6	8	11	13	11	50
222	4	7	8	9	10	12	50
223	2	8	7	10	12	11	50
224	4	5	9	8	12	12	50
225	3	6	7	12	11	11	50
226	5	6	8	9	10	12	50
227	4	7	9	9	11	10	50
228	3	6	10	10	9	12	50
229	2	6	7	11	13	11	50
230	3	8	5	11	12	11	50
231	3	7	8	10	9	13	50
232	2	8	10	9	11	10	50
233	3	6	8	10	11	12	50
234	1	7	8	9	12	13	50
235	3	4	7	11	11	14	50
236	4	5	9	9	11	12	50
237	1	8	9	11	10	11	50
238	6	5	7	10	9	13	50
239	4	7	8	10	10	11	50
240	3	6	7	9	12	13	50
241	4	6	8	10	10	12	50
242	5	8	6	10	10	11	50
243	3	5	7	8	13	14	50
244	1	6	8	12	10	13	50
245	6	8	7	9	9	11	50
246	2	7	7	11	9	14	50
247	3	9	8	8	10	12	50
248	4	7	8	9	10	12	50
249	5	6	7	10	12	10	50
250	2	8	6	11	11	12	50
251	3	6	7	9	12	13	50
252	4	5	7	10	11	13	50
253	5	5	8	11	10	11	50
254	3	4	9	9	11	14	50

255	1	4	9	11	13	12	50
256	4	5	7	10	11	13	50
257	5	6	8	9	11	11	50
258	3	5	7	11	10	14	50
259	4	5	9	8	13	11	50
260	3	6	8	9	11	13	50
261	4	8	7	10	10	11	50
262	5	6	5	8	12	14	50
263	3	5	9	10	11	12	50
264	4	6	5	9	12	14	50
265	2	7	8	9	11	13	50
266	3	6	9	12	9	11	50
267	4	6	7	11	10	12	50
268	2	5	9	11	9	14	50
269	4	7	8	9	10	12	50
270	6	5	6	12	9	12	50
271	4	6	5	11	13	11	50
272	2	7	9	8	11	13	50
273	4	5	6	11	12	12	50
274	5	6	6	10	10	13	50
275	3	6	7	9	13	12	50
276	4	5	6	11	13	11	50
277	5	6	7	9	10	13	50
278	6	7	8	11	9	9	50
279	5	7	6	9	11	12	50
280	3	6	9	10	11	11	50
281	4	5	7	9	12	13	50
282	5	6	8	9	10	12	50
283	4	6	9	10	10	11	50
284	3	5	10	9	12	11	50
285	4	5	7	10	11	13	50
286	5	7	8	9	10	11	50
287	4	7	7	10	10	12	50
288	3	5	8	10	11	13	50
289	2	4	7	12	13	12	50
290	4	6	5	11	12	12	50
291	3	6	8	10	9	14	50
292	4	7	8	9	11	11	50
293	3	5	8	10	12	12	50
294	1	4	9	11	13	12	50
295	5	6	5	10	10	14	50
296	5	4	9	9	11	12	50
297	4	6	7	9	11	13	50
298	5	5	8	10	10	12	50
299	4	4	10	11	11	10	50

300	4	5	6	12	11	12	50
301	5	6	6	10	10	13	50
302	3	6	8	9	12	12	50
303	5	6	9	9	10	11	50
304	5	6	7	10	9	13	50
305	4	8	6	9	11	12	50
306	5	6	8	10	10	11	50
307	2	6	9	10	11	12	50
308	2	6	6	11	12	13	50
309	4	7	8	10	11	10	50
310	3	6	8	9	11	13	50
311	2	6	9	11	10	12	50
312	5	3	5	11	12	14	50
313	6	7	8	10	9	10	50
314	5	4	5	11	12	13	50
315	4	5	9	10	10	12	50
316	3	6	8	9	14	10	50
317	5	5	6	10	13	11	50
318	5	6	6	9	11	13	50
319	4	6	8	11	10	11	50
320	5	4	8	9	11	13	50
321	4	5	6	10	13	12	50
322	4	4	5	11	12	14	50
323	3	5	8	10	12	12	50
324	5	5	8	10	9	13	50
325	4	5	7	12	10	12	50
326	4	5	5	11	11	14	50
327	3	5	8	10	11	13	50
328	2	4	7	12	13	12	50
329	5	6	8	9	11	11	50
330	3	6	7	9	13	12	50
331	2	5	8	11	13	11	50
332	5	5	7	10	11	12	50
333	4	6	9	11	9	11	50
334	5	5	8	11	9	12	50
335	2	5	9	10	13	11	50
336	3	4	7	11	12	13	50
337	5	5	8	10	11	11	50
338	2	6	9	10	11	12	50
339	4	5	7	11	12	11	50
340	4	5	7	10	11	13	50
341	5	4	8	10	10	13	50
342	4	6	9	10	11	10	50
343	3	6	9	10	10	12	50
344	3	4	6	11	14	12	50

345	4	6	5	11	13	11	50
346	3	6	8	9	10	14	50
347	2	6	10	9	11	12	50
348	3	6	8	10	11	12	50
349	1	7	8	10	11	13	50
350	3	4	8	11	10	14	50
351	4	5	9	9	10	13	50
352	3	6	9	11	10	11	50
353	6	5	5	10	10	14	50
354	4	6	8	9	11	12	50
355	3	8	7	9	10	13	50
356	3	7	9	9	11	11	50
357	4	5	7	11	11	12	50
358	5	5	6	11	10	13	50
359	3	5	8	9	11	14	50
360	3	5	7	11	12	12	50
361	4	4	5	12	11	14	50
362	3	6	5	11	12	13	50
363	2	6	8	11	11	12	50
364	5	4	6	12	11	12	50
365	4	5	8	10	10	13	50
366	3	6	7	12	10	12	50
Total	**1259**	**2216**	**2827**	**3667**	**3964**	**4367**	**18300**

The Fuzzy set be contained six attributes, namely $F_i\{L_1 = Good, L_2 = Satisfactory, L_3 = Moderate, L_4 = Very\,Poor, L_5 =$ Poor and $L_6 = Severe\}, i = 1,2,...,n.$ each term L_j is associated with a fuzzy subset and described by the following membership function

$$\mu_{L_j}(x_j) = 50e^{(-kx)},\quad if\ x \in [0,1];\quad i = 1,2,...,n.$$

Where $k_1 = 0.0912, k_2 = 0.1211, k_3 = 0.1545, k_4 = 0.2004, k_5 = 0.1266$ and $k_6 = 0.2386.$ For converting the attribute into membership values, in order to assess the intermediate values lying between variables we can divide $[0,1]$ into six partition with heterogeneous intervals, say $[0,0.03],[0.03,0.30],[0.30,0.50],[0.50,0.70],[0.70,0.90]$ and $[0.90,1]$. For calculating fuzzy response of degree of membership values are; $m_{11} = 1.4984, m_{12} = 13.2359, m_{13} = 9.418, m_{14} = 8.8698, m_{15} = 8.3869$ and $m_{16} = 3.9807$ and also obtain the total membership value is equal to 1, we have the degree of membership values are; $r_1 = 0.033, r_2 = 0.2916, r_3 = 0.2025, r_4 = 0.1954, r_5 = 0.1848$ *and* $r_6 = 0.0877$ respectively. For n samples of each size $n_i; i = 1,2,\ldots,n$ and $n = 366$, the central line at distances expressed on multiples of the mean deviation are; $CL = \overline{M} = 0.1697, UCL = 0.174$ and $LCL = 0.1654$ thus the resulting left ends, fuzzy response and right ends of 366 samples are given in Table 7.2.

Table 7.2 Membership Approach Control Parameters

S. No	Left End	Fuzzy Response	Right End	Representative $\overline{M_i}$	UCL	CL	LCL
1	0.1322	0.1762	0.1814	0.1762	0.174	0.1697	0.1654
2	0.1477	0.1764	0.189	0.1764	0.174	0.1697	0.1654
3	0.1306	0.1686	0.1804	0.1686	0.174	0.1697	0.1654
4	0.1366	0.1606	0.1659	0.1606	0.174	0.1697	0.1654
5	0.1227	0.1624	0.1715	0.1624	0.174	0.1697	0.1654
6	0.1386	0.1657	0.1717	0.1657	0.174	0.1697	0.1654
7	0.1273	0.1664	0.1685	0.1664	0.174	0.1697	0.1654
8	0.1162	0.1635	0.1708	0.1635	0.174	0.1697	0.1654
9	0.1223	0.1604	0.1712	0.1604	0.174	0.1697	0.1654
10	0.1163	0.1649	0.1706	0.1649	0.174	0.1697	0.1654
11	0.1282	0.1688	0.1694	0.1688	0.174	0.1697	0.1654
12	0.1241	0.1697	0.1796	0.1697	0.174	0.1697	0.1654
13	0.1264	0.161	0.1607	0.161	0.174	0.1697	0.1654
14	0.129	0.1669	0.1747	0.1669	0.174	0.1697	0.1654
15	0.1262	0.1593	0.1607	0.1593	0.174	0.1697	0.1654
16	0.1254	0.1662	0.1702	0.1662	0.174	0.1697	0.1654
17	0.1135	0.1667	0.1743	0.1667	0.174	0.1697	0.1654
18	0.1366	0.1606	0.1659	0.1606	0.174	0.1697	0.1654
19	0.1256	0.1679	0.1703	0.1679	0.174	0.1697	0.1654
20	0.133	0.1707	0.179	0.1707	0.174	0.1697	0.1654
21	0.1267	0.1627	0.1608	0.1627	0.174	0.1697	0.1654
22	0.1273	0.165	0.1687	0.165	0.174	0.1697	0.1654
23	0.1345	0.1733	0.1725	0.1733	0.174	0.1697	0.1654
24	0.1497	0.173	0.1723	0.173	0.174	0.1697	0.1654
25	0.1368	0.1623	0.166	0.1623	0.174	0.1697	0.1654
26	0.1313	0.1747	0.1757	0.1747	0.174	0.1697	0.1654
27	0.1259	0.174	0.1732	0.174	0.174	0.1697	0.1654
28	0.1261	0.1758	0.1806	0.1758	0.174	0.1697	0.1654
29	0.1436	0.1688	0.1694	0.1688	0.174	0.1697	0.1654
30	0.1339	0.1731	0.1798	0.1731	0.174	0.1697	0.1654
31	0.1286	0.1723	0.1768	0.1723	0.174	0.1697	0.1654
32	0.1436	0.1688	0.1694	0.1688	0.174	0.1697	0.1654
33	0.149	0.1767	0.1744	0.1767	0.174	0.1697	0.1654
34	0.1343	0.1731	0.1722	0.1731	0.174	0.1697	0.1654
35	0.1293	0.1744	0.1774	0.1744	0.174	0.1697	0.1654
36	0.1288	0.183	0.187	0.183	0.174	0.1697	0.1654
37	0.1306	0.1709	0.168	0.1709	0.174	0.1697	0.1654
38	0.1377	0.1826	0.1865	0.1826	0.174	0.1697	0.1654
39	0.1323	0.1729	0.1739	0.1729	0.174	0.1697	0.1654
40	0.1311	0.1764	0.1833	0.1764	0.174	0.1697	0.1654
41	0.1273	0.165	0.1687	0.165	0.174	0.1697	0.1654
42	0.1364	0.1662	0.1683	0.1662	0.174	0.1697	0.1654

43	0.1315	0.1763	0.1758	0.1763	0.174	0.1697	0.1654
44	0.1394	0.1554	0.1545	0.1554	0.174	0.1697	0.1654
45	0.152	0.1737	0.1711	0.1737	0.174	0.1697	0.1654
46	0.1313	0.1747	0.1757	0.1747	0.174	0.1697	0.1654
47	0.1453	0.1746	0.1701	0.1746	0.174	0.1697	0.1654
48	0.1353	0.1606	0.1603	0.1606	0.174	0.1697	0.1654
49	0.1429	0.1725	0.1715	0.1725	0.174	0.1697	0.1654
50	0.1371	0.1698	0.1687	0.1698	0.174	0.1697	0.1654
51	0.1406	0.1776	0.1754	0.1776	0.174	0.1697	0.1654
52	0.1256	0.1737	0.1729	0.1737	0.174	0.1697	0.1654
53	0.1426	0.1798	0.1816	0.1798	0.174	0.1697	0.1654
54	0.1373	0.1789	0.1786	0.1789	0.174	0.1697	0.1654
55	0.1347	0.1677	0.1701	0.1677	0.174	0.1697	0.1654
56	0.1271	0.1706	0.1711	0.1706	0.174	0.1697	0.1654
57	0.1406	0.1776	0.1754	0.1776	0.174	0.1697	0.1654
58	0.1273	0.1723	0.1712	0.1723	0.174	0.1697	0.1654
59	0.1473	0.1782	0.1761	0.1782	0.174	0.1697	0.1654
60	0.1323	0.1728	0.1739	0.1728	0.174	0.1697	0.1654
61	0.134	0.1828	0.1848	0.1828	0.174	0.1697	0.1654
62	0.1324	0.1565	0.1613	0.1565	0.174	0.1697	0.1654
63	0.1549	0.1719	0.1674	0.1719	0.174	0.1697	0.1654
64	0.1388	0.1625	0.1643	0.1625	0.174	0.1697	0.1654
65	0.1471	0.1765	0.1761	0.1765	0.174	0.1697	0.1654
66	0.1235	0.1718	0.1746	0.1718	0.174	0.1697	0.1654
67	0.14	0.1774	0.1827	0.1774	0.174	0.1697	0.1654
68	0.1373	0.1642	0.1663	0.1642	0.174	0.1697	0.1654
69	0.1508	0.1787	0.1803	0.1787	0.174	0.1697	0.1654
70	0.1436	0.1688	0.1694	0.1688	0.174	0.1697	0.1654
71	0.1269	0.1669	0.1768	0.1669	0.174	0.1697	0.1654
72	0.131	0.1744	0.1754	0.1744	0.174	0.1697	0.1654
73	0.1359	0.1807	0.1806	0.1807	0.174	0.1697	0.1654
74	0.1256	0.1703	0.1652	0.1703	0.174	0.1697	0.1654
75	0.1399	0.1739	0.1676	0.1739	0.174	0.1697	0.1654
76	0.1323	0.1729	0.1739	0.1729	0.174	0.1697	0.1654
77	0.138	0.1787	0.1842	0.1787	0.174	0.1697	0.1654
78	0.1324	0.1565	0.1613	0.1565	0.174	0.1697	0.1654
79	0.1531	0.1691	0.1614	0.1691	0.174	0.1697	0.1654
80	0.1366	0.1621	0.1657	0.1621	0.174	0.1697	0.1654
81	0.1354	0.1693	0.1626	0.1693	0.174	0.1697	0.1654
82	0.117	0.1729	0.1739	0.1729	0.174	0.1697	0.1654
83	0.1382	0.1755	0.1767	0.1755	0.174	0.1697	0.1654
84	0.139	0.1662	0.1722	0.1662	0.174	0.1697	0.1654
85	0.1508	0.1787	0.1803	0.1787	0.174	0.1697	0.1654
86	0.1473	0.1709	0.1737	0.1709	0.174	0.1697	0.1654
87	0.1341	0.1787	0.1746	0.1787	0.174	0.1697	0.1654

88	0.1309	0.1761	0.1831	0.1761	0.174	0.1697	0.1654
89	0.1473	0.1782	0.1761	0.1782	0.174	0.1697	0.1654
90	0.1287	0.1707	0.1697	0.1707	0.174	0.1697	0.1654
91	0.1396	0.1828	0.1848	0.1828	0.174	0.1697	0.1654
92	0.1287	0.1544	0.1571	0.1544	0.174	0.1697	0.1654
93	0.1479	0.1638	0.1639	0.1638	0.174	0.1697	0.1654
94	0.1388	0.1625	0.1643	0.1625	0.174	0.1697	0.1654
95	0.1471	0.1765	0.1761	0.1765	0.174	0.1697	0.1654
96	0.1233	0.1736	0.1822	0.1736	0.174	0.1697	0.1654
97	0.1317	0.1741	0.181	0.1741	0.174	0.1697	0.1654
98	0.1332	0.1636	0.1694	0.1636	0.174	0.1697	0.1654
99	0.1486	0.1782	0.1818	0.1782	0.174	0.1697	0.1654
100	0.132	0.1604	0.1563	0.1604	0.174	0.1697	0.1654
101	0.1273	0.1684	0.1764	0.1684	0.174	0.1697	0.1654
102	0.1325	0.1688	0.1789	0.1688	0.174	0.1697	0.1654
103	0.1345	0.1733	0.1725	0.1733	0.174	0.1697	0.1654
104	0.1536	0.1735	0.1689	0.1735	0.174	0.1697	0.1654
105	0.1351	0.1604	0.16	0.1604	0.174	0.1697	0.1654
106	0.1292	0.1791	0.1846	0.1791	0.174	0.1697	0.1654
107	0.1259	0.174	0.1732	0.174	0.174	0.1697	0.1654
108	0.1261	0.1758	0.1806	0.1758	0.174	0.1697	0.1654
109	0.1436	0.1688	0.1694	0.1688	0.174	0.1697	0.1654
110	0.1319	0.1729	0.1815	0.1729	0.174	0.1697	0.1654
111	0.1302	0.176	0.1904	0.176	0.174	0.1697	0.1654
112	0.1414	0.1683	0.1709	0.1683	0.174	0.1697	0.1654
113	0.1508	0.1787	0.1803	0.1787	0.174	0.1697	0.1654
114	0.1323	0.1729	0.1739	0.1729	0.174	0.1697	0.1654
115	0.1311	0.1764	0.1833	0.1764	0.174	0.1697	0.1654
116	0.1285	0.1813	0.1869	0.1813	0.174	0.1697	0.1654
117	0.1436	0.1688	0.1694	0.1688	0.174	0.1697	0.1654
118	0.1377	0.1826	0.1865	0.1826	0.174	0.1697	0.1654
119	0.1362	0.168	0.176	0.168	0.174	0.1697	0.1654
120	0.1247	0.1699	0.1723	0.1699	0.174	0.1697	0.1654
121	0.1399	0.1666	0.1652	0.1666	0.174	0.1697	0.1654
122	0.1471	0.1765	0.1761	0.1765	0.174	0.1697	0.1654
123	0.1404	0.1759	0.1753	0.1759	0.174	0.1697	0.1654
124	0.1226	0.1728	0.1814	0.1728	0.174	0.1697	0.1654
125	0.1398	0.182	0.1899	0.182	0.174	0.1697	0.1654
126	0.1312	0.1711	0.1607	0.1711	0.174	0.1697	0.1654
127	0.1378	0.1828	0.1868	0.1828	0.174	0.1697	0.1654
128	0.1323	0.1729	0.1739	0.1729	0.174	0.1697	0.1654
129	0.1266	0.1811	0.1886	0.1811	0.174	0.1697	0.1654
130	0.1234	0.1626	0.1642	0.1626	0.174	0.1697	0.1654
131	0.1344	0.166	0.17	0.166	0.174	0.1697	0.1654
132	0.1331	0.1839	0.1841	0.1839	0.174	0.1697	0.1654

133	0.1398	0.1573	0.1548	0.1573	0.174	0.1697	0.1654
134	0.1473	0.1768	0.1763	0.1768	0.174	0.1697	0.1654
135	0.1426	0.1798	0.1816	0.1798	0.174	0.1697	0.1654
136	0.1373	0.1789	0.1786	0.1789	0.174	0.1697	0.1654
137	0.1344	0.166	0.17	0.166	0.174	0.1697	0.1654
138	0.1271	0.1706	0.1711	0.1706	0.174	0.1697	0.1654
139	0.1406	0.1776	0.1754	0.1776	0.174	0.1697	0.1654
140	0.1273	0.1723	0.1712	0.1723	0.174	0.1697	0.1654
141	0.1473	0.1782	0.1761	0.1782	0.174	0.1697	0.1654
142	0.1323	0.1729	0.1739	0.1729	0.174	0.1697	0.1654
143	0.1396	0.1828	0.1848	0.1828	0.174	0.1697	0.1654
144	0.1324	0.1565	0.1613	0.1565	0.174	0.1697	0.1654
145	0.1549	0.1719	0.1674	0.1719	0.174	0.1697	0.1654
146	0.1388	0.1625	0.1643	0.1625	0.174	0.1697	0.1654
147	0.1471	0.1765	0.1761	0.1765	0.174	0.1697	0.1654
148	0.1235	0.1718	0.1746	0.1718	0.174	0.1697	0.1654
149	0.14	0.1774	0.1827	0.1774	0.174	0.1697	0.1654
150	0.1373	0.1642	0.1663	0.1642	0.174	0.1697	0.1654
151	0.1508	0.1787	0.1803	0.1787	0.174	0.1697	0.1654
152	0.1436	0.1688	0.1694	0.1688	0.174	0.1697	0.1654
153	0.1269	0.1669	0.1768	0.1669	0.174	0.1697	0.1654
154	0.131	0.1744	0.1754	0.1744	0.174	0.1697	0.1654
155	0.1359	0.1807	0.1806	0.1807	0.174	0.1697	0.1654
156	0.1256	0.1703	0.1652	0.1703	0.174	0.1697	0.1654
157	0.1399	0.1739	0.1676	0.1739	0.174	0.1697	0.1654
158	0.1323	0.1729	0.1739	0.1729	0.174	0.1697	0.1654
159	0.138	0.1787	0.1842	0.1787	0.174	0.1697	0.1654
160	0.1296	0.1761	0.1775	0.1761	0.174	0.1697	0.1654
161	0.1219	0.1643	0.1662	0.1643	0.174	0.1697	0.1654
162	0.1254	0.1721	0.1729	0.1721	0.174	0.1697	0.1654
163	0.1362	0.166	0.1681	0.166	0.174	0.1697	0.1654
164	0.121	0.1663	0.1683	0.1663	0.174	0.1697	0.1654
165	0.122	0.1751	0.1837	0.1751	0.174	0.1697	0.1654
166	0.1279	0.1613	0.1666	0.1613	0.174	0.1697	0.1654
167	0.1453	0.1707	0.1754	0.1707	0.174	0.1697	0.1654
168	0.123	0.1665	0.1666	0.1665	0.174	0.1697	0.1654
169	0.1405	0.1703	0.1729	0.1703	0.174	0.1697	0.1654
170	0.1258	0.1667	0.1707	0.1667	0.174	0.1697	0.1654
171	0.1335	0.1785	0.182	0.1785	0.174	0.1697	0.1654
172	0.1321	0.1618	0.1561	0.1618	0.174	0.1697	0.1654
173	0.1302	0.171	0.1756	0.171	0.174	0.1697	0.1654
174	0.1293	0.1651	0.1597	0.1651	0.174	0.1697	0.1654
175	0.1265	0.1751	0.1738	0.1751	0.174	0.1697	0.1654
176	0.1349	0.1768	0.18	0.1768	0.174	0.1697	0.1654
177	0.1388	0.1625	0.1643	0.1625	0.174	0.1697	0.1654

178	0.1251	0.167	0.1651	0.167	0.174	0.1697	0.1654
179	0.135	0.1753	0.1728	0.1753	0.174	0.1697	0.1654
180	0.1251	0.1684	0.1649	0.1684	0.174	0.1697	0.1654
181	0.1347	0.1691	0.1699	0.1691	0.174	0.1697	0.1654
182	0.1256	0.1679	0.1703	0.1679	0.174	0.1697	0.1654
183	0.1361	0.1809	0.1808	0.1809	0.174	0.1697	0.1654
184	0.1332	0.1616	0.1615	0.1616	0.174	0.1697	0.1654
185	0.1295	0.1687	0.1676	0.1687	0.174	0.1697	0.1654
186	0.1341	0.1734	0.1801	0.1734	0.174	0.1697	0.1654
187	0.1354	0.1787	0.1803	0.1787	0.174	0.1697	0.1654
188	0.1347	0.1677	0.1701	0.1677	0.174	0.1697	0.1654
189	0.1228	0.1697	0.174	0.1697	0.174	0.1697	0.1654
190	0.1382	0.1755	0.1767	0.1755	0.174	0.1697	0.1654
191	0.1208	0.166	0.168	0.166	0.174	0.1697	0.1654
192	0.1323	0.167	0.1713	0.167	0.174	0.1697	0.1654
193	0.1267	0.1685	0.1635	0.1685	0.174	0.1697	0.1654
194	0.1294	0.1773	0.177	0.1773	0.174	0.1697	0.1654
195	0.1348	0.1587	0.16	0.1587	0.174	0.1697	0.1654
196	0.1483	0.1657	0.1642	0.1657	0.174	0.1697	0.1654
197	0.1323	0.1636	0.1636	0.1636	0.174	0.1697	0.1654
198	0.1319	0.171	0.1736	0.171	0.174	0.1697	0.1654
199	0.1189	0.1673	0.1695	0.1673	0.174	0.1697	0.1654
200	0.1345	0.1675	0.1698	0.1675	0.174	0.1697	0.1654
201	0.1312	0.1599	0.1634	0.1599	0.174	0.1697	0.1654
202	0.1432	0.1741	0.1716	0.1741	0.174	0.1697	0.1654
203	0.1358	0.164	0.1604	0.164	0.174	0.1697	0.1654
204	0.1347	0.1697	0.178	0.1697	0.174	0.1697	0.1654
205	0.1258	0.1647	0.1628	0.1647	0.174	0.1697	0.1654
206	0.1248	0.1719	0.1802	0.1719	0.174	0.1697	0.1654
207	0.1251	0.1645	0.1702	0.1645	0.174	0.1697	0.1654
208	0.1433	0.1671	0.1694	0.1671	0.174	0.1697	0.1654
209	0.1492	0.1711	0.172	0.1711	0.174	0.1697	0.1654
210	0.1368	0.1623	0.166	0.1623	0.174	0.1697	0.1654
211	0.132	0.1758	0.1811	0.1758	0.174	0.1697	0.1654
212	0.1217	0.1713	0.1684	0.1713	0.174	0.1697	0.1654
213	0.1233	0.1751	0.1894	0.1751	0.174	0.1697	0.1654
214	0.1369	0.1696	0.1684	0.1696	0.174	0.1697	0.1654
215	0.131	0.1691	0.1809	0.1691	0.174	0.1697	0.1654
216	0.1159	0.1723	0.1807	0.1723	0.174	0.1697	0.1654
217	0.1373	0.1642	0.1663	0.1642	0.174	0.1697	0.1654
218	0.1408	0.172	0.173	0.172	0.174	0.1697	0.1654
219	0.1287	0.1707	0.1697	0.1707	0.174	0.1697	0.1654
220	0.1269	0.1723	0.1788	0.1723	0.174	0.1697	0.1654
221	0.1261	0.1792	0.1883	0.1792	0.174	0.1697	0.1654
222	0.1371	0.1698	0.1687	0.1698	0.174	0.1697	0.1654

223	0.1315	0.1798	0.1835	0.1798	0.174	0.1697	0.1654
224	0.1325	0.1658	0.1717	0.1658	0.174	0.1697	0.1654
225	0.1354	0.1729	0.1776	0.1729	0.174	0.1697	0.1654
226	0.1394	0.1647	0.1648	0.1647	0.174	0.1697	0.1654
227	0.1427	0.1742	0.1792	0.1742	0.174	0.1697	0.1654
228	0.1362	0.1712	0.1707	0.1712	0.174	0.1697	0.1654
229	0.1287	0.1757	0.1845	0.1757	0.174	0.1697	0.1654
230	0.1339	0.176	0.1794	0.176	0.174	0.1697	0.1654
231	0.1325	0.1712	0.1663	0.1712	0.174	0.1697	0.1654
232	0.1378	0.1828	0.1868	0.1828	0.174	0.1697	0.1654
233	0.1319	0.171	0.1736	0.171	0.174	0.1697	0.1654
234	0.1211	0.177	0.1784	0.177	0.174	0.1697	0.1654
235	0.1234	0.1626	0.1642	0.1626	0.174	0.1697	0.1654
236	0.1344	0.166	0.17	0.166	0.174	0.1697	0.1654
237	0.1331	0.1839	0.1841	0.1839	0.174	0.1697	0.1654
238	0.1398	0.1573	0.1548	0.1573	0.174	0.1697	0.1654
239	0.1408	0.172	0.173	0.172	0.174	0.1697	0.1654
240	0.126	0.1683	0.1708	0.1683	0.174	0.1697	0.1654
241	0.1367	0.1679	0.1684	0.1679	0.174	0.1697	0.1654
242	0.1436	0.1702	0.1692	0.1702	0.174	0.1697	0.1654
243	0.12	0.1641	0.1679	0.1641	0.174	0.1697	0.1654
244	0.1245	0.1755	0.1747	0.1755	0.174	0.1697	0.1654
245	0.1486	0.1674	0.1643	0.1674	0.174	0.1697	0.1654
246	0.1258	0.172	0.1653	0.172	0.174	0.1697	0.1654
247	0.1352	0.1769	0.1729	0.1769	0.174	0.1697	0.1654
248	0.1371	0.1698	0.1687	0.1698	0.174	0.1697	0.1654
249	0.1427	0.1683	0.1765	0.1683	0.174	0.1697	0.1654
250	0.1296	0.1776	0.1773	0.1776	0.174	0.1697	0.1654
251	0.126	0.1683	0.1708	0.1683	0.174	0.1697	0.1654
252	0.1303	0.1634	0.1652	0.1634	0.174	0.1697	0.1654
253	0.1427	0.1649	0.1688	0.1649	0.174	0.1697	0.1654
254	0.1238	0.163	0.1647	0.163	0.174	0.1697	0.1654
255	0.1217	0.1734	0.1837	0.1734	0.174	0.1697	0.1654
256	0.1303	0.1634	0.1652	0.1634	0.174	0.1697	0.1654
257	0.1412	0.1667	0.1708	0.1667	0.174	0.1697	0.1654
258	0.1258	0.1647	0.1628	0.1647	0.174	0.1697	0.1654
259	0.1343	0.1678	0.1777	0.1678	0.174	0.1697	0.1654
260	0.1282	0.1688	0.1694	0.1688	0.174	0.1697	0.1654
261	0.141	0.1737	0.173	0.1737	0.174	0.1697	0.1654
262	0.1275	0.1592	0.159	0.1592	0.174	0.1697	0.1654
263	0.1317	0.1693	0.1735	0.1693	0.174	0.1697	0.1654
264	0.1247	0.1625	0.1625	0.1625	0.174	0.1697	0.1654
265	0.1259	0.174	0.1732	0.174	0.174	0.1697	0.1654
266	0.1397	0.1738	0.1747	0.1738	0.174	0.1697	0.1654
267	0.1364	0.1677	0.1681	0.1677	0.174	0.1697	0.1654

268	0.1253	0.1686	0.1652	0.1686	0.174	0.1697	0.1654
269	0.1371	0.1698	0.1687	0.1698	0.174	0.1697	0.1654
270	0.1433	0.1592	0.1588	0.1592	0.174	0.1697	0.1654
271	0.1339	0.1687	0.1769	0.1687	0.174	0.1697	0.1654
272	0.1261	0.1742	0.1735	0.1742	0.174	0.1697	0.1654
273	0.1319	0.1651	0.1709	0.1651	0.174	0.1697	0.1654
274	0.1353	0.162	0.1601	0.162	0.174	0.1697	0.1654
275	0.1278	0.1703	0.1767	0.1703	0.174	0.1697	0.1654
276	0.1336	0.167	0.1769	0.167	0.174	0.1697	0.1654
277	0.1355	0.1623	0.1603	0.1623	0.174	0.1697	0.1654
278	0.1557	0.17	0.1727	0.17	0.174	0.1697	0.1654
279	0.1375	0.1659	0.1663	0.1659	0.174	0.1697	0.1654
280	0.1358	0.1734	0.1782	0.1734	0.174	0.1697	0.1654
281	0.1284	0.1632	0.1669	0.1632	0.174	0.1697	0.1654
282	0.1394	0.1647	0.1648	0.1647	0.174	0.1697	0.1654
283	0.1405	0.1703	0.1729	0.1703	0.174	0.1697	0.1654
284	0.1336	0.1715	0.1797	0.1715	0.174	0.1697	0.1654
285	0.1303	0.1634	0.1652	0.1634	0.174	0.1697	0.1654
286	0.1436	0.1688	0.1694	0.1688	0.174	0.1697	0.1654
287	0.1369	0.1696	0.1684	0.1696	0.174	0.1697	0.1654
288	0.1277	0.1669	0.169	0.1669	0.174	0.1697	0.1654
289	0.1241	0.1697	0.1796	0.1697	0.174	0.1697	0.1654
290	0.1321	0.1668	0.171	0.1668	0.174	0.1697	0.1654
291	0.1284	0.1671	0.1617	0.1671	0.174	0.1697	0.1654
292	0.1389	0.1718	0.1746	0.1718	0.174	0.1697	0.1654
293	0.1295	0.1688	0.175	0.1688	0.174	0.1697	0.1654
294	0.1217	0.1734	0.1837	0.1734	0.174	0.1697	0.1654
295	0.1314	0.1596	0.1556	0.1596	0.174	0.1697	0.1654
296	0.1368	0.1609	0.1662	0.1609	0.174	0.1697	0.1654
297	0.1308	0.1653	0.1656	0.1653	0.174	0.1697	0.1654
298	0.139	0.1627	0.1645	0.1627	0.174	0.1697	0.1654
299	0.1416	0.1687	0.1785	0.1687	0.174	0.1697	0.1654
300	0.1338	0.1653	0.1692	0.1653	0.174	0.1697	0.1654
301	0.1353	0.162	0.1601	0.162	0.174	0.1697	0.1654
302	0.13	0.1707	0.1753	0.1707	0.174	0.1697	0.1654
303	0.1433	0.1671	0.1694	0.1671	0.174	0.1697	0.1654
304	0.1375	0.1625	0.1586	0.1625	0.174	0.1697	0.1654
305	0.1352	0.1711	0.1702	0.1711	0.174	0.1697	0.1654
306	0.1431	0.1668	0.1691	0.1668	0.174	0.1697	0.1654
307	0.1293	0.1744	0.1774	0.1744	0.174	0.1697	0.1654
308	0.123	0.1714	0.1741	0.1714	0.174	0.1697	0.1654
309	0.1425	0.1739	0.1789	0.1739	0.174	0.1697	0.1654
310	0.1282	0.1688	0.1694	0.1688	0.174	0.1697	0.1654
311	0.1313	0.1747	0.1757	0.1747	0.174	0.1697	0.1654
312	0.1262	0.1534	0.158	0.1534	0.174	0.1697	0.1654

313	0.152	0.1679	0.1684	0.1679	0.174	0.1697	0.1654
314	0.1303	0.1575	0.1626	0.1575	0.174	0.1697	0.1654
315	0.1364	0.1662	0.1683	0.1662	0.174	0.1697	0.1654
316	0.1335	0.1746	0.1872	0.1746	0.174	0.1697	0.1654
317	0.1364	0.1638	0.1733	0.1638	0.174	0.1697	0.1654
318	0.1337	0.1618	0.1618	0.1618	0.174	0.1697	0.1654
319	0.1403	0.1701	0.1726	0.1701	0.174	0.1697	0.1654
320	0.1329	0.1585	0.1617	0.1585	0.174	0.1697	0.1654
321	0.1299	0.1649	0.1726	0.1649	0.174	0.1697	0.1654
322	0.1238	0.1586	0.1619	0.1586	0.174	0.1697	0.1654
323	0.1295	0.1688	0.175	0.1688	0.174	0.1697	0.1654
324	0.1372	0.1608	0.1586	0.1608	0.174	0.1697	0.1654
325	0.136	0.1658	0.1678	0.1658	0.174	0.1697	0.1654
326	0.1262	0.1608	0.1604	0.1608	0.174	0.1697	0.1654
327	0.1277	0.1669	0.169	0.1669	0.174	0.1697	0.1654
328	0.1241	0.1697	0.1796	0.1697	0.174	0.1697	0.1654
329	0.1412	0.1667	0.1708	0.1667	0.174	0.1697	0.1654
330	0.1278	0.1703	0.1767	0.1703	0.174	0.1697	0.1654
331	0.1285	0.174	0.1845	0.174	0.174	0.1697	0.1654
332	0.1368	0.1623	0.166	0.1623	0.174	0.1697	0.1654
333	0.1425	0.1705	0.1712	0.1705	0.174	0.1697	0.1654
334	0.1409	0.163	0.1628	0.163	0.174	0.1697	0.1654
335	0.1287	0.1743	0.1847	0.1743	0.174	0.1697	0.1654
336	0.1251	0.1645	0.1702	0.1645	0.174	0.1697	0.1654
337	0.1407	0.1647	0.1705	0.1647	0.174	0.1697	0.1654
338	0.1293	0.1744	0.1774	0.1744	0.174	0.1697	0.1654
339	0.1358	0.1675	0.1754	0.1675	0.174	0.1697	0.1654
340	0.1303	0.1634	0.1652	0.1634	0.174	0.1697	0.1654
341	0.1348	0.1587	0.16	0.1587	0.174	0.1697	0.1654
342	0.1423	0.1723	0.1788	0.1723	0.174	0.1697	0.1654
343	0.134	0.1714	0.1722	0.1714	0.174	0.1697	0.1654
344	0.1247	0.166	0.1775	0.166	0.174	0.1697	0.1654
345	0.1339	0.1687	0.1769	0.1687	0.174	0.1697	0.1654
346	0.1264	0.1669	0.1634	0.1669	0.174	0.1697	0.1654
347	0.1295	0.1747	0.1777	0.1747	0.174	0.1697	0.1654
348	0.1319	0.171	0.1736	0.171	0.174	0.1697	0.1654
349	0.1231	0.1772	0.1768	0.1772	0.174	0.1697	0.1654
350	0.1255	0.163	0.1628	0.163	0.174	0.1697	0.1654
351	0.1327	0.1641	0.1641	0.1641	0.174	0.1697	0.1654
352	0.1377	0.1736	0.1764	0.1736	0.174	0.1697	0.1654
353	0.1337	0.1545	0.1517	0.1545	0.174	0.1697	0.1654
354	0.1347	0.1677	0.1701	0.1677	0.174	0.1697	0.1654
355	0.1308	0.1726	0.168	0.1726	0.174	0.1697	0.1654
356	0.1363	0.1753	0.1784	0.1753	0.174	0.1697	0.1654
357	0.134	0.1655	0.1695	0.1655	0.174	0.1697	0.1654

358	0.1349	0.1601	0.1598	0.1601	0.174	0.1697	0.1654
359	0.124	0.1647	0.1648	0.1647	0.174	0.1697	0.1654
360	0.1293	0.1686	0.1747	0.1686	0.174	0.1697	0.1654
361	0.1258	0.1588	0.1602	0.1588	0.174	0.1697	0.1654
362	0.1256	0.1679	0.1703	0.1679	0.174	0.1697	0.1654
363	0.1291	0.1742	0.1771	0.1742	0.174	0.1697	0.1654
364	0.1362	0.1601	0.1654	0.1601	0.174	0.1697	0.1654
365	0.1325	0.1638	0.1638	0.1638	0.174	0.1697	0.1654
366	0.1336	0.1709	0.1717	0.1709	0.174	0.1697	0.1654
Total	**48.9193**	**62.1263**	**62.945**	**62.1263**			
Average	**0.1337**	**0.1697**	**0.172**	**0.1697**			

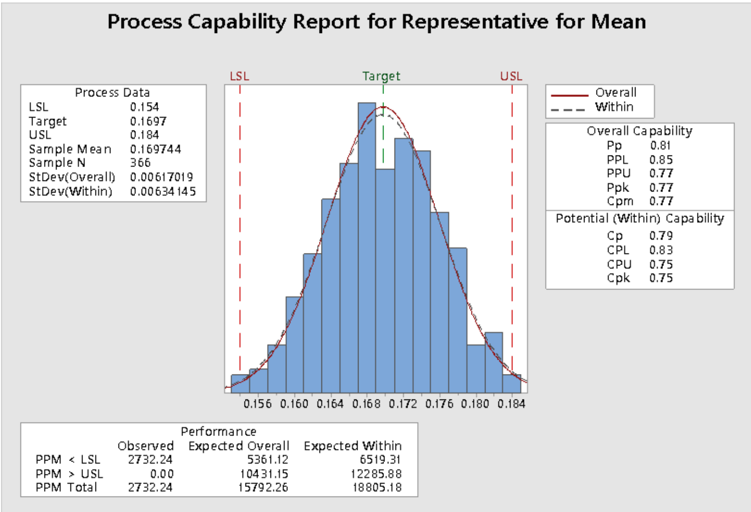

Figure 7.2 Fuzzy Membership Approach Control Charts

VIII. CONCLUSION

Air pollution can cause health problems that include burning eyes and nose, itchy irritated throat, and breathing problems. Some chemicals found in polluted air can cause cancer, birth defects, brain and nerve damage, and long-term injury to the lungs and breathing passages in certain circumstances. Air pollution can also damage the environment and property. Trees, lakes, and animals have been harmed by air pollution. Air pollution has thinned the protective ozone layer above the Earth. Therefore, the control of air quality is very important. In this present study, traditional and fuzzy probabilistic approaches for quality evaluation have been applied to control air pollution. The performance of the fuzzy probabilistic and membership approach control charts depend on assessing the degree of human feeling when the membership functions are reflecting people's complete and definite thought on the linguistic variables. The most important of air pollution causes are analysed by aid of fuzzy membership approach control chart analysis.

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