Chapter 4

Research Methods and Process.

In this chapter, comprehensive research methods and process adopted is presented. The data collection and analysis methods are described in the sections. The main goal of this chapter is to provide a clear structure to those researchers evaluating the survey instrument for the use of statistical, neuro-fuzzy, and genetic approaches. This chapter begins with the research design that presents the sampling design, demographic information of respondents and the structure of survey instrument includes the development of measurement scale and questionnaire items are described. Further, the data analysis process of validity and reliability of measurement done on the basis of statistical, Neuro-Fuzzy, Genetic algorithms approaches adopted in this research are also explained.

4.1 RESEARCH METHODOLOGY

This study was designed to investigate the GSD teams’ partnership quality and service climate aspects with relate to GSD project outcome. The investigation of GSD project outcome satisfies the following research criteria: it aims to address the research question “how does a partnership quality, service climate aspect create a significant impact on the GSD project outcome in the real-life context?” The research methodology mostly relies on researcher’s paradigm. A combination of qualitative and quantitative approach is used in this research to understand the partnership quality factors and service climate aspects affecting the outcome of GSD projects.

The research methodology includes literature survey followed by data collection and analysis through qualitative approach. Strauss and Corbin (1998) define qualitative research as any type of research that produces findings not arrived at by statistical procedures or other means of quantification. Consequently, quantitative research focuses on collecting numerical data and generalizing it across groups of people. In this quantitative research, researchers have clearly stated the research question to which objective answers are required and all aspects are carefully and exactly designed before the data collection process was carried out. Based on this
context this research adopted the data analysis and collection method through a combination of qualitative and quantitative approaches. Moreover the case study method is widely used and observed for the greater use in qualitative techniques offers various approaches in data analysis and collection. Subsequently, this research is based on case study method which includes (i) within-case analysis (analyze each approach separately) and (ii) cross-case analysis (results from multiple approaches addressing the research question).

4.1.1 DATA COLLECTION AND ANALYSIS THE POPULATION

Data was collected from various primary data sources, which includes: (i) web based survey (ii) interviews (iii) E-mail and (iv) telephone conversation. The web based online survey tool was mainly used for collecting the majority of data and ensured that all the measurement items were answered by respondents. In this research, web-based online survey was adopted due to various reasons. The web based surveys have offered valid and reliable survey method for typical survey questionnaires and it has been proven in earlier studies (e.g. Vehovar et al. 2002; Dillman 2000). Additionally, using a quantitative approach and using a survey that has been used in multiple industries can help in applying the findings to other organizations and related industries (Creswell, 2012).

Apart from the web based survey 1050 e-mails and 250 copies of the survey forms were sent to the software experts over a period of two years. The target populations for this research were executive committee, solution development team, and solution delivery team in the southern Indian region of an Indian software industry. This area covers the following cities: (a) Chennai (b) Bengaluru (c) Hyderabad (d) Trivandrum (e) Visakhapatnam (f) Coimbatore and (g) Madurai. The southern Indian region was selected because the office can also assist in developing a questionnaire and in administering the surveys of the teams. A majority of 450 experts (34.6%) had responded. Out of these 112 were not willing to participate because they did not have enough experience on GSD projects. So we had 338 responses (response rate: 26.1%) for analyzing the GSD teams’ partnership quality and service climate aspects in relation to GSD project outcome. The distribution of the responses from target
respondents by company wise with details of their professional affiliations are shown in Table 4.1 and Table 4.2

<table>
<thead>
<tr>
<th>Measure</th>
<th>Items</th>
<th>Frequency</th>
<th>Cumulative Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admin</td>
<td>16</td>
<td>4.7%</td>
<td></td>
</tr>
<tr>
<td>Analyst</td>
<td>17</td>
<td>5.0%</td>
<td></td>
</tr>
<tr>
<td>Assistant Software Engineer</td>
<td>09</td>
<td>2.6%</td>
<td></td>
</tr>
<tr>
<td>Associate Engineer</td>
<td>10</td>
<td>2.9%</td>
<td></td>
</tr>
<tr>
<td>Consultant</td>
<td>17</td>
<td>5.0%</td>
<td></td>
</tr>
<tr>
<td>Deputy Manager</td>
<td>10</td>
<td>2.0%</td>
<td></td>
</tr>
<tr>
<td>Lead Engineer</td>
<td>19</td>
<td>5.6%</td>
<td></td>
</tr>
<tr>
<td>Project Manager</td>
<td>45</td>
<td>13.3%</td>
<td></td>
</tr>
<tr>
<td>Software Engineer</td>
<td>88</td>
<td>26.0%</td>
<td></td>
</tr>
<tr>
<td>Senior Software Engineer</td>
<td>55</td>
<td>16.2%</td>
<td></td>
</tr>
<tr>
<td>Team Leader</td>
<td>18</td>
<td>5.3%</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>34</td>
<td>10.0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>338</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td><strong>Member History</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 1 year</td>
<td>41</td>
<td>12.1%</td>
<td></td>
</tr>
<tr>
<td>Between 1 to 5 years</td>
<td>189</td>
<td>55.9%</td>
<td></td>
</tr>
<tr>
<td>More than 5 years</td>
<td>108</td>
<td>32.0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>338</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

**Table 4.1: Demographic Details of the Respondents**

4.1.2 CONDUCT SURVEY QUESTIONNAIRES

In this research, this study refines this goal into a set of questions, and set metrics must provide the information to answer these questions. This research was an empirical study where in the data were collected by using standard questionnaires based on literatures listed in Appendix-A. To test the research model and hypotheses, an empirical field study was made on the offshore software development, maintenance project at Indian software companies. The members of offshore and on-site teams were asked to share their experience which contributed a lot to this survey.

The questionnaire used in this study consists of two parts: The first page of the survey instrument describes the objective of this empirical study and demographic details of the respondents and offshore/on-site project experience and designation. The second part was GSD project related information which contains 40 questionnaires to study GSD teams’ exchange relationship/service climate aspects on GSD project outcome. The empirical study ensures the confidentiality of their responses.
The demographic details of respondents are listed in Table 4.1. The survey instrument consists of 40 items related to measuring respondents’ partnership quality towards the outcome of the GSD project from the service provider perspective. We measured each of the constructs with reference to a 5-point Likert’s scale (1 = strongly disagree to 5 = strongly agree) in the form of survey questionnaires. The data has been collected and investigated on the basis of OB research on GSD teams i.e., partnership quality and service climate aspects in the context of GSD project outcome relationship. The definitions and sources of the measurement indicators used in this research were based on previous studies and are summarized in Chapter 2 and Table 2.1. The measurement items are shown in Appendix-A and Fig 4.1.

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Targeted Respondents</th>
<th>No.of Responses Received</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accenture</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td>CTS</td>
<td>60</td>
<td>37</td>
</tr>
<tr>
<td>HCL</td>
<td>80</td>
<td>59</td>
</tr>
<tr>
<td>IBM</td>
<td>30</td>
<td>11</td>
</tr>
<tr>
<td>LogicaPvt Ltd</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>Patni Computer</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td>Samsung</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>TCS</td>
<td>70</td>
<td>43</td>
</tr>
<tr>
<td>Wipro</td>
<td>50</td>
<td>16</td>
</tr>
<tr>
<td>Inowits</td>
<td>200</td>
<td>138</td>
</tr>
<tr>
<td>Total</td>
<td><strong>580</strong></td>
<td><strong>338</strong></td>
</tr>
</tbody>
</table>

**Table 4.2: Structure of the Target Population**

4.2 DATA ANALYSIS PROCESS AND SURVEY INSTRUMENT

The statistical approach of data analysis (two-step approach) suggested by Anderson and Gerbing (1998) has been adopted in this research: 1. Analysis of measurement model and 2. Analysis of structural model (discussed in Chapter 3 and Section 3.6). The main aim of using two-step approach is to evaluate reliability, validity of the measures and to test the structural relationship among the latent constructs. Data from 338 respondents were analyzed using Smart-PLS version 2.0. Descriptive statistical analysis was used to describe respondents’ demographic characteristics and to evaluate partnership quality of GSD teams’ from the service provider perceptions. Exploration of the underlying structure of the data was performed on the 38 items included in the questionnaire through exploratory factor
analysis. The data analysis processes of statistical approach (refer chapter 3) and neural-fuzzy and genetic approaches are elaborated in chapter 5, 6, 7 and 8.

This study captures the GSD teams’ partnership quality influential factors through existing literature reviews. From this, we have classified the eleven main factors that include knowledge sharing, trust, team commitment, knowledge transfer, social interaction, interpersonal trust, organizational commitment, absorptive capacity, arduous relationship, shared understanding, and GSD project outcome. From these factors, 38 influential factors have been derived towards the outcome/success of the GSD project from a service provider perspective.

The hierarchical structure of determining the GSD teams’ partnership quality and service climate aspects towards a GSD project outcome is shown in Fig 4.1. Each question in the survey instrument pertaining to the factors under study, have been designed carefully to get the responses from respondents that can pragmatically evaluate that factor. The objective is to empirically investigate the responses from the sample to reveal GSD teams’ partnership quality and service climate towards the outcome of GSD projects. The details of measuring partnership quality and service climate factors in the survey instrument are summarized as follows:

a. Knowledge sharing (C1). C11: clear vision to solve their professional problems towards the GSD project outcome; C12: clear objective to initiate the project in GSD environment; C13: motivation to share knowledge among team members; C14: specialty and knowledge creation ability among teams (Tsung-Han Chang and Tien-Chin Wang 2009; Kankanhalli et al. 2005; Chiu et al. 2006).

b. Trust (C2). C21: team members understanding their roles in GSD project; C22: understanding the project requirements; C23: flexibility and beneficial decisions among teams C24: team members' ability to provide assistance to teams (Tsung-Han Chang and Tien-Chin Wang 2009; Buckman 1999; Chiu et al. 2006; Child 2001).

c. Team commitment (C3). C31: feeling of togetherness or closeness among team members C32: mutual coordination among team members; C33: persistent, conscientious responsiveness towards the project outcome; C34: establishing
pertinent information towards the project outcome (Tsung-Han Chang and Tien-Chin Wang 2009; Chiu et al. 2006; Shim et al. 2010; Kwan-Sik et al. 2007; Edward Shih-Tse et al. 2012).

**Figure 4.1:** The Hierarchal Structure of the Determinants

*d. Knowledge transfer (C₄).* C₄₁: knowledge incentive towards client business process and project outcome; C₄₂: evaluation of project requirements; C₄₃: participation, acceptance and learning incentive of innovative technology; C₄₄: build up a pilot knowledge between teams; C₄₅: learning, and sharing the work materials of employees (Tsung-Han Chang and Tien-Chin Wang 2009; Ko et al. 2005; Markus Westner, Susanne Strahringer 2010; Brain D.Janz and Pattarawan prasarnphanich 2003)

*e. Social interaction (C₅).* Three influential factors are included in this aspect. They are: C₅₁: social relationship in GSD environment; C₅₂: invigorate sharing
knowledge among teams; C_53: participation in helping each other (Chiu et al. 2006; Edward Shih-Tse et al. 2012; Adler and Kwon 2002).

**f. Interpersonal trust (C_6).** C_61: evenhanded in negotiations among team members; C_62: faith and interest of employees C_63: trust relationship among teams (Zaheer et al. 1998; Child 2001; Bishop et al. 2000)

**g. Organizational commitment (C_7).** C_71: personal attachment and support towards organization; C_72: employee attitude and recognition towards organization; C_73: brainstorming actions for organizations (Bishop et al. 2000; Meyer and Allen 1993; Szulanski 1996; Edward Shih-Tse et al. 2012).

**h. Absorptive capacity (C_8).** C_81: capacity to absorb technical knowledge; C_82: capacity to absorb business knowledge; C_83: participation and support to solve issues; C_84: understanding the goals, task, and responsibilities over the client’s business process (Szulanski 1996; Ko et al. 2005; Gerwin and Moffat 1997).

**i. Arduous relationship (C_9).** C_91: arduous relationship among team members; C_92: participation and communication relationship; C_93: cooperation towards project outcome (Szulanski 1996; Ko et al. 2005; Gerwin and Moffat 1997; Tsung-Han Chang and Tien-Chin Wang 2009).

**j. Shared understanding (C_10).** C_101: understand the process with respect to the implementation; C_102: mutual understanding towards the process; C_103: explicit and standard communication pattern in the GSD environment (Ko et al. 2005; Tsung-Han Chang and Tien-Chin Wang 2009; Gerwin and Moffat 1997).

**k. GSD project outcome (C_11).** C_111: evaluating the project quality with respect to the service. C_112: assessment project time and schedule; C_113: cost improvement for establishing the client’s business process; C_114: project functionality towards client’s business process (Grover and Cheon 1996; Markus Westner, Susanne Strahringer 2010; Erickson et al. 2006; Tomi Dahlberg et al. 2006; Lahiri et al. 2012).
4.3 NEURO-FUZZY APPROACHES FOR DATA ANALYSIS

The data analysis processes of statistical approach have elaborated in Chapter 3 and Section 3.6. The purpose of this section the data analysis process of neuro-fuzzy and genetic approaches adopted in this research have been discussed in the following sections.

4.3.1 CALCULATION OF TRIANGULAR FUZZY NUMBERS FROM LIKERT SCALE VALUES

This section will discuss the conversion of likert scales values into the triangular fuzzy numbers. Suppose S is a set of ordered natural linguistic label which is consists of odd elements k. The linguistic labels in this research are Strongly Agree = 5; Agree= 4; Fair= 3; Disagree= 2; Strongly Disagree= 1. Let S = s₀, s₁, s₂………, sₖ₋₁ and the triangular fuzzy expression of linguistic variable is denoted as

\[ s_t = (s_t^l, s_t^m, s_t^u), \]

where \( s_t^l \) being the lower bound value, \( s_t^m \) being the upper bound value and \( s_t^u \) being the upper bound value for the likert scale value given for the respondents. The membership functions are derived through conversion of likert scale values into TFN. The membership functions are as follows:-

\[ s_0^l = 0; \]
\[ s_i^l = \frac{i-1}{k-1} (1 \leq i \leq k - 1) \]
\[ s_i^m = \frac{i}{k-1} (0 \leq i \leq k - 1) \]
\[ s_i^u = \frac{i+1}{k-1} (0 \leq i \leq k - 2) \]
\[ s_{k-1}^u = 1 \]

With use of above membership functions we have been able to convert likert scale value in the range of 1 to 5 to triangular fuzzy numbers (i.e., 0 to 1). The membership function and their respective TFN are given in Chapter 5 and Section 5.3.1. The calculation of weight of the attributes and aspects in FMCDM-GA is given below

1. **For calculation weight of the attributes**
   (a) Construct fuzzy decision matrix.
   (b) Determine the weighted normalized fuzzy decision matrix.
(c) Determine the ideal positive and ideal negative solutions.
(d) Calculate the distance of each alternative.
(e) Rank the preference order.

2. *For calculation the weights of aspects*

(a) The upper bound values will be squared and added. Then we will take under root. Then each individually added lower bound value will be divided by the above one.
(b) Multiply each of the bounds with attributes weights already calculated.
(c) These will be triangular fuzzy numbers of weights.
(d) Make rank calculation and weights likewise.

4.3.2 **CONVERSION OF TRIANGULAR FUZZY NUMBERS INTO NORMALIZED TRIANGULAR FUZZY NUMBERS**

1. Construction of evaluation matrix $Y$ for degree of importance calculation of the attributes and aspects ($D_i$, $i=1, 2, 3...n$). The respondents of the questionnaire are asked to provide their linguistic opinions about importance of each attribute.

$$
\begin{bmatrix}
y_1^1 & y_2^1 & y_3^1 & \cdots & \cdots & y_n^1 \\
y_1^2 & y_2^2 & y_3^2 & \cdots & \cdots & y_n^2 \\
y_1^3 & y_2^3 & y_3^3 & \cdots & \cdots & y_n^3 \\
\vdots & \vdots & \vdots & \cdots & \cdots & \vdots \\
y_1^k & y_2^k & y_3^k & \cdots & \cdots & y_n^k \\
\end{bmatrix} = Y, \ i=1, 2, 3...n \ ; \ j=1, 2, 3\ldots\ldots k \quad (1)
$$

$R_1, \ R_2, \ R_3, \ldots \ldots R_k$ (where $k=1$ to $100$)

(These 100 respondents are selected after the min-max normalization of 338 responses) Where ‘$n$’ denotes number of evaluation values and ‘$k$’ is the evaluation factor $y_j^i = (y_{ij}^l, y_{ij}^m, y_{ij}^u)$. Where $y_j^i$: indicates the fuzzy performance values of $j^{th}$ evaluation factor

2. The subjective judgments of each respondent differ from others based on their experience and knowledge, this study employs linguistic scale values with corresponding triangular fuzzy number to incorporate the fuzzy performance values of $m$ respondents to match the perceptions of individuals. For calculating Normalized
Fuzzy Triangular number we are using formulae for measuring the upper, middle, and lower value.

a. For calculating the lower value $b_{it}^l$ of normalized triangular fuzzy number

$$y_{ij}^l / \sqrt{\sum_{i=0}^{k} (y_{ij}^l)^2} = b_{it}^l$$

Here $y_{ij}^l$ is lower bound value of the triangular fuzzy number and $y_{ij}^u$ is upper bound value of triangular fuzzy number.

b. Similarly for calculating the Middle value $b_{it}^m$ of normalized triangular fuzzy number

$$y_{ij}^m / \sqrt{\sum_{i=0}^{k} (y_{ij}^m)^2} = b_{it}^m$$

Where $y_{ij}^m$ is the middle bound value of triangular fuzzy number.

c. For calculating the Upper value $b_{it}^u$ of normalized triangular fuzzy number

$$y_{ij}^u / \sqrt{\sum_{i=0}^{k} (y_{ij}^l)^2} = b_{it}^u$$

Where $y_{ij}^u$ is the lower bound value of triangular fuzzy number and $y_{ij}^l$ is upper bound value of triangular fuzzy number.

So finally we will get Normalized Fuzzy triangular number for each of the attributes denoted by $(b_{it}^l,b_{it}^m,b_{it}^u)$

3. Calculation of aspect value with the help of normalized triangular fuzzy numbers calculated in step-2. To obtain the aspect value we multiply $W_{ij}^{at}$ with the normalized triangular fuzzy number of each of the attributes and add them.

$$C_j = \sum_{i=0}^{k} (W_{ij}^{at} b_{it}^l, W_{ij}^{at} b_{it}^m, W_{ij}^{at} b_{it}^u)$$

Where $W_{ij}^{at}$ denotes the weights of attributes with respect to the aspect.

$$\sum_{i=0}^{n} W_{ij}^{at} = 1$$

And then using $C_j$ we can calculate the weight of aspects using genetic algorithm.
4. The value $C_j$ calculated in the previous step is used to calculate the performance value $\theta$

$$\theta = \sum_{i=0}^{s} (W_j^o C_{il}, W_j^o C_{im}, W_j^o C_{iu})$$

(7)

Where $W_j^o$, denotes the weights of aspects $C_j$ with respect to objective and

$$\sum_{i=0}^{n} W_j^o = 1$$

(8)

The Global weight $W_j^g$ for the objective can be calculated as

$$W_j^g = \frac{W_j^o W_{ij}^at}{\sum_{i=0}^{s} W_j^o \sum_{i=0}^{n} W_{ij}^at}$$

(9)

4.3.3 STEPS FOR RANK CALCULATION

In this section, the steps involved in the calculation of attributes and the attributes which should be selected as the most fit chromosome is explained. It further describes those attributes that should proceed further with the calculation of weight of attributes and in turn those aspects of the above point for the conversion of triangular fuzzy number into the normalized number.

1. Fuzzy Ideal Solution

The Fuzzy Positive Ideal Solution (FPIS) which has the best evaluation value with respect to each criterion is determined as follows:-

$$A^+ = [y_1^+, y_2^+, \ldots, y_n^+] \text{ where } y_j^+ = \max_{i=1,\ldots,k}(y_{ij})$$

(1)

$$= (\max_{i=1,\ldots,k}(y_{ij}^1), \max_{i=1,\ldots,k}(y_{ij}^m),\max_{i=1,\ldots,k}(y_{ij}^n)) \text{ where } j=1,\ldots,n \text{ (n=no of attributes here total number of attributes is 25).}$$

To calculate Fuzzy Negative Ideal Solution which will be the calculation of minimum lower, middle and upper bound value among the whole 25 attribute chromosome.

The Fuzzy Negative Ideal Solution (FNIS) which has the worst evaluation value respective to each criterion is determined as follows:-

$$A^- = [y_1^-, y_2^-, \ldots, y_n^-] \text{ where } y_j^- = \min_{i=1,\ldots,k}(y_{ij})$$

(2)

$$= (\min_{i=1,\ldots,k}(y_{ij}^1), \min_{i=1,\ldots,k}(y_{ij}^m),\min_{i=1,\ldots,k}(y_{ij}^n)) \text{ where } j=1,\ldots,n$$
2. Distance to Fuzzy Ideal Solution

Let \( a = (a_l, a_m, a_u) \) and this is the value obtained through the above step 1, and \( b = (b_l, b_m, b_u) \) and this will be the value we take for each individual attribute in the 25 attribute of most fit chromosome. The distance between \( a \) and \( b \) can be calculated by using the vertex method:

\[
d(a, b) = \sqrt{\frac{1}{3} (a^l - b^l)^2 + (a^m - b^m)^2 + (a^u - b^u)^2}
\]

(3)

Then, the distance from each alternative to FPIS and FNIS can be respectively derived through eqn. 4 and 5

\[
d_i^+ = \sum^n_{j=1} (x_{ij}, x_i^+) \quad \text{where } j=1..., k
\]

(4)

\[
d_i^- = \sum^n_{j=1} (x_{ij}, x_i^-) \quad \text{where } j=1,……,k
\]

(5)

3. Closeness Coefficient

The rank \( R_i \) is calculated through closeness coefficient. The above step 2 is will be further used to calculate these ranks. Closeness coefficient of each alternative is used to determine the ranking of all alternatives. The higher value of closeness coefficient indicates that corresponding alternative is closer to FPIS and further from FNIS simultaneously (Mahdavi et al. 2008)

\[
R_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad \text{where } i=1..., k
\]

(6)

Through the rank calculated for 25 attribute chromosome, the fittest one is taken and further it is applied in the calculation of steps for the conversion of triangular fuzzy number into normalized triangular fuzzy number. These are further used in the FMCDM and genetic algorithm to arrange the aspects according to their priority.

4.3.4 DATA PROCESSING IN ANFIS

ANFIS approach is combination of neural networks fuzzy mechanism. The Chapter 6 discusses FMCDM-GA approach for calculation of weights of the attributes. The neural network is designed with the help of weights and biases. Further, the weights obtained through FMCDM-GA will be useful for designing
ANFIS on the basis of Sugeno fuzzy inference system. The following section will elaborate the processing of data in ANFIS:

First, the input data is fed through sub clustering that will identify the cluster points. The following built-in MATLAB function denotes the calculation of boundaries via sub-clustering method.

\[
[C,S] = \text{subclust}(X,\text{radii},\text{xBounds},\text{options})
\]

The function returns the position of the cluster centers in the matrix \( C \). Here \( S \) denotes the vector which includes the same set of sigma values that specify the range in the influence of a cluster center with each of TSC dimensions. Moreover TSC attributes are clustered under three dimensions (i.e., Managerial practices, Service leadership, and global service climate). Clustering will help to determine the influence of these three input clusters (TSC attributes) on the output cluster which is team service climate aspect. In addition, the variable \( \text{radii} \) contain the value 0 to 1 that denotes cluster range of significance of TSC dimensions. Moreover, \( \text{xbounds} \) represents the matrix that describes how to map service climate attributes in ‘\( x \)’ into a TSC dimensions. Subtractive clustering which determines the rules automatically from the data set. The rules are extracted from the data using the fuzzy clustering which is equal to the number of clusters (Aziz et al. 2012). Through this process we can obtain the region of influence of each parameter is obtained.

\( (a) \) Designing of membership functions in ANFIS

This is further enhancement of the fuzzy values further obtained through FMCDM. The fuzzy numbers limits are thus obtained under lower bound, middle bound and upper bound values are used here for designing of the membership functions as shown in Table 4.3. The above example of Strongly Disagree is designed with Lower bound value = 0, middle bound value = 0 and upper bound value = 0.25. Here whenever a value less than ‘0’ and a value greater than ‘0.25’ will come they wouldn’t be lying in the plane decided for ‘Strongly Disagree’ as strongly disagree does not come in that range of :- 0 to 0.25. Whereas values which lie between these two limits are taken and divided by the constant difference we have which in this case is 0.25. This gives us the idea of how much does a prescribed value of strongly agree falls in the range.
For example when we have ‘0.1’ as the value we know that it is greater than ‘0’ and less than ‘0.25’, so we know the value it will take according to the above membership function is 0.5. This tells us that the value 0.1 is occupying 50% of the plane. In this thesis, framing these membership functions are a range in which can fit the values of linguistic expressions and how they will differ with their weights that needs to be analyzed.

(b) Rules formation:

The Fuzzy Inference System (FIS) editor which is defines the fuzzy values into an inference system. The membership function editor that displays and edits each of the membership functions with respective service climate attributes (input) and output variables (TSC) for the complete fuzzy inference system. There are many things under consideration while designing the fuzzy rules:

a. First, designing the membership function and their linguistic expression is based on lower, middle and upper bound values as shown in Table 4.3.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Membership Functions</th>
</tr>
</thead>
</table>
| Strongly Disagree ($u_{A_1(x)}$) | \[
\begin{align*}
0 & \quad x \leq 0 \\
(0.25 - x)/0.25 & \quad 0 \leq x \leq 0.25 \\
0 & \quad x \geq 0.25
\end{align*}
\] |
| Disagree ($u_{A_2(x)}$)       | \[
\begin{align*}
0 & \quad x \leq 0 \\
(x - 0)/0.25 & \quad 0 \leq x \leq 0.25 \\
(0.5 - x)/0.25 & \quad 0.25 \leq x \leq 0.5 \\
0 & \quad x \geq 0.5
\end{align*}
\] |
| Fair ($u_{A_3(x)}$)           | \[
\begin{align*}
0 & \quad x \leq 0.25 \\
(x - 0.25)/0.25 & \quad 0.25 \leq x \leq 0.5 \\
(0.75 - x)/0.25 & \quad 0.5 \leq x \leq 0.75 \\
0 & \quad x \geq 0.75
\end{align*}
\] |
| Agree ($u_{A_4(x)}$)           | \[
\begin{align*}
0 & \quad x \leq 0.5 \\
(x - 0.5)/0.25 & \quad 0.5 \leq x \leq 0.75 \\
(1 - x)/0.25 & \quad 0.75 \leq x \leq 1 \\
0 & \quad x \geq 1
\end{align*}
\] |
| Strongly Agree ($u_{A_5(x)}$)  | \[
\begin{align*}
0 & \quad x \leq 0.75 \\
(x - 0.75)/0.25 & \quad 0.75 \leq x \leq 1 \\
1 & \quad x = 1
\end{align*}
\] |

Table 4.3: Design of the Membership Functions
b. Second, the weights of the attributes is initially calculated through FMCDM-GA

c. The Team service climate aspect values is classified under ‘Managerial Practices, Global Leadership and Service Leadership dimensions

d. The list of values calculated for each attributes through FMCDM. This will form the basis of values is calculated through membership functions.

e. The respondent response is taken for each of the Team Service Climate Aspect and then the value of each rule is formulated. Then will multiply each membership functions values with their respective weights.

f. This will form the basis for how much region is under influence of that particular aspect. The weight of attributes to be considered with respect to degree of importance. The inference rules description given in Chapter-8.

4.4 RESEARCH DESIGN AND PROCESS

The research design and respective research process are shown in Fig 4.2. The first step in the research process involved a literature review that is relevant to GSD teams’ partnership quality towards a GSD project outcome. Based on the literature study, research framework was developed (step 2). Afterwards, the empirical study to collect data, analysis was performed. Data analysis was performed on the basis of statistical approaches, Fuzzy-genetic approaches and Neuro-fuzzy approaches (step 3)

Finally, the results from different approaches address the research question ‘How do partnership quality, service climate aspects create a significant impact on GSD project outcome?’ were presented and discussed in Step 4.

The results cover

(a) Theoretical framework that investigates the GSD teams’ partnership quality factors influencing the success of the GSD project outcome.

(b) Fuzzy-genetic and Neuro-fuzzy approaches to evaluate the team-level service climate and GSD project outcome relationship.
Figure 4.2: The Research Process and Research Design
4.5 SUMMARY

Chapter 4 presents the research methodology and explains the research process. Section 4.1 explains the research methodology which includes data collection process and details of the survey instrument. In addition it describes structure of target of population. The hierarchical structure of the determinants, data analysis process including statistical and neuro-fuzzy, and fuzzy genetic approaches was elaborated in section 4.2 and 4.3. Finally, the research design, research process, and outline of the thesis contribute towards the research questions are presented in section 4.4.