CHAPTER III

RESEARCH METHODS AND SURVEY DESIGN

This chapter is divided in four parts. Part one deals with the study area and the textile units selected for the purpose of the study. Second part presents the sample design adopted for the study. Part three gives details about the material such as construction of questionnaires, procedure of data collection, scoring and tabulation etc. Part four describes the hypothesis and statistical methods employed in the study for testing the hypothesis.

PART-I

STUDY AREA AND UNITS:

The study is concerned with some units selected from north India comprising Delhi, Haryana and Uttar Pradesh. Four units were selected: two from public sector (National Textile Corporation) and two from private sector. All the four units were matched for their size, technology, product and organisational structure. The licences of these units ensure almost similar regulations ensured by Ministry of Textile. All the units are quite old, i.e., more than three decades. In the selected units
Workers are organised under various banners of trade unit. Due to anonymity as a precondition of the permission to conduct the study in their units the names will not be cited. Big textile units, structurally and in terms of process of production, have six departments: spinning, weaving, seizing, dyeing, folding, and personnel and administration. In each department there were three levels of hierarchy among employees, i.e. Head of the department (Manager), Assistant Managers (Supervisory Cadre) and workers (floor level). Thus, the organisational structure is a mixture of tall-cum-flat typology (as depicted in figure-1).

The history of textile industry in India is quite old. Perhaps this is the first type of industry developed from all points of view in India. A large task force is involved in this industry. With the maturation of the industry, the problems of labour, change, receptivity to change, technological developments etc., come naturally before the management. Public sector innovation in textile in India is the result of crippling managements, strikes, lock-outs, losses and other hinderances. The private sector units survived only when they changed their management practices and production technology with the passage of time. Thus, textile industry in India offers an area to gauge and scan
### Table 3.1

<table>
<thead>
<tr>
<th>Deparments</th>
<th>Total</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: M'm, and W indicates Manager, Assistant Manager, and Worker respectively.

(N = 384)

Sampling Design: Frequencies of Respondents in Various Units at Different Hierarchy Levels
**Table 3-2**

**Sampling Characteristics (in Percentages)**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Sex</td>
<td>Male: 100</td>
<td>Female: Nil</td>
<td></td>
</tr>
<tr>
<td>3. Age</td>
<td>20 to 30 yrs.</td>
<td>33 to 45 yrs.</td>
<td>Above 45 yrs.</td>
</tr>
<tr>
<td></td>
<td>34.04</td>
<td>35.64</td>
<td>30.32</td>
</tr>
<tr>
<td>4. Experience</td>
<td>1 to 12 yrs.</td>
<td>13 to 25 yrs.</td>
<td>Above 25 yrs.</td>
</tr>
<tr>
<td>(Total)</td>
<td>39.36</td>
<td>35.64</td>
<td>25.00</td>
</tr>
<tr>
<td>5. Experience in present Org.</td>
<td>1 to 12 yrs.</td>
<td>13 to 25 yrs.</td>
<td>Above 25 yrs.</td>
</tr>
<tr>
<td></td>
<td>42.55</td>
<td>32.11</td>
<td>24.74</td>
</tr>
<tr>
<td>6. Experience in present position</td>
<td>Upto 10 yrs.</td>
<td>Above 10 yrs.</td>
<td>26.86</td>
</tr>
<tr>
<td>7. Marital status</td>
<td>Unmarried</td>
<td>Married</td>
<td>8.51</td>
</tr>
<tr>
<td>8. Educational Qualification</td>
<td>Illiterate</td>
<td>Upto Matric</td>
<td>Graduate</td>
</tr>
<tr>
<td></td>
<td>2.93</td>
<td>58.24</td>
<td>20.48</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.99</td>
<td>5.56</td>
</tr>
<tr>
<td></td>
<td>Engg.Dip. .80</td>
<td>LLB.</td>
<td>M.B.A.</td>
</tr>
<tr>
<td></td>
<td>13.80</td>
<td>83.86</td>
<td>1.04</td>
</tr>
<tr>
<td>10. Salary</td>
<td>Upto Rs.1000</td>
<td>Rs.1000</td>
<td>More than Rs.2000 p.m.</td>
</tr>
<tr>
<td></td>
<td>p.m.3.19</td>
<td></td>
<td>to Rs.2000 p.m.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>21.78</td>
</tr>
<tr>
<td>11. Shift</td>
<td>General Shift</td>
<td>Changeable Shift</td>
<td>51.60</td>
</tr>
</tbody>
</table>
PART-II

SAMPLE :

A total of 384 employees in four units was selected by stratified random sampling. However, for departmental heads it was fixed. Sampling design is given in table:3-1. From each unit 96 respondents were selected. Within each unit 6 managers, 30 assistant managers and 60 workers were selected. From all the 6 departments within each unit one departmental head, 5 assistant managers and 10 workers were selected from each department. The distribution of respondents in relation to various personal characteristics have been given in table:3-2.

The positionwise distribution of the sample was 6.25% of managers (24), 31.25% of assistant managers (120) and 62.5% of workers (240). The sampling fraction hierarchically was highly variable which was 1 in case of managers, about 3 in case of assistant managers and 0.12 in case of workers. All the respondents were male. The actual population of textile employees was highly sex biased and only a few female employees were there in personnel and administration branch of the units who, however, did not cooperate with us and information could not be elicited in respect of them. The age-wise distribution of workers was almost in equal percentage in
the first two age-groups. In younger age group (20 to 32 years) the percentage of respondents was 34.04 whereas it was 35.64 % in the middle age group (33 to 45 years). Among mature group (over 45 years) the percentage was 30.32 %. Owing to the age differences the number of respondents in different experience groups were 39.36 % (low experienced group) upto 12 years, 35.64 % in middle experience group of 13 to 25 years and 25% in high experience group of above 25 years experience. The percent frequencies of respondents in relation to experience in present organisation was 42.55 %, 32.71% and 24.74% in low, middle and high experience respectively. Positionwise 26.86 and 73.14 percent of the sample population possessed experience in their present position upto 10 years and above 10 years respectively.

The majority of the respondents (91.41 %) in the sample was married. The sample was highly heterogeneous for their educational qualifications. There were only 2.93% illiterates. Among the literates, 58.24% had attained the education upto Matric. About 24% were formal 'degree-holders. The remaining 15% , among managers and assistant managers, possessed various types of technical educations such as B.Text
degree (3.99%) and Diploma in Textile (5.56%). Among the respondents selected for sample 83.85% were confirmed and 13.8% were on probation on their jobs. In terms of salary their ranges were considered namely less than Rs. 1,000 per month, between Rs. 1,000 to Rs. 2,000 per month and above Rs. 2,000 per month. The percentage of employees falling in these groups were 3.19%, 75.53% and 21.75% respectively. It may be noted that in all the four units, three working shifts were in operation. Every employee is bound to work in any one shift alternatively. But managers, some assistant managers and employees of personnel and administration department work in day-shift only. The per-cent respondents in day shift (general shift) was 48.40% and remaining 51.60% in all the three changeables shifts.

PART-III

MATERIAL :

For conducting the survey, five detailed structured questionnaires were administered to the respondents. The details of the questionnaires are given below:

(i) **Personal Information Questionnaire** :

It was a nine item questionnaire designed to obtain information about the respondents in respect of
sex, age, position, educational qualification, marital status, salary, nature of appointment and experience. The item for experience was of a compound nature consisting of three sub-items namely total experience, total experience in present organisation and experience in the present position. To ask such questions from the respondents helped the researcher to establish close rapport with the former. The format of personal information questionnaire is given in appendix-I.

(ii) Assumptions About People at Work:

This questionnaire is defined to measure the assumptions about people and human nature at work. The questionnaire is defined by Kplb et al (197) based on the theory of work-motivation by Mc Gregor (1960). It contains ten pairs of statements. Within each pair, one statement is based on theory 'X' and other on theory 'Y'. The respondents were instructed to assign a total weight of ten to each statement of the pair to show the relative strength of assumptions in theory 'X' and theory 'Y'. They were specifically instructed that the points assigned for each pair must in each case be total of 10. The format is given in appendix-II.

(iii) Managerial Skill (Self Assessed) Questionnaire:

It was a ten item questionnaire. Each item deals with a quality desirable of a skilled manager such
as quickness, clarity, decision making capability, receiving the information and emitting the information, effective delegation etc. Each item could be responded with a bi-polar 5-point scale. The instructions to administer the scale are given on the top of the questionnaire. The scale was elected from Kolb et al (1971). The format is given in appendix-III.

(iv) Organisational Climate Questionnaire:

This questionnaire was a short version of organisational climate questionnaire prepared by Litwin and Stringer (1968). This questionnaire measures seven dimensions of organisational climate. These dimensions were: conformity, responsibility, standards, rewards, clarity, wants and support and leadership. Each dimension was clearly defined and described in the questionnaire. A bi-directional 10-point rating scale was used for each dimension separately. The rating for each dimension could be done to measure existing perceptions of organisational climate and ideal perceptions by making different symbols on the rating scale that is 'E' for the current position and 'I' for the ideal position. The questionnaire starts with few describing instructions to the respondents. The format of this questionnaire is given in appendix-IV.
(v) **Job-Satisfaction Questionnaire:**

A questionnaire constructed and standardized by Muthayya (1973), Director of Psychology, National Institute of Community Development, Hyderabad, was used to measure job satisfaction. This scale consisted of 34 items and which could be responded in four categories: Agree (A), Disagree (D), not sure (NS) and not applicable (NA). If the particular item is true for the respondent he was instructed to encircle A, if it was not true, he was instructed to encircle D. In the event of not being able to decide either way, he was asked to encircle NS. In case, any item was not applicable to him, he was to encircle NA. The instructions were already depicted on the top of the scale. For the present study, a few words were substituted in the original scale. In fact, the scale prepared by Muthayya for village level workers in blocks. Therefore, block was substituted by industry and village people by workers. The format is presented in appendix-V.

Besides these five questionnaires detailed above we also adopted efficiency Charts prepared by the units. All the selected units for the purpose of the study have a practice to record the efficiency index in percentage in their efficiency-register departmentwise. The
efficiency is calculated on the basis of output/input ratio multiplied by hundred and is recorded daily shiftwise. The index used is an average of one year for each unit. It may be pointed out that the efficiency recorded is from the charts and not from the published accounts. It is not the practice of these units to publish the efficiency in their annual reports.

Procedure of Data Collection:

The data were collected personally from four textile units situated at Bhiwani (Haryana), Delhi and Saharanpur (Uttar Pradesh) after obtaining the prior permission from the authorities of the units. Due to the nature of the enquiry personal visit was the only appropriate method of data collection. The respondents were resorted to with the help of pre-determined questionnaires mentioned earlier. Managers, assistant managers were mostly contacted in the offices and some at their residences also. Workers were contacted at work and in the trade union offices. Thus, the questionnaires were generally administered in the units inside or in trade union offices where workers were easily available. Two questionnaires relating to managerial skill and assumptions about people at work were got filled up from managers. Four questionnaires
were filled up by the assistant managers. The workers were required to fill up two questionnaires of organisational climate (existing and ideal) and job satisfaction. Data collection took about 120 days i.e., from March, 1986 to July, 1986.

**Scoring:**

Self assessed managerial skill score-ratings or 10-items were added. The maximum of this score could be 50. The scoring of assumptions about people was also done by adding the weights of the two i.e., the weight of X-statements and the weights for the Y-statements. A composite score was obtained by dividing the score of Y by score of X. This score was termed as Y/X ratio. When it is one, it indicates equal weights in X and Y assumptions about people at work. If more than one, the respondent believes in Y-approach (human relation-approach) where it was less than one it indicates of traditional profit oriented-approach. MS(SA) and assumption about people were also scored similarly from the assistant managers. In addition, three climate-score were obtained, the ratings for existing position were added which could be 70 maximum. Similarly, the ratings
of ideal portion were also summated the range of which could be 7 to 70. A third derivative was the difference between I and E conditions, which could be bi-directional, may be -63 or +63. However, it was always positive because to obtain D-score, E-score was subtracted from I-score, since I score was invariably greater than E-scores. In case of job satisfaction, the items for A, 7, NA, and NS were separately matched with the scoring-key. The agreement with the scoring key gets 2 marks, the disagreement in the key gets zero mark and NS get only one mark. Thus, the total score could be zero to 68 because total items were 34. The higher the score, the greater the dissatisfaction and lower the score the higher the job satisfaction. Similarly, all the three scores of organisational climate and the scores of job satisfaction were attained for workers.

Tabulation:

The attained raw scores for each respondent were tabulated. The relevant scores were shown against serial number of the respondent Sector/Unit/Departmentwise, in the tabulation.
Hypothesis:

Hypothesis refers to the assumption which is made about the sample before reaching the final result. It gives the direction for the whole project of the research. In our study, the hypothesis which has been adopted is given below:

Hypothesis adopted states that efficiency is the function of effectiveness. This also can be written in equation form as:

\[ \text{Efficiency} = f(\text{effectiveness}) \]

\[ \text{Effectiveness} = \text{Assumption about people at work} + \text{Self assessed managerial skill} + \text{Organisational climate (existing and ideal)} + \text{Job satisfaction} + K \]

Where, \( K \) = Constant due to many other factors.

The hypothesis can also be summarized in the following model:

<table>
<thead>
<tr>
<th>EFFECTIVENESS</th>
<th>EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>HUMAN FACTORS</td>
<td></td>
</tr>
<tr>
<td>Superiors-Subordinates Relationships.</td>
<td>Output/Input</td>
</tr>
<tr>
<td>Organisational (Existing Climate Ideal)</td>
<td></td>
</tr>
<tr>
<td>Job satisfaction</td>
<td></td>
</tr>
</tbody>
</table>
To test the hypothesis and to meet the objectives of the study, raw scores were treated with different kinds of analysis. For carrying out the analysis the different types of tests were used like t-test, \( x^2 \)-test, Fredman's two way analysis of variance (ANOVA), single factor one-way analysis of variance, two factor way analysis of variance. It may be clarified that the confidence level of probability to accept the hypothesis fixed for all tests was .05. multiple correlation and multiple regression were also used to see the aggregate relationship and association were also used to see the aggregate relationship and association of the effectiveness variables and efficiency. The following are the procedures, notations and formulae for the different tests:

**t-test**

The significance of differences between means was tested by t-test which is appropriate for two independent groups. The steps were:

1. \( n_1 \) and \( n_2 \).
2. \( \bar{x}_1 \) and \( \bar{x}_2 \).
3. \( \bar{x}_1^2 \) and \( \bar{x}_2^2 \)
4. \( \bar{x}_1 = \frac{\bar{x}_1}{n_1} \) and \( \bar{x}_2 = \frac{\bar{x}_2}{n_2} \)
5. \( SS_1 = \frac{x_1^2}{n_1} - (\bar{x}_1)^2 \) and \( SS_2 = \frac{x_2^2}{n_2} - (\bar{x}_2)^2 \)
6. \( t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\left(\frac{SS_1 + SS_2}{n_1-1}(\bar{x}_1 - \bar{x}_2)^2\right)}} \)
After obtaining $t$ and $df$, the standard tables can be referred to ascertain the probability.

The test was used to see the mean differences of various personal factors variably among managers of 2 age groups, 2 experience groups, 2 salary groups, 2 education groups. It was also used for mean differences in variably between 2 salary group among assistant managers. Thus there were five variables and in total 25 $t$-tests were worked out.

**$\chi^2$-test**:

After putting the observed frequencies in the contingency table the expected frequencies were derived by observed frequencies with the help of following formulae:

$$fe = \frac{\sum f \times \sum e}{\sum f}$$

Then in each cell the $\chi^2$ was obtained:

$$\chi^2 = \frac{(f_o - f_e)^2}{fe}$$

After obtaining $\chi^2$ for all cells, the values were summated. The df. was obtained by $(r-1)(c-1)$. In last, the $\chi^2$ and df. were referred to standard tables to ascertain the associated probability value.
The test was used to see the association between education and experience frequencies among assistant managers.

**Friedman's Two Way Anova:**

It is a non parametric test, which is subjected to scores of different categories, known as K and different rows known as N, i.e., all K belong to one N. The test was applied to see the significance of differences between % ER of 6 departments in four units. The procedure involves converting, first, raw scores into ranks within a row. Then, for each K category the Rs are summated. The steps were:

1. \( R = \text{the sum of ranks of N rows} \)
2. \( R_j^2 \)
3. \( \chi^2 Y = \frac{12}{NK(K+1)} \sum_{j=1}^{K} (R_j^2) - 3N(K+1) \)
4. \( df = K-1 \)

After obtaining \( \chi^2 \) and df, the standard chi-square distribution is referred to obtain associative probability value.

**Single Factor ANOVA(F):**

To test the significance of difference between more than two groups for variables, the F-test was used. However, the distribution of frequencies
in the study revealed unequal cases in groups, and therefore, required some modifications in the usual procedure. The test was used to assess the role of age, experience and education among assistant managers for five variables, separately and for age and experience among workers for three variables. Thus a total of 21 F-tests, suitable for unequal samples, were used.

The procedure was as follows:

1. \[ n_1 \quad n_2 \quad n_3 \]
2. \[ \sum x_1 \quad \sum x_2 \quad \sum x_3 \]
3. \[ \frac{\sum x_1^2}{n_1} \quad \frac{\sum x_2^2}{n_2} \quad \frac{\sum x_3^2}{n_3} \]

These figures yielded three notations as:

1. \[ G^2(n) = \frac{(\sum x_1 + \sum x_2 + \sum x_3)^2}{(n_1 + n_2 + n_3)} \]
2. \[ \sum \sum x_i^2 = (\sum x_1^2 + \sum x_2^2 + \sum x_3^2) \]
3. \[ \frac{\sum x_i^2}{n} = \frac{\sum x_1^2}{n_1} + \frac{\sum x_2^2}{n_2} + \frac{\sum x_3^2}{n_3} \]

These three notations lead to the summary given in the table.
### Table 3-3

#### Summary of Analysis of Variance (ANOVA)

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>(3) - (1) K-1</td>
<td>SSB/df_b</td>
<td>MS_b/MS_d</td>
<td></td>
</tr>
<tr>
<td>Within</td>
<td>(2) - (3) N-K</td>
<td>SS_w/df_w</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>(2) - (1) N-1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The obtained F value can be referred to table by numerator in the column side and denominator in the row side. Standard tables provide probabilities and associated F values. The obtained values must be equal or greater than the required value given in the table against appropriate degrees of freedom. If it exceeds the differences between the groups are granted. The means are used for interpretation and trend of relation between independents and dependent variables.

**Two Way ANOVA:**

In order to assess the role of two factors simultaneously on dependent variables, two way analysis of variance suitable for unequal cell frequencies was used (Winer, 1971). This analysis was applied for various variables or factors such as: effect of hierarchy and sector on Y/X assumptions, on managerial skill. Effect of sector and industry on existing organisational climate, d-score of ideal and existing
organisational climate, job satisfaction and efficiency.

The general procedure was as follows given in table 3.4

<table>
<thead>
<tr>
<th>A Two Way Contingency Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/A</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>$B$</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>$B_2$</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Then, sums of scores, their squares and within cell, sum of squares (SS) were computed as follows given in table 3.5.

<table>
<thead>
<tr>
<th>Sum of Scores and Their Squares</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/A</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>$B_1$</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>$B_2$</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Then, total within cell sum of squares was computed with the help of the following formulae:

$$SS\text{ within cell } = SS_{11} + SS_{12} + SS_{21} + SS_{22}$$

The harmonic means ($\bar{\eta}_h$) was calculated as:

$$\bar{\eta}_h = \frac{\bar{x}^2}{\frac{1}{\eta_{11}} + \frac{1}{\eta_{12}} + \frac{1}{\eta_{21}} + \frac{1}{\eta_{22}}}$$

Where $p$ = levels of A factor and $q$ = levels of B factor

Next step was to prepare 2-way contingency table of cell means as given below:

<table>
<thead>
<tr>
<th>B/A</th>
<th>A_1</th>
<th>A_2</th>
<th>$\Xi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>B_1</td>
<td>$\bar{x}_{11}$</td>
<td>$\bar{x}_{21}$</td>
<td>$\bar{x}<em>{11} + \bar{x}</em>{21}$</td>
</tr>
<tr>
<td>B_2</td>
<td>$\bar{x}_{12}$</td>
<td>$\bar{x}_{22}$</td>
<td>$\bar{x}<em>{12} + \bar{x}</em>{22}$</td>
</tr>
<tr>
<td>$\Xi$</td>
<td>$\bar{x}<em>{11} + \bar{x}</em>{12}$</td>
<td>$\bar{x}<em>{21} + \bar{x}</em>{22}$</td>
<td>$\bar{x}<em>{11} + \bar{x}</em>{12} + \bar{x}<em>{21} + \bar{x}</em>{22}$</td>
</tr>
</tbody>
</table>

After this the computation of five notations are required which are given below:

(1) $G^2_q = \frac{(\bar{x}_{11} + \bar{x}_{12} + \bar{x}_{21} + \bar{x}_{22})^2}{(n_p \times n_q)}$
The last step was to prepare summary table of ANOVA as given below:

<table>
<thead>
<tr>
<th></th>
<th>Source</th>
<th>SS</th>
<th>df.</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$\bar{x}_A (3-1)$</td>
<td>$p-1$</td>
<td>$SS/df$</td>
<td>$MS_A/MS_{\text{within}}$</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>$\bar{x}_B (4-1)$</td>
<td>$q-1$</td>
<td>''</td>
<td>$MS_B/MS_{\text{within}}$</td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>$\bar{x}_{AB} (5-3-4+1)$</td>
<td>$(p-1)(q-1)$</td>
<td>''</td>
<td>$MS_{AB}/MS_{\text{within}}$</td>
<td></td>
</tr>
<tr>
<td>within</td>
<td>From $SS\beta$</td>
<td>$N-p-2$</td>
<td>''</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After calculating F values for A, B and AB scores their significance can be tested in the table of F with their numerator and denominator, degrees of freedom. The obtained F value must be equal to or greater than the value required for respective degrees of freedom.

**Multiple Correlation and Regression:**

In order to obtain the predictive function of five predictors for efficiency in the organisation, a
multiple regression equation was considered fit for this purpose. In addition to having an account of joint correlation of $Y/X$ assumptions, managerial skill, OC(E), OC(D) and job satisfaction with $\%$ efficiency, the multiple correlation ($R$) was also computed. For comparing their relationship, it required six scores for each respondent. This was achieved by certain justified transformations. Firstly, managers were excluded in this analysis and $N$ was only 360. Managers, it may be recalled, undertook only two questionnaires. The scores stand for 360 respondents were as under:

(1) $\%$ efficiency ratio of department.
(2) Mean of $Y/X$ assumption scores of immediate superior.
(3) Mean of MS score of immediate superior.
(4) OC (E) score.
(5) OC (d) score.
(6) Job satisfaction score.

With this set of scores for 360 cases, the product moment correlation was computed between all possible pairings in variables by the following formula:

$$r_{xy} = \frac{\sum xy - \sum x \cdot \sum y}{\sqrt{\left[ \sum x^2 - \left( \sum x \right)^2 \right] \left[ \sum y^2 - \left( \sum y \right)^2 \right]}}$$
These obtained co-efficients are called zero order correlations. The number of such coefficients was 15 i.e. \(N(N-D/2)\). These are: \(r_{12}', r_{13}', r_{14}', r_{15'} \), \(r_{16}, r_{23}, r_{24}, r_{25}, r_{26}, r_{34}, r_{35}, r_{36}, r_{45} \), \(r_{46} \) & \(r_{56} \).

The next step was to calculate 1st order partial correlations by following formula utilizing input as zero order coefficients:

\[
r_{12.3} = \frac{r_{12} - r_{13} \times r_{23}}{\sqrt{(1 - r_{13}^2)(1 - r_{23}^2)}}
\]

Where \(r_{12.3}\) means the correlation between first and second variable by partialling out the affect of third variable. A total of 30 such first order coefficients were computed in different combinations. The List was as follow:

\(r_{12.3}, r_{14.3}, r_{15.3}, r_{16.3}, r_{23.1}, r_{24.1}, r_{25.1}, r_{26.1}, r_{34.1}, r_{35.1}, r_{36.2}, r_{45.2}, r_{46.2}, r_{56.2}, r_{24.3}, r_{25.3}, r_{26.3}, r_{13.2}, r_{14.2}, r_{16.2}, r_{34.2}, r_{35.2}, r_{45.3}, r_{46.3}, r_{56.3}, r_{36.1}, r_{45.1}, r_{46.1}, r_{56.1} \).

Then, 2nd order coefficients of correlation were computed with input as first order correlation coefficients such as:-
\[ r_{14.23} = \frac{r_{14.2} - r_{13.2} \times r_{34.2}}{\sqrt{(1 - r_{13.2}^2) \times (1 - r_{34.2}^2)}} \]

which means the correlation between 1st and 4th variable by partialling out the effect of 2nd and 3rd variables. A total of 30 such correlation coefficients were computed. These are given as follows:

\[ r_{14.23} \quad r_{56.23} \quad r_{46.13} \quad r_{36.24} \quad r_{25.34} \]
\[ r_{15.23} \quad r_{25.13} \quad r_{56.13} \quad r_{56.24} \quad r_{16.34} \]
\[ r_{16.23} \quad r_{45.13} \quad r_{13.24} \quad r_{16.24} \quad r_{26.34} \]
\[ r_{45.23} \quad r_{26.13} \quad r_{15.24} \quad r_{12.34} \quad r_{56.34} \]
\[ r_{46.23} \quad r_{24.13} \quad r_{35.24} \quad r_{15.34} \quad r_{34.12} \]
\[ r_{35.12} \]
\[ r_{36.12} \]
\[ r_{45.12} \]
\[ r_{46.12} \]
\[ r_{56.12} \]

Further, the 3rd order correlation coefficients were obtained taking the 2nd order coefficients of correlation as input for this step. The formula is:
\[ r_{12.345} = \frac{r_{12.34} - r_{15.34} \times r_{25.34}}{\sqrt{1 - r_{15.34}^2} \sqrt{1 - r_{25.34}^2}}. \]

Here \( r_{12.345} \) refers to the correlation coefficient between the 1st and 2nd variables partialling out the effect of 3rd, 4th, 5th variables. A total of 21 correlation coefficients were computed to serve the objective. These are listed as below:

\[
\begin{align*}
& r_{12.345}, \quad r_{35.124}, \quad r_{56.234}, \\
& r_{16.345}, \quad r_{14.235}, \quad r_{46.123}, \\
& r_{26.345}, \quad r_{16.235}, \quad r_{26.134}, \\
& r_{25.134}, \quad r_{46.235}, \quad r_{56.134}, \\
& r_{13.245}, \quad r_{45.123}, \quad r_{56.124}, \\
& r_{36.245}, \quad r_{15.234}, \quad r_{36.124}, \\
& r_{16.245}, \quad r_{16.234}, \quad r_{56.123}.
\end{align*}
\]

Lastly, the correlation coefficients were computed in the 4th order taking 3rd order correlation coefficients as inputs. The following formula was used.

\[ r_{12.3456} = \frac{r_{12.345} - r_{16.345} \times r_{26.345}}{\sqrt{1 - r_{16.345}^2} \sqrt{1 - r_{26.345}^2}}. \]

Here \( r_{12.3456} \) shows the correlation coefficient between the variable one's two keeping 3rd, 4th, 5th & 6th partialling
out 9 Coefficients of correlation of 4th order were calculated to feed the requirement of analysis. These were:

\[
\begin{align*}
    r_{26.1345} & \quad r_{36.1245} & \quad r_{46.1235} \\
    r_{16.2345} & \quad r_{56.1234} & \quad r_{15.2346} \\
    r_{13.2456} & \quad r_{14.2356}
\end{align*}
\]

The coefficient of standard deviation for each variable was computed with the help of following formula:

\[
\sigma = \sqrt{\frac{N(\overline{X}^2 - (\overline{X})^2)}{N}}
\]

Then the partial standard deviations were computed using the coeff. of S.D., and different order coefficient of correlation. The formula was as under:

\[
\sigma_{1.23456} = \sigma_1 \sqrt{1 - r_{12}^2} \sqrt{1 - r_{14.23}^2} \sqrt{1 - r_{13.2}^2} \sqrt{1 - r_{15.234}^2} \sqrt{1 - r_{16.2345}^2}
\]

Such as, 6 partial standard deviations were calculated. These were:

\[
\begin{align*}
    \sigma_{1.23456}, \quad \sigma_{2.13456}, \quad \sigma_{3.12456}, \\
    \sigma_{4.12356}, \quad \sigma_{5.12345}, \quad \sigma_{6.12345}
\end{align*}
\]

1.23456 means the partial std. Deviation which has been freed of the influence exempted upon its variability by variables 2, 3, 4, 5 and 6.
The next step was to calculate the partial regression coefficients. The General formula was:

\[ b_{12.3456} = r_{12.3456} \times \frac{\sigma_{1.23456}}{\sigma_{2.3456}} \]

Then the standard Error of Multiple Correlation Coefficients were computed with the help of following formula:

\[ \sigma_{b_{12.3456}} = \frac{\sigma_{1.23456}}{\sigma_{2.3456} \sqrt{N - m}} \]

Significance can be tested at .95 Confidence internal as

\[ b \pm Z \sigma_b \]

- The multiple Correlation: The Coefficient of MR are calculated by the formula:

\[ R_{1.23456} = \sqrt{1 - \frac{\sigma_{1.23456}^2}{\sigma_r^2}} \]

Significance of R will be seen by using:

\[ S.E. R = \frac{1 - R^2}{\sqrt{N - 5}} \]

and the confidence interval

\[ R \pm Z \times S.E. R \] (at .95 Confidence interval)

-Coefficient of Determination was also computed by taking the scare of R.
Coefficient of indetermination will be:

$$K = 1 - R^2.$$  

The percentage of variance analysis has been calculated by:

$$R^2 \times 100.$$