4 Setting of the Research Problem

This Chapter describes the research problem by first establishing the conceptual framework that will be used in this research. Leveraging the work done by previous authors as reviewed in Chapter 3, the purpose statement and objectives are conveyed and the research hypotheses as formulated. The Chapter concludes with reviewing the assumptions finally made for this study.

4.1 Conceptual Framework: Purpose Statement and Research Objectives

To state briefly, the research purpose is to determine the key variables in formulating a model for an effective recruitment and selection system for the IT Software Industry in India. In order to achieve this purpose, key research objectives were identified in section 1.3. Each research objective pertains to determining the key variables for an effective recruitment and selection system for the IT Software Companies in India. As stated, first has been a need to identify techniques that are employed in selection. Based on those techniques, key employee gauges like academic record, work experience etc. were identified as “Input Variables”. The attributes that companies consider essential for IT Software professionals were also identified and these also formed part of the input variables. The companies’ performance depends on its employee base without question and these performance indicators in the form of growth rate, profits and profit/revenue growth and net profit per employee are identified as “Output Variables”. Finally, using various statistical methods, an attempt has been made to determine the relationship between key company performance metrics to selection techniques, thereby obtaining key variables in an effective recruitment and selection system. The methodology used involves setting up Null and Alternate Hypotheses and testing those hypotheses using a multivariate analysis scheme.
Figure 4.1: Conceptual Model for Research.

4.2 Numerical Framework

A concept for research applied is a multifactor experiment involving varying some controllable factors in a prescribed manner to study their relationship with measurable output responses. The experiment also involves some uncontrollable factors which are dealt by blocking or randomization strategies so as to reduce their effect on the final output response relationship. The underlying assumption in a multifactor experiment is that the true mean of a response variable, $Y$ (average $Y_1$, $Y_2$, $Y_3$, ..., $Y_n$), is a function of the settings of the controllable factors ($X_1$, $X_2$, $X_3$, ..., $X_n$). Thus, at a given set of $X_i$ values, the function is:

$$
\mu_{Y|X} = f(X_1, X_2, ..., X_n)
$$

(4.1)

For most experiments, the actual form of the function in Equation 1 is unknown, and perhaps very complicated. Also the ability to observe and measure a response at a given set of $X_i$ values may be clouded by sources of bias and variation (including the impact of the uncontrollable factors). Therefore, each observed response value, $Y_i$, in an experiment is expressed as:
\[ Y = f(X_1, X_2, \ldots, X_n) + \varepsilon \]  \hspace{1cm} \text{.......................... 4.2}

where \( \varepsilon^* \) includes the contribution of random variation.

The mathematical form of the function in Equation 1 and 2 is usually unknown. However the experimental ranges of the factors are often limited, and a low order Taylor series (polynomial) approximation over the experimental region is adequate to meet the objectives. Depending on the number of terms in the expansion, the approximation can be labeled as first order (linear) and second order (quadratic) approximation. Thus, a first order or linear approximation is represented as:

\[ Y \approx \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \varepsilon \]  \hspace{1cm} \text{.......................... 4.3}

where \( \beta \) are the first order or linear main effects. This approximation is useful if \( \varepsilon \) represents predominantly random error. In cases where this is not the case, a second order or quadratic approximation is used which is described as:

\[ Y \approx \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \sum_{i=1}^{n} \beta_i^2 X_i^2 + \sum_{i=1, j>1}^{n \cdot n-1} \beta_{ij} X_i X_j + \varepsilon \]  \hspace{1cm} \text{.......................... 4.4}

where \( \beta \) are now referred to as the second order or quadratic main effects. The second order effects also include interaction effects represented by \( \beta_{ij} \) in Equation 4.

Thus, in a multifactor experiment like the one which will be employed in this thesis, the validity of results depends on the adequacy of the approximation of the unknown function. The approximation is done by assuming a function, comparing it against the measured response and estimating the error. This is done by using the method of least squares. An example of this method is as follows: Let \( y = a + bx \). For a data point \((x_i, y_i)\), compute \([y_i - (a + bx_i)]^2\). This represents the deviation of the data point from function \( y \). By summing all \( n \) squared deviations, we form the sum of squares for a given \( a, b \) value:
\[ SSE(a, b) = \sum_{i=1}^{n} (Y_i - \bar{Y})^2 = \sum_{i=1}^{n} (Y_i - (a + bX_i))^2 \] .......................... 4.5

**4.2.1 Analysis of Variance (ANOVA)**

A primary objective of fitting a regression model is to approximate the unknown true function that relates x and y. If there is a relationship, and if the fitted model is a useful approximation, then the fitted model should explain a large portion of the total variability in the observed y-values. The analysis of variance (ANOVA) is used in regression analysis to globally evaluate how well this objective has been met. The total sum of squares (SSE~SS\textsubscript{Total}) can be partitioned into two components,

\[ SS_{Total} = \sum_{i=1}^{n} (Y_i - \bar{Y})^2 = \sum_{i=1}^{n} (\hat{Y}_i - \bar{Y})^2 + \sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2 = SS_{Model} + SS_{Error} \] .......................... 4.6

This is illustrated in Figure 10. The Sum of squares and relationship informed are typically presented in an ANOVA table as the one shown on next page.

---

![Figure 4.2: Illustration of ANOVA](image)

- 98 -
Source | DF | Sum of Squares | Mean Squares | F Ratio  
--- | --- | --- | --- | ---  
Model | 1  | 601.67 | 601.67 | 31.61  
Error | 10 | 190.33 | 19.03 | Prob>F 0.0002  
Ctotal | 11 | 792.0 |  |

Table 4.1: Sum of Squares and Relationship Typically Observed.

The F-ratio, $\frac{MS_{Model}}{MS_{Error}}$, is an overall test for significance of the model. Large values of F-ratio indicate that the fitted model explains a significant portion of the total variability in the observed response values. Another feature which is used is the p-value. The p-value represents the probability $> F$ and is typically designated by alpha =0.05. This implies, for a (1-alpha), i.e. 95% probability, the p value is very small. Hence, the model explains most of the data.

The objectives then of a multifactor experiment are:
- Approximate the unknown function over a range
- Assess the adequacy of the approximation
- Estimate the random error variance ($\sigma^2_e$)
- Study the relationship between the response and the factors
- Identify key factor setting for an effective predicted response
- Identify a range of factor settings for further experimentation
- A survey was sent to multiple software companies to aid in determining the input and output variables of this study.

The survey details and results are discussed next.

- 99 -
4.3 Pilot Questionnaire: Identifying Key Variables

Broadly the recruitment and selection system could be analyzed in terms of their criteria for selection, methodology of testing to include number of tests conducted, the preference given to academic qualification / experience and other background information of potential candidates and lastly the effect of other factors including size and turnover of the Company as it affected their system of recruitment and selection. The Pilot Questionnaire therefore elicits response to some of such queries.

**Job Specification.** Amongst the most important criteria considered is if the recruitment and selection by the IT Software Companies is based on any scientific system and for that, stating a proper job specification is considered essential. Any company undertaking recruitment and selection in a manner other than firstly specifying the job specification was considered as unscientific. This criterion is therefore taken as a screening factor for inclusion of the IT Software Companies for the sample taken for research.

**Attributes for Recruitment and Selection.** Due to lack of uniformity in the Recruitment and Selection system followed by the IT Software Companies, companies gave several qualities as attributes they considered essential/desirable for potential candidates for their companies. This general list of attributes considered by them for software professionals though found to be varying comprised a large number of general attributes that were largely common. The differences existed mainly in terms of words and semantics. This was resolved after analyzing the response to the Pilot questionnaire (Appendix A) and undertaking the qualitative inputs of traits as stated in the conceptual definitions. The final questionnaire includes the list of attributes / traits which has been compiled from the responses of the IT Software Companies and is presented in (Appendix B).
Number and Type of Tests for the Recruitment and Selection System. Having arrived at the criteria for recruitment and selection systems, the number of tests IT Software Companies were conducting appeared as they met their operational requirement. A scientifically designed set of tests for the recruitment and selection did not appear in the responses from a majority of the software companies. More details of the research methodology in making the Pilot Questionnaire are presented in Chapter 5.

4.4 Attributes Identified as Aptitude for Software Development: Input Variables

Research of attributes identified for aptitude for Software Development had several companies giving out their own list of traits based on their organizational requirements, testing mechanism and recruitment and selection system undertaken by the company. Amongst all, there was unanimous agreement in some key variables. These were: Academic record, views on socio-economic status, background in the field and overall work experience and these are listed in Table 2.

<table>
<thead>
<tr>
<th>(a)</th>
<th>Academic Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>Overall Work Experience</td>
</tr>
<tr>
<td>(c)</td>
<td>Background in the field</td>
</tr>
<tr>
<td>(d)</td>
<td>Socio-Economic Status</td>
</tr>
</tbody>
</table>

Table 4.2: Variables Companies were in 100% Agreement

Other attributes that were found to have general acceptance by several companies were the qualities they felt were necessary for software developers. The majority of the IT Companies mentioned these attributes in some form or the other qualitatively. It must be stated
that there were more attributes considered by a few companies and these may not be the only attributes and hence a limitation of the study. After resolving the commonalities and semantics, a list of these attributes was evolved. These are listed in Table 3. Though all attributes were not listed in the order as stated below, there was general congruity of thought in the qualities as listed. These are therefore being taken as input variables for the study.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Intelligence: Comfortably deals with concepts and complexity.</td>
</tr>
<tr>
<td>(b)</td>
<td>Problem Solver: Solves difficult problems with effective solutions and probes all fruitful sources for answers. Can see underlying or hidden patterns. Looks beyond the obvious and does not stop at the first answer.</td>
</tr>
<tr>
<td>(c)</td>
<td>Creative: Comes up with a lot of new and unique ideas. Easily makes connections among previously unrelated ideas.</td>
</tr>
<tr>
<td>(d)</td>
<td>Flexible: Effectively copes with change. Shifts gears comfortably. Decides to act without having the total picture.</td>
</tr>
<tr>
<td>(e)</td>
<td>Quick to Learn: Learns new concepts quickly when facing new problems. Can think about ideas “on the fly”.</td>
</tr>
<tr>
<td>(f)</td>
<td>Persevering: Pursues everything with energy, drive and a need to finish. Seldom gives up, especially in the face of resistance or setbacks.</td>
</tr>
<tr>
<td>(g)</td>
<td>Passion for Technology: Drive to see product, project or service reach completion / highest standards. Desire to solve problems with their product service that were hard to solve previously. Putting technology to work for people and driving technology and product innovation; understands and interprets implications of relevant technologies for his/ her work; stays abreast of what is happening in the business and industry.</td>
</tr>
<tr>
<td>(h)</td>
<td>Team Spirit: Helps to create strong morale and spirit. Shares wins and successes. Creates a feeling of belonging in the team. Is prepared to make a sacrifice of personal interest for another member.</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>(j)</td>
<td>Prioritizes: Spends times and the time of others on what’s important. Quickly zeroes in on the critical few and puts the trivial many aside. Can quickly sense what will help or hinder accomplishing goal. Can sift the essential and can understand between importance and urgency.</td>
</tr>
<tr>
<td>(k)</td>
<td>Result Oriented: Can be counted on to execute goals successfully. Is constantly and consistently one of the top performers. Consistently pushes self and others for results.</td>
</tr>
<tr>
<td>(l)</td>
<td>Decision Maker: Makes good decisions based upon a mixture of analysis, wisdom, experience and judgment.</td>
</tr>
<tr>
<td>(m)</td>
<td>Motivated: Creates focus and continuity of purpose. Has ability to seek improvement and the desire to undertake work without being assigned.</td>
</tr>
<tr>
<td>(n)</td>
<td>Dynamic: Can influence people and strategies. Is lively, self motivated, energetic and can move things.</td>
</tr>
<tr>
<td>(o)</td>
<td>Long Term Planner: Accurately assesses length and difficulty of tasks and projects. Sets objectives and goals. Breaks work down into steps. Anticipates and adjusts for problems and roadblocks.</td>
</tr>
<tr>
<td>(p)</td>
<td>Analytical Skills: Thinks, questions, challenges; learns new things quickly and puts them into action; works until it is right; is creative; demonstrates a high level of expertise in work; takes responsibility; learns from mistakes; takes risks to learn and seeks out tough challenges.</td>
</tr>
</tbody>
</table>
Maintains Focus: Gets results, stays focused for result, relentless in the pursuit of goals; sets and communicates clear, and prioritizes for his/her area of responsibility; monitors progress and makes timely corrections when necessary; stays on track when distractions or problems arise; stabilizes and focuses quickly when changes occur.

Table 4.3: List Of Traits And Their Definitions Based On Organizational Requirements for Recruitment And Selection System Undertaken By The Company

In addition, companies employed various testing methodologies and hence they are listed as key variables in Table 4.

<table>
<thead>
<tr>
<th>(a)</th>
<th>Interviewing</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>Group Testing</td>
</tr>
<tr>
<td>(c)</td>
<td>Psychological testing</td>
</tr>
<tr>
<td>(d)</td>
<td>Intelligence Testing</td>
</tr>
<tr>
<td>(e)</td>
<td>Technical Testing</td>
</tr>
</tbody>
</table>

Table 4.4: List of techniques used in Testing

4.5 Key Company Outputs Dependant on Employee Skills: Output Variables

To scientifically arrive at an effective recruitment and selection system, the input variables have to be seen in relation to the output variables that were identified. The research undertook study of the number of tests administered for recruitment and selection and the impact on the IT
Software Companies in terms of effectiveness and how it translated into growth of sales of the company. This was a leading parameter identified in the survey. Companies also saw that hiring translated directly to revenue/profit growth for the technology that was being investigated. Finally, the average net profit per employee was a key parameter that was monitored consistently in all companies surveyed.

4.6 Assumptions of the Study

From the response during the interactions and interviews as also to the Pilot questionnaire served to the IT Companies, it emerged that there is a varying nature of recruitment and selection system, that is unique to each Company, that has been followed by the IT Software Companies. The assumptions taken at the time of the research:

- The assessment and answers given by the companies will hold true to the environment prevailing for the next five years.

- The subjects fully understand the questions and responded honesty.

-The response given by IT Companies is based on their company position at the time the questionnaire has been served. Changing environment can affect economic and output state.
5 Research Procedure

The research being undertaken is one to help the IT Industry and the software companies identify a new system of employment selection that could lead to greater effectiveness of the IT Software Industry. The objective of the research is to identify opportunities, and provide a greater cutting edge to meet future challenges of the Indian IT Software Industry. To an extent, it is problem that the industry may face in the coming years if not addressed. The research being undertaken is exploratory research that is defining the problem, helping identifying a course of action and gaining insight into the problem and opportunities. This chapter describes the research design and the procedure undertaken for conducting the study.

5.1 Instrument Surveys Used

Following section describes the process of instrument development which started with an introductory letter sent along with the questionnaire for pilot testing, sampling, data collection, and data analysis procedures (Appendix A). To have authenticity in the effectiveness of the study undertaken, a set of variables was evolved comprising the input variables, controlled variables and output variables. The detailed description of the instrument shows the variables as they are used. The questionnaire is non-disguised and structured with approximately 12-18 questions. The issues of the reliability and validity of the measurement scales are also covered in the chapter. Due to the variety of respondents in terms of their turnover, number of employees and diversity in services provided, the collection of data was unstructured. The professionals who are interviewed or to whom questionnaires were administered comprised Project Managers, HR Managers, Industry experts and software professionals who gave grass
root inputs. From the size of the population available, the objective is to have a sample, which represented at least a population sample with about 95 percent confidence level. The response provided by the IT Software Companies has been positive but their perception of corporate secrecy and willingness to part with confidential financial data has been far from positive. Quota sampling is used for the study of the population. These responses were used to describe the sample parameters and to screen out some companies that did not meet the sample criteria in a scientific manner.

The pilot survey was conducted by sending the Pilot Questionnaire to about 204 IT Companies identified as part of quota sampling. The initial email to each company HR Head/representative included an introductory letter about the research and the link to online questionnaire itself to complete the survey. After about 15 days, a follow up email was sent reminding IT Companies that had not answered the questionnaire and thanking IT Companies that had responded in the survey. Telephone calls were also made directly to some IT Companies that could be accessed. The response was analyzed and discussed with the Guide and a main questionnaire was evolved. Finally, the revised “Final version” of the instrument that was evolved, is as given in (Appendix B). The research variables identified were specific qualities and weight-ages, if any considered for these in effectiveness of the recruitment and selection system. The number of tests companies employ at the time of recruitment and selection, the combination of interviews, psychological tests and intelligence tests employed by them and the weight-ages if any given for effectiveness of recruitment and selection were asked. The selection criteria employed by the IT Software Companies with reference to the preference for academic record, performance in interviews, performance in group tests, experience record and any other test used were also elicited. IT Companies were also to respond to the minimum educational qualities acceptable in terms of 10+2 level, engineering
graduate and non engineering graduate, preference of the IT Software Companies to the nature of entry preferred in terms of IT engineering graduate, other engineering graduate, graduate from non engineering stream, diploma holders and others. The other variables were the forecast to meet challenges of the IT Industry in the next 5 years, the evolution of specific criteria to meet the effectiveness in recruitment and selection of IT Software Companies, the viability of undertaking psychological testing of the software professionals. A response was also elicited to identify the possible stage at which the centralized system of testing could be introduced.

5.2 Instrument Validation: Pilot Testing

It was important to validate the instrument by pilot testing of the items and verify the whole scale. This was to seek confirmation of some of the measurement items that were developed or modified for the purposes of this research. In this study, both the validity and reliability of the instrument were checked by means of using statistical validating techniques. It was also necessary, in order to evolve a new questionnaire. The preliminary survey questionnaire that was sent to 204 IT Companies was also to gain their feedback regarding the content, criteria, wording and ease of understanding the measurement items. They were also asked to offer suggestions for improving the proposed scale and suggest criteria, query on variables posed in the questionnaire and content adequacy. The feedback was taken into account in revising the questionnaire. The response from the Companies to Pilot Instrument was encouraging and assisted immensely in formulating the list of qualities, which the IT Companies were employing to evaluate while selecting the IT professionals. A few specific examples from these questionnaires are listed below to illustrate the research methodology.
5.2.1 Response to Job Specification Criteria to Meet Sample Criteria

The first section of the instrument asked the Companies, if a proper job specification was considered by them as criteria for undertaking the recruitment and selection system. Most Companies stated that they had a job specification for employees who came forward as potential candidates but several Companies did not give out the job specification on grounds of corporate secrecy. A few companies were vague in answering the query possibly for the same reason. A proper response to this requirement was considered as a preliminary process to screen out companies that do not meet the sample criteria.

5.2.2 Tests Conducted During Recruitment and Selection System

The number of tests conducted by companies varied from one/two to four/five. The response of the IT Companies to the tests conducted during recruitment and selection and weight-ages given to the tests was collated and response was thereafter categorized into three groups. The first group A comprised companies that undertook 4/5 prescribed tests out of Interviews, Group Tests, Psychological Tests, Intelligence Tests, Technical Tests and others. The second group B comprised companies that took 3/5 tests and the last group C comprised companies that took less than two of such tests.

5.2.3 Sampling Procedure and Questionnaire Administration

The population for this research study was the IT software companies in India, who in their quest for growth were recruiting and selecting potential candidates for meeting their business needs in the IT Software Industry. An unstructured list of such companies was generated by search on the net. A sample was chosen using systematic quota sampling technique. Further details of the companies in terms of number of employees and turnover were also acquired so as to classify them in the intended categories for the research study. This data
was only partially provided by most of the IT Companies and therefore had to be largely collected using online survey through search engines and accessing websites of IT Companies. The details of HR Officials of the IT Companies were also acquired from the Company websites and online.

5.3 Hypotheses Formulation

Based on the research objectives, the instrument for research (main questionnaire) helped formulate 12 hypotheses to test relationship between the variables identified in Chapter 4. The level of significance for rejecting null hypothesis was kept at .05. Descriptive statistics were computed for all variables before testing the null hypothesis for means, standard variables, frequencies, percentages and to correlated response values between variables.

The key hypotheses relating to the questions and its analysis are: It is widely perceived that greater number of tests would assist in sieving better candidates in the selection and recruitment to result in higher growth and sales in IT Companies. In this vein, the research tests for H1-H4 posit that there is no significant difference in the growth in sales, net margin of profit, revenue / profit growth or average net profit per employees of the IT Companies.

H1. Increased combination of interviews, psychological tests, intelligence tests, technical tests and others taken at the time of recruitment and selection for the IT Software Companies in India does not improve the relationship of growth in sales of IT Software Companies.

H2. Increased combination of interviews, psychological tests, intelligence tests, technical tests and others taken at the time of recruitment and selection for the IT Software Companies in India does not improve the relationship of net profit margin of IT Software Companies.
H3. Increased combination of interviews, psychological tests, intelligence tests, technical tests and others taken at the time of recruitment and selection for the IT Software Companies in India does not improve the relationship of revenue/profit growth of IT Software Companies.

H4. Increased combination of interviews, psychological tests, intelligence tests, technical tests and others taken at the time of recruitment and selection for the IT Software Companies in India does not improve the relationship of average net profit per employee, of IT Software Companies.

Considerable thought is given by IT Companies to the academic record, socio economic conditions, overall work experience and experience in the IT field while undertaking recruitment and selection in respective companies. While considering the socio economic background, only few IT Software Companies, across the board, gave any weight-age to the socio economic background of candidates. On the issue of assessing the Overall Work Experience, there was much more agreement. A few companies did give preference to work experience while selecting candidates. Some IT Software Companies have however preferred new candidates for employment. Hypothesis H5-H8 addresses the relative importance of these variables.

H5. The academic record has no domination while overall work experience, experience in field and socio-economic conditions, have more effect on the recruitment and selection for the IT Software Companies in India that affects growth in sales of IT Software Companies.
H6. The academic record has no domination while overall work experience, experience in field and socio-economic conditions, have more effect on the recruitment and selection for the IT Software Companies in India that affects the net profit margin of IT Software Companies.

H7. The academic record has no domination while overall work experience, experience in field and socio-economic conditions, have more effect on the recruitment and selection for the IT Software Companies in India that affects the revenue/profit growth of IT Software Companies.

H8. The academic record has no domination while overall work experience, experience in field and socio-economic conditions, have more effect on the recruitment and selection for the IT Software Companies in India that affects the average net profit per employee, of IT Software Companies.

Several attributes for potential candidates were listed in the responses from the software companies. After collating the feedback from companies, a generally common list of attributes, that the software companies considered desirable in potential candidates, was evolved. These attributes have constituted the variables which are used in selection for the study. Hypothesis H9-12 test the relative contributions of those parameters.

H9. The combination of various factors considered in the study at the time of recruitment and selection for the IT Software Companies in India affects growth in sales of IT Software Companies of all the factors considered for evaluation of the output variables of most factors did not affect the growth rate and revenue / profit growth.
H10. The combination of various factors considered in the study at the time of recruitment and selection for the IT Software Companies in India affects net profit margin of IT Software of all the factors considered for evaluation of output variables, factors and affect the net profit margin and net profit per employee of IT Companies.

H11. The combination of various factors considered in the study at the time of recruitment and selection for the IT Software Companies in India affects revenue/profit growth of IT Software Companies of all the factors considered for evaluation of the output variables of most factors did not affect the growth rate and revenue / profit growth.

H12. The combination of various factors considered in the study at the time of recruitment and selection for the IT Software Companies in India affects net profit margin of IT Software of all the factors considered for evaluation of output variables, factors and affect the net profit margin and net profit per employee of IT Companies.

5.4 Data Analysis

The data gathered from the online questionnaire were entered into a computer database and then analyzed using Statistical Package for Social Sciences (SPSS.10). The statistical software used for the research analysis (SPSS 10.0) can undertake complex analyses on large data files. It can run multiple SPSS sessions simultaneously on the same desktop computer, making it possible to analyze more than one data file at the same time. It has variables tab that makes it much easier to view and define variable attributes such as data types and descriptive variable and value labels. Improved quality for interactive graphics can now be copied as Windows metafiles, which are better suited to resizing and printing in other applications without jagged
lines and edges. SPSS can also print interactive graphs as metafiles for faster results at the same high quality. It enables application of regression techniques to ordinal outcomes (such as low, medium and high).

The data analysis consisted of factor analysis, multivariate analysis, multiple regression and descriptive statistics including multiple means, frequencies and percentiles, Independent samples Kruskal-Wallis tests and Independent samples Mann-Whitney ‘U test.

5.5 Reliability of Instrument and Testing

For the research to able to draw valid results, measures of variables should have validity and reliability. While reliability deals with how consistently similar measures produce similar results (Rosental and Rosnow 1984), and it has repeatability and internal consistency as two dimensions. Internal consistency in generally referred to the ability of a scale item to correlate with other items in the scale, that are intended to measure the same construct.

A hypothesis test tells us the probability of our result (or a more extreme result) occurring, if the null hypothesis is true. If the probability is lower than a pre-specified value (alpha, usually 0.05), it is rejected. It can be likened to a search process; we are searching for evidence to reject the null hypothesis, in the same way that we may search for (say) presence of a chemical in an environment. The ability to reject the null hypothesis depends upon:

Alpha (α): Usually set to be 0.05, although this is somewhat arbitrary. This is the probability of a Type I error, that is the probability of rejecting the null hypothesis given that that the null hypothesis is true. To use the search analogy, it is the probability of thinking we have found something when it is not really there.

Sample Size: A larger sample size leads to more accurate parameter estimates, which leads to a greater ability to find what we were looking for.
Effect Size: The effect of size the in the population. The bigger it is, the easier it will be to find. However, the above is not strictly correct. Jacob Cohen (author of several books and articles on power analysis) has pointed out "all null hypotheses, at least in their 2-tailed forms, are false." Whatever we are looking for is always going to be there – it might just be there in such small quantities that we are not bothered about finding it, (J Cohen, 1989).

A key factor in avoiding these small quantities is “Sample Size”. To determine the minimum sample size required for this research, the factors that were considered were the confidence level, nature of model, its size and maximum likelihood estimation. The minimum requirement for sample in each group was to exceed the number of dependent variables and provide statistical power to assess group differences. Power analysis enables this aspect to be viewed from the context so as to make sure that the data has been analyzed adequately enough to find from the data what the purpose of the research is. It is equally important that the size of what is being searched is also vital. It is generally referred as the "effect size." Several methods exist for deciding what effect size would be interested in the research. The power of a test refers to its ability to detect what it is looking for. In other words, the power of a test is the probability of finding what the research is looking for, given its size.

The above analysis uses data from over 50 companies to test across 4 different output variables and numerous input variables. In determining the reliability of this sample size and the overall validity of the analysis, it is to be ascertained whether the differences that were detected in the initial analysis undertaken across the various sample means were significant or not. This is typically done using the same statistical software.

As an Example: Analyzing the Null Hypothesis in Question 3. In Part 1, the study is testing the effect of Y1 across groups A, B and C. Each group has a mean of 36, 47 and 102 respectively with a standard deviation (stdev) around ~ 30. The experiment is trying to
determine that for a given Alpha value (0.05 as in this case), whether a difference in means (~50) can be detected at various sample sizes. This results in a plot of power vs, sample size. As can be seen in the plot below, a group sample of ~18-20 yields in a >95% confidence in Power. Thus, in this study, a sample size of 50 is more than sufficient to detect the differences that the research is looking for.

![Sample Size Graph](image)

Figure 5.1: A Sample Size of 50

Carrying out this analysis for the hypothesis in Question 4, the experiment is comparing means across groups D and E with means of 31 and 64 respectively. A power analysis results in the following
A sample size of ~ 25-30 results in sufficiently high power, i.e. greatly lower risk of accepting a false null hypothesis. It is therefore unambiguous that the sample size of 50, chosen is adequate.