

Chapter 4

Data Collection

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4.1 Background

Research Objectives 1 and 2 (Ref. Chapter 3) set the direction of the Study. While Objective 1 intends to find out the contributions of various Critical Risk Factors (CRF) to total risk and their impact on the Business Success Indicators (BSI), Objective 2 intends to develop a set of Risk Mitigation Strategies (RMS) and find their impact on the Business Success Indicators (BSI). For conducting the Study, it was essential to collect data. Data collection was done in two (2) Phases – Phase 1 (Pilot Study and Literature Review) and Phase 2 (Final Survey) as explained below:

4.2 Data Collection - Phase 1 (Primary and Secondary Data)

4.2.1 Identification and Selection of Risk Factors corresponding to Research Objective 1

4.2.1.1 Risk Factors as per Pilot Study (Stage 1)

Researcher conducted a Pilot Study and obtained data from 30 experts from diverse areas/ disciplines (Ref. **Appendix 3**). Study required excellent knowledge, experience and understanding of EPC Business as well as the Indian Power Sector. In view of this critical requirement, Judgement sampling was adopted in selecting the experts/ professionals having minimum 10 Years' experience and above for both Pilot Study and the Final Survey.

Researcher developed a questionnaire (given below), validated by the guides and a few experts, for probing and obtaining data:

- What is EPC Business and how it is different from other businesses?
- What is meant by (a) EPC Project Success (b) Sustained Business Success of an EPC Project Company?
- What are the (a) risks encountered at project level and (b) what are additional risks encountered at organisational level?
- Best practices that can help project succeed despite all challenges
- Whether in-house manufacturing of critical equipment helps EPC business
- What is the outlook of Thermal Power Sector in next 10-15 years?
- Recommendations for the existing business and potential new businesses

Semi-Structured Interview

Semi-Structured interviews were conducted with the above 30 Experts from different areas/ disciplines of EPC business. Experience levels (in number of years) of these 30 experts are as given below:

- 10 to 22 years: 6
- 23 to 30 years: 7
- 31 to 35 years:12
- >35 years: 5

Risk Factors came out of the above exercise are given in **Appendix 4**.

4.2.1.2 Risk Factors as per Literature Review

Twenty-four (24) literature gave specific risk factors that impact business success of EPC Project Organizations (ref. **Appendix 5**).

4.2.1.3 Risk Factors as per Risk Map of EPC Power Projects

All EPC organizations have, under different names - risk checklists, risk policies, risk protocols, risk management guidelines etc. for use in their projects. Based on such guidelines as well as various reports and researchers' work on the subject e. g. Deloitte Report, 'Capital Projects' (2016), Pawar et al. (2015), Singh et al (2017), Shaikh (2015), Jayasudha et al. (2016), Researcher developed a Risk Map of EPC Power Projects that gives various risks, sources of risk and project phases of risks (ref. **Appendix 6**).

4.2.1.4 Risk Factors as per Case Studies of Mega Power Projects

In order to make the Study more robust risk data from Nine (9) mega EPC power projects were reviewed with the concerned Project Managers/ Project Control Managers to understand the major risk factors encountered in these projects (ref. **Appendix 7**). These risk factors were also considered while consolidating the risk factors. Project Manager/ Project Control Manager provided risk data from their respective Project Risk Registers. Name of the projects have not been revealed to protect identity of the same.

4.2.1.5 Criticality Score of Risk Factors

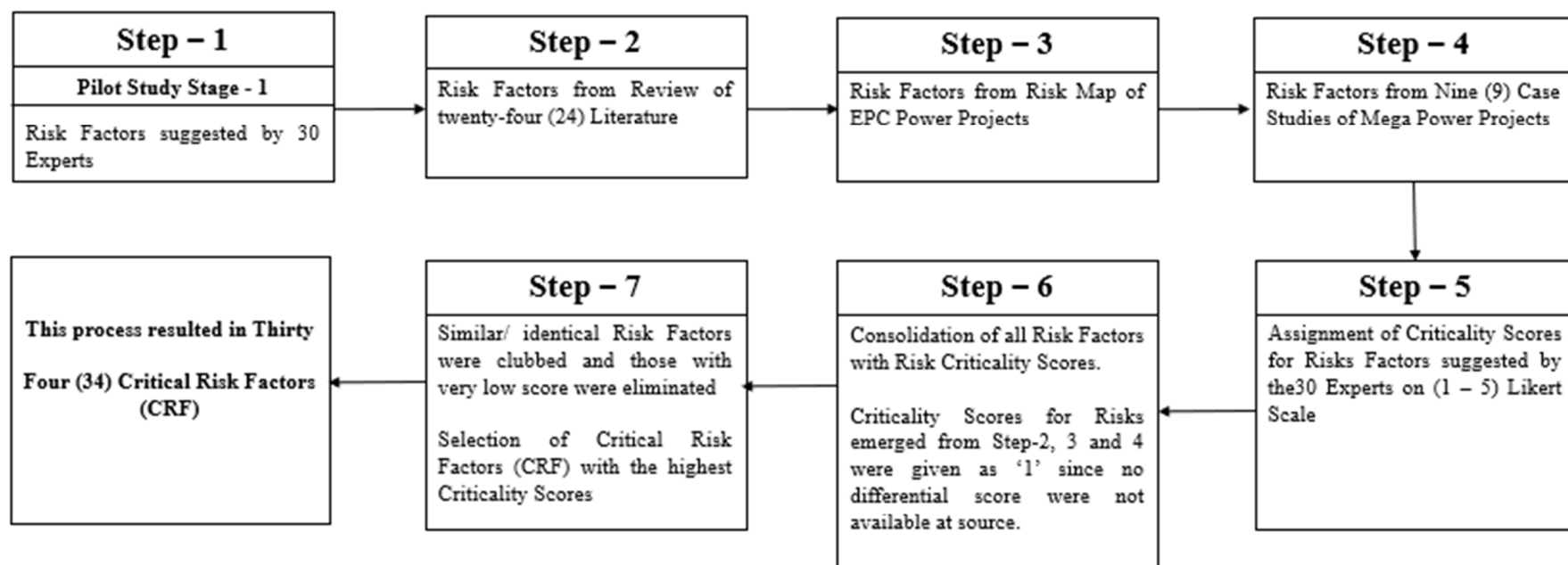
At this stage, each of the 30 experts were asked to indicate the criticality of each risk factors suggested by them on a (1 to 5, 1=Minimum, 5=Maximum) Likert Scale (Ref. **Appendix 8**).

4.2.1.6 Selection of Critical Risk Factors (CRF)

Based on the identification of risk factors from Pilot Study, Literature Review, EPC Risk Maps and Case Studies, the same were consolidated (Ref. **Appendix 9**). Total 109 risk factors emerged. Risks came out of primary source (Pilot Study - Stage 2) had criticality scores on a (1-5) Likert scale, as explained in Chapter 6. However, the risks that came out of the secondary sources did not have any criticality score since the same were not available at source. In view of this, it was decided in consultation with the supervisors that these risks shall not be given any differential criticality score and a score of '1' was given to all. Identical/ similar risk factors were merged together and the ones with very low scores were eliminated, in consultation with the experts and supervisors. This process reduced the Risk Factors to 34 (Ref. **Appendix 10**), henceforth, called as **Critical Risk Factors (CRF)**. Literature suggested various categories or groups of Risks and the same is given in **Appendix 11**. Based on these inputs, all CRFs were grouped under 7 risk groups – Management, Proposal & Contract, Engineering, Procurement, Construction, Financial, Customer.

4.2.1.7 Identification and selection of the Critical Risk Factors (CRF) as described above, is depicted through the flow diagram (Ref. Figure 4.2.1.7.1) below:

Figure 4.2.1.7.1: Identification and Selection of Critical Risk Factors



4.2.2 Identification and Selection of Business Success Indicators (BSI) Corresponding to Research Objective 1

The concept of Business Success and Business Success Indicators have been discussed in Chapter 1 and Chapter 2. List of Project Success, Business Success and Business Success Indicators (BSI) were obtained from Primary and Secondary sources.

4.2.2.1 Pilot Study (Stage 1)

Pilot Study provided the meaning of Business Success and the List of Business Success Indicators (BSI) (Ref. **Appendix 14**).

4.2.2.2 Literature Review

Review of Literature also provided the concepts of project success, business success and business success indicators (ref. **Appendix 15**).

4.2.2.3 Selection of Business Success Indicators (BSI)

List of Project Success, Business Success and Business Success Indicators (BSI) were obtained from Primary and Secondary sources (ref. **Appendix 14** and **Appendix 15** respectively). Data given in Appendix 13 and Appendix 14 were assimilated and it resulted in the following four (4) Business Success Indicators (BSI), in consultations with the supervisors and experts (Ref. **Appendix 16**):

1. BSI 1: Financial Performance
2. BSI 2: Project Performance
3. BSI 3: Brand Image
4. BSI 4: Creation/ Enhancement of Shareholders' Value

During this exercise, it was observed that that while BSI 1 (Financial Performance) and BSI 2 (Project Performance) are more Short-Term in nature as they indicate an organisation's performance on year-to-year basis, BSI 3 (Brand Image) and BSI 4 (Creation/ Enhancement of Shareholders' Value) are comparatively Long-Term in nature. This concept has been used after being validated by the supervisors/ experts and have been used in the Study.

4.2.3 Identification and Selection of Risk Mitigation Strategies (RMS) - Pilot Study (Stage 2) corresponding to Research Objective 2

4.2.3.1 Identification of Risk Mitigation Strategies (RMS)

Once the 34 Critical Risk Factors (CRF) were selected as given in section 4.2.1 above and as given in **Appendix 10**, the 30 experts were asked to suggest Risk Mitigation

Strategies (RMS) for the 34 CRFs selected. Details are given in **Appendix 12**. A total of 165 RMS was suggested for 34 CRFs.

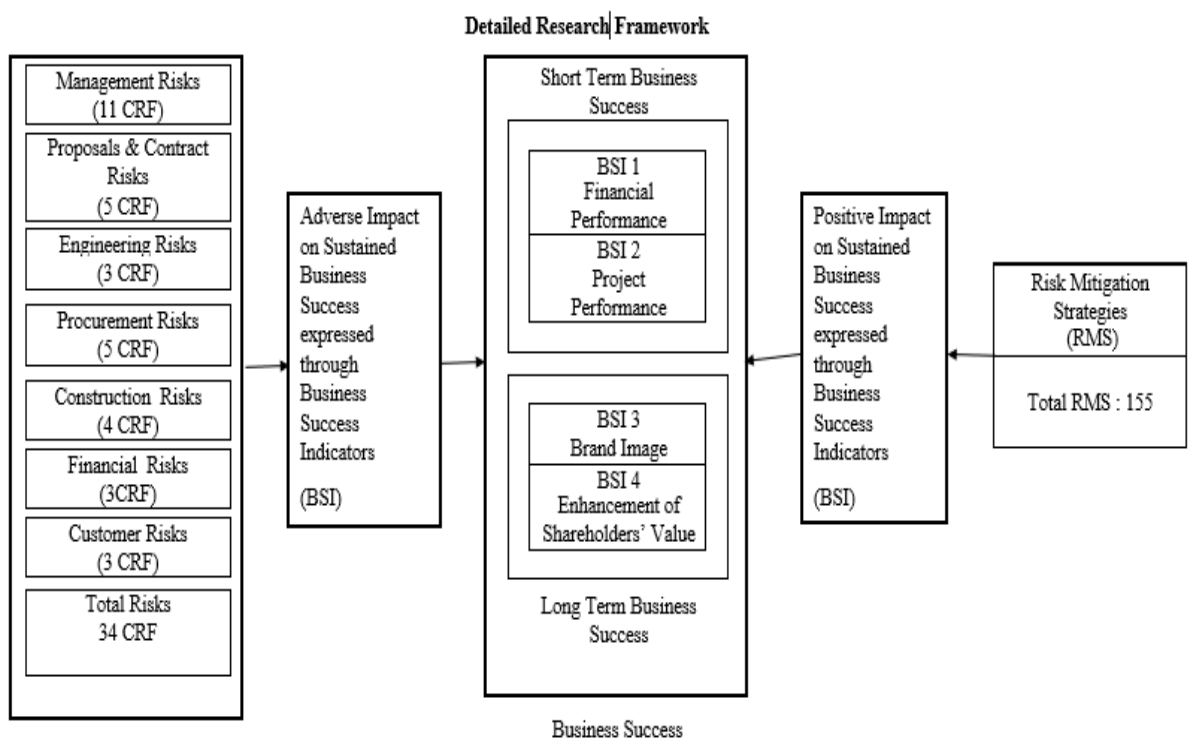
4.2.3.2 Selection of Risk Mitigation Strategies (RMS)

Each of these RMS were scrutinized in consultation of the experts. After a careful scrutiny, only 10 RMS were eliminated as few were either repetitions or already included in other strategies or not quite relevant. Finally, total 155 Risk Mitigation Strategies (RMS) emerged from this exercise. These 155 RMS with their corresponding Critical Risk Factors (CRF) are presented in **Appendix 13**.

4.3 End of Exploratory Phase

The exploratory phase resulted in development of (a) 34 Critical Risk Factors (CRF) under 7 Risk Groups (Management, Proposal & Contract, Engineering, Procurement, Construction, Financial and Customer), (b) 2 Short-Term Business Success Indicators (BSI 1: Financial Performance and BSI 2: Project Performance), (c) 2 Long-Term Business Success Indicators (BSI 3: Brand Image and BSI 4: Creation/ Enhancement of Shareholders' Value) and (d) 155 Risk Mitigation Strategies (RMS). Details are given subsequently in this thesis. This exercise helped in refining and detailing the Basic Research Framework (described in Figure 3.2.1) and the detailed research framework is presented Figure 4.3.1 hereinafter.

Figure 4.3.1: Detailed Research Framework



4.4 Development of Research Hypotheses

Literature review indicated a clear need/ gap for a Study for Risk Mitigation of EPC Organisations working in Indian Thermal Power Sector. Chapter 1 discussed about the three constructs of the Study – risk, business success and risk management.

A very preliminary idea was available about the relationships amongst these three constructs. However, at the end of exploratory stage after receiving primary and secondary data from Data Collection Phase 1, more clarity and insights emerged. For investigating and finding the relationships amongst the three research constructs in line with the two (2) Research Objectives, a set of seven (7) Research Hypotheses were developed, in consultation with the supervisors, as given below.

4.4.1 Total five (5) Research Hypotheses were developed corresponding to **Research Objective 1** that deals with finding the impact of Critical Risk Factors (CRF) on Total Risk and the Business Success Indicators (BSI) as given below:

1. **Null-Hypothesis, H_{1a}**: There will be no significant contributions of the risks under the 7 Risk Groups to Total Risk.

Alternative Hypothesis, H_{1b}: There will be significant contribution of the risks under 7 Risk Groups on Total Risk.

2. **Null-Hypothesis, H_{2a}**: There will be no significant difference in the impacts of the risks under 7 Risk Groups on the Short-Term Business Success Indicator, BSI 1: Financial Performance.

Alternative Hypothesis, H_{2b}: There will be significant difference in the impacts of the risks under 7 Risk Groups on the Short-Term Business Success Indicator, BSI 1: Financial Performance.

3. **Null-Hypothesis, H_{3a}**: There will be no significant difference in the impacts of the risks under 7 Risk Groups on the Short-Term Business Success Indicator, BSI 2: Project Performance.

Alternative Hypothesis, H_{3b}: There will be significant difference in the impacts of the risks under 7 Risk Groups on the Short-Term Business Success Indicator, BSI 2: Project Performance.

4. **Null-Hypothesis, H_{4a}**: There will be no significant difference in the impacts of the risks under 7 Risk Groups on the Long-Term Business Success Indicator, BSI 3: Brand Image.

Alternative Hypothesis, H_{4b}: There will be significant difference in the impacts of the risks under 7 Risk Groups on the Long-Term Business Success Indicator, BSI 3: Brand Image.

5. **Null-Hypothesis, H_{5a}**: There will be no significant difference in the impacts of the risks under 7 Risk Groups on the Long-Term Business Success Indicator, BSI 4: Creation/ Enhancement of Shareholders' Value.

Alternative Hypothesis, H_{5b}: There will be significant difference in the impacts of the risks under 7 Risk Groups on the Long-Term Business Success Indicator, BSI 4: Creation/ Enhancement of Shareholders' Value.

4.4.2 Following two (2) Research Hypotheses were developed corresponding to **Research Objective 2** that deals with finding the impact of Risk Mitigation Strategies (RMS) on Business Success Indicators (BSI):

1. **Null-Hypothesis, H_{6a}**: There will be no significant impacts of the Risk Mitigation Strategies (RMS) on the Business Success Indicators (BSI 1, BSI 2, BSI 3 and BSI 4).

Alternative Hypothesis, H_{6b}: There will be significant impacts of the Risk Mitigation Strategies (RMS) on the Business Success Indicators (BSI 1, BSI 2, BSI 3 and BSI 4).

2. **Null-Hypothesis, H_{7a}**: There will be no significant difference in the impacts of various Risk Mitigation Strategies (RMS) on the Business Success Indicators (BSI) for each Critical Risk Factor (CRF).

Alternative Hypothesis, H_{7b}: There will be significant difference in the impacts of various Risk Mitigation Strategies (RMS) on the Business Success Indicators (BSI) for each Critical Risk Factor (CRF).

From this point onwards, the Study moved into explanatory phase. Final survey provided data required for analysis to support or refute the assumptions of hypotheses and to find out the relationships amongst the constructs.

4.5 Data Collection – Phase 2 (Final Survey)

4.5.1 Survey Questionnaire

In order to work on the two (2) Research Objectives, required data were to be collected through Final Survey (data Collection – Phase 2).

Accordingly, Questionnaire for the Final Survey was prepared to seek answers to the following:

- Ranking of each Critical Risk Factor (CRF) on a (1 to 5) Likert Scale based on criticality of the same to develop a comparative ranking of the CRF.
- Identification of Business Success Indicator (BSI) affected most by each CRF to find out the impact of CRF on BSI (Research Objective 1).
- Identification of the positive impact of each Risk Mitigation Strategy (RMS) on BSIs (BSI 1, BSI 2, BSI 3 and BSI 4) for each CRF on a (1 - 5) Likert Scale (Research Objective 2).

All questions of the Survey were kept mandatory. One free text field (open question) was also provided to capture people's recommendations on the Action Plan to be adopted to ensure business success for the EPC organisations working in Indian thermal power sector. The intent was to create an actionable framework that the EPC organizations can implement.

Appendix 17 gives the Questionnaire used for the Final Survey. Content and construct were validated through discussions with the Experts of project management, contract & risk management, procurement, construction and corporate strategy groups. To facilitate web-based online survey through internet, the questionnaire was converted to e-form using Microsoft Technology (DotNet) with Oracle database at the back end. The data were then exported to carry out analysis. The Survey Portal was tested and validated by few experts to rule out any hiccups, at a later stage.

4.5.2 Population

L&T, BHEL and GE Power (India) are the main EPC companies operating in Indian Thermal Power Sector and participating in Main Plant bidding. Each of these organizations is estimated to have around 200-250 EPC Engineers with 10+ years' experience. Thus, the population is estimated to be around 600–750.

4.5.3 Target Sample

As per Cochran (1963), the sample size, n is given by:

$$n = N * [Z^2 * p * (1-p)/e^2] / [N - 1 + (Z^2 * p * (1-p)/e^2)]$$

where,

N = Population size = 750

Z = critical value of the normal distribution at the required confidence level = 1.96 at 95% confidence level,

p = estimated proportion of an attribute that is present in the population = 0.5 (assumed), and

e = margin of error = 0.05

Based on the above data, sample size works out to be 255.

Again, a simplified formula is provided by Yamane (1967) as:

$$n = N / [1 + N (e)^2] \text{ and based on this formula, sample size works out to be 260.}$$

Thus, the target sample is 260.

Survey proposed for the Study required excellent knowledge, experience and understanding of EPC Business as well as the Indian Power Sector. To meet this critical requirement, judgement sampling was adopted in survey of professionals having minimum 10 Years' experience and above.

4.5.4 Sending Questionnaire

Survey Questionnaire was sent to 296 professionals (including 29 identified in 6.3.4 above) selected through judgement sampling.

4.5.5 Return of Filled-in Questionnaire

267 persons submitted the filled-in questionnaire. One response was rejected as the person had less than 10 years' experience. Thus, 266 responses were considered for this research Study.

4.5.6 Tools

For Data Collection

Semi-structured Interviews for Pilot Study, Web-based Survey Questionnaire for Final Survey.

For Statistical Analysis

Descriptive Statistics: for getting insight in to the data in terms of central tendency and correlations.

One Way ANOVA: for comparison of values for more than one groups

Post-Hoc Tukey B/LSD: In ANOVA, once the text concludes that there is significant difference between the means of different groups, the next step is to find out which group has that difference. For this purpose, Post-Hoc Tukey B/ LSD text are used,

Structural Equation Modelling: Used for getting the path coefficients (correlations) between independent variables and dependent variables

SPSS Software: Since the research includes the multivariate analysis. This is very difficult to do manually. Hence, SPSS software was used.

4.5.7 Details of Respondents of Final Survey

Details of Respondents are given in Table 4.5.7.1 below:

Table 4.5.7.1: Details of Respondents of Final Survey

Total No. of Respondents	Valid	Minimum Experience	Maximum Experience	Mean	Standard Deviation
266	266	10	48	24.91	8.392

Experience Class	Frequency	%
< 15 Years	34	12.8
15 – 25 Years	98	36.8
25 – 35 Years	92	34.6
> 35 Years	42	15.8

The above table is represented as a pie-chart in Figure 4.5.7.1 below:

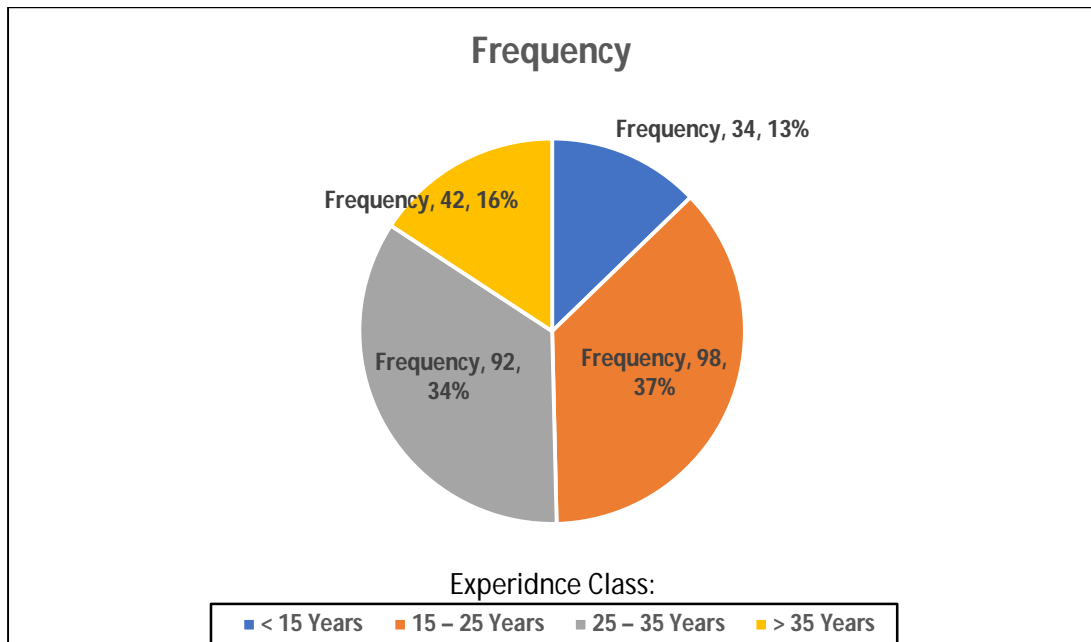


Figure 4.5.7.1: Details of Respondents of Final Survey

It may be seen for the above Table and Pie-chart, that very experienced (mean experience level: 24.91 years) people participated and provided data required for the Study.

4.5.8 Final Survey Data

Summary of Final Survey Data are given in **Appendix 18**. The same have been used in data analysis.

4.6 Summary

Data collection commenced with a view to obtain more data of the research constructs and have greater insights. At the end of the exploratory phase, Researcher got more clarity on the research problem and the way forward. For investigating and finding the relationships amongst the three research constructs in the context the two (2) Research Objectives, a set of seven (7) Research Hypotheses were developed, in consultation with the supervisors for testing to confirm or refute the assumptions made. Subsequently, Questionnaire for the final survey was developed to conduct the Data Collection – Phase 2. Valid responses obtained from 266 people. The data were analysed and presented in Chapter 5.