# Chapter 5

# Results and Analysis

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## 5.1 Background

Data collected from 266 people were analysed and presented below related to Research Objective 1 as well as Research Objective 2.

## 5.2 Results and Analysis

### 5.2.1 Results and Analysis corresponding to Research Objective 1

#### 5.2.1.1 Criticality Scores of the Critical Risk Factors (CRF)

Based on the Final Survey data, criticality scores of the CRFs (mean, mode, median) have been worked out and the same have been presented in **Appendix 19**.

#### 5.2.1.2 Contribution of Critical Risk Factors (CRF) under different Groups to Total Risk (Testing of Hypothesis 1)

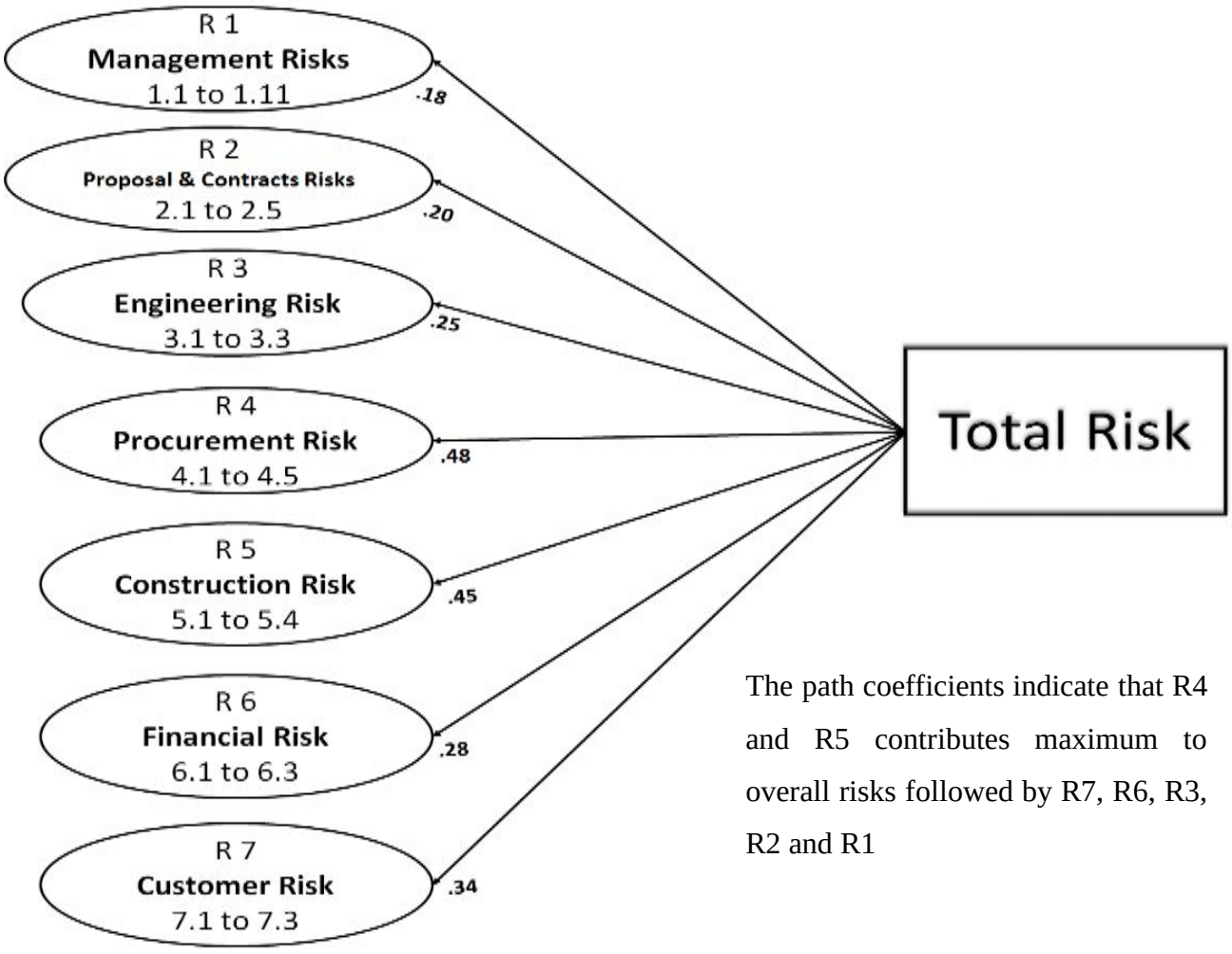
Testing of Hypothesis 1 (ref. Chapter 3) related to Research Objective 1 is given below:

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

**Analysis**: Since the p value of 0.002 (Ref. **Appendix 20**) is significant i.e. <0.05, the Null-Hypothesis, $H_{1a}$ is rejected and the Alternate Hypothesis, $H_{1b}$ is accepted. In other words, Risks under all 7 Risk Groups significantly contribute to the Total Risk.

**Figure 5.2.1.2.1**




The path coefficients indicate that R4 and R5 contributes maximum to overall risks followed by R7, R6, R3, R2 and R1

### 5.2.1.3 Impacts of Critical Risk Factors (CRF) on Business Success Indicators (BSI)

People surveyed were asked to identify one Business Success Indicator (Short-Term or Long-Term) that is impacted most by each of the 34 Critical Success Factor (CRF) grouped under seven (7) groups – Group 1: Management Risks (11 CRF), Group 2: Proposal & Contracts Risks (5 CRF), Group 3: Engineering Risks (3 CRF), Group 4: Procurement Risks (5 CRF), Group 5: Construction Risks (4 CRF), Group 6: Financial Risks (3 CRF) and Group 7: Customer Risks (3 CRF).

Survey responses (in % of respondents) are given in Table 5.2.1.3.1 below:

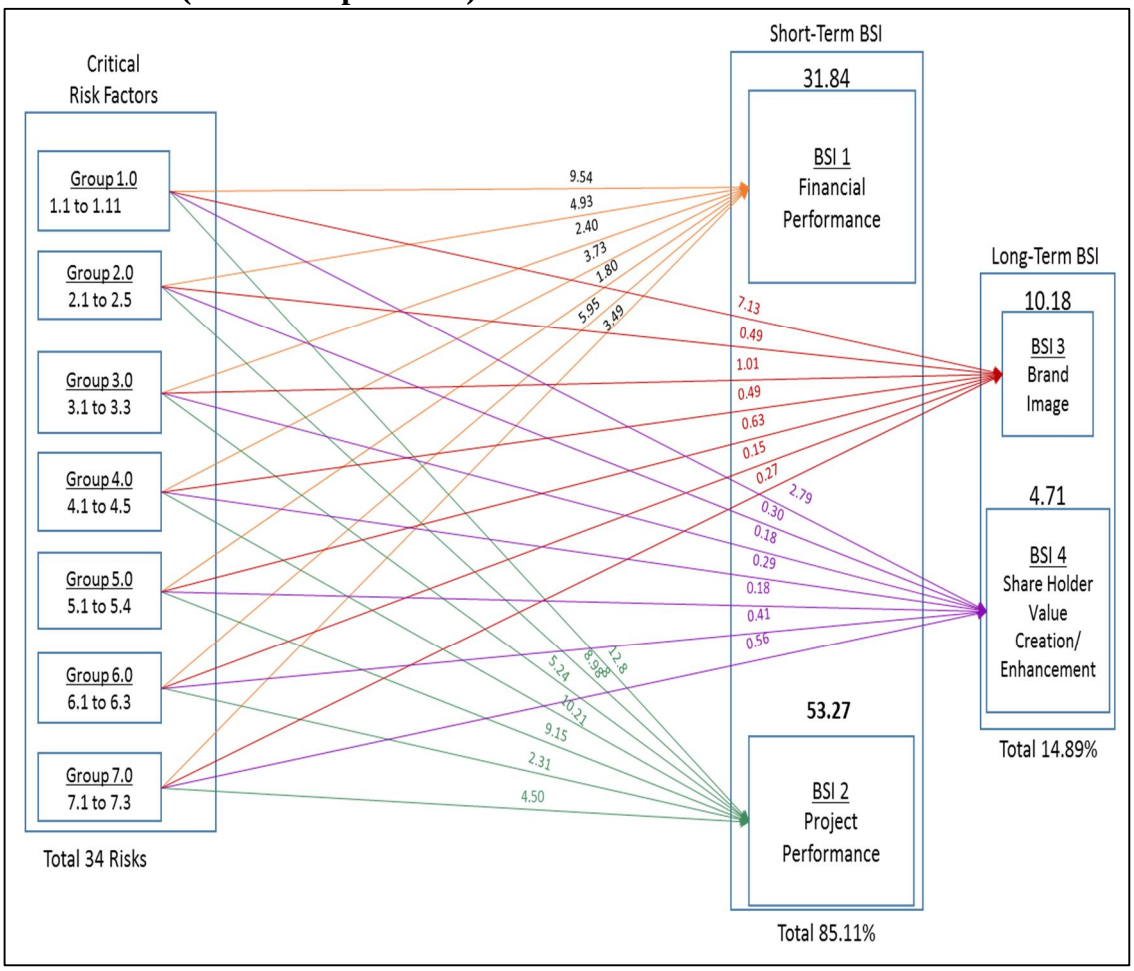
**Table 5.2.1.3.1: Impacts of CRF on BSI (in % of Respondents)**

| Serial No. | CRFs under Risk Groups | Most Impacted BSI by the CRFs (in % of respondents) | | | |
|---|---|---|---|---|---|
| | | **BSI 1** | **BSI 2** | **BSI 3** | **BSI 4** |
| 1 | Group 1: Management Risks | 9.54 | 12.88 | 7.13 | 2.79 |
| 2 | Group 2: Proposal & Contracts Risks | 4.93 | 8.98 | 0.49 | 0.30 |
| 3 | Group 3: Engineering Risks | 2.40 | 5.24 | 1.01 | 0.18 |
| 4 | Group 4: Procurement Risks | 3.73 | 10.21 | 0.49 | 0.29 |
| 5 | Group 5: Construction Risks | 1.80 | 9.15 | 0.63 | 0.18 |
| 6 | Group 6: Financial Risks | 5.95 | 2.31 | 0.15 | 0.41 |
| 7 | Group 7: Customer Risks | 3.49 | 4.50 | 0.27 | 0.56 |
| | **Total** | **31.84** | **53.27** | **10.18** | **4.71** |

If the Management Risks are considered, according to the above table, 9.54 % respondents felt that Management Risks impact BSI 1, 12.88 % respondents felt it impact BSI 2, 7.13 % respondents felt it impact BSI 3 while 2.79 % respondents felt it impact BSI 4. Similarly, other data represent the impact of other risks on the Business Success Indicators (BSI -1, 2. 3 and 4) in terms of respondents (in %) opted for it.

Data presented in Table 5.2.1.3.1 in the previous page is shown pictorially in Figure 5.2.1.3

**Figure 5.2.1.3.1: Impacts of Critical Risk Factors on Business Success Indicators (in % of respondents)**




It is observed that more than 85% risks affect BSI 1 (Financial Performance) or BSI 2 (Project Performance) which are grouped under Short-Term Business Success Indicators (BSI) and less than 15% risks impact BSI 3 (Brand Image) or BSI 4 (Creation/ Enhancement of Shareholders' Value).

Enhancement of Shareholders' Value) which are the Long-Term Business Success Indicators (BSI). Again, BSI 2 is impacted much more (53.27 %) compared to BSI 1 (31.84 %).

**5.2.1.4 Testing of Hypotheses 2, 3, 4 and 5 (ref. Chapter 4) corresponding to Research Objective 1** are presented below:

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).

   **Analysis**: One Way AONVA was conducted and the results are presented in **Appendix 21**. The p value was found to be 0.214. Since the p value is 0.214 i.e. > 0.05, the Null-Hypothesis is failed to get rejected. In other words, there is no significant difference in the impacts of 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).

   **Analysis**: As per **Appendix 21**, the p value is 0.098. Since the p value is 0.098 i.e. > 0.05, the Null-Hypothesis is failed to get rejected. In other words, there is no significant difference in the impacts of 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).

   **Analysis**: As per **Appendix 21**, the p value is 0.013. Since the p value is 0.013 i.e. < 0.05, the Null-Hypothesis is rejected and the Alternative Hypothesis is accepted. In other words, there is a significant difference in the impacts of Risks

under 7 Risk Groups on the Long-Term Business Success Indicator, BSI 3 (Brand Image).

Following ANOVA, Post-Hoc Tukey B/LSD test was conducted. This test generated two homogeneous groups. According to this, Risks under Management Risks have a higher impact on the BSI 3 (Brand Image) while the risks under other six Risk Groups (Proposal & Contract, Engineering, Procurement, Construction, Financial and Customer) are having comparatively lesser impact on 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 (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 (Enhancement of Shareholders' Value).

   **Analysis**: As per **Appendix 21**, the p value is 0.639. Since the p value is 0.639 i.e. > 0.05, the Null-Hypothesis is rejected. In other words, there is no significant difference in the impacts of Risks under 7 Risk Groups on the Long-Term Business Success Indicator, BSI 4 (Enhancement of Shareholders' Value).

### 5.2.2 Results and Analysis corresponding to Research Objective 2

#### 5.2.2.1 Impacts of Risk Mitigation Strategies (RMS) on Business Success Indicators (BSI)

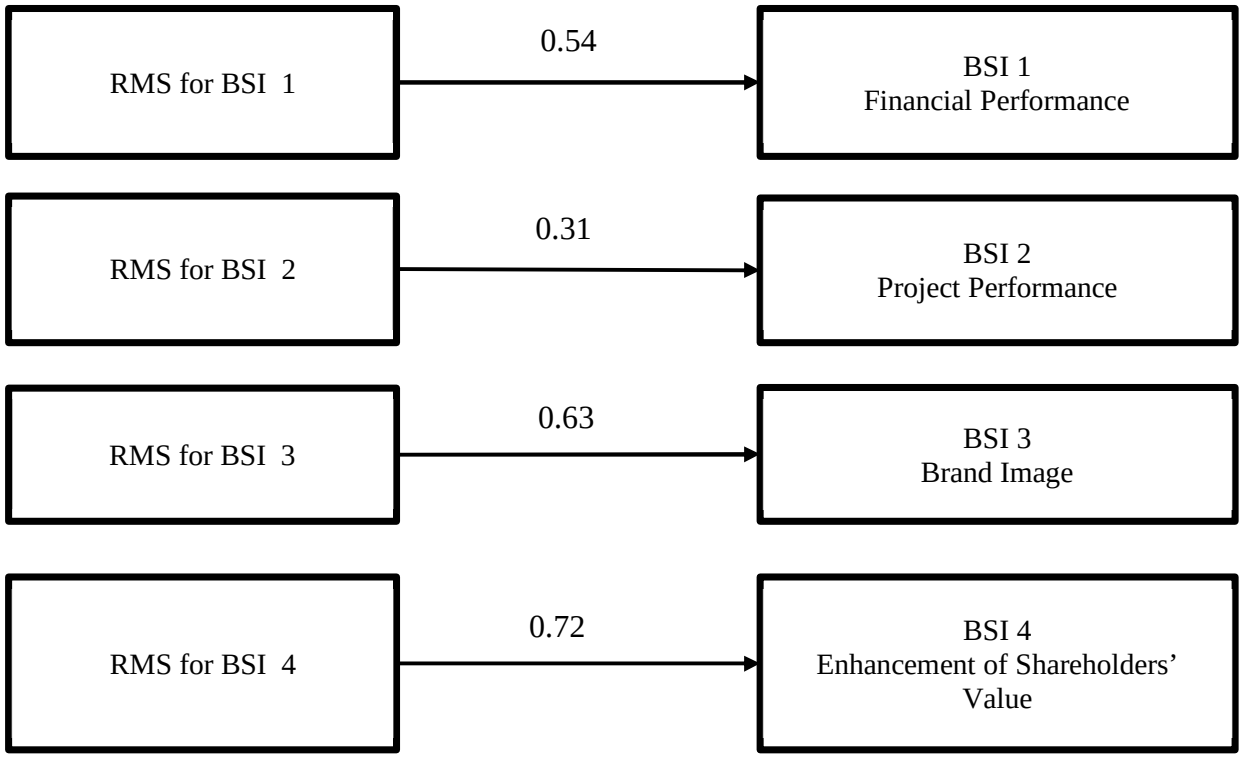
Testing of Hypotheses 6 and 7 (ref. Chapter 3) related to Research Objective 2 are presented below:

6. **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)

Ref. Figure 5.2.2.1.1 below:

**Figure 5.2.2.1.1: Impacts of RMS on BSI 1, BSI 2, BSI 3 and BSI 4**




**Analysis**: A structural model was tested to investigate the hypothesis whether various RMSs have impacts on the BSIs. Since the p value of 0.015 (ref. **Appendix 20**) being significant i.e. <0.05, Null-Hypothesis H06 is rejected and the Alternate Hypothesis is accepted. In other words, Risk Mitigation Strategies (RMS) significantly impact BSI 1, BSI 2, BSI 3 and BSI 4.

Path coefficients indicate that RMS have maximum impact on BSI 4, BSI 3 and BSI 1 while its impact has been lowest for BSI 2.

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

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

**Analysis**: One Way ANOVA test was conducted for all the 34 CRFs. In each case, p value was found to be < 0.05. Thus, the Null-Hypothesis was rejcted and the Alternative Hypothesis was accepted. In other words, there are significant difference in the impacts of various RMS on the BSI.

Post-ANOVA, Post-Hoc Tukey B test was conducted for all the 34 CRFs and the test resulted in homogeneous grouping of RMS having varying degree of impacts on BSI and the same is presented under recommendation. Details are presented in **Appendix 22**. Impact of RMS on BSIs pertaining to each CRF are given in table 9.2.2.1. It may be seen that corresponding to each CRF, there are multiple RMS that have varied positive impacts - from lowest to highest on the BSIs. For example, for Risk ID 1.1, while RMS 1.1_4_(d) has the lowest impact, RMS 1.1_3_(d), 1.1_1_(d) and 1.1_5_(d) have moderate impacts and 1.1_2_(d) has the highest impct on the BSI.

**Table 5.2.2.1.1: Groups of RMS based on varying Impact on BSI for each CRF**

| Serial No. | Risk ID | ID and Impacts of Risk Mitigation Strategies (RMS) on Business Success Indicators (BSI) | | | |
|---|---|---|---|---|---|
| | | Lowest Positive Impact | Moderate Positive Impact | High Positive Impact | Highest Positive Impact |
| 1 | 1.1 | 1.1_4_(d) | 1.1_3_(d), 1.1_1_(d), 1.1_5_(d) | - | 1.1_2_(d) |
| 2 | 1.2 | 1.2_3_(d) | 1.2_2_(d), 1.2_4_(d) | - | 1.2_1_(d) |
| 3 | 1.3 | 1.3_4_(d), 1.3_3_(d) | - | - | 1.3_1_(d) |
| 4 | 1.4 | 1.4_5_(d) | 1.4_4_(d), 1.4_3_(d), 1.4_2_(d) | - | 1.4_1_(d) |
| 5 | 1.5 | 1.5_5_(d) | 1.5_3_(d), 1.5_4_(d), 1.5_2_(d) | - | 1.5_1_(d) |
| 6 | 1.6 | 1.6_4_(d), 1.6.5_(d) | - | - | 1.6_3_(d), 1.6_2_(d), 1.6_1_(d) |
| 7 | 1.7 | 1.7_3_(d), 1.7_4_(d) | - | - | 1.7_2_(d). 1.7_1_(d) |
| 8 | 1.8 | 1.8_3_(d), | 1.8_5_(d), 1.8_2_(d) | - | 1.8_4_(d), 1.8_1_(d) |

| Serial No. | Risk ID | ID and Impacts of Risk Mitigation Strategies (RMS) on Business Success Indicators (BSI) | | | |
|---|---|---|---|---|---|
| | | **Lowest Positive Impact** | **Moderate Positive Impact** | **High Positive Impact** | **Highest Positive Impact** |
| 9 | 1.9 | 1.9_3_(d), 1.9_5_(d), 1.9_4_(d) | 1.9_2_(d) | - | 1.9_1_(d) |
| 10 | 1.10_ | 1.10_4_(d) | 1.10_3_(d), 1.10_2_(d) | - | 1.10_1_(d) |
| 11 | 1.11 | 1.11_5_(d) | 1.11_4_(d), 1.11_3_(d), 1.11_1_(d) | - | 1.11_2_(d) |
| 12 | 2.1 | 2.1_5_(d) | 2.1_4_(d), 2.1_3_(d), 2.1_2_(d) | - | 2.1_1_(d) |
| 13 | 2.2 | 2.2_3_(d), 2.2_4_(d) | - | - | 2.2_2_(d), 2.2_1_(d) |
| 14 | 2.3 | 2.3_4_(d), 2.3_3_(d), 2.3_5_(d) | - | - | 2.3_2_(d), 2.3_1_(d) |
| 15 | 2.4 | 2.4_4_(d), 2.4_3_(d) | 2.4_2_(d) | - | 2.4_1_(d) |
| 16 | 2.5 | 2.5_3_(d) | 2.5_2_(d) | - | 2.5_4_(d), 2.5_1_(d) |
| 17 | 3.1 | 3.1_3_(d) | - | - | 3.1_2_(d), 3.1_4_(d), 3.1_1_(d) |
| 18 | 3.2 | 3.2_4_(d), 3.2_5_(d), 3.2_3_(d) | - | - | 3.2_2_(d), 3.2_1_(d) |
| 19 | 3.3 | 3.3_3_(d), 3.3_2_(d), 3.3_5_(d) | - | - | 3.3_4_(d), 3.3_1_(d) |
| 20 | 4.1 | 4.1_5_(d) | 4.1_3_(d) | 4.1_4_(d) | 4.1_1_(d), 4.1_2_(d) |
| 21 | 4.2 | 4.2_2_(d) | 4.2_4_(d) | - | 4.2_3_(d), 4.2_1_(d) |
| 22 | 4.3 | 4.3_2_(d), 4.3_3_(d) | - | - | 4.3_1_(d) |
| 23 | 4.4 | 4.4_3_(d), 4.4_5_(d), 4.4_2_(d) | - | - | 4.4_4_(d), 4.4_1_(d) |
| 24 | 4.5 | 4.5_4_(d), 4.5_3_(d) | - | - | 4.5_1_(d) |
| 25 | 5.1 | 5.1_5_(d) | - | - | 5.1_4_(d), 5.1_3_(d), 5.1_1_(d), 5.1_2_(d) |

| Serial No. | Risk ID | ID and Impacts of Risk Mitigation Strategies (RMS) on Business Success Indicators (BSI) | | | |
|---|---|---|---|---|---|
| | | Lowest Positive Impact | Moderate Positive Impact | High Positive Impact | Highest Positive Impact |
| 26 | 5.2 | 5.2_1_(d), | 5.2_3_(d) | - | 5.2_4_(d), 5.2_2_(d), 5.2_5_(d) |
| 27 | 5.3 | 5.3_4_(d) | 5.3_5_(d) | - | 5.3_1_(d), 5.3_2_(d), 5.3_3_(d) |
| 28 | 5.4 | 5.4_3_(d) | - | - | 5.4_1_(d), 5.4_2_(d) |
| 29 | 6.1 | 6.1_3_(d) | - | - | 6.1_4_(d), 6.1_1_(d), 6.1_2_(d) |
| 30 | 6.2 | 6.2_4_(d) | 6.2_3_(d) | - | 6.2_5_(d), 6.2_2_(d), 6.2_1_(d) |
| 31 | 6.3 | 6.3_4_(d) | 6.3_5_(d) | 6.3_1_(d) | 6.3_3_(d) |
| 32 | 7.1 | 7.1_1_(d) | 7.1_3_(d), 7-.1_5_(d) | - | 7.1_4_(d), 7.1_2_(d) |
| 33 | 7.2 | 7.2_5_(d), 7.2_4_(d), 7.2_3_(d) | - | - | 7.2_2_(d), 7.2_1_(d) |
| 34 | 7.3 | 7.3_2_(d) | 7.3_4_(d), 7.3_5_(d) | - | 7.3_3_(d), 7.3_1_(d) |

### 5.2.3 Mean Scores of Impact of Risk Mitigation Strategies (RMS) on Business Success Indicators (BSI)

Mean Scores of Impact of the Risk Mitigation Strategies (RMS) on BSI 1, BSI 2, BSI 3 and BSI 4, calculated from final survey data are presented in **Appendix 23**.

### 5.2.4 Action Plan for Business Success per Qualitative Feedback

Question No. 8 (an open question) of the Final Survey Questionnaire sought recommendations from the people surveyed on the actions to be taken to ensure Business Success for the EPC organizations. Out total 266 respondents, 198 gave their recommendations. Based on their recommendations, similar words/ expressions were collated and their frequencies have been summarised and presented in Table 5.2.4.1 below (in descending order).

**Table 5.2.4.1: Recommended Action Plan for Business Success (per qualitative feedback)**

| Rank | Recommended Action Plan for Business Success | Total Frequency | % |
|---|---|---|---|
| 1 | Strong Project Management / Execution / Operational Excellence including Construction-Driven Project Micro-Planning (L3/L4), Project Reviews, Monitoring & Control Including Cost Control / Project Closure | 68 | 34.34 |
| 2 | Cost Reduction / Cost Leadership / Cost Competitiveness | 50 | 25.25 |
| 3 | Diversification into R&M, O&M, Nuclear, Solar with Storage, IGCC, Clean Energy/After Sales Services/ Spares/Fuel Cell/Other Areas and focus on FGD. SCR & other Enviro Products | 45 | 22.73 |
| 4 | Robust Risk Management | 39 | 19.70 |
| 5 | Internationalisation / Exploration of new Geographies | 34 | 17.17 |
| 6 | Smart Contract Negotiation & Drafting / Contract Management / Documentation including Management of Legal Aspects | 32 | 16.16 |
| 7 | On-time Project Completion within Cost | 28 | 14.14 |
| 8 | Strong & Visionary Leadership / Leadership Development / Empowered Faster Decision-Making Teams | 27 | 13.64 |
| 9 | Superior/Cutting Edge/Sate-of-the-Art Technology / Engineering Capability / Innovative Engineering | 27 | 13.64 |
| 10 | Employee Engagement / Motivated Employee / Retention of Talents / Positive Attitude / Value People as Human | 26 | 13.13 |
| 11 | Lean / Agile /Dynamic / Flexible / Innovative Organisation | 24 | 12.12 |
| 12 | Development of Financially Sound/Competent Vendors/Site Contractors/Effective Vendor Management | 23 | 11.62 |
| 13 | Zero Tolerance to Quality & Safety | 23 | 11.62 |
| 14 | Building Capability, Skills, Competent Employees / Workmen / High Performing Teams / Teamwork | 20 | 10.10 |
| 15 | Innovation / Value Added Engineering | 15 | 7.58 |
| 16 | Digitalisation | 15 | 7.58 |
| 17 | Strong BD & Proposal Team / Market Knowledge, Trends & Intelligence / Competitors' Strategies & Information | 14 | 7.07 |
| 18 | Due Diligence of Customer, Project, Contractual Obligations, Project Funding, Clearances, Geo-political Factors, Risks | 14 | 7.07 |

| Rank | Recommended Action Plan for Business Success | Total Frequency | % |
|---|---|---|---|
| 19 | Partnering with Major Vendors / OEMs / Contractors & Transfer back-to-back all contract conditions to them / Timely Payment of Vendors / Contractors | 13 | 6.57 |
| 20 | Strong Procurement (SCM) /Logistics / Global Sourcing Team | 13 | 6.57 |
| 21 | Knowledge Management / Learning & Sharing of Past Experience | 12 | 6.06 |
| 22 | Customer Focus / Satisfaction / Customer Relationship / Warranty / After Sales Services | 11 | 5.56 |
| 23 | Accurate BOQ / Optimisation of BOQ / Continuous Review & Management of BOQ | 11 | 5.56 |
| 24 | Timely Invoicing / Collection / Maintaining Positive Cashflows / Strong Working Capital Management | 10 | 5.05 |
| 25 | Strong & Empowered Construction & Site Administration Team | 9 | 4.55 |
| 26 | Standardisation of Processes/Systems/Work Methods/Engineering Designs/Deliverables | 7 | 3.54 |
| 27 | Meeting Shareholders' and other Stakeholders' Expectations | 4 | 2.02 |
| 28 | Financial & Techno-Commercial Acumen | 3 | 1.52 |
| 29 | Investment in Business and R&D | 3 | 1.52 |
| 30 | Robust HR Policies / Systems | 3 | 1.52 |
| 31 | Design Freeze Centre | 2 | 1.01 |
| 32 | Policy Advocacy | 1 | 0.51 |

As explained above, various recommendations proposed by the respondents have been presented in the above table in descending order per their frequencies. In other words, the recommendation at rank1 has been proposed by the maximum number of respondents and the bottom most recommendation has been proposed by the lowest number of respondents.

The above findings have been subsequently converted into an actionable framework, in consultation with the experts and the supervisors, that can be implemented by the EPC organizations and the same is presented in Chapter 6 as a part of Recommendations. It may be seen that the recommendation frequencies are varying from 34.34% to 0.51%. It was deliberated and decided with the experts and supervisors that responses below 5% may be ignored. However, on recommendation that was recommended by less than 5% respondents was also considered since it was felt that it addresses a very important aspect of business success i.e. ‘Meeting Shareholders and

other Stakeholders' expectations'. Acordingly, the total 25 recommendations have been considered.

## 5.3 Implementation of Risk Mitigation Strategies (RMS) in EPC Organizations

The Research Study threw up various Risk Mitigation Startegies (RMS) to be implemented by the EPC Organizations to ensure business success. Implementation of RMS will vary from one organization to another based on the their structure, systems and processes. In view of this, the Researcher felt that it would be useful to develop a generic framework that can be used by the EPC Organizations for implementation of the various RMS. Necessary tweeking may be done by the organizations according to their needs.

## 5.4 Summary

This chapter provided Results and Analysis of data collected. It indicated high criticality scores of all the Critical Risk Factors (CRF) implying importance of all, significant contribution by riaks under 7 risk groups to the total risk with procurement and construction risks being the most critical. The results also found higher impacts of CRFs on Short-Term Business Success Indicators (BSI) compared to the Long-Term BSIs. These findings corroborate with the ground reality. It also found no significant differenece in impact of risk under 7 risk groups on BSI 1 (Financial Performance), BSI 2 (Project Performance) and BSI 4 (Creation/ Enhancement of Shareholders' Value) while risks under Management group has greater impact on BSI 3 (Brand Image). As far as Risk Mitigation Strategies (RMS) are concerned, the same has significant impact on all the BSIs. Understandably, unlike CRF, RMS maximum impact of Long-Term BSIs compared to the Short-Term BSIs. These findings point out that it is comparatively more challenging to meet BSI 1 and BSI 2. It is also found that there is significant difference in the oimpact of the multiple RMS on the BSIs for each CRF. Grouping of RMS has been developed. Finally, this section presented Action Plans suggested by the people who participated in the final survey, to ensure business success.