Using Analytic Hierarchy Process for the Evaluation of Large IT Systems

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Abstract. The project entails the development and implementation of an enterprise wide system to enable the company to effectively manage its resources. The project called for the submission of proposals in a limited tender to selected suppliers. Due to the cost and complexity of the project, the Analytic Hierarchy Process was used in the evaluation process. Selection of the criteria and the assignment of weights to the criteria was a challenging task as different stakeholders have different perception on the importance of each of these criteria due to the relevance to their specific area of concerns. This paper deliberates on the process by which the project team develops the criteria, the rationale behind the weights assigned and how the judgements of the different stakeholders are reconciled.

Background

The Venture System project entails the development and implementation of an enterprise wide system for the company. It is an effort to transform the existing information systems into an integrated unified system for enhanced visibility and control.

The Analytic Hierarchy Process (AHP) mechanism had been used for the evaluation of this tender due to the complexity, extensive developmental effort and high implementation cost of the project.

Through a limited tender, four vendors - Vendor A, Vendor B, Vendor C and Vendor D were invited to submit their proposals. Only Vendor A and Vendor B responded with a full proposal at the close of the tender.

Several sessions were arranged for the two vendors to present their proposals to the Project Management Team (PMT) and for the PMT to seek clarifications. The PMT comprised of representatives from all the stakeholders and users of the project. These clarification sessions helped the PMT better understand the benefits and setbacks of each proposal thus paving the way for a more objective and equitable comparison to be done on the two proposals.

Selection of Criteria and Assignment of Weights

Selection of criteria and assignment of weights were challenging, as different stakeholders have different perception on the importance of each of the criteria used, depending on the relevance of the criteria to their specific area of concern. Each stakeholder would want to a greater weight to be allocated to his area of interest to maximise the chances of the eventual winner meeting the attributes that are more valuable to him.

The key concern of the PMT was the complexity of the project. Many stakeholders were involved. More than 50 business scenarios were to be developed. The system would be rolled out to more than 5,000 users. The project was started 2 years before – the blueprint of the business processes was already completed and the implementation of the first phase had already been carried out. The selected Tenderer would thus be coming in mid-stream in the project. The schedule involved a 2-phase roll-outs, and all implementations were to be carried out on the same hardware. The risks involved were high. Therefore it was not surprising that one of the key criteria was Program Risks. To mitigate this, the successful vendor was required to have adequate project management skills and experience in managing large and complex projects. The Tenderer was therefore expected to provide a strong management team coupled with experienced consultants with strong technical skills. In addition, the Tenderer was expected to have domain knowledge in the user business areas as well as in the specified ERP software so as to be able to recommend commercial best practices and solutions.

For an Information Technology project such as this, the success of the project is also dependent on the Tenderer's experience in Implementation, Testing and Deployment. The quality of the Tenderer's proposal for Landscape Management (hardware) and Configuration Management Plan (for documentation and software version controls), integration and data migration strategy were also key considerations.

Selection of criteria was first carried out through brainstorming sessions with the various users, and facilitated by the PMT. This was followed by the assignment of indicative weights to each of the selected criteria. For each criterion, the scores used by the PMT were taken as the collective consensus score from the various teams. This agreed set of weighted criteria was later presented to the Project Steering Committee for final comments and approval. This was to ensure that consensus and support from across the wide community had been sought and endorsed.

As there were only two proposals to be evaluated, the scale range of 1.0 to 1.9, as shown in Table 1, was used so as not magnify the disparities between the two proposals.

Table 1 – Scale used for Evaluation

Intensity	Definition	Explanation
1.0	Equal Advantage	Two Tenderers have equal strength in the considered criteria
1.3	Moderate Advantage	Experience and judgment slightly favour one Tenderer over the other
1.5	Strong Advantage	Experience and judgement exhibit strong favour for one Tenderer over the other
1.7	Very Strong Advantage	A Tenderer is strongly favoured and its dominance is demonstrated in practice
1.9	Absolute Advantage	The evidence favouring one Tenderer over the other is of the highest possible order of affirmation
1.1, 1.2, 1.4,1.6, 1.8	Intermediate values between two adjacent judgements	When the assessment of the Tenderers is in between the above

Detailed Description of Criteria and Weights for Benefit Assessment

Three Level 1 criteria were used for this evaluation. They were Program Risks, Domain Knowledge and Quality of Solution. The Level 1 criteria were cascaded downwards to Levels 2 & 3 criteria and were further weighted, through consensus. The detailed assessment is as follows:

1. Program Risks – 17.4%

1.1 Project Management Team (PMT) Experience – 7.9%

Tenderers were evaluated based on the following aspects of the project management team:

1.1.1 Ability to Identify Risk and Propose Risk-Mitigation Strategy – 1.98%

The ability of the project management team to identify risks comprehensively, provide an effective mechanism and process to manage the identified risks over the entire development life cycle as well as their ability to creatively and effectively mitigate such risks to an acceptable level.

Tenderers were viewed more favourably if they exhibited the ability to identify project related risk and had proposed feasible in-depth Risk-Mitigation Strategy.

1.1.2 Ability to Ensure Complete Integration of the entire 3 phases of implementation – 1.98%

Tenderers were viewed more favourably if they exhibited the ability to identify and consider all the various essential components necessary for the complete integration of the entire 3 phases of implementation. This included considerations for integration of the system with interfaces to external systems.

1.1.3 Ability to Manage Large and Complex Implementation with reference to similar operating environment – 1.98%

The ability of the project management team to manage large-scale and complex projects in similar operating environment with high development cost and development duration of at least 1 year.

Tenderers were viewed more favourably if they have previous experience on large and complex projects in similar operating environment.

1.1.4 Ability to Manage Large-Scale Defence Related Enterprise wide ERP Implementation – 1.98%

The ability of the project management team to manage large-scale Defence Related Enterprise wide ERP implementations with high development cost and development duration of at least 1 year.

Tenderers were viewed more favourably if they have previous experience on large-scale Defence related Enterprise Wide ERP Implementation.

1.2 Manpower Resource Loading & Profile – 9.5%

Tenderers were evaluated based on the following aspects of the manpower resource loading and profile:

1.2.1 Feasibility of Month to Month Resource Planning and Allocation – 4.75%

Tenderers were viewed more favourably for appropriate number of Full Time Equivalents (FTE) assigned monthly based on Schedule/Work Breakdown Structure and profile loading with reference to concurrent implementation.

1.2.2 Project Team Structure and Profile – 4.75%

Tenderers were viewed more favourably for appropriate:

a. Organisation Structure
Tenderers were viewed more favourably for consolidated and well defined project organisation that was staffed with an experience team with competent key players in critical position for the overall integration.

b. Number of FTEs
Tenderers were viewed more favourably for more number of FTEs provided to support the successful implementation of the project.

c. Number of Key Roles & Relevant Experience Level
Tenderers were viewed more favourably for the assignment of appropriate and experienced management staff (Program Director, Program Manager or Project Manager) to the project.

2. Domain Knowledge – 19.2%

2.1 Project Team Combination of Expertise – 9.6%

Tenderers were evaluated on the project team combination of expertise based on the following:

2.1.1 Ability to Provide Best Mix of Project Team Members with Appropriate Combination of Required Expertise – 4.8%

Tenderers were viewed more favourably if they exhibited the ability to provide best mix of Project Team members with appropriate combination of key Functional, Technical and Implementation Expertise. Strong Consortium/Partnerships with clearly defined roles were viewed more favourably.

2.1.2 Ability to Gather and Put in Additional Expertise, if Required – 4.8%

Tenderers were viewed more favourably if they are able to gather additional Expertise quickly (either world-wide or locally), if required. In addition, a Tenderer with a Senior Management team that demonstrated stronger commitment was viewed more favourably.

2.2 Enterprise-Wide Technical Expertise in specified ERP software – 9.6%

Tenderers should have adequate knowledge and experience in the areas of Engineering & Maintenance Management (EM), Supply Management (SM), Financial & Controlling (FC) Modules as well as New Dimension modules in order to ensure its successful implementation. Tenderers were evaluated based on the following:

2.2.1 Previous Experience in Engineering & Maintenance Management (EM), Supply Management (SM), Financial & Controlling (FC) Modules – 4.8%

Tenderers were viewed more favourably if the proposed Project Team has previous experience on EM, SM and FC domain knowledge (business, design or technical domain knowledge).

2.2.2 Previous Experience in New Dimension Modules - Business Information Warehouse (BW) and ePortal – 4.8%

Tenderers were viewed more favourably if the proposed Project Team has previous experience in New Dimension Modules - Business Information Warehouse (BW) and ePortal.

3. Quality of Solution – 63.4%

This criterion had been given the highest weight as the comprehensiveness of the implementation approach and strategy for the realisation of the project is crucial to the success of this project.

3.1 Compliance with Requirements – 31.5%

As the scope of the project is extensive, Tenderers were evaluated based on the number and extent of compliance to the following:

3.1.1 Compliance with Technical/Functional Specifications – 10.7%

It is important that the Tenderers comply with the User's Functional Requirements to ensure that the Users' operational needs are met. Tenderers who complied more with the Technical Requirements were viewed more favourably.

3.1.2 Compliance to deliver user-specific requirements – 8.5%

Proposed solutions were assessed on:

a. Whether it delivers the expected outcome for each phase of rollout within the stated schedule.
b. Tenderers' understanding on the crucial and key issues related to the project as well as the overall project development.

3.1.3 Feasibility of Proposed Solution – 9.2%

Tenderers were viewed more favourably if they were able to provide:

a. Schedule Feasibility (option mix)
b. Feasible Data Migration Programme

3.1.4 Compliance with Tender Clauses – 3.1%

Tenderers who complied with more of the contractual requirements were viewed more favourably.

3.2 Comprehensive Approach & Strategy for Delivery of the project – 23.3%

This criteria was evaluated based on the following:

3.2.1 Comprehensive Configuration Management Plan – 9.6%

Tenderers were viewed more favourably if they exhibited the ability to propose feasible:
a. Document Management Control
b. Baselining of Documentation with respect to concurrent development
c. Source Code / Transport Management Control

3.2.2 Comprehensive Landscape Management Strategy – 6.1%

Tenderers were viewed more favourably if they exhibited the ability to propose feasible Landscape Management solution that reduces the implementation risk and enhances the synchronisation of concurrent development of the project.

3.2.3 Comprehensive Implementation, Testing and Deployment Strategy – 7.6%

Tenderers were viewed more favourably if they exhibited the ability to propose feasible Testing and Deployment Approach that could reduce the effort required as well as to minimise the risk involved.

3.3 Quality of Proposal – 8.6%

This criteria was evaluated based on the following:

3.3.1 Additional Value-added Proposal / Solution – 2.9%

Tenderers were viewed more favourably if they exhibited the ability to provide additional in-depth advice such as benefits assessment, overall integration, management and control, suitable configuration management controls/tools as well as feasible and efficient data migration strategy.

3.3.2 Comprehensiveness, Completeness of Proposal – 5.7%

Tenderers were viewed more favourably if they complete and revert with all required sections in the tender returns during tender submission. The completeness and clarity of the tender returns were evaluated.

Benefit Assessment

While both proposals met the needs of the tender, overall, Vendor B scored a relative benefit ratio of **0.514** while Vendor A scored a relative benefit ratio of **0.486**. In summary, Vendor B scored better for Program Risks (9% vs 8.4% for Vendor A) for their more thorough program Risk Analysis and a more practical Risk Mitigation Strategy based on actual implementation experience. For Domain Knowledge, Vendor A scored better (9.9% vs 9.3% for Vendor B) as they have the advantage of incumbent knowledge of the business blueprint (design). For Quality of Solution, Vendor B scored better (33.1% vs 30.3% for Vendor A) based on their stronger technical proposals for Landscape Management, Data Migration, Deployment and Testing Strategies.

The relative benefit ratio of the two vendors were calculated as follows:

$$\text{Relative Benefit Ratio (Vendor A)} = \frac{0.486}{0.514} = 0.95$$

$$\text{Relative Benefit Ratio (Vendor B)} = \frac{0.514}{0.514} = 1.00 \Rightarrow \text{(Vendor B has advantage)}$$

Cost Ratio and Benefit-Cost Assessment

The tender price was released to the PMT after the endorsement of the Benefit Assessment. Vendor A quoted $A and Vendor B quoted $B, where $A is greater than $B. The relative cost ratios are as follows:

$$\text{Relative Cost Ratio (Vendor A)} = \frac{\$A}{\$A} = 1.00$$

$$\text{Relative Cost Ratio (Vendor B)} = \frac{\$B}{\$A} = 0.82 \Rightarrow \text{(Vendor B has advantage)}$$

The benefit-cost indices are therefore

$$\text{Benefit-Cost Index (Vendor A)} = \frac{0.95}{1.00} = 0.95$$

$$\text{Benefit-Cost Index (Vendor B)} = \frac{1.00}{0.82} = 1.22 \Rightarrow \text{(Vendor B has advantage)}$$

Overall, Vendor B has the higher Benefit-Cost Index of 1.22 compared to Vendor A's Benefit-Cost Index of 0.95.

In the tender, Vendor B has requested for the provision of training briefs on the current implementation and the design blueprints. This incurred an additional cost of $X to the User. This additional cost was added to the price of $B proposed by Vendor B to derive the new Benefit-Cost Index. Note that $B + $X is still lower than $A. Hence the new relative cost ratios are as follows:

$$\text{Relative Cost Ratio (Vendor A)} = \frac{\$A}{\$A} = 1.00$$

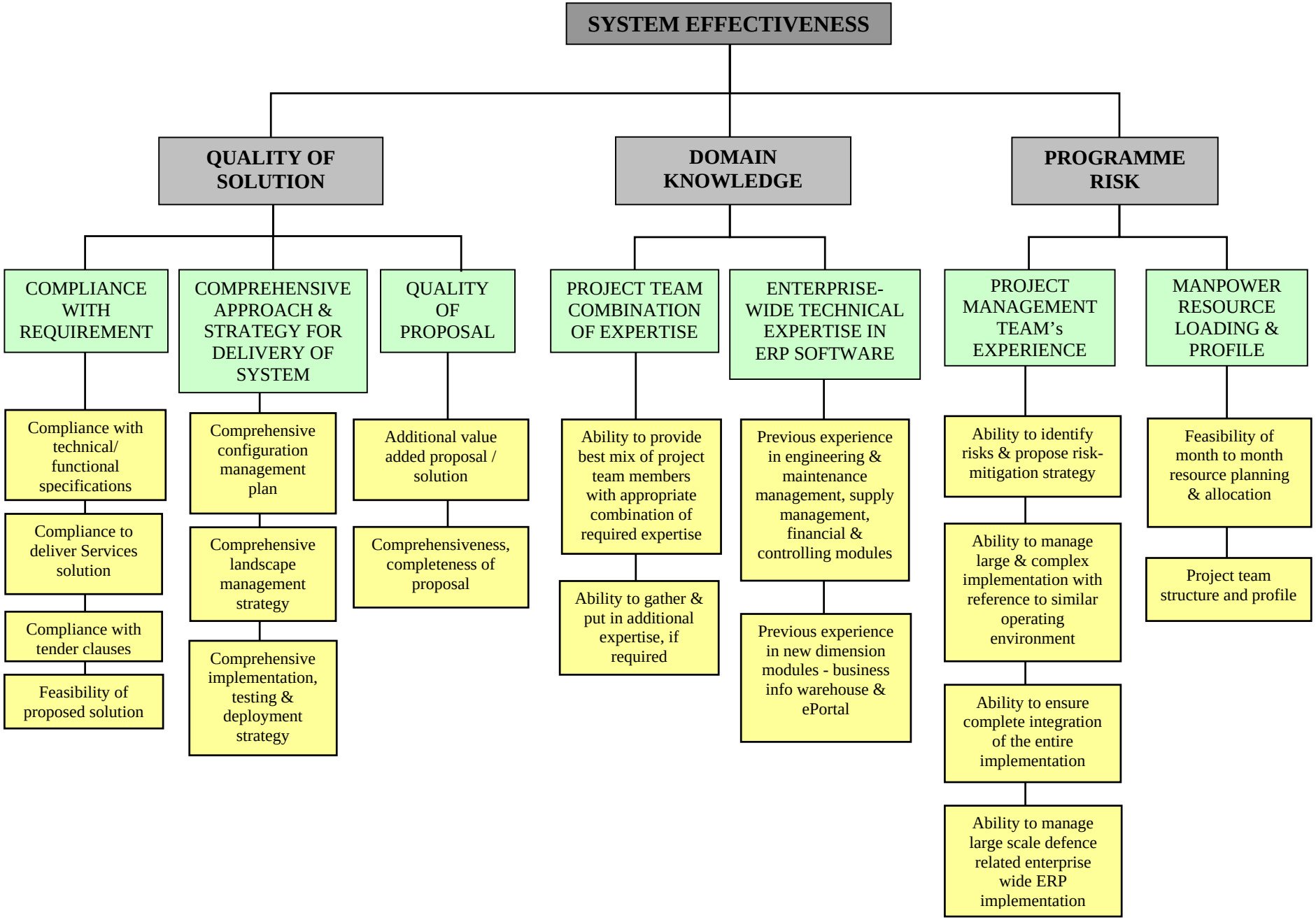
$$\text{Relative Cost Ratio (Vendor B)} = \frac{\$B + \$X}{\$A} = 0.89 \Rightarrow \text{(Vendor B has advantage)}$$

The new Benefit-Cost Indices are as follows:

$$\text{New Benefit-Cost Index (Vendor A)} = \frac{0.95}{1.00} = 0.95$$

$$\text{New Benefit-Cost Index (Vendor B)} = \frac{1.00}{0.89} = 1.12 \Rightarrow \text{(Vendor B has advantage)}$$

Vendor B still has a higher benefit-cost index even with the cost of training included. Hence the PMT recommended that Vendor B be awarded the contract.


SYSTEM EFFECTIVENESS
QUALITY OF SOLUTION
DOMAIN KNOWLEDGE
PROGRAMME RISK
COMPLIANCE WITH REQUIREMENT
COMPREHENSIVE APPROACH & STRATEGY FOR DELIVERY OF SYSTEM
QUALITY OF PROPOSAL
PROJECT TEAM COMBINATION OF EXPERTISE
ENTERPRISE-WIDE TECHNICAL EXPERTISE IN ERP SOFTWARE
PROJECT MANAGEMENT TEAM's EXPERIENCE
MANPOWER RESOURCE LOADING & PROFILE
Compliance with technical/ functional specifications
Compliance to deliver Services solution
Compliance with tender clauses
Feasibility of proposed solution
Comprehensive configuration management plan
Comprehensive landscape management strategy
Comprehensive implementation, testing & deployment strategy
Additional value added proposal / solution
Comprehensiveness, completeness of proposal
Ability to provide best mix of project team members with appropriate combination of required expertise
Ability to gather & put in additional expertise, if required
Previous experience in engineering & maintenance management, supply management, financial & controlling modules
Previous experience in new dimension modules - business info warehouse & ePortal
Ability to identify risks & propose risk-mitigation strategy
Ability to manage large & complex implementation with reference to similar operating environment
Ability to ensure complete integration of the entire implementation
Ability to manage large scale defence related enterprise wide ERP implementation
Feasibility of month to month resource planning & allocation
Project team structure and profile

Conclusion

The use of AHP together with the 2-envelope system, i.e., assessing and confirming the relative benefit ratio based on the merits of the individual proposal, followed by determining the benefit-cost indices was a fair, robust and objective method of evaluation. In the conventional evaluation, where the cost envelope was opened and evaluated together with the benefits of the proposal, the evaluation team might be swayed towards the vendor with the lowest / lower quote as it would be much more difficult to justify the award to a vendor with a higher quote but with better proposal.

The following are some of the valuable lessons learnt through the AHP evaluation process:

- AHP evaluation criteria and assigned weights need to be justified, defended and finally agreed with all key stakeholders and supported by higher management (e.g. steering committee). This process could be tedious if there were differing views and could take longer than expected. A firm and fair facilitator, with good knowledge of the system concerned, helps greatly in the success of this process.
- Ample time has to be catered for AHP evaluation as there may be a need to seek clarifications with the Tenderers after the cost envelope is opened as there could discrepancies, incomplete information, insufficient details, etc. This may lead to schedule overrun for the evaluation.
- The weights given for each criterion varies from project to project, depending on the area of concern and the possible high-risk area. It is good to categorise and rank the criteria first prior to the weight allocation process.
- Key Users, especially those involved in the AHP evaluation, should be briefed or even trained on the AHP procedure and process so that they are conversant with the methods used and the implication of their decisions made. This will also set their expectation right.
- AHP evaluation team needs to be familiar with the use of the software “Expert Choice” for the benefit assessment. It would be good if one or more of the PMT member is familiar with the basic working mathematical model used in “Expert Choice” as a simple spreadsheet could be used for the initial estimates of the relative benefit during the consensus process.
- PMT needs to finalise the firm options / requirements prior to the open of the cost envelope as inclusion of optional item/s (if any) in the contract will affect the final Benefit-Cost Index.
- For future references, the AHP evaluation template/s with the most used criteria for IT Projects could be compiled. Past project teams using AHP could also conduct sharing sessions to share some of the “DOs and DON’Ts”.