Journal of Information Technology Management

ISSN #1042-1319

A Publication of the Association of Management

A FRAMEWORK FOR LINKING SOFTWARE PROJECT REQUIREMENTS TO BUSINESS VALUES

RAHUL THAKURTA
XAVIER INSTITUTE OF MANAGEMENT BHUBANESWAR
rahul@ximb.ac.in

MAYANK GUPTA
INFOSYS TECHNOLOGIES LIMITED
mayank_gupta@infosys.com

ABSTRACT

With increasing dependence on IS/IT, organizational IT investments have inflated in the last couple of decades. There is an increasing expectation that investments in the IT systems will result in greater value for the business organizations. All these justify the needs for methods to assess the business value of IT-investments. The investment decision is primarily about selecting the right combination of IT-systems that is able to provide the maximum business value in dimensions that are important business-wise. However a larger issue is that many of the available methods in this regard fails to provide explanations of what technical characteristics the IT systems(s) should have to achieve the business value desired. The evaluation process is further complicated because of the presence of high degree of uncertainty.

In this research, we present an IT investment evaluation framework in order to indicatively assess the differences in contribution to business value from IT-investment alternatives. The framework provides indications of both the technical differences between the IT-investment alternatives in a specific investment situation, and an assessment of the differences in types and amounts of their business value in a cost effective manner. The results are expected to assist project organizations to better negotiate project requirements that cater to the chosen IT-investment alternative, and in the process contribute towards greater fulfilment of business objectives.

Keywords: business value, IS/IT investment, use case, non-functional requirements

INTRODUCTION

Enterprises today increasingly rely on IS/IT to conduct their business [19]. The increased complexity and integration issues stand as a barrier to achieving the full potential hoped to be achieved by IT investments [10]. The IT system(s) with the most functionality, the best information security, the best data quality, etc might not be the best IT -system(s) for an organization. The best IT system(s) is likely to be the one which provides the most value in dimensions that is important business-wise, for instance in terms of increasing business processes efficiency, enabling a more flexible organizational structure, improving decision making etc [10]. Furthermore, the business value of the IT-investment is also influenced by the functionalities that the system offers, and its other non-functional qualities such as how easy the IT system(s) are to use, the data quality in the system, the information security etc [10]. Hence any investment evaluation needs to include technical assessment of the investment and to relate this assessment to the impact on business value [10].

The history of 'value' concept can be traced back to the 17th century when the philosophers and the ethicists used to define value as a normative approach to separate right from wrong [1]. The basic concept of value in economic theory [17] can be traced to the 19th century. Mill [17] defined value at a very abstract level in terms of use and exchange value. The concept of value evolved into the 'value adding' concept in the 20th century, and was found to be embraced as a term associated with product development [1]. This approach was based on the notion that value was related to long-term relationships between the customer and the company organization. Value was created in cooperation with the customer where the customer was an active participant in value creation activities [12, 21]. The concept of value-based approach in software engineering was introduced in the context of decision-making about product lines [8], managing investments in reusable software [9] and software economics [4]. The value-based approach has attracted both software practitioners and academics in their efforts to integrate business value considerations in software principles and practice [3].

Resource constrain sometimes act a barrier to this IT investment evaluation exercise [10]. Ballantine and Stray [2] based on six different studies concludes that very few simplistic methods are used in practice in this regard. It appears that organizations either avoid or tend or prefer simplistic approaches considering the fact that an extensive evaluation would be both time consuming and resource intensive. The evaluation process also involves high degrees of uncertainty. The information required for evaluation could be highly subjective, incomplete, and contradictory apart for the fact that benefit evaluation is intangible [20]. All this implies that an IT-investment evaluation method also should incorporate ways to measure the extent of inherent uncertainty in order to provide a reliable estimate of the business value.

In this research, we take into account the above considerations to arrive at a framework that will enable one to evaluate the business values of different investment alternatives. The framework which is an extension of Gammelgård's [10] contribution is expected to provide an indication of not only the technical differences between the IT-investment alternatives, but also the differences in types and amounts of business value the investment alternatives can be expected to generate. The different investment alternatives which we refer to as 'scenarios' represent implementations of single IT system or combinations of IT systems and support specific business objectives. The assessment process contained within the framework is based on relative valuation wherein the business value is assessed at the capability/utility level and not at direct revenue/cost contribution level (elaborated later). The process also does not require detailed metric driven analysis thereby making it to be easily implementable in organizations.

This paper is organized in the following sections. The next section introduces the business value assessment framework which we elaborate in this paper. Subsequently we detail on the eleven steps of the assessment process using a case study. Finally the last section summarizes the findings, and offers direction for future research.

BUSINESS VALUE ASSESSMENT APPROACH

We adopt a eleven step framework (Table 1) in order to arrive at the business value contributions of the different investment alternatives. The third column indicates for each of the steps, the key stakeholders who provide the inputs for that step.

Table 1: Steps in Business Value Assessment

Step #	Description	Inputs Provided By
1	Prioritization of business value dimensions	Business organization representatives
2	Identification of non-functional requirements (NFRs)	
3	Creation of project level scenarios	Project organization representatives
4	Linking scenario to business value dimensions	
5	Assessment of scenarios (use cases, NFRs)	
6	Adjustment of scenario NFR scores	Computation steps
7	Derivation of scenario technical assessment score	
8	Derivation of relative business contributions	
9	Assessing credibility of responses	Project organization representatives
10	Derivation of adjusted business contributions	Computation steps
11	Derivation of aggregate business contribution	

Taking help of a case study, we now try to show how these steps can be applied leading to derivation of business value contributions of different investment alternatives.

BUSINESS VALUE EVALUATION - A CASE STUDY

The case study was conducted at a leading information technology services organization with headquarter in Bangalore, India, and offices worldwide. The organization follows a global delivery model for delivering IT services to its different clients. The IT service is organized as an onsite/offshore delivery model and uses industry standard frameworks for providing solutions to the business. The projects follow standard organizational framework. The teams caters to the organizational capabilities for performing the various project related activities like planning, scheduling and tracking, review and audit, requirements management, test management, defect and issue management. Detailed data about the process is regularly captured and stored in the software environment.

The proposed framework was refined and validated based on a questionnaire based approach carried out on a live organizational project which was still in its early stages. The project in concern intended to develop an exam assessment system in order to facilitate conducting, assessing and reporting of university examinations. Given the project context, the assessment framework was applied in order to judge its suitability and also identify areas of refinements. Each step is elaborated below.

Step1: prioritization of business value dimensions

Business value refers to all forms of value that determine the health and well-being of an organization in the long-run. Business value expands the concept of value of the organization beyond economic value (i.e. economic profit) to include other forms of value such as employee value, customer value, supplier value, channel partner value, alliance partner value, managerial value, societal value, etc[1]. Thus business value is looked upon in terms of the capabilities that the organization possesses. An increase in these capabilities results in fulfilment of the broad objectives of business like value enhancement, cost reduction. The business values in turn can be combined into related categories which are known as business value dimensions (BVD). Based on a literature review of documented benefits and business value of IT-systems [11], 24 BVDs could be identified. A description of these BVDs is included in the Appendix.

In the first step, these 24 BVDs were presented to two representatives from the business organization. The respondents were asked to prioritize the dimensions, with the priority values indicating the imperatives and focus areas from purely a business point of view. Numerical Assignment Technique [15] was used for prioritization on a scale of 0 (implying 'not at all important') to 9 (implying 'extremely important'). The final priority value of a BVD is the average of the individual ratings ascribed to it by all the stakeholders, and indicates the relative ranks associated with the dimensions. The results of prioritization provided in Table 2 suggests that the business considers 'Customer Relations', 'Competitor Relations', 'Decision Making', 'Strategy Formulation and Planning' and 'Control and Follow-up' to be the prime foci considering their organizational objectives. Hence projects that address these areas successfully are likely to be more impactful from the business perspective.

[1] http://en.wikipedia.org/wiki/Business_value

Table 2: Prioritization – Business Value Dimensions

		Assigned Priority (Individual Ratings)			Priority (Average)	Ranks
	Business Value Dimensions	**Assessor 1**	**Assessor 2**	**…**		
Organization External Interface	**Inbound logistics**	8	6		**7.0**	**4**
	Supplier Relations	7	6		**6.5**	**5**
	Customer Relations	9	7		**8.0**	**2**
	Competitive Dynamics	9	6		**7.5**	**3**
	Competitor Relations	7	9		**8.0**	**2**
	Business Innovation	7	6		**6.5**	**5**
	Product and Service Enhancement	9	6		**7.5**	**3**
	Deliveries	9	5		**7.0**	**4**
	Third Party Relations	8	3		**5.5**	**7**
	Marketing Support	7	5		**6.0**	**6**
Organization Resources	**Decision Making**	8	8		**8.0**	**2**
	Learning and Knowledge	7	5		**6.0**	**6**
	Organization Culture	6	2		**4.0**	**8**
	Information	8	5		**6.5**	**5**
	Technology/tools	7	8		**7.5**	**3**
Structure of Business Organization	**Strategy Formulation and Planning**	9	7		**8.0**	**2**
	Organizational Effectiveness and Efficiency	8	4		**6.0**	**6**
	Economies of Production	8	5		**6.5**	**5**
	Communication	7	6		**6.5**	**5**
	Flow of Products/Services	7	4		**5.5**	**7**
	Control and Follow Up	9	8		**8.5**	**1**
	Change Management	7	6		**6.5**	**5**
	Integration and Coordination	6	5		**5.5**	**7**
	Flexibility	8	7		**7.5**	**3**

Step2: identification of non-functional requirements (NFRs)

Non-functional requirements (NFRs) represent the services or functions offered by the system. These apply to the system as a whole, and describe the capabilities of the system. NFRs include timing constraints, constraints on the development process and standards. Based on a literature review [7, 18], we arrived at a list of 20 NFRs which are regarded as important from project and user perspectives. The interpretations of these are provided in the Appendix. Here we requested the business representatives to identify the NFRs which they think would assist the proposed project (i.e. the investment decision choice in concern) in achieving the intended business objectives. The respondents were asked to rate each of the 20 NFRs on a scale of 1-5, with five representing 'most relevant'. Table 3 lists the 17 NFRs which were

considered to be more relevant (i.e. having a rating of four or five) in the context of the proposed project.

Step 3: creation of project level scenarios

Scenarios represent alternate investment decision choices which might realize business objectives better than the initially proposed requirements set [10]. The objective of creating the scenarios is to come up with alternate development choices having greater contribution to overall business objectives. Each scenario can be visualized as a system with specific capabilities (i.e. NFRs), and providing some functionality to the business. Figure 1 presents a component level view of a typical scenario.

Table 3: NFRs considered more relevant from business perspective (value within bracket specifies the rating assigned to each)

• Availability & Reliability (5)	• Compatibility (4)
• Compliance (4)	• Constraints (4)
• Human Engineering (4)	• Security (5)
• Integrity (5)	• Interoperability (4)
• Flexibility (5)	• Installability & Portability (5)
• Reusability (5)	• Stability/Resilience (4)
• Maintainability (4)	• Usability (5)
• Resource Savings (5)	• Workload Capabilities (4)
• Durability (4)	

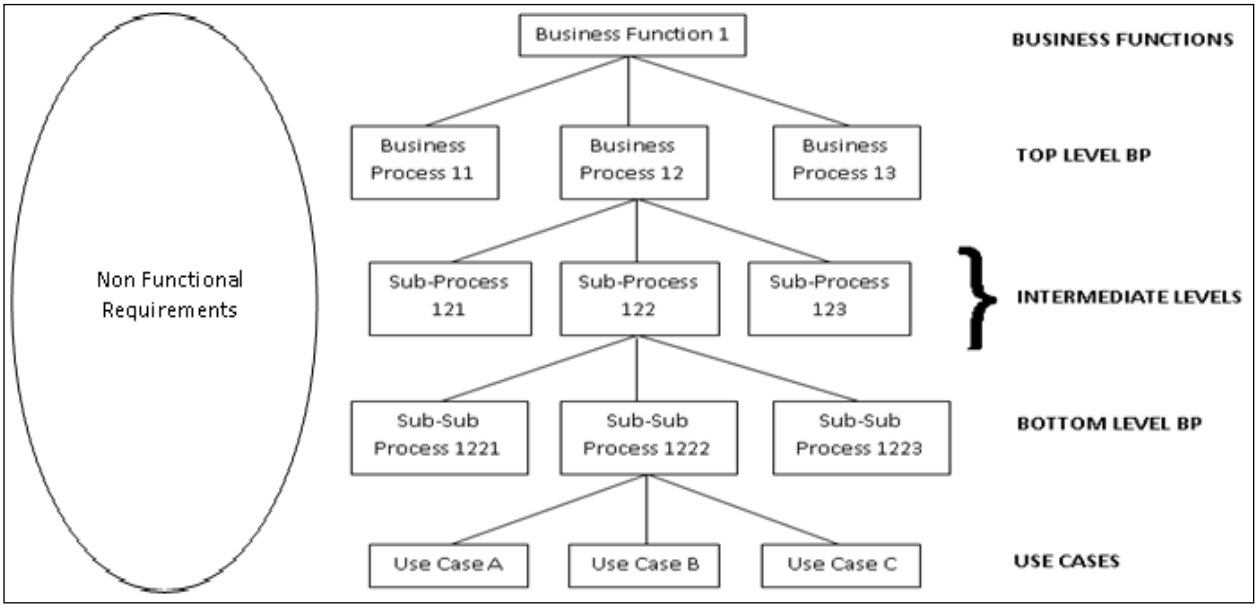

Figure 1: Components of a Scenario

As it can be seen from Figure 1, a scenario consists of the following components:

- **Business Function:** Business function identifies **WHAT** an organization does[2]. A business function is carried out by the organisation, organisation unit or business role. An organisation can be designed as a set of business functions and usually the structure of the organisation units within an organisation is closely based on the business functions. Examples of business functions include: sales, marketing, supply chain management, financial management, operations, product management, supplier/partner relationship management, etc.
- **Business Process:** A business function can be broken up into several processes. A business process indicates **HOW** the work identified by the business function is accomplished[2]. It often can be visualized with a flowchart as a sequence of activities. Some examples of business processes say within the supply chain management (business function) are: goods acquisition, services acquisition, inventory control, etc. A business process can be further decomposed into several sub-processes, which have their own attributes, but also contribute to achieving the goal of the super-process. The analysis of business processes typically includes mapping of processes and sub-processes down to use-case (which are descriptions of 'who' does 'what' with the system in question) level. The top-level business processes are those which are directly linked to business function. The sub-processes occupy intermediate levels depending upon the extent to which the sub-processes can be further split up. The bottom-level business processes are mapped to the **use cases** that are finally implemented.

  The top-level business processes can again be grouped into two broad categories:

  - **Industry-level Business Process:** This is the set of business processes which completely describes the business function. Awareness of the industry-level business processes can be achieved based on experiences in previous projects, domain experiences, based on published standards, etc.
  - **Project-level Business Process:** This is the subset of the industry-level business processes which is addressed within the proposed project scope.

Other than the components stated above, a scenario also consists of the set of NFRs as shown in Figure 1. The NFRs here represent the property of the concerned scenario as a whole. Here we make a distinction between any two scenarios in the following ways:

- There must be atleast one difference in the range of functionalities (i.e. use cases) offered by any two scenarios
- The scenarios may also have differences in the capabilities where capabilities refer to system NFRs like usability, availability, etc.

For the exam assessment system case study, we created two hypothetical scenarios as given in Figure 2. Scenario A consists of two top level business processes i.e. 'Entries Management' and 'Product Definition'. Within 'Entries Management', Scenario A implements functionalities related to bottom level business process: 'Entries Submission' and 'Exceptions Mgmt', and within 'Product Definition' functionalities related to 'Assessment Setup' are implemented. Scenario B consists of three top level business processes i.e. 'Product Definition', 'Scripts Tracking', and 'Results Production'. 'Product Definition' is thus common to both Scenarios A and B. Within 'Scripts Tracking', Scenario B implements functionalities related to two bottom level business processes viz. 'OMR Scripts Handling' and 'SCORIS – Scripts Handling'. Within 'Results Production', functionalities related to 'Result Enquiry Verification' are implemented in Scenario B. The NFRs relevant to each of the Scenarios A and B have also been shown in the figure.

[2] http://it.toolbox.com/enterprise-solutions/guidelines-for-decomposing-business-functions-and-processes-14635

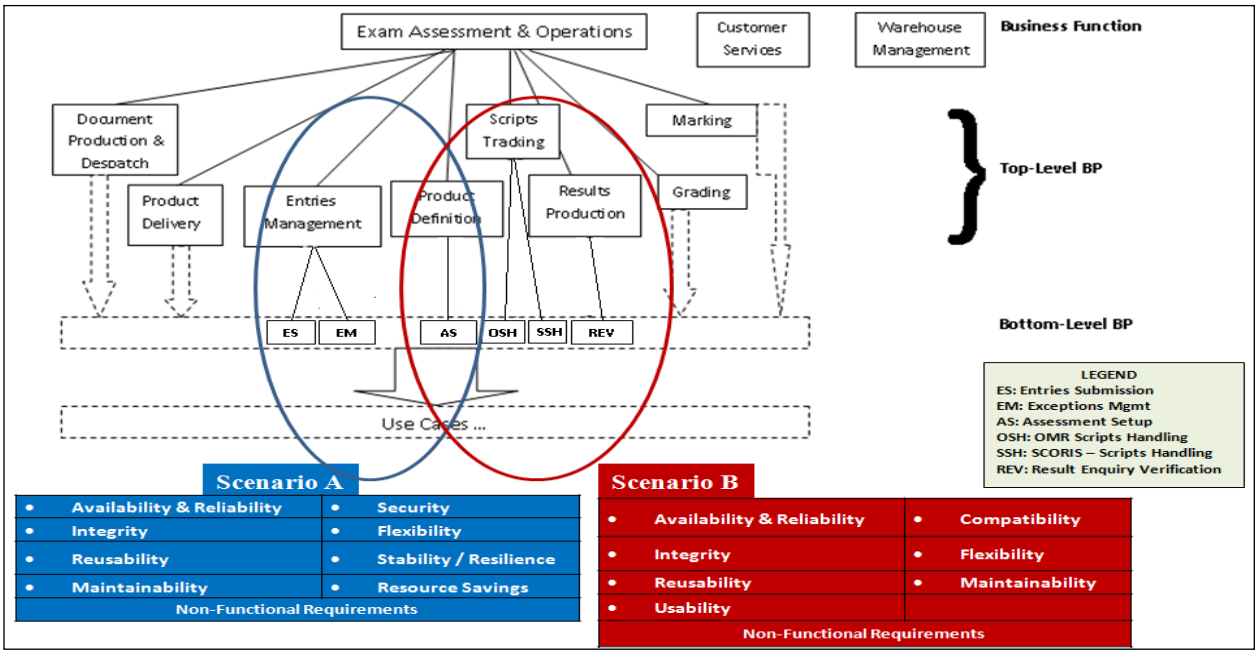

Figure 2: Scenarios A and B

Step 4: linking scenario to business value dimensions

Here we estimate the contribution of the conceived scenarios on each of the BVDs identified in Step 1. The assessment is carried out at the level of bottom-level business processes constituting each scenario. A scale of 1 (minimum) – 9 (maximum) is used as a measure of the extent of direct contribution of the business processes on the BVDs. Absence of association is indicated with zero. One assumption behind these ratings is that the scenarios considered here are at the same level in terms of technical fulfilment (addressed later). The same business process belonging to different scenarios can also have different levels of contribution to a given BVD; the difference attributed to differences in use-cases making up the business process, and the capabilities influencing these business processes.

For the case study considered here, the contribution of the constituent business processes on the BVDs of the two Scenarios A and B is given in Table 4. Step 1 identified five BVDs (i.e. Customer Relations, Competitor Relations, Decision Making, Strategy Formulation and Planning, and Control and Follow-up) to be the prime foci from the organization's perspective. Table 4 indicates that Scenario A better relates to 'Customer Relations' (since 2 of the 3 constituent BPs' i.e. 'Entries Submission' and 'Exceptions Mgmt' are attributed a high (8/9) rating on this dimension), while Scenario B better relates to 'Competitor Relations', 'Strategy Formulation and Planning', 'Control and Follow-up' (since 3 of the 4 BPs i.e. OMR Scripts Handling, SCORIS - Scripts Handling , Result Enquiry Verification are attributed a high (8/9) rating on these 3 dimensions).

Intuitively, it also appears from the results that with the technical competency of the scenarios assumed to be at par, Scenario B contributes to more value fulfilment. Step 4 results also suggest ways by which scenarios can be improved. For example, the BVD: 'Decision Making' was found to be lowly rated in both the scenarios. Since 'Decision Making' assumes priority from the business perspective (Step 1), hence scenarios which is also able to address this is likely to contribute towards more value fulfilment.

Table 4: Business Process Contribution on Business Value Dimensions

		Scenario A			Scenario B			
		Bottom-Level Business Processes			Bottom-Level Business Processes			
	Business Value Dimensions	Assessmnt Setup	Entries Submission	Exceptions Mgmt	Assessment Setup	OMR Scripts Handling	SCORIS - Scripts Handling	Result Enquiry Verifictn
Organization External Interface	Inbound logistics	7	7	7	7	7	8	7
	Supplier Relations	6	7	7	6	8	8	7
	Customer Relations	7	9	8	7	7	7	7
	Competitive Dynamics	9	9	8	9	8	8	8
	Competitor Relations	7	7	8	7	9	9	9
	Business Innovation	8	7	6	8	7	6	6
	Product and Service Enhancement	9	8	8	9	8	8	8
	Deliveries	9	9	8	9	8	8	9
	Third Party Relations	5	5	5	5	5	5	5
	Marketing Support	3	5	3	3	3	3	3
Organization Resources	Decision Making	6	4	5	6	5	6	6
	Learning and Knowledge	3	3	3	3	3	3	3
	Organization Culture	3	3	3	3	3	3	3
	Information	6	6	5	6	5	5	5
	Technology/tools	3	3	3	3	2	2	4
Structure of Business Organization	Strategy Formulation and Planning	8	8	7	8	8	8	8
	Organizational Effectiveness and Efficiency	7	7	8	7	8	8	8
	Economies of Production	7	7	8	7	8	8	8
	Communication	7	8	8	7	7	7	7
	Flow of Products/Services	7	7	7	7	7	7	7
	Control and Follow Up	7	7	8	7	8	8	8
	Change Management	3	3	3	3	4	3	3
	Integration and Coordination	4	4	4	4	4	4	4
	Flexibility	8	6	6	8	8	8	7

In order to figure out which of these two scenarios contribute more on the BVDs, the ratings given in Table 4 are normalized on a 0-9 scale for both the scenarios. The normalized ratings are shown in graphical format in Figure 3.

Step 5: assessment of scenarios (use cases, NFRs)

The assessment procedure up to this point is based on the assumption that the constructed scenarios are at par with respect to their technical competencies. At this point, we assess the technical qualities of the scenarios based on the following considerations:

- ***Step 5A: assessment of all the use cases that successfully implements the scenario***
- ***Step 5B: assessing the NFRs that are relevant to the scenario***

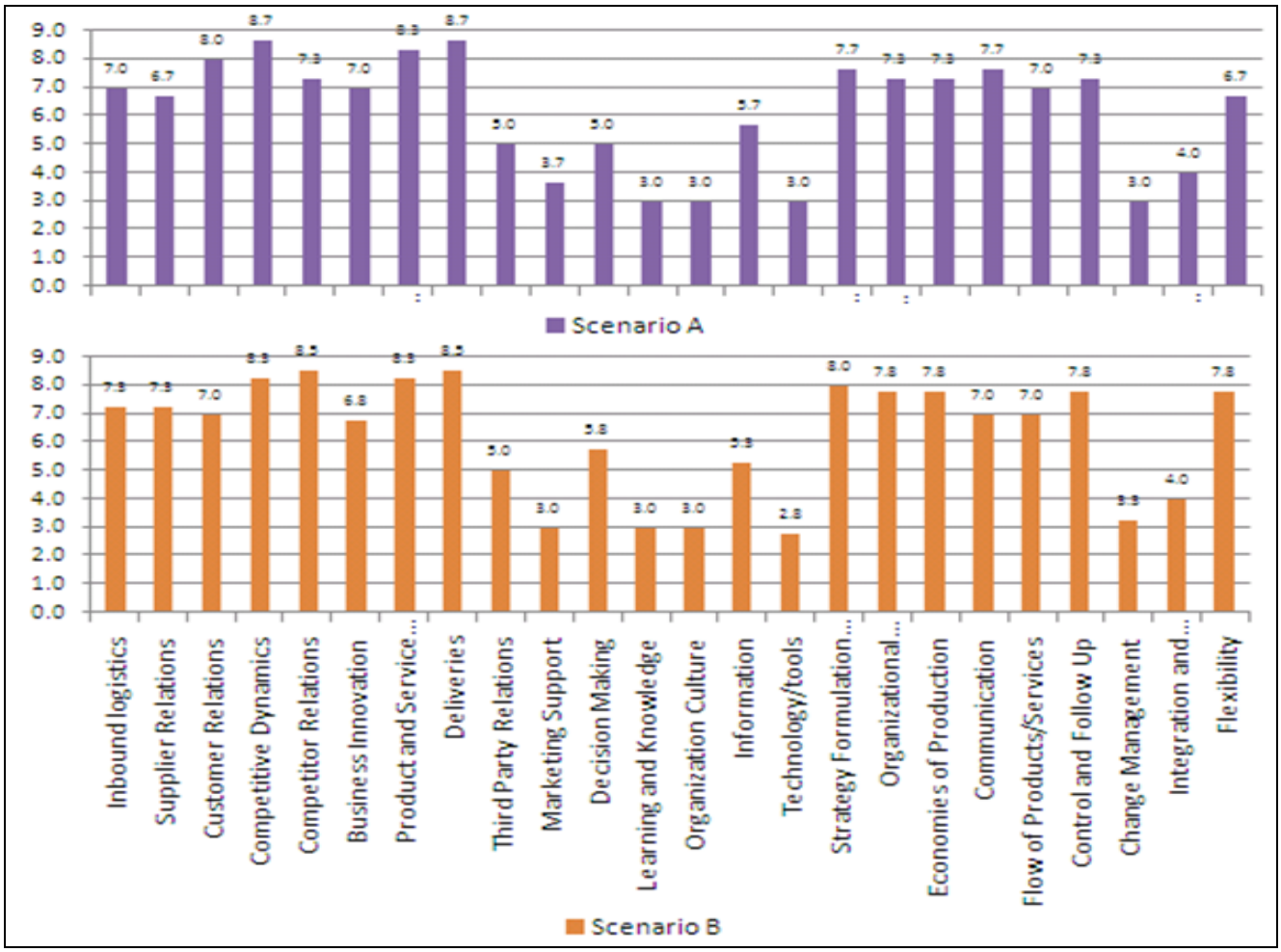

Figure 3: Normalized BVD Contribution Scores for Both the Scenarios

Step 5A: assessment of all the use cases that successfully implements the scenario

First we try to find out the contribution of the different use cases to the system scenarios. The Wiegers' framework [22] is used where each of the use cases are assessed from the following four dimensions:

- **Value:** It indicates the extent to which a use case is perceived to be necessary for successful fulfilment of the given scenario. By successful fulfilment, we mean that the business processes which comprises the scenario is able to achieve the BVD contributions as specified in Step 4
- **Penalty:** It refers to the penalty that the customer or business is likely to suffer if the particular use case is not incorporated in the scenario
- **Cost:** It refers to the cost of implementing the particular use case in the given scenario
- **Risk:** It refers to the business and technical risks associated with implementing the use case in the given scenario

Each of these four dimensions is assessed on a scale of 1 (minimum) – 9 (maximum). For each use case, the rating on four dimensions is then combined, which indicates the relative importance of the use case in successfully realizing the scenario. The Wiegers' formula [22] is used to arrive at a relative importance score for each of the use cases considered for implementation within the scenario. The formula can be easily implemented using a spreadsheet application, and it computes the relative importance for each use case as follows:

$$\textit{Relative Importance}_i = \textit{(Value+Penalty)\%/(Cost\%+Risk\%)} \quad \text{.....(I)[22]}$$

Where:

$\text{Relative Importance}_i$: Relative Importance of the i^{th} use case considered for implementation in the scenario

(Value + Penalty) % = $\frac{Value_i + Penalty_i}{\sum_N Value_i + \sum_N Penalty_i} * 100$;

N: Total # of use cases belonging to the scenario

$$\text{Cost \%} = \frac{Cost_i}{\sum_N Cost_i} * 100$$

$$\text{Risk \%} = \frac{Risk_i}{\sum_N Risk_i} * 100$$

For the case study considered here, the ascribed rating of the use cases on the four dimensions and the computed relative importance values are shown in Table 5. Relative importance is an indicator of the relative value of these use cases from the project organization perspective.

Table 5: Scenario Use Case Relative Importance

Scenario A

Bottom-Level Business Process	Use Cases	Value	Penalty	Cost	Risk	Relative Importance
Assessment Setup	Create Components for an Assessment	8	9	5	4	*0.830*
	Define Sub-skills	8	9	5	4	*0.830*
	Define Grading Set	4	4	4	4	*0.434*
	Define Grade Thresholds (Pre-Grading)	8	4	7	4	*0.487*
	Define Grading Rules	6	9	8	7	*0.437*
	Define Revision Criteria	8	8	8	6	*0.504*
	Define Marking Methods	5	6	9	9	*0.265*
Entries Submission	Submit Entries	9	7	6	5	0.638
	Submit Reserve Entries	5	4	6	5	0.359
	Submit Bulk Entries	5	4	7	5	0.331
	Update Entry Details in the system	9	9	7	5	0.663
Exceptions Mgmt	Log Exception Requests	4	3	4	4	0.380
	Approve/Reject Exception	4	3	4	4	0.380
	Update Entry Details in the system	9	9	7	5	0.663

Scenario B

Bottom-Level Business Process	Use Cases	Value	Penalty	Cost	Risk	Relative Importance
OMR Scripts Handling	Book-out a Script/ Script Packet	5	7	7	5	*0.404*
	Book-in a Script/ Script	5	7	7	5	*0.404*
	Request for Manual upload of OMR batch	6	5	5	3	*0.563*
	Manual upload of OMR Batch	6	5	5	3	*0.563*
SCORIS – Scripts Handling	Book-out a Script/ Script Packet	5	7	7	5	0.404
	Book-in a Script/ Script	5	7	7	5	0.404
Result Enquiry Verification	Submit Results Enquiry request through Channel Partner or Candidate Portal	6	2	3	2	0.650
	Approve / Reject Enquiries	6	7	4	2	0.900
	Track Result Enquiries	6	7	5	2	0.784
	Process Results for Results Enquiries	6	8	5	3	0.717
Assessment Setup	Create Components for an Assessment	8	9	5	4	0.757
	Define Sub-skills	8	9	5	4	0.757
	Define Bill of Materials	7	8	7	5	0.505
	Define Article	7	8	8	7	0.398
	Define BOM Processing Rules	6	8	7	6	0.429
	Define Revision Criteria	8	8	8	6	0.460
	Define Marking Methods	5	6	9	9	0.241

Considering 0.5 as the threshold value of relative importance, these ratings can be represented in the graphical format as given in Figure 4. The figure indicates where (i.e. how much above or below 0.5) the use-cases stand with respect to the threshold. Apart from figuring out the 'important' use cases (i.e. those which have positive rating w.r.t threshold, Figure 4), the bar chart also indicates the use cases which can be dropped from the scenario without affecting the scenario score too much. Use cases which are below the threshold are potential candidates of being dropped / needs to be improved in order to improve the scenario fulfilment score.

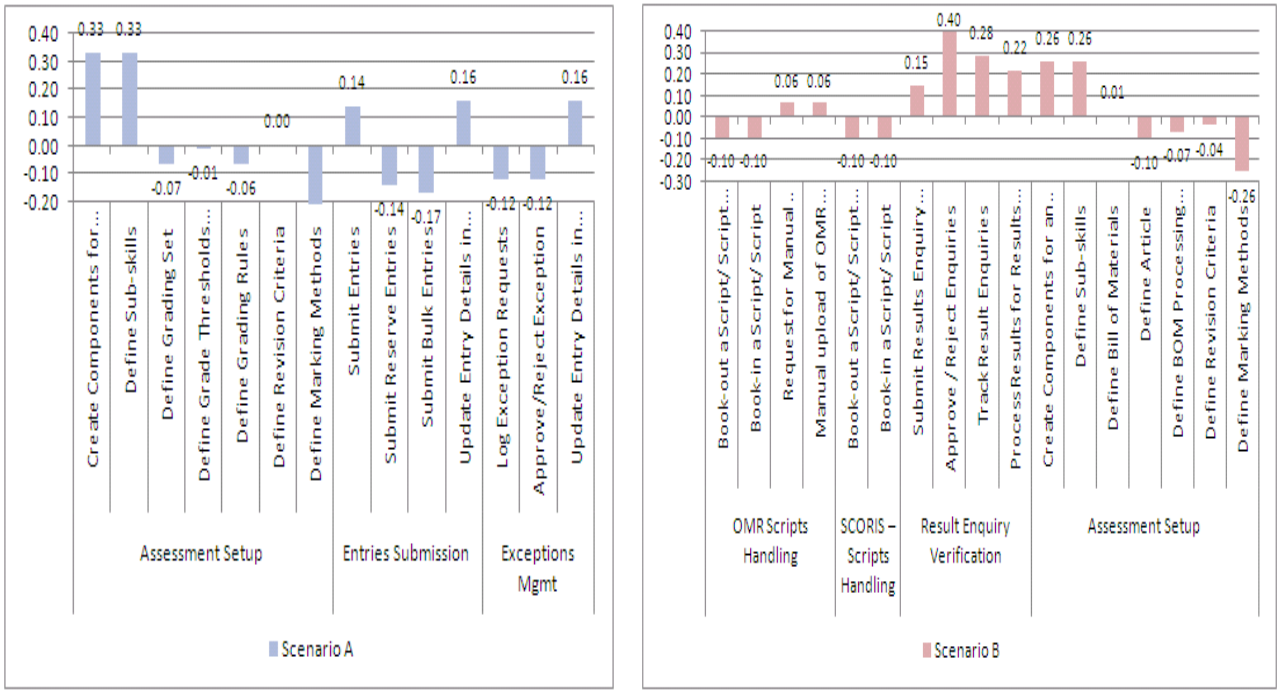

Figure 4: Use Case Relative Importance w.r.t. Threshold

Step 5B: assessing the NFRs that are relevant to the scenario

The NFRs relevant to each of the scenarios are evaluated as follows:

Step 5B-1: assessing the NFRs on the 4 dimensions of Value, Penalty, Cost, Risk using a 1 – 9 scale

Each of the NFRs characterizing the scenarios is also assessed on the following four dimensions implying the following:

- **Value:** The extent to which a NFR is perceived to be necessary so that the scenario is able to achieve the Normalized BVD contribution scores as shown in Figure 3.
- **Penalty:** The penalty that the customer or business is likely to suffer if the particular NFR is not incorporated in the scenario.
- **Cost:** It refers to the cost of implementing the particular NFR in the given scenario.
- **Risk:** It refers to the risks associated with implementing the NFR in the given scenario.

For our example, the ratings on the four dimensions of value, penalty, cost, and risk for the NFRs are obtained, and then combined (using Wiegers' formula explained in Step 5A) to arrive at the relative importance of the NFRs in successfully realizing the scenario (Table 6). Relative importance is an indicator of the relative value of these NFRs from the project organization perspective.

We define the following ranges for comparison: Low (0 – 0.3) Medium (0.3 – 0.7), and High (0.7 – 1.0), with the threshold at 0.5. Similar to use case relative importance (Figure 4), the NFR relative importance scores can be interpreted in the following way. Taking the NFR Integrity, its relative importance for Scenario A is Medium (0.682 > 0.5) implying presence of Integrity positively assists Scenario A to achieve the normalized BVD contribution scores as shown in Figure 3. The same score for Scenario B is Low (0.281 < 0.5) implying Integrity does not contribute to Scenario B fulfilment, under the assumption that none of the other NFRs impact Integrity to influence its rating.

Table 6: Scenario NFR Relative Importance

Scenario A					
Non Functional Requirements	Value	Penalty	Cost	Risk	Relative Importance
Availability & Reliability	7	6	8	6	0.411
Security	5	4	9	4	0.335
Integrity	9	5	7	3	0.682
Flexibility	5	7	7	3	0.584
Reusability	3	4	6	2	0.443
Stability / Resilience	4	4	7	2	0.460
Maintainability	7	3	4	3	0.633
Resource Savings	4	2	2	2	0.633

Scenario B					
Non Functional Requirements	Value	Penalty	Cost	Risk	Relative Importance
Availability & Reliability	8	6	7	3	0.558
Compatibility	7	1	5	4	0.340
Integrity	5	2	3	6	0.281
Flexibility	6	5	4	2	0.724
Reusability	3	5	4	1	0.656
Maintainability	7	7	5	4	0.596
Usability	6	1	2	3	0.515

Step 5B-2: Identification of the extent of association among the NFRs

For a given scenario, there may be associations among the relevant NFR's [16]. An improvement in the capability identified by an NFR might result in improvements in capabilities identified by other NFR's, for example 'Usability' positively influencing 'Maintainability' [5]. It can be the other way round also i.e. an improvement in the capability identified by an NFR might result in degradation in capabilities identified by other NFR's, for example 'Usability' negatively influencing 'Security'. An example of an NFR association matrix is shown in Figure 5. The indicators a, b, c, .. in the figure denotes the % improvement/degradation of capability identified by NFRs (column-wise) because of each NFR present row-wise.

For Scenarios A and B pertaining to our case study, the respondents were asked to indicate the NFR association matrix. These are given in Tables 7 and 8 below. The 'Net % Change' column indicates the aggregate % improvement/degradation of capability identified by NFRs (column-wise) because of all the NFRs present row-wise.

Step 6: adjustment of scenario NFR scores

Here for each of the scenarios, we adjust the scenario NFR relative importance scores (Step 5B-1) based on the mutual associations (Step 5B-2). The rational at this step is that if there are other NFRs which +vely affects an NFR, then the importance of the target NFR would be further enhanced, and vice versa. The final adjusted value represents the adjusted importance (adjusted value) of each of the NFR in successfully realizing the scenario, and is computed as follows:

$$\textit{Adjusted Importance}_i = \textit{Relative Importance}_i * (1 + \textit{Net\%Change}_i) \quad \ldots(II)$$

Where:

i: the i^{th} NFR considered for implementation in the scenario

The equation above suggests that for a particular NFR, the extent of change in the importance value is not the same, and is dependent upon its relative importance values as given in Table 6. Hence considering two NFRs, the same % change would result in unequal amount of change if the relative importance values are different. The argument behind such implementation is that for an NFR which has a higher relative importance, any improvement in its capability is likely to contribute more value compared to the NFR whose relative importance is low, and vice versa. The adjusted importance value is then aggregated over all the NFRs constituting a scenario to arrive at adjusted NFR importance at scenario level. Table 9 provides the adjusted NFR importance scores for Scenario A. The corresponding values for Scenario B are given in Table 10.

	Accessibility	Availability & Reliability	Compliance	Human Engineering	Integrity	Flexibility	Maintainability	Usability	Resource Savings	Aesthetic Features	Durability
Accessibility			-a				-b			-c	
Availability & Reliability					+d			-e			+f
Compliance	-a					-e	-g		-a		
Human Engineering								+h		+i	
Integrity		+d				-b	+j				+k
Flexibility			-e		-b			+i		-l	
Maintainability	-b		-g		+j			-c			+h
Usability		-e		+h		+i	-c		+k		+k
Resource Savings			-a					+k		-c	
Aesthetic Features	-c			+i		-l			-c		-b
Durability		+f			+k		+h	+k		-b	

Figure 5: Example of an NFR Association Matrix [5]

Table 7: NFR Association Matrix – Scenario A

	Availability & Reliability	Security	Integrity	Flexibility	Reusability	Stability / Resilience	Maintainability	Resource Savings
Availability & Reliability		-25	+10					-75
Security	-30					+20		-50
Integrity	+25			-50				
Flexibility			-60		-20			
Reusability				-25		-60	+50	
Stability / Resilience		+30			-50		-50	
Maintainability					+30	-40		-50
Resource Savings	-60	-35					-35	
Net % Change	-65	-30	-50	-75	-40	-80	-35	-175

Table 8: NFR Association Matrix – Scenario B

	Availability & Reliability	Compatibility	Integrity	Flexibility	Reusability	Maintainability	Usability
Availability & Reliability						-10	+25
Compatibility			-60		-25	-30	-50
Integrity		-50		-30	-50		
Flexibility			-25		-10	+25	
Reusability		-25	-30	-20		-50	+75
Maintainability	-20	-10		+60	-25		+60
Usability	+40	-20			+50	+50	
Net % Change	20	-105	-115	10	-60	-15	110

Table 9: Adjusted NFR Importance – Scenario A

NFRs	Relative Importance (NFRs)	Net % Change(NFRs)	Adjusted Importance (NFRs)	Adjusted Importance (Scenario Level)
Integrity	0.682	-50	**0.341**	1.160
Maintainability	0.633	-35	**0.411**	
Resource Savings	0.633	-175	**-0.475**	
Flexibility	0.584	-75	**0.146**	
Stability / Resilience	0.460	-80	**0.092**	
Reusability	0.443	-40	**0.266**	
Availability & Reliability	0.411	-65	**0.144**	
Security	0.335	-30	**0.235**	

Table 10: Adjusted NFR Importance – Scenario B

NFRs	Relative Importance (NFRs)	Net % Change(NFRs	Adjusted Importance (NFRs)	Adjusted Importance (Scenario Level)
Flexibility	0.724	10	**0.796**	3.256
Reusability	0.656	-60	**0.262**	
Maintainability	0.596	-15	**0.506**	
Availability & Reliability	0.558	20	**0.669**	
Usability	0.515	110	**1.081**	
Compatibility	0.340	-105	**-0.017**	
Integrity	0.281	-115	**-0.042**	

Similar to use cases, the adjusted NFR priority values also highlight the NFRs which can be dropped from the scenario. NFRs which have negative priority values (column 4) are potential candidates which can be dropped from the scenario, thereby resulting in improvement of scenario score. Results also highlight the potential reasons why some of the NFRs attain low scores. In Scenario A, 'Availability & Reliability' has a very low priority (0.144, Table 9), but its priority is comparatively high (0.669, Table 10) in Scenario B. Scenario A additionally contains NFRs 'Resource Savings', 'Stability/Resilience', and 'Security'. Since these are not in Scenario B, any/all three of these could have opposed the 'Availability & Reliability' capability thereby resulting in its low score in Scenario A. Hence the results also point to how one can arrive at the desired capabilities of a scenario by dropping/selecting NFRs based on their mutual association levels.

Step 7: derivation of scenario technical assessment score

With the relative importance of use cases and NFRs being estimated, we now derive the technical score for the scenario which indicates the extent to which a scenario is capable of achieving the normalized BVD contribution scores as shown in Figure 3. The technical assessment score of both the scenarios is arrived upon by aggregating the use case importance score (Table 5) and NFR adjusted importance values (Table 9, 10). These scores, aggregated at the bottom level business process level are shown in Tables 11 and 12.

Table 11: Technical Assessment Score (Scenario A)

Bottom-Level Business Process	Use CaseImportance (Aggregated at BP level)	NFR Adjusted Importance (Scenario Level)	Technical Assessment Score (Aggregated at BP level)
Assessment Setup	3.788	1.16	4.948
Entries Submission	1.991		3.151
Exceptions Mgmt	1.423		2.583

Table 12: Technical Assessment Score (Scenario B)

Bottom-Level Business Process	Use CaseImportance (Aggregated at BP level)	NFR Adjusted Importance (Scenario Level)	Technical Assessment Score (Aggregated at BP level)
OMR Scripts Handling	1.935	3.256	5.191
SCORIS – Scripts Handling	0.809		4.065
Result Enquiry Verification	3.051		6.307
Assessment Setup	3.547		6.803

Step 8: derivation of relative business contributions

The business value contributions (BVC, Table 4) are combined with the technical assessment scores (TAS) which determines the relative business contributions (RBC) of the constituent business processes of a scenario. The relative business contributions are actual indicators of how far the scenario is able to contribute to the business objectives, the only assumption here being that the same set of respondents has assessed both the scenarios. The RBCs for each of the scenarios are expressed at the BVD level, and computed as follows:

$$RBC_i = \sum_{j=1}^{N} BVC_j * TAS_j \quad \text{.....(III)}$$

Where:

i: Each of the BVDs

j: Each Business Process belonging to a Scenario

The RBCs for both the scenarios expressed in bar-chart format is shown in Figure 6. Respondents 1, 2, … are representatives of the project organization who is executing the project. The responses clearly indicate the perceived importance assigned by the respondents to Scenario B is higher as compared to Scenario A.

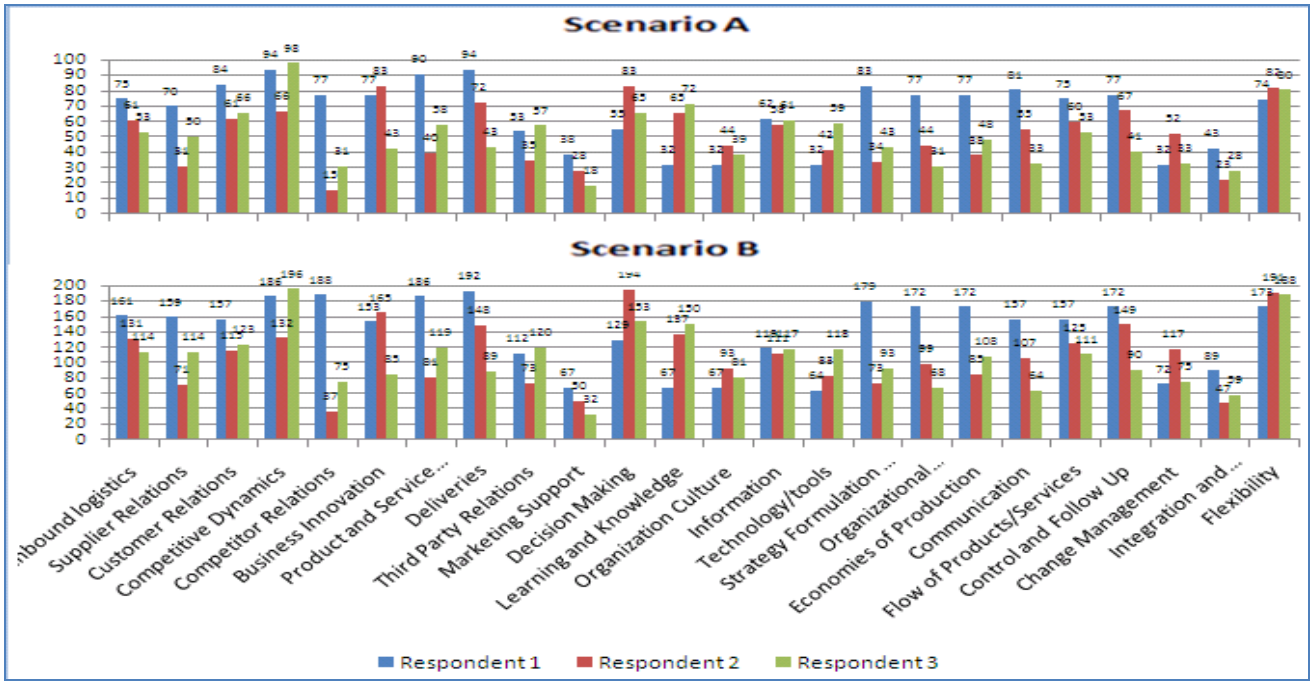

Figure 6: Relative Business Contributions for both the Scenarios

Step 9: assessing credibility of responses

In order to make well-considered decisions, the credibility level of the information that the decisions are based on must be known to the decision maker. One type of credibility estimates is statistical credibility [13], where credibility levels generally are expressed as confidence levels and confidence intervals. However, this type of credibility estimates does not help to assess the credibility of individual answers to questions. It merely assumes that all observations are fully credible. This is a problem since it is very likely that different (potentially conflicting) answers are obtained from different sources with different credibility. To assess the uncertainty of each collected answer, a set of heuristics based on witness psychology and source criticism as employed in historical research were used [6, 13]. The credibility heuristics are:

- **Source Proximity:** The further away from the truth, the lower the credibility of the answers. E.g. if a respondent has had personal experience with a system the answers emanating from that respondent regarding that system have a higher credibility compared to if the same respondent were to answer questions regarding a system of which the respondent has only heard rumors.
- **Age of Answer:** This heuristic refers to when the respondent obtained the information in the answer, e.g. days, months or years ago.
- **Question Domain - Respondent Competence:** This refers to the degree to which the respondent's general competence matches the domain of the asked question. It is desired to have respondents from the same type of business and with the same type of work tasks as the question refers to.
- **Match of Area of Expertise:** This dimension refers to if the respondent is correctly chosen and differs from the previous insofar as it refers to the credibility of the respondent per se, rather than the individual answers given by the respondent.
- **Appropriateness with Role:** If the respondents' position is appropriate with level of details sought in the questionnaires
- **Years of Experience:** This refers to the number of years of experience the respondent has had in the relevant field of inquiry. The longer the experience, the higher the credibility.
- **Respondents' Self Assessment:** The level of certainty in the responses to most of the questions that the respondent have given so far in the questionnaires.

These properties were all quantified using a scale from 0 - 4, were four denotes the highest degree of credibility and zero the lowest. For our example, in order to simply the assessment procedure we assumed that the same three respondents were involved in assessing both the scenarios. Table 13 presents the answers and their credibility of the three respondents' using the seven credibility dimensions given above.

Step 10: derivation of adjusted business contributions

Based on the response credibility's given above, the RBC scores for each of the respondents (Step 8) were aggregated into the adjusted business contribution score. The Evidential Reasoning Algorithm [23, 24] was employed for the purpose, and accomplished using the IDS software[3]. The algorithm provides the net score (i.e. adjusted business contribution) and an uncertainty estimate. The adjusted business contribution score on the top five prioritized business value dimensions (Step 1) for the both the scenarios are shown in Figure 7.

The graph clearly indicates higher contribution of Scenario B on the five prioritized business value dimensions as compared to Scenario A. This suggests that Scenario B is able to fulfill business objectives better than Scenario A.

[3] Available at: http://www.e-ids.co.uk/

Table 13: Response Credibility's (Both Scenario A and B)

	Respondent 1		Respondent 2		Respondent 3	
	Response	Numerical	Response	Numerical	Response	Numerical
Credibility Assessments						
Source Proximity (0 - 4)	Personal Experience Feedback from Project Members Feedback from other project stakeholders	2.67	Personal Experience	4	Feedbacks from project users	2
Age of Answer (0 - 4)	< Than a month	3	< Than a week	4	< Than a Year	2
Question Domain & Respondent Competence Domain (0 -4)	Same type of business and work tasks	4	Same type of business and comparable work tasks	3	Comparable type of business and same type of work tasks	2
Matched Area of Expertise (0 - 4)	High match	3	High match	3	Moderate match	2
Appropriateness with Role (0 - 4)	Moderately appropriate	2	Highly appropriate	3	Moderately appropriate	2
Years of Experience (0 - 4)	1 - 3 Years	3	< 1 Year	2	< 1 Year	2
Respondent Self Asessment (0 -4)	Fairly Certain	3	Very Certain	4	Fairly Certain	2
Total Credibility		0.74 (20.67/28)		0.82 (23/28)		0.5 (14/28)

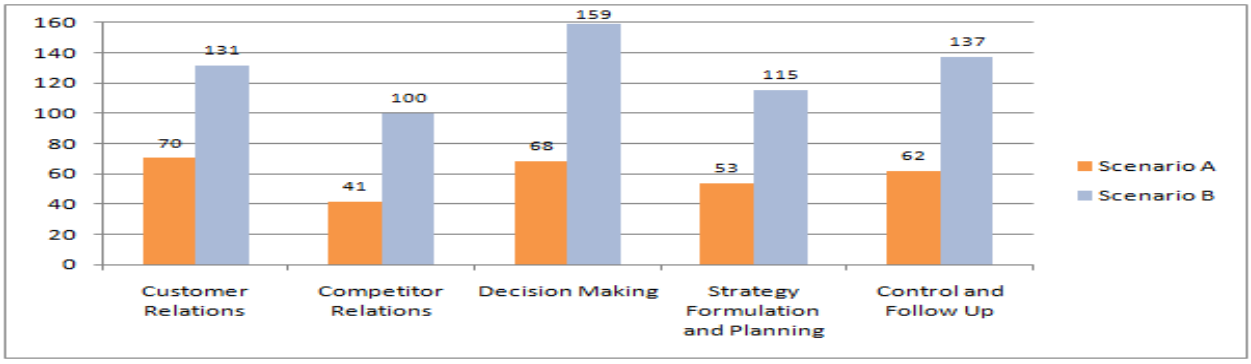

Figure 7: Adjusted Business Contributions for both the Scenarios

Step 11: derivation of aggregate business contribution

In the final step, the adjusted business contribution scores (Step 10) is weighted by the prioritized BVDs (Step 1) in order to arrive at the aggregate contribution score for each of the scenarios. The formula for computing the aggregate business contribution score for a scenario is given below:

Aggregate Business Contribution =

$$\sum_{j=1}^{N} ABC_j * Priority\_Avg_j \quad \text{..... (IV)}$$

Where:

ABC: Adjusted Business Contribution Score

j: Business Value Dimensions

Application of the formula resulted in derivation of the aggregate business contribution for the two scenarios. The aggregated business contribution for Scenario A was calculated as 9231 and that of Scenario B was calculated as 19528. When converted on a 0 – 10 scale taking

the higher aggregated business contribution as 'Base: 10', the values were calculated as:

- **Scenario A: 5 (rounded)**
- **Scenario B: 10**

Thus considering the investment alternatives, Scenario B is found to better contribute to business objectives as compared to Scenario A.

CONCLUSION

As stated earlier, the overall purpose of the research project has been to develop a method that indicatively assesses the differences in contribution to business value for IT-investment alternatives. Apart from highlighting which scenario contributes most towards realizing business objectives, the intermediate results further indicate:

- Which of the BVDs are important from business perspective
- Which of the use cases and NFRs needs to be improved or dropped so as to increase the scenario contribution score
- The NFRs that are positively associated with others and hence should be considered for implementation
- Those respondents' whose response-credibility is questionable and hence these responses can be eliminated in the final analysis

The work is still under evaluation and modifications are being carried out based on reviews by field experts. The refinements include dissecting the BVDs in terms of value items and arriving upon measures of the value items. This would assist in removing ambiguities related to how the BVDs can be assessed, prioritized, and then associated with the business processes. Efforts are also on in order to simplify the assessment process by combining/eliminating some of the steps. Considerations are also being given to whether a balanced scorecard approach [14] which is more prevalent in organizations can be used for this. The final results are expected to lead to a 'win-win' situation for both the project organization and business in terms of realization of individual objectives.

REFERENCES

[1] Aurum, A. and Wohlin, C. "A value-based approach in requirements engineering: explaining some of the fundamental concepts," *Lecture Notes in Computer Science*, Volume 4542, 2007, pp. 109-115.

[2] Ballantine, J.A. and Stray, S. "Information systems and other capital investments: evaluation practices compared," *Logistics Information Management*, Volume 12, Number 1/2, 1999.

[3] Biffl, S., Aurum, A., Boehm, B., Erdogmus, H., and Grunbacher, P. (eds.) "*Value-Based Software Engineering*," Springer, Heidelberg, 2005.

[4] Boehm, B.W. and Sullivan, K.J. "Software Economics: A Roadmap," *Proceedings of the Future of Software Engineering Conference*, 2000, pp. 319–343.

[5] Deutsch, M.S. and Willis, R.R., *Software Quality Engineering: A Total Technical and Management Approach*, Prentice-Hall Series in Software Engineering, 1988.

[6] Edvardsson, B. "The need for critical thinking in evaluation of information: criteria, principles and responsibility," *Proceedings of the 18th International Conference on Critical Thinking*, Rohnert Park, USA, 1998.

[7] Erlank, S. *Perspectives on Software Quality*, 2007.

[8] Faulk, S.R., Harmon, R.R. and Raffo, D.M. "Value-Base Software Engineering: A Value-Driven Approach to Product-Line Engineering," *Proceedings of the 1st International Conference on Software Product-Line Engineering*, Colorado, 2000.

[9] Favaro, J. "Value-Based Management and Agile Methods," *Proceedings of 4th International Conference on XP and Agile Methods*, 2003.

[10] Gammelgård, M. "*Business Value Assessment of IT Investments - An Evaluation Method Applied to the Electrical Power Industry*," Unpublished Ph.D. Dissertation, Industrial Information and Control Systems, KTH, Royal Institute of Technology, Stockholm, Sweden, 2007.

[11] Gammelgård, M., Ekstedt, M. and Gustafsson, P. "A Categorization of Benefits from IS/IT Investments," Proceedings of the 13th European Conference on Information Technology Evaluation, 2006.

[12] Heinonen, K. "Reconceptualizing Customer Perceived Value: The Value of Time and Place," *Managing Service Quality*, Volume 14, Number 2/3, 2004, pp. 205–215.

[13] Johansson, E. and Johnson, P. "Assessment of Enterprise Information Security – Estimating the Credibility of the Results," *Proceedings of the Symposium on Requirements Engineering for Information Security (SREIS)*, Paris, France, 2005.

[14] Kaplan, R. S. and Norton, D. P. "Putting the Balanced Scorecard to Work," *Harvard Business Review*, September – October, 1993, pp. 2–16.

[15] Khan, K.A. "*A Systematic Review of Software Requirements Prioritization*," Master Thesis, School

of Engineering, Blekinge Institute of Technology, Sweden, 2006.
[16] Kotonya, G. and Sommerville, I. *Requirements Engineering: Processes and Techniques*, John Wiley and Sons Ltd., 1998.
[17] Mill, J.S. *Principles of Political Economy with Some of Their Applications to Social Philosophy* (First published in 1848), Winch, D. (ed.) Harmondsworth, Penguin, 1970.
[18] Miller, R.E. "Get Your Users "IN" the Doghouse and Keep Yourself Out: Eliciting Nonfunctional Requirements," Minneapolis IIBA Chapter 9, available at http://www.RequirementsQuest.com, 2009.
[19] Pisello, T. "ValueIT: IT Value Chain Management for CIOs and IT Executives," Alinean white paper, available at http://www.alinean.com, 2003.
[20] Purewal, K., Yang, L. and Grigg, A. "Quantitative Assessment of Quality Attributes in Systems Architecture using Evidential Reasoning," *Proceedings of the 7th Annual Conference on Systems Engineering Research (CSER)*, 2009.
[21] Storbacka, K. and Lehtinen, J.R. *Customer Relationship Management: Creating Competitive Advantage through Win-Win Relationship Strategies*. McGraw-Hill, New York, 2001.
[22] Wiegers, K.E. "First Things First: Prioritizing Requirements," Process Impact, available at http://www.processimpact.com, 1999.
[23] Yang, J. and Xu, D. "Nonlinear Information Aggregation via Evidential Reasoning in Multi-attribute Decision Analysis under Uncertainty," *IEEE transactions on Systems Man and Cybernetics*, 2002a.
[24] Yang, J. and Xu, D. "On the Evidential Reasoning Algorithm for Multiple Attribute Decision Analysis under Uncertainty," IEEE transactions on Systems Man and Cybernetics, 2002b.

AUTHOR BIOGRAPHIES

Rahul Thakurta is an Assistant Professor of Information Systems at Xavier Institute of Management Bhubaneswar, India. His primary research interests are software process and project management, and technology adoption and diffusion. He is also the Managing Editor of *Research World*, and holder of the DAAD Research Fellowship.

Mayank Gupta is a Business Process Management Consultant & Thought Leader at Infosys. He has extensive experience in consulting with CXOs in business process strategy, IT strategy and organizational design. His experience spans industries and geographies including Australia, Europe, North America and India. He has co-authored books, presented in prestigious conferences and published in Business Process Management Journal and IEEE Software magazine. Mayank has extensive skills in aligning operational and IT strategy to business results and transformation of organizations through people, process and technology levers. He has led multiple change initiatives within client organizations as well as within Infosys. His current work involves organization themes like Innovation, Collaboration and Sustainability.

APPENDIX

Business Value Dimensions (BVDs)

Dimension	Interpretation
Related To: Organization External Interface	
Inbound logistics	It assesses improvement of products/services that the organization purchases from suppliers
Supplier Relations	It assesses improvements in the relationship that the organization has with its suppliers
Customer Relations	It assesses improvements in the relationship that the organization has with its customers
Competitive Dynamics	It assesses actions and responses of the organization against all its potential competitors
Competitor Relations	It assesses improvements in the organization's relationship with the competitors
Business Innovation	It assesses improvements related to making different areas of business feasible for the organization
Product and Service Enhancement	It assesses enhancements in the quality of the organization's products and services
Deliveries	It assesses improvements related to delivery of the organization products and/or services to customers
Third Party Relations	It assesses improvements in the organization's relationship with external parties that are neither customers, competitors nor suppliers, (i.e. various organizations, authorities, society etc)
Marketing Support	It assesses the role played by the marketing group or equivalent
Related To: Organization Resources	
Decision Making	It assesses the overall decision making process of the organization
Learning and Knowledge	It relates to improvements associated with learning and/or increased knowledge of employees in the organization
Organization Culture	It assesses improvements in aspects related to the organizational culture
Information	It assesses improvements in information distribution and support
Technology/tools	It assesses improvements in non-IT infrastructure related to the organization's product/services
Related To: Structure of the Business Organization	
Strategy Formulation and Planning	It assesses improvements in organizational ability to develop long-term business strategies and plans
Organizational Effectiveness and Efficiency	It assesses improvements related to organization's effectiveness (i.e. ability to achieve stated goals or objectives, judged in terms of both output and impact) and efficiency (i.e. doing as much as before with less resources)
Economies of Production	It assesses improvements related to achieving economies of production (i.e. reduction in costs, or increase in production or throughput related to product/services)
Communication	It assesses improvement/increase in communication within/between processes or departments in the organization
Flow of Products/ Services	It assesses improvements related to the flow of products/services within/between processes or departments in the organization
Control and Follow Up	It assesses overall improvements associated with organization's ability to control and follow up (i.e. say improved reporting possibilities)
Change Management	It assesses organizational capabilities to deliberately make changes in the organization, e.g. to replace people or roles, to restructure, to add/remove departments or processes etc
Integration and Coordination	It assesses improvements in the ability to coordinate and integrate different parts of the organization, e.g. coordination of production and distribution department, of sales and production planning departments etc
Flexibility	It assesses improvements in the organizational ability to adapt to changes in market conditions/requirements

List of Non-Functional Requirements (NFRs)

NFR Identifier	Description
Accessibility	The capability that allows your system to be accessible by as many people as possible
Availability and Reliability	The capability that makes sure that your system will perform its intended function satisfactorily (from the viewpoint of the user) for its intended life under specified environmental and operating conditions
Compatibility	The capability that makes your system more compatible with previous versions, various platforms, etc
Compliance	The capability that makes your system compliant with the specified standards or regulations
Composibility	The capability that provides users the ability to compose the system from plug-and-play components
Constraints	It refers to the different types of constraints (which could be for example Interface Constraints, Protocol Constraints, Platform Constraints, Architectural Constraints, Design and development Constraints, Networking Constraints, etc) which may be imposed on the performance/output of the system so as to enable the system to better realize the business objectives
Human Engineering	The functionalities that takes into considerations aspects of human performance principles, models, measurements, and techniques during system design
Security	The capability that makes your system and aspects related to information and communication more secured
Integrity	The capability that makes sure that the data maintained by the system is accurate, authentic, and without corruption
Interoperability	The capability that provides the ability to your system to inter-operate with other diverse systems, taking into account social, political, and organizational factors that impact system to system performance
Flexibility	The capability that assists in deploying changes to the system with minimal cost/effort. The changes could be in respond to environment or stakeholder requirements, or driven by business opportunities
Installability and Portability	The capability that allow for deployment or transfer of your system's hardware or software environment in/across environments without major effort
Reusability	The capability that enable re-use of system attributes (features, functionalities, design characteristics, etc) in future systems
Stability / Resilience	The capability that enables your system to maintain an acceptable level of service in the event of natural or human-induced disaster
Maintainability	The capability that enable technical support personnel to install, configure, and monitor computer products, identify exceptions or faults, debug or isolate faults to root cause analysis, and provide hardware or software maintenance in pursuit of solving a problem and restoring the product into operation
Usability	The capability that enables the users to learn, operate, prepare inputs and interpret outputs through interaction with the system at ease
Resource Savings	The functionalities that enable saving of key resources for example financial saving, time saving, effort saving, equipment saving
Workload Capacities	The functionalities that contribute towards increasing the system's ability to handle capacity, throughput, and response time
Aesthetic Features	The functionalities that contribute to an increase in aesthetic properties of the system (e.g. better appearance, more environment friendly, etc)
Durability	The capability that contributes to an increase in the lifespan of your product/service