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A framework for evaluating ERP projects

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The objective of this paper is to propose a methodological framework for dealing with the complex problem of evaluating Enterprise Resource Planning (ERP) projects. The competitive pressure unleashed by the process of globalization is driving implementation of ERP projects in increasingly large numbers. They occupy a dominant space in today's rapidly increasing IT investments. Paradoxically, researchers have noted a deteriorating trend of evaluation of these investments. Considering huge organizational stakes coupled with a high risk of failure associated with the ERP projects, it is imperative that they are properly evaluated. Conventional methodology, which reckoned cost displacement as the only benefit, has proved inadequate for modern IT projects that have decreasing scope for cost displacement and an increasing focus on effectiveness objectives. Effectiveness is a multi-dimensional attribute and is not amenable to easy quantification. ERP projects need multi-dimensional evaluation criteria and a methodology that extends into the implementation phase as their profile really shapes up in the latter. A solution, in the form of a process framework that incorporates participatory learning and decision-making processes based on Nominal Group Technique (NGT) and the evaluation methodology adopting the Analytical Hierarchy Process (AHP), is proposed. A case example is given to illustrate its applicability in practice.

1. Introduction

Enterprise Resource Planning (ERP) is a generic term for integrated systems for corporate computing that supersedes concepts such as Materials Requirement Planning (MRP) of the 1970s and, later, Manufacturing Resources Planning (MRP II) of the 1980s. ERP projects basically represent the implementation of these systems. These systems are embodied in ERP software, which provides a set of functional capabilities in terms of process options that can be chosen to fit one's preferred business model, on a specific technological platform. ERP software thus largely profiles ERP projects. However, their specific capabilities and limitations in the organizational context unfold during their implementation, which determines the delivery of ultimate value. Therefore, evaluation of ERP projects essentially encompasses the evaluation of ERP software as well as its implementation.

ERP projects aim at the automation of many basic processes with the goal of integrating information across the enterprise and eliminating complex, expensive interfaces between computer systems. They promise to replace most of the legacy systems built over a long time in a typical company with a single integrated information system and hence enable detection and elimination of process level redundancies. The software products involved in these projects are designed for better longevity and claim to offer numerous options representing best practices. These attributes of a typical ERP software make an ERP project a very desirable but, at

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the same time, very complex and expensive proposition. Many large organizations, under the competitive pressure unleashed by the processes of globalization, are however, rushing to implement ERP projects.

ERP projects, in essence, represent investment in IT. Since they claim to cover a substantial transactional domain and displace most of the legacy systems built over decades, they tend to be the single biggest IT investment in any enterprise. On account of their huge unit costs, ERP projects certainly occupy a dominating position in IT investment in recent times. Their capability to integrate multiple business operations and to eliminate redundancies in business processes has endeared them to companies, particularly the large ones who could afford huge up-front investment in them. The continuously changing business environment; the highly competitive markets in terms of products, delivery, customer satisfaction, quality, and price; the need for a high degree of flexibility and responsiveness; a balanced supply chain for effective operations; and enterprise-wide integrated information access, impel companies to see ERP projects as a strategic investment. This strategic feature of the investment could rather explain why, even during the period of recent severe recession (1990-1992) the IT expenditure continued to grow for the corporate sector while, for the government sector, it registered a decline (Fitzgerald 1998). It can be surmised that the increasing expenditure in IT by companies is largely attributable to ERP projects.

The state of evaluation of IT investments in general is regarded as unsatisfactory (Strassmann 1997). Willcocks and Lester (1997) observed it to be patchy. The predominant reason for this sorry state of evaluation of IT investments is that organizations find it very difficult to perform such evaluation (Ballantine *et al.* 1996, Vowler 1990, PA Consulting 1990, Kearney 1990). When compelled, they significantly underestimate costs and overestimate benefits to justify their projects through the conventional methodology of financial evaluation. The state of evaluation is much worse in the case of ERP projects as, in their case, it is extremely difficult to estimate all the costs and to assess all the benefits much before the 'to be' processes are configured. In this process, the strategic dimension of ERP projects that may override financial consideration gets totally lost. A recent survey by Meta Group Inc revealed that ERP projects typically cost users more than they pay back in measurable financial benefits (Stedman 1999). Dilip Wagle (1998) observes that the ERP investments are too often made on faith and not on good judgement. This observation is further corroborated by many studies (Ballantine *et al.* 1996, Willcocks 1992, 1996, Hochstrasser and Griffiths 1991, Vowler 1990, PA Consulting 1990, Kearney 1990).

The primary reason for this state is the limitation of the conventional methodology of project evaluation based on financial costs and benefits. This methodology worked well during early computerization projects, which significantly displaced certain traditional costs and thus brought in efficiencies. However, as the scope for efficiency enhancement decreased, and the IT projects increasingly dealt with effectiveness issues, the limitations of the conventional methodology started surfacing acutely. The non-availability of a suitable methodology, coupled with the tendency in top management to short select ERP projects, made their evaluation sketchier. Evidence is building up on the failures of these projects to meet expectations (Trepper 1999). Considering the huge amount of risk exposure and the virtual irreversibility of the decisions, the necessity of proper evaluation of ERP projects cannot be overemphasized. This paper seeks to propose a comprehensive framework for

evaluation of ERP projects. A case example is presented wherein this framework was used successfully.

2. Problem analysis

The precursor to the implementation of ERP projects is the change initiative taken by the top management. With the attributes, such as integration, flexibility, robustness, best practices and longevity, associated with ERP software being universally desirable, the initial decision of top management to go for the ERP project is never adequately debated. The evaluation really centres on the selection of ERP software from among the many products available in the market with their varied claims of capabilities and their associated price tags, all of which entail differential times and costs of implementation and imply varying magnitudes of change. The evaluation methodologies relying on financial cost benefit analysis utterly fail to apply, as most of the factors dealing with cost as well as benefits defy attempts at quantification. The methodologies that accommodate multiple attributes with the assignment of weights are too simplistic to deal with the complex relationships among the attributes as well as with the products in the repertoire. This methodological lacuna results in improper choice of ERP projects and can be surmised to be at the root of the growing incidence of failures or the disillusionment of the management when failures are not pronounced.

In view of the long term and pervasive impact of ERP projects, the evaluation problem needs to have organization-wide ownership. The latter could be engendered through the involvement of representative structures in the evaluation process. The core group anchoring the process should have a clear mandate of these structures. Since the information availability improves as the evaluation progresses, the process should incorporate participatory learning and decision making. The evaluation criteria for ERP projects may not significantly differ across organizations but their mutual relationships will be organization specific. The evaluation process needs to incorporate organizational preferences for each of these criteria. Since much of the project profiling in ERP projects happens during the implementation phase, particularly along the incremental investments in IT infrastructure and in functionality enhancements, it is necessary periodically to revisit the evaluation to ensure the initial expectations are met. Since, these projects typically galvanize complete organizations into potentially stressful action, the evaluation process needs to be simple enough to be followed.

3. Evaluation criteria

The need to review the evaluation of IT projects is relatively recent. Academic literature on evaluation of ERP projects is still scarce. Fitzgerald (1998) observes the limitation of the conventional evaluation methodology and proposes a multidimensional approach for evaluating information systems projects. The eight steps of this approach are: (i) identification of costs, (ii) the contribution to business strategy (iii) analysis of benefits, (iv) second-order effects (v) flexibility (vi) implementability, (vii) risk and (viii) testing the business idea. Shankarnarayanan (1999) recommends the following criteria for evaluating ERP software: (i) functional fit with the Company's business processes, (ii) degree of integration between the various components of the ERP system, (iii) flexibility and scalability, (iv) complexity; user friendliness, (v) quick implementation; shortened ROI period, (vi) ability to support multi-site planning and control, (vii) technology; client/server capabilities, database independence,

security (viii) availability of regular upgrades, (ix) amount of customization required, (x) local support infrastructure, (xi) availability of reference sites, (xii) total costs, including cost of licence, training, implementation, maintenance, customization and hardware requirements.

While the first set deals with generic Information Systems (IS) projects and needs development to evolve specific criteria for ERP projects, the second set, although specific to the latter, appears to exclude some of the important requirements such as strategy consideration and comprehensive vendor credentials. From the viewpoint of evaluation, the criteria need to be defined precisely for their exclusive content and should comprehensively map all the desired characteristics of ERP projects. The following 10 criteria are proposed on these considerations:

3.1. *Strategy-fit*

ERP projects reflect a strategic imperative in the rapidly changing business and technological environment and an increasingly competitive marketplace. In most cases, such projects are the direct result of business strategy, while in the rest they are conceived as support to one or more of its components.

The strategic drivers for ERP projects are many. Increasing pressure on margins and therefore the need to devise various cost reduction measures; the need to reduce product development cycle time and response time to the increasing expectations of customers; the flexibility to meet the rapid changes taking place in the marketplace; the increasing need to deal with the complexity of managing the motivational aspects of employees; the need to cope with the challenges of rapidly changing technology; the need for increasing the information and knowledge intensity in organizations, etc, could all be examples. While all of these might spell the reality today, every company will have its specific strategic focus underscoring one or many of these needs. Although, in generic terms, ERP projects promise to meet all of these needs in varying degrees, a specific project based on specific ERP software will be best suited to serve a specific strategic need of a company.

3.2. *Technology*

ERP being essentially an IT application, its technological dimensions assume importance particularly in the environment of rapid technological changes. Foremost, the technology determines the longevity of the product. As ERP projects, in view of their resource intensity, assume long time horizons for their return stream, consideration of technology becomes critical. The threat of obsolescence through rapid changes in technology is real in IT. If the ERP product is built on a proprietary technology, however advanced, it would subject the organization to potential risk of obsolescence. In order to fortify the products from these eventualities, the ERP software design should be independent of the crucial technologies of, for example, databases, operating systems, hardware, networks etc. Technology also determines the scalability and flexibility (in terms of functionality expansion) dimensions of the project and thus has a direct impact on the total project cost. It may even determine the basic feasibility of the project. For example, the design of a dialogue process and data transmission could be so bandwidth hogging that it would make it unimplementable. Similarly, the architectural premise of product design could conflict with the business strategy. The other technological considerations are the degree of intrinsic integration of the product, data security, clarity of its upgrade path, and technological road map, each of which can add serious implications to the project.

3.3. *Change management*

ERP implementation is predominantly a change management project (Kay 1999). It takes a process view of an organization and aim at the integration as per the repertoire of processes assumed in the business model. Notwithstanding the claims to flexibility, the ERP products have their specific preferred business model, which dictates the manner of doing business. In order to take advantage of the ERP software, companies need to adapt to the new model and, correspondingly, change themselves. Paradoxically, the source of problems and benefits of the ERP systems is the same—that is, re-engineering a company's core business processes to take advantage of the software (Martin 1998). Martin (1998) quotes Bruce Richardson of AMR, a Boston-based firm that specializes in ERP, saying that about 80% of the ERP benefits come from what you change in your business.

However, there is some evidence (Earl 1989) that building on existing strengths and existing systems to develop enhanced functionality and effectiveness is an important contributor to success rather than adopting a 'big bang' approach. (Willcocks *et al.* 1997). The differential capability of ERP products to enable the regulated change constitutes an important parameter in project evaluation.

3.4. *Risk*

Risk is a measure of the degree of possible variation in the outcome or benefits of the project (Fitzgerald 1998). The risk emanates basically from the size of investment in, and the complexity of, the enterprise and therefore ERP projects are fraught with substantial risk.

Discussions on the failure of ERP projects in actually delivering the promised benefits abound in the literature. According to the Eden Prairie Minnesota Gartner Institute (a spin off of the Gartner Group), the gap between the promise of an ERP system and the business value actually delivered once the project has been deployed is great. Many big ERP projects, on this account, are prone to suffer time and cost overruns and at least 90% of ERP implementations end up late or over budget (Trepper 1999). Besides the project management related risks, there are more serious risks in ERP projects and they relate to technology and process. Many of these risks stem from the intrinsic product design and so should be carefully assessed during the evaluation process.

3.5. *Implementability*

Implementability basically relates to the degree of mismatch between the product requirements and the available technical infrastructure and also between the business model assumed in the product design and that of the organization. Different ERP products put different demands on technical architecture, particularly in terms of capacities of communication links. While infrastructure can be improved with additional investment, at some point it might pose a serious feasibility problem. Likewise, although an ERP project entails pervasive changes, the drastic change in the business model could impair the conceptual foundation of the enterprise. Business models may clash even at the cultural levels and may have questionable feasibility. *Assessment of Implementability* of ERP projects at a given level of ERP-readiness of the organization is thus necessary.

3.6. *Business functionality*

ERP products are expected to have a functional fit with the company's business processes. Although all the major ERP products claim process support across industries, there is none yet to do so in totality. The generic functionality in ERP products is unlikely to meet all the industry-specific functionalities and the country-specific business requirements. The extent of lack of support and the consequences thereof needs to be carefully ascertained while considering a particular ERP product.

3.7. *Vendor credentials*

In view of the expected longevity of ERP products, the commitment of the vendor to the product, her/his capability to support it and his/her support infrastructure constitute crucial parameters. The commitment could be assessed in terms of the relative importance of the product in the vendor's product portfolio. The capability could be assessed with the help of certain surrogates like her/his market share, earning profile and the general health of her/his balance sheet. Unless the vendor has a sustainable earning stream, her/his capability to support the necessary R&D in order to be in competition shall be in question. Vendor support infrastructure and her/his service track record in the relevant country also constitute critical factors.

3.8. *Flexibility*

Flexibility denotes the capability of the system to support the needs of the business over its lifetime. It is a function of the number of options to configure the business processes with relative ease. The absence of flexibility will render the system sub-optimal and even obsolete. The flexibility could be practically assessed by predicting the wide range of changes that might come in during the life cycle of the product and examining the degree of support the product could render.

3.9. *Cost*

ERP products have a differential cost association—some are considered more expensive than others. The cost here relates, however, to the total cost. From the consideration of the requirement of technology infrastructure, scalability, flexibility, interfaces, upgrading, and change management etc, the initial balance could reverse. Even the implementation costs differ significantly for different ERP software. The cost data on ERP projects are difficult to obtain. Nonetheless, it is important to have comparative data across products for evaluation purpose.

3.10. *Benefits*

Like costs, benefits also are differentially associated with different ERP products. Whereas some of the business benefits may be easily quantifiable, many more important benefits may not be quantifiable. For example, the benefits from reduced response time or contracted product development cycle or better availability of control information are far more important but not directly quantifiable. As in the case of cost, it is difficult to estimate total benefits from ERP projects. Nonetheless, it is necessary to have comparative data on the benefits for evaluation purposes.

4. Framework for evaluation

The framework comprises the following seven domains of action.

4.1. *Creation of organisational infrastructure*

Top management constitutes a steering committee and an evaluation team on well-defined criteria. It creates or promotes the representative structures across the hierarchies. It makes a formal announcement and issues a clear charter with communication to all.

4.2. *Constitution of the repertoire of ERP products*

The team evolves criteria for pre-selecting ERP products with Nominal Group Technique (NGT). NGT is a structured methodology that enables assimilation of ideas and judgements of knowledgeable individuals towards building a group consensus over the desired outcome. It captures subjective-qualitative attributes by regulating the group dynamics unleashed by the participating members (Olsen 1982). A note on NGT is given in Appendix 1. The outcome of the NGT will provide the list of criteria for constituting a repertoire of ERP products based on the information collected from various sources. The list is validated through communication to the representative structure and approved by the steering committee.

4.3. *Preparation phase*

The team draws up people from businesses with in-depth process knowledge as 'process champions'. The process champions map all the core processes in the organization, and prepare a comprehensive list of business functionalities and the demo scripts on the core processes. They also create a structured questionnaire for soliciting information on technology, vendor credentials and implementation methodology. They map the ERP-readiness of the organization in terms of its business culture, technology usage, past history of change, profile of people, etc.

4.4. *Context setting phase*

An iterative process of information gathering, analysing, engaging, educating and validating with the broader community of stakeholders is carried out.

4.5. *Evaluation and selection phase*

The team evolves the conduct framework to manage the evaluation process. The script demos on the products are observed over several days and each member fills in the structured functionality score sheet. At the day-end the scores are collated on all the criteria. These product evaluation scores guide the members in scoring into the Analytical Hierarchy Process (AHP). AHP is a multi-attribute decision-making technique that helps in objectively prioritizing the preferred alternatives. It is widely applied by researchers (Partovi *et al.* 1990) and has been validated during the last 15 years in numerous settings. A note on AHP is given in Appendix 2.

4.6. *Approval of the selection*

The team obtains top management approval to the selected product. The flow processes within the framework are given in the figure 1.

4.7. *Mid-course evaluation*

The priority weights along the 10 criteria gained for the selected product may be graphically represented in an Expectation Web, as depicted in figure 2. The mid-course evaluation should be carried out with the involvement of a larger set of people involved in the implementation. These 'actual scores' plotted on the Expectation

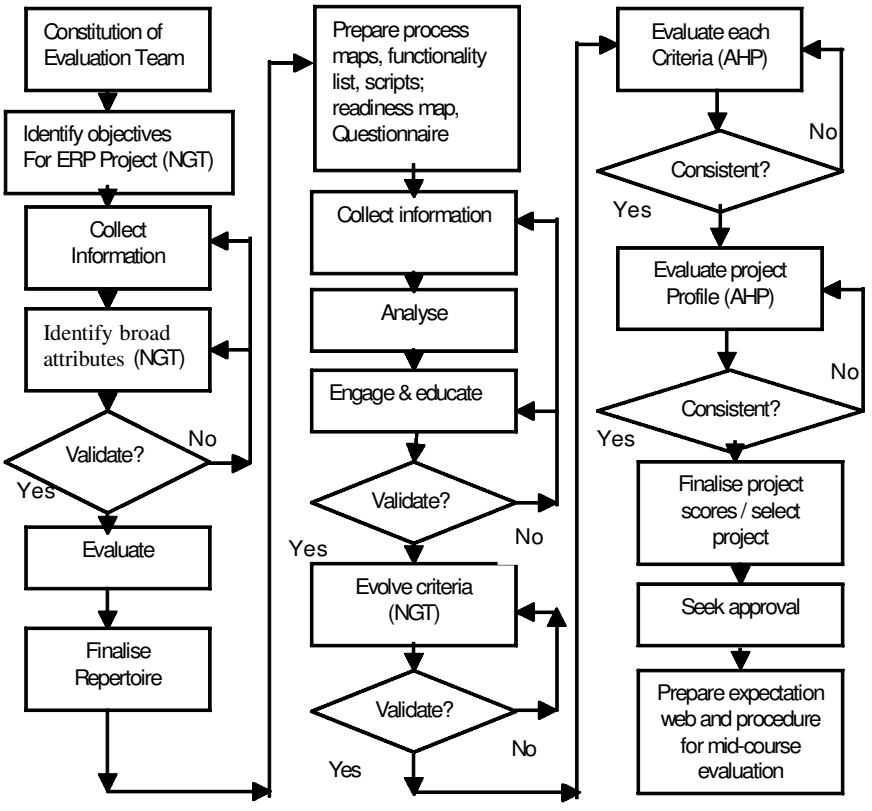

Figure 1. Process flow within the framework.

Web may be reviewed and necessary corrective actions taken so as to bridge the gap between the expected and the actual states of the project.

The construction of expectation and actual webs for mid-course evaluations of the project can be done with the priority weights of the project on each of the evaluation criteria.

5. Application Case

The above methodology was used for evaluating and selecting an ERP project in a public sector undertaking (PSU) in India. The company had undertaken a comprehensive exercise in the wake of deregulation announced by the Government of India in 1991. It comprised a four-step methodology; namely, co-creating the vision for the company, assessing current reality, derivation of the gaps between the two, and evolution of the action plan to bridge the gaps. The broad methodology was sourced from the body of knowledge in the Learning Organization.

The conception of the ERP project came out of the action plan. By the time the action was initiated, the restructuring of the organization as envisaged in the action plan was already executed. The complete exercise ensured participation of over 20% of employees and the rest underwent extensive communication workshops over the period of one and half years. This galvanization of people for shaping the company made it relatively easier to introduce ERP.

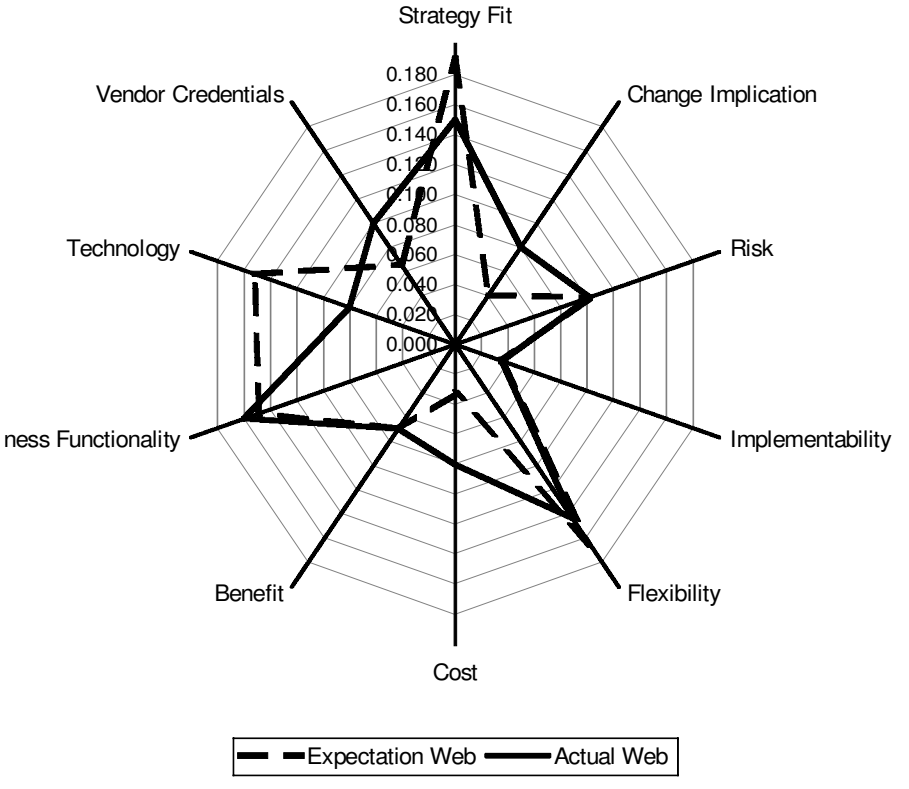

Figure 2. Expectation and actual web depicting the mid-course evaluation of ERP.

A team of ten people, five from business and five from IS, was constituted for the ERP project formulation team with specific responsibilities to select an ERP software, and to formulate the project plan. The steering committee comprising the business heads was also constituted. The various councils that were carved out as the governance structure during the restructuring exercise served as the representative structure. The criteria for the business representatives were that the member should have put in at least 10 years of service in the organization, had exposure to at least three business areas, had worked on at least one special project and had displayed visible conceptual skills. The IS representative were selected on the same criteria except for the three systems analyses and development exposures in place of three business areas.

The team constituted the repertoire of the ERP products on the criteria of business functionality, industry-usage, vendor credentials and local support, evolved with NGT. The team mapped all the core processes in the organization with the involvement of 20 process 'champions' drawn from the businesses, and prepared a detailed functionality list and developed demo scripts along the core processes. A structured questionnaire was prepared to solicit information on technology and vendor credentials. A series of workshops were held for the stakeholders to validate the team analyses. At the stage where the validation process necessitated more product knowledge, the product demos were organized for all the middle-to-senior management staff. This process of information gathering, analysing, engaging-educating

and validating was iterated until the team was given the go-ahead for final evaluation. The product evaluation was based on the comprehensive product demonstration on the scripts. A strict context sustenance discipline was observed during the 15 day long exercise. The final evaluation followed the AHP methodology and incorporated the product evaluation data.

	P1	P2	P3	Priorities of alternatives	Consistency ratio
Strategy fit					
P1	1.000	4.00	6.00	0.671	0.095
P2	0.250	1.000	4.00	0.244	
P3	0.167	0.250	1.000	0.085	
Change implication					
P1	1.000	0.33	0.20	0.104	0.075
P2	3.000	1.000	0.25	0.231	
P3	5.000	4.000	1.000	0.665	
Risk					
P1	1.000	3.00	4.00	0.623	0.016
P2	0.333	1.000	2.00	0.239	
P3	0.250	0.500	1.000	0.137	
Implementability					
P1	1.000	0.33	0.25	0.123	0.016
P2	3.000	1.000	0.50	0.320	
P3	4.000	2.000	1.000	0.557	
Flexibility					
P1	1.000	7.00	6.00	0.755	0.028
P2	0.143	1.000	0.50	0.092	
P3	0.167	2.000	1.000	0.154	
Cost					
P1	1.000	2.00	0.25	0.224	0.094
P2	0.500	1.000	0.33	0.156	
P3	4.000	3.000	1.000	0.620	
Benefit					
P1	1.000	7.00	8.00	0.765	0.093
P2	0.143	1.000	3.00	0.161	
P3	0.125	0.333	1.000	0.074	
Business functionality					
P1	1.000	6.00	7.00	0.739	0.088
P2	0.167	1.000	3.00	0.179	
P3	0.143	0.333	1.000	0.082	
Technology					
P1	1.000	7.00	8.00	0.780	0.030
P2	0.143	1.000	2.00	0.137	
P3	0.125	0.500	1.000	0.083	
Vendor credentials					
P1	1.000	5.00	8.00	0.737	0.038
P2	0.200	1.000	3.00	0.186	
P3	0.125	0.333	1.000	0.077	

Table 1. AHP matrix showing relative priorities of projects on each of the criteria.

	Strategy	Change implication	Risk	Implementability	Flexibility	Cost	Benefit	Business functionality	Technology	Vendor credentials	Priorities of alternatives
Strategy fit	1.000	4.000	3.000	5.000	2.000	4.000	3.000	3.000	1.000	2.000	0.190
Change implication	0.250	1.000	0.333	0.333	0.333	4.000	0.500	0.250	0.200	0.333	0.040
Risk	0.333	3.000	1.000	3.000	2.000	3.000	2.000	0.250	0.200	2.000	0.102
Implementability	0.200	3.000	0.333	1.000	0.250	0.500	0.250	0.250	0.250	0.333	0.035
Flexibility	0.500	3.000	0.500	4.000	1.000	4.000	3.000	2.000	4.000	2.000	0.165
Cost	0.250	0.250	0.333	2.000	0.250	1.000	0.500	0.200	0.250	0.333	0.033
Benefit	0.333	2.000	0.500	4.000	0.333	2.000	1.000	0.333	0.500	2.000	0.069
Business functionality	0.333	4.000	4.000	4.000	0.500	5.000	3.000	1.000	0.333	4.000	0.148
Technology	1.000	5.000	0.333	4.000	0.250	4.000	2.000	3.000	1.000	5.000	0.152
Vendor credentials	0.500	3.000	0.500	3.000	0.500	3.000	0.500	0.250	0.200	1.000	0.066

Table 2. AHP matrix giving priorities of the evaluation criteria.

	Relative weights of criteria	Relative weights of projects		
		P1	P2	P3
Strategy fit	0.190	0.671	0.244	0.085
Change implementation	0.040	0.104	0.231	0.665
Risk	0.102	0.623	0.239	0.137
Implementability	0.035	0.123	0.320	0.557
Flexibility	0.165	0.755	0.092	0.154
Cost	0.033	0.224	0.156	0.620
Benefit	0.069	0.765	0.161	0.074
Business functionality	0.148	0.739	0.179	0.082
Technology	0.152	0.780	0.137	0.083
Vendor credentials	0.066	0.737	0.186	0.077
Cumulative weightage of projects		0.661	0.182	0.157

Table 3. Cumulative weightage of projects.

The AHP analyses showing the relative priorities of projects on each criterion and the inter-criterion priority weights are presented in tables 1 and 2 respectively. Table 3 gives the cumulative weight leading to the selection of the project P1.

Based on the results, an expectation web was frozen for the selected product, for conducting the mid-course evaluation, as shown in figure 2.

6. Conclusions

With increasing competitive pressure in the marketplace ERP projects will continue to occupy dominant space in IT investments in coming years. Unlike the hyped belief of early years that they lent companies a competitive edge, they will constitute the datum line for the business infrastructure. Having ERP may not lend companies a sure advantage but not having it will put them at a certain disadvantage. The distinction will not be in terms of whether ERP is implemented but which ERP product is chosen and how it is deployed to cater to the strategic needs of the business. A wrong product selection would certainly have a lasting adverse impact on the business performance.

The framework proposed here provides a structured methodology to reach the best solution. It is flexible enough to accommodate additional processes to refine the methodology. The framework demands a collection of essential information on the alternative ERP projects along ten different criteria in a group setting and thus ensures the most suitable option is chosen. The mid-course evaluation envisaged in the framework is found to help in highlighting the deviations and to help in overcoming them through alternative courses of action. The success, however, should not be assumed to be intrinsic to the framework, as much of it depends upon the climate of trust and mutual support within the team as well as the change in readiness in the organization beyond the team.

Appendix 1: A note on Nominal Group Technique (NGT)

The nominal group is a structured group that meets to identify problems and priorities. Individuals work alone but in a group setting. There are five steps in the Nominal Group Technique.

(1) Individuals silently write down their ideas in a few words.
(2) Each member presents ideas but does not discuss them. The leader records all the presented ideas.
(3) The leader reads each idea and asks if there are questions, interpretations, or explanations.
(4) The leader asks each person to write down the ideas that seem especially important. The leader then goes down the list and records the number of people who consider each item a priority.
(5) Finally, participants rate each item from no importance (0) to top priority (10). The leader then collects and calculates the ratings and records the cumulative rating for each item.

Appendix 2: A note on the Analytic Hierarchy Process (AHP)

The AHP is a methodology for multi-criteria analysis and decision-making, developed by Thomas L. Saaty (Saaty 1980). AHP uses a hierarchy to structure a decision problem, which decomposes the problem into its component elements, groups the elements into homogeneous sets and arranges them hierarchically. Based on the hierarchical model, the AHP provides a method to assign numerical values to subjective judgements on the relative importance of each element, and then to synthesize the judgements to determine which elements have the highest priority.

The method consists of six steps, as presented bellow:

Step 1. Choose the requirements to be prioritized.
Step 2. Set the requirements into the rows and columns of the $n \times n$ AHP matrix.
Step 3. Perform a pair wise comparison of the requirements in the matrix according to a set of criteria.
Step 4. Sum the columns.
Step 5. Normalize the sum of rows.
Step 6. Calculate the row averages.

It is a method that advocates the comparison of two requirements at one moment.

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