Knowledge Management in Evaluating Technology: Study on How Firm Select their Technology Needs

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ABSTRACT

This paper study the approach of the Knowledge Management concept in making assessment of the technology investment evaluation and benefits identification. It is thus with the increasing amount of technology investment and substantial evidence of failure, together with claims of gaining competitive advantages Evaluation of technology benefits in most cases concerned mainly with either the classification of types of benefits or the initial assessment and justification procedures for identifying and evaluating potential benefits which technology project may deliver. Technology on it own does not deliver benefits. If benefits are derived from technology through business changes, then it is reasonable to assumes that the implication of these changes be assessed before the technology being utilized in order to quantify the potential the potential benefits. It was found out that the decision to invest resources into technology is taken with the help of action plan (a strategy) aimed at achieving the technology investment target like efficiency (quality of service) improving business process (modeling) and specification of technology benefit objectives. When the evaluation dictates a change to the system, benefits profiles and programmers are updated; it is the perspectives for the technology selection.

Keywords:

Evaluation, information system, information technology strategy, Investment

1.0 INTRODUCTION

The introduction of technology into the workplace involves substantial capital expenditures. A total systems approach can be used to justify new technologies. Other financial justification techniques are also useful, not as a stand-alone methodology but as sanity check. The comprehensive justification of a new technology requires that managerial judgment be applied to weigh both the tangible and intangible benefits and costs associated with the use of new technology.

2.0 KNOWLEDGE MANAGEMENT CONCEPT IN EVALUATION OF NEW TECHNOLOGY

In evaluating new technology, most of financial literatures concern merely on financial implications without taking into consideration another important impact to the firm, which is strategic planning. In the strategic planning perspective, evaluation technology is essential in order to measure effectiveness and efficiency, monitor the changes in R&D performance and practices within the firm over time, expand R&D activities, and compare with competitors (Dressler, Wood and Alvarez, 1999).

Traditionally, new technology or project evaluation is fully based on the financial measures in which firms normally focus on financial performance as dominant factor in evaluation process by concentrating on the wellness of financial returns of the new technology or project. Conventional financial approaches such as accounting income based, discounted cash flows based and cash flow based have been widely use in evaluating technology.

Accounting income-based refers to return on equity (ROE) and return on capital (ROC) which focus on measuring financial returns compared to capital or equity. In this case, if the financial return of new technology is larger than ROE or ROC, then the new technology is well performed. Secondly, cash flows

based emphasizes on the length of time it will take for nominal cash flows from the technology to cover the initial investment or it is so-called payback period which means the shorten payback the better the technology. Finally, discounted cash flows approach, which is commonly used by the firms compared to the other two approaches, emphasizes on measuring net present value (NPV) and internal rate of return (IRR) of the technology. If the net present value is positive and IRR is larger than COC, then the technology is considered favorable.

However, the rapid changes in technology and business environment in 1980's cause criticisms on the financial measures. Some critiques view conventional financial measures are no longer appropriate to evaluate high technologies, which are often complex, offer intangible benefits and carry high risks (Lefley, 1996). In addition, such measures also fail to capture the strategic benefits and may discourage the investment in the high technology.

Due to these critiques, two financial techniques have been developed to evaluate R&D; cost saving ratio and new sales ratio. Both financial techniques focus on the contribution of development in R&D and for the growth of the business. New sales ratio approach emphasizes on measuring the contribution of new products to the profitable growth of business by calculating the ratio of current annual sales of new product to total annual sales (Whitley, Parish and Dressler and Nicholson, 1998). Cost saving ratio approach on the other hand, concentrates on measuring the reduction in cost of good sold or cost of operation that are realized from technology changes. This ratio is obtained by summing all cost savings from new technology compared to gross profit (Dressler, Wood and Alvarez, 1999). However, both approaches still focus on financial benefits rather than other benefits, hence, the issues of evaluating new technology still remains unsolved.

3.0 TECHNOLOGY EVALUATION IN BUSINESS PERSPECTIVE

The opponents of financial measures as primary tools to technology evaluation argue that traditional financial measure techniques may have been adequate for appraising cost reduction and machine replacement investment, but they are inadequate in appraising sophisticated new technology projects. These techniques cannot cope with the nature of the benefits offered, such as flexibility and synergy, and the risks inherent in today advanced manufacturing technologies. Further, management is always placed in a dilemma when they wish to invest in new technology such as AMT because they find it difficult to justify the capital expenditure using financial measures techniques. For better understanding of dilemma, consider this real example of the Yamazaki Machinery Company in Japan. This company has installed flexible manufacturing system. This system can reduced the number of machines from 68 to 18 units, the number of employees from 215 to 12, the required production area from 103,00 square feet to 30,000 square feet and the processing time from 35 days to one and a half days only. However, the financial return over for the first two years is less than 9 percent of total investment. Thus, it is argued that at this lower financial return, it would be difficult to justify the acceptance of such a project on financial basis.

Based on apparent inability of the financial measures, they proposed a more positive approach of technology evaluation. This approach emphasizes that evaluation process must take into consideration the strategic benefits together with financial implications of the technology. Several strategic models such as The Kaplan Model, The Bromwich and Bhimani Model, The Airey and Young Model the Samuel, Wilkes and Bryshaw Model have been developed over the past decade in order to overcome evaluation problems of technology especially for high technology.

All of these models focus mainly on the importance of strategic benefits of technology and are given equal weight as financial return. The Kaplan Model for instance, argues that any new technology proposal should not be rejected if the NPV is negative. The management must first calculate the value of intangible benefits and then compare with the amount cash flows needed for NPV of investment to be positive. If the value of intangible benefits is smaller than the amount needed, then the investment is rejected or otherwise. This approach is supported by Kakati and Dhar (1991) who suggest two level model; first the financial justification and then, if the technology does not meet the financial criteria, a strategic assessment is made. Other models are also in similar arguments but their approach revels that financial justification is still given a priority. Although the positive approach reveals a significant improvement in evaluating new technology. The problem of how to quantify strategic and intangible benefits becomes another controversial issue. A lot of efforts have been done to develop mechanisms, which can properly justify such benefits.

The University of Manchester Institute of science and technology (UMIST) has developed an interesting computer program, which is known as IVAN specifically to deal with problem of quantifying such benefits. This program claims that all benefits can be identified and quantified by incorporating a number of statistical models and uses a range of inputs variables rather than single figure. Variables are calculated in respect of the better-known quantifiable data and estimates are used for the previously so-called intangible benefits.

4.0 TACTICAL AND STRATEGIC BENEFITS OF TECHNOLOGY

Wabalickis (1998) suggests another practical mechanism to justify the new technology. This technique divides the benefits form new technology into tactical benefits and strategic benefits. The tactical benefits are those benefits that are reasonably measurable and can be evaluated using conventional financial appraisal methods while the strategic benefits are assessed using a weighted score system based on the analytic hierarchy process (AHP) developed by Saaty. This process produces a desirability index (DI) and selection of new technology must be based on this index. A new technology with highest desirability index is considered the best technology and should be selected. In practice, the central issue of how should new technology is evaluated normally depends on individuals organization. There is no such standard and therefore, the organization is free to choose any methods. However, this method will depend on the nature of the organization's activity, technology employed and strategic planning.

Asea Brown Boveri Ltd (ABB), a technology-based company has a method of assuring that it is making the right investments in technology. That process is known as business Technology Evaluation (BTE) and is seen as being applicable to any global organization that seeks to create business advantage through technology. BTE is a systematic process to assess the role of R&D and product/process technology in enhancing a business areas competitive position and market/financial success (Stillman, 1997). It lays the groundwork for selecting the product or process technology areas suited to support a business unit's mid and long-term viability and also provide a basis for focusing R&D efforts and expenditures. Besides assuring its commitment to technological innovation, technological competence and technological leadership, the company also allocates a substantial amount of resources to R&D, technology-based joint ventures and license agreements for the success of ABB. BTE has four (4) objectives (Stillman, 1997): (1) *Identification of breakout opportunities*. In this case, BTE should try to identify new technology applications that may lead to innovative product offerings to the existing customers and in new market areas. (2) *Achievement of cost reduction* – BTE should achieve lower cost through the manufacturing of new product and process technologies. (3) *Identification of, and defense against, technology treats*. BTE should make sure that this technology treats be identified earlier so that countermeasures can be undertaken. (4) *Review and fill gaps in capability* – This is a final and important objective whereby the analysis of mechanisms to link R&D projects with business strategies, and the assessment of management tools to ensure that technology development efforts meet time, cost, performance and technology strategic is done. ABB also developed a general framework in which all BTEs are conducted, which mainly consists of three (3) somewhat overlapping stages as follows (Stillman, 1997):

Table 1: Model of ABB Business Technology Evaluation

	BUSINESS TECHNOLOGY EVALUATION		
	STAGE 1	**STAGE 2**	**STAGE 3**
Focus: What	Structured information collection	Analysis of current situation	Gap analysis and identification of options
Methods (HOW)	• Consensus wrt key issues • Interviews • Reviews of existing documents • Internal view on competencies	• Workshops e.g. market need, technology position • Capabilities assessment • Proposal for focused subsidiary projects	• Subsidiary projects • Definition of options to fill gaps • Integrated technology and Business evaluation • Improvement recommendation

However, for BTE projects to be successful, it needs business-unit top managers to directly support and guide them.

The context of evaluation should also include external (*environmental*) and *internal (organizational*) factors to the organization that influence evaluation and its management (Serafeimidis & Smithson, 1999). External context includes those factors typically beyond the control of the organization, that the organization and its members need to respond to and accommodate, for example, the national economic situation, government policy, legislation changes, markets and market demands and competition. Internal context of evaluation on the other hand, include the management processes (such as information system planning and quality management), organizational structure 9such as information system department), the individuals and their roles, the information technology, organizational strategies and organizational strategies and organizational culture and norms.

Benda (1999) suggested that the right people, criteria and direction are to be the critical criteria in a successful process. The three most important criteria in the evaluation are cost, effectiveness and safety (Benda, 1999). In this case, the process must not set the assessment bar too high (which would impede effectiveness) or too low (which would waste resources). The process also must appear unbiased to avoid liability litigation.

There are three (3) factors that could influence an increase in the value of the technology investments (Boivie, 1998). First is efficiency for example reduction of cost of operations, products and services; measured by benchmarks, comparison to others, percentage of revenue and similar tools. Second is effectiveness such as delivering more value for investment; measured by the degree to which technology contributes to the achievements of corporate objectives. Third is productivity. Productivity will ensure that the right things are automated; measured by how well the technology investment are aligned with the business objectives. However, there are meaningful results that cannot always be objectively measured. For example, the benefit of increased flexibility that technology can provide a business is difficult to assess. In this case, effective measures will depend on what the business goals are.

In empirical analysis on innovation evaluation program designed to judge the commercial feasibility of new products and ideas, Bowman-Upton, Seaman and Sexton (1989) identified five (5) factors of evaluation criteria. First are societal factors such as legality, safety, environmental impact and societal impact. Second are demand analysis factors such as potential market, potential sales, trends of demands, stability of demand, product life cycle and product line potential. Third are competitive factors. In this case, the criteria are appearance, function, durability, price, existing competition, new competition and protection. The forth are business risk factors such as functional feasibility, production feasibility, stage of development, investment cost, payback period, profitability, marketing research and R&D. finally, market acceptance factors. These include compatibility, learning, need, dependence, visibility, promotion, distribution and service.

For the valuation of technology, it differs from the valuation of ordinary physical and financial assets in three (3) ways (Peter, 1998). Firstly, innovative technology is very intangible and therefore often financial invisible. In this case, much of this kind of technology is embodied in the skills, experiences and records of scientists and engineers. Secondly, a technology asset only realizes its value when it is linked to other technology assets and/or physical assets. Thirdly, the degree of unique risk in the R&D marketplace, where new and innovative ideas are conceives, patented and developed, is extraordinarily high as compared to the normal degree of risk encountered in financial markets.

Gaynor (1998) recommends that the following questions be asked and answered when evaluating projects: Are the objectives of the technology project clearly defined? Do the objectives of the technology support the strategies of the organization? Why is this technology important? Is this a business projects or technology project?

Could the research effort, for the example, be reduce or minimizes by joining forces with other organizations?, Does the projects leverage the current organizational bank of technology? What is the "value-added" in terms of new knowledge?, Do patents, that is, cover the technology proprietary? What other technologies could competition develops to achieve the same results? Has the applicable technology been explored on a global basis?

Can the known and unknown aspects of the technologies be clearly stated? What are the specified technologies involved?, If the project is related to research, what are the estimated costs to the organization (that is the total cost)? What are the potential capital requirements is successful? Has a thorough been made regarding the project staffing? Can the required expertise and the level of expertise be defined? Is there a project manager with the credentials plus the experience and the track record? Have the requirements been detailed?

5.0 FACTORS WHEN CONSIDERING NEW TECHNOLOGY

Due to the increasing numbers of new technologies expected in the work environment, decision-makers such as engineers in particular will be faced with the complex problem of how to introduce a new technology into the workplace. Edowsomwan (1989) suggested three step approach: (1) perform technology task environment analysis to understand the implications from a user's perspective; (2) provide training facilities for personnel using technology; and (3) involve the user in the maintenance and adaptation issues that are likely to occur in the work environment.

Meredith and Green (1998) offer some guidance and warnings for firms working to introduce new technology. First, be clear in your mind before implementing what you are trying to accomplish strategically with the new technology. Second, assess the functional characteristics of a new technology and attempt to anticipate the "unavoidable" consequences of it. Third, threat the disease, not the symptoms. In this case, the firm needs to recognize that the individual and group consequences of new technology

are symptoms of fundamental changes to the organization's form and operation. Forth, expand your view of the "job". New technology offers many trade-offs. Recognize that the old "job" may appear to be eliminated by the technology, but what appears to be elimination may be transformation. Fifth, be prepared to change your strategy. In the number of cases, new technology brought unexpected benefits that allowed the firm to change from a defensive posture to a growth posture. Lastly, stay flexible and responsive to both problems and opportunities with the new technology. Monitor the organizational and group consequences and take action to address the issues that will inevitably arise.

However, Kanet (1998) on the other hand suggested eight (8) factors that should be included when considering new technology. These factors arise from the overview of IVA Manufacturing, the apparel-marker and its owner, William Epstein. The first factor is technology's central role such as long term strategy (example, marketing scheme, operating policies and corporate financial structuring), technology capabilities (example, offer to complete customer service), and technology know-how (example, engineering/production, process technology, shipping and consulting). The second factor is generating revenue from technology. In this case, we have to make a decision whether to buy equipment or not so as to be still in business. The third factor is remuneration that encourages innovation. The firm has to foster an innovation culture by building a technically competent and motivated personnel base, encourage and support employee education and training and also economic and productivity incentives are embedded in the pay and salary structure at all levels of the organization. The forth factor is the role of de-skilling. De-skilling means lower the required skill level. Does technology lower the required skill level? The fifth factor is overcoming resistance to change. This resistance must always be reckoned with when a new technology is being introduced. The sixth factor is building commitment through ownership. The seventh factor is how technology is brought in. employees might resist using the technology if it is adopted from their competitor that is the "not-invented here" syndrome. The last factor is following a technology plan. The firm has to have a plan and uses technology to carry out the plan. The plan should integrate mission, objectives, corporate structure, marketing plan, organizational practices, pay structure and other that can facilitate the use of technology. Another four factors suggested by Peter (1998) that can be considered in valuing the options created by proposed new technology are technology-pairing, size of current and potential markets, strength of linkages and polarization of the linkages. In the technology-pairing, a new technology will be paired with the existing or future technology to create value. Technology is all about linkages and the linkages between the technology pairs can be strong or weak. Polarization is important since it will govern whether the owner of the new technology or existing technology is dominant.

6.0 TRAPS, PITFALLS, SUCCESS AND FAILURES IN EVALUATING TECHNOLOGY

The following are eight (8) of the most serious traps and pitfalls that the technology manager may encounter (Peter, 1998). The first is confusing hurdle rate with discount rate. Kaplan (1986) point out that one of the difficulties encountered in the justification of new technology is the use of unrealistically high discount rates to cushion the firm or analyst from the risk associated with high-technology innovations. This misuse occurs because financial analyst that are not familiar with the R&D do not explicitly recognize that a central part of the R&D process is risk reduction, and that the most of the investment will be made, and only made after the key risk issues are resolved (Peter, 1998). The second is using the status quo as the baseline. In the case of technology business, standing still is not an option. The third is miscalculating horizon value. Horizon value (terminal, continuing or residual value) represents the value of all future cash flows beyond those explicitly included in the cash flow table discounted to the horizon year. Therefore, the assumptions used in treating horizon value are absolutely critical to the value of the project. The forth trap is focusing too narrowly on cash flow. In is argued that the using of cash flow models can lead to poor decision. It makes little difference if the valuation is based on cash flow or earnings. The fifth is confusing investment with operating expense. In this case, for example, R&D, investment in market development, training of personnel, and plant start-up costs are usually treated as expenses and therefore charged against earnings from the viewpoint of accountants, when in effect, the are investments. The sixth is over weighting the Analytic (versus the Synthetic) approach. In the analytic approach, the project proposals often contain several pieces and astute choices be made to which technical developments will create promising positions and be highly compromised. In this case, the best technologists are synthesizers because they think broadly, are often in a domain where there are no quantitative tools, and use the language of technology. The seventh trap is neglecting the spectrum of possibilities. Using the decision trees technique can do the spectrum of probability of its happening. Last but not least, neglecting the options approach to valuation. By neglecting the option value will therefore undervalues the technology.

7.0 CONCLUSION

Technology asset only realizes its value when it is linked to other technology assets or physical asset. Valuing technology is all about valuing linkages. A

possible linkages may include scores of past ,current and future developments in the technical world–owned internally by competitors and customers, The degree of unique risk in the technology marketplace, where new and innovative ideas are conceived, patented and developed is extraordinary high compared to the normal degree of risk encountered in financial market.

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