Technology Introduction in a Systemic Context for IT Project Success

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ABSTRACT: *The management of information technology (IT) introduction is a complex, interconnected systemic process. Sub-optimal solutions may result when an enterprise fails to analyse a broad spectrum of worthy solutions, taking a systemic standpoint. The information technologies selected and the means adopted to introduce those technologies, can be crucial to the eventual success or failure of an IT project. In this paper various analyses crucial to the management of change are identified and critically examined. The potential consequences of failure to successfully carry out such analyses are canvassed.*

Keywords: Technology Management, Change Management, IT Projects

INTRODUCTION

People and processes must undergo a significant change, learning, adaptation and growth in response to the introduction of Information Technology. The technologies selected and the means adopted to introduce those technologies, can be crucial to the eventual success or failure of an IT project. Technologies should be analysed in a systemic context to avoid sub optimal systems when introducing new technologies. Taking action to enhance technology acceptance in this way is a major change management activity for those managing IT projects.

In this paper various analyses crucial to the management of change, that might be carried out in the course of an IT project, have been identified and critically examined, drawing upon extant technology management literature. The paper details analysis processes that might support examination of: requirement, resource, implementation and strategic goals; customer requirements with a view to determining project viability and generating specifications; characteristics of the technology; system architecture, system interfaces and compliance with standards; and the structural and process flexibility of the technology. The potential consequences of failure to successfully carry out such analyses are canvassed.

ASPECTS OF EXAMINATION IN TECHNOLOGY INTRODUCTION

This section introduces various aspects of technology that require careful analysis so that the best option or courses of action are taken in the introduction and subsequent management of changes in an organisation.

Analysis of Technology Feasibility

Probert and Shehabuddeen (1999) emphasise on technology feasibility analysis in the process of managing technological changes. They proposed a planning tool called Technology Road Map (TRM) to use for formulating the links between the current, emerging and potential technologies. The TRM may help an organisation to choose technologies to exploit and analyse their long-term market opportunities.

When using the TRM, potential technologies may be analysed in a system context for requirements, resources, implementation and strategic goals. In summary:

- Requirement analysis establishes and justifies the requirements of introduction of new technology into an organisation and decides where and when to start the introduction. The internal and external environmental requirements may be considered in the requirement analysis
- Resource analysis seeks resources that must be available to acquire for implementing and utilising new technology. It may include skills, physical, information and financial resources. Strengths and weaknesses of

a firm may be identified when analysing resources
- Implementation analysis determines the implementation easiness of a project. The analysis may determine:
  - Impact of the new technology on the existing systems
  - The adaptability or fit between the old and the new system
  - Effectiveness of the new technology when integrated into the existing system
  - Likely obstacles arising from the implementation and necessary preparation
  - Techniques for optimal exploitation of the new technology
- Strategic goal analysis examines requirement, resource and implementation analyses of the project against strategic goals of the organisation.

Requirement Analysis as Technology Market Integration

Requirement analysis enables the analysis of the project viability and then the generation of product specifications to satisfy the identified requirements (Cooper et al. 1999). It can be considered as a process of technology-market integration.

When formulating the technology strategy of an organisation, effective processes are required for identifying and assessing technologies and balancing the technology portfolio. Requirement analysis process does not only collect, record and analyse information for the specific requirements but also collect other useful material related to customers, market and technologies. The requirement analysis is an iterative process (Cooper et al. 1999) by which the needs, preferences and requirements of individuals and groups significant to the product development may be researched and identified. It is essential to capture market, design and technical requirements at an early stage of a project or product, in order to generate right product specifications.

Customer focus is also important in R&D (Brook and Brewster 1999, p.640). A framework called Customer Needs Tree can be used to build customer awareness within R&D. The Customer Needs Tree is a hierarchy of customer needs for a given market segment, with a customer needs at each level weighted to reflect their relative importance. It represents a distillation of the knowledge from customer, market, competitor, technology and other intelligence processes. It is also a simple and effective tool for improved communication. Customer Need Tree concept is also described in contemporary Total Quality Management (TQM) literature. Quality, value, and services are all customer-related (Oates 1997) concepts.

Reasons for Project Performance Gaps

The project management process translates the customer requirements into a specific sequence of activities. In this process, five individual gaps in project performance may accumulate (Deane et al. 1997) to cause an ineffective project result. Project Performance Gap Model proposed by Deane et al (1997) for IT projects is shown in figure 1.

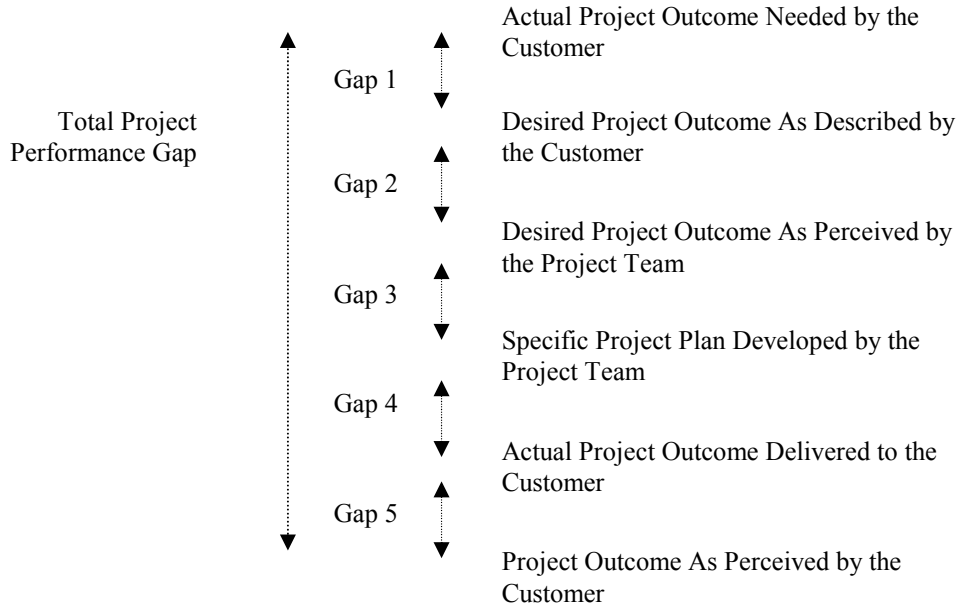

Figure 1: IT Project Performance Gap Model [source Deane et al. (1997)]

Project managers should use efficient project control processes to narrow the cumulative gap between the customer needs and the project outcomes.

Analysis of Characteristics of Technology

Characteristics of technology can be described in terms of (Probert and Shehabuddeen 1999, p.654-659) uncertainty of new technology, technology discontinuity, technology diffusion and resistance to change. According to Innovation Diffusion Theory (Rogers 1983), attributes of technology can be described in terms of relative advantage, complexity, compatibility, trialability and observability.

The characteristics of technology is related to common reasons for failing new technology at various stages from initiation through to implementation and utilisation (Probert and Shehabuddeen (1999, p.654).

- Uncertainty of new technology will be increased with complexity. Complexity is the difficulty with which new technology is understood. Technology forecasting involves the making of informed decisions and helps to reduce both the uncertainty and level of risk associated with new technology
- Technology discontinuity occurs at the time at which a technology will become obsolete. It may have wide-ranging implications upon various areas such as employee training, organisational structure, reorganisation of customers, strategic planning, supplier's ability, and product and process life cycle
- Technology diffusion occurs in two areas, production floor and market place. In these processes new technology will be developed to its fullest potential and gain full acceptance from the workforce and the products of new process technology will be fully accepted by the customer
- Less resistance may be expected for the improvement of existing technologies than the substitution with existing technologies by new technologies. Resistance to change may be analysed with reference to legitimate reason for change (rational), phobia of change (emotional) or personal ambitions of individuals (political)

Concepts of Product Modularity and Information Structure

Complex products or systems are composed of a series of components or sub-systems. The overall functionality of the system that performs a specific function is determined by the collective functioning of the interrelated components of the system.

The component interface in a system (Galvin 1999) defines the functional, spatial, physical and non-physical nature of the components and links between components. When component interfaces are standardised products become modular. In modular products components are highly independent. In integral products components are highly interdependent. The flexibility of the system is determined from the independent nature of the components.

The creation of a functional product using a combination of highly independent components requires (Galvin 1999) knowledge of the various component interfaces. This knowledge is referred to as 'product design information structure', and it may include details of system architecture, system interfaces and standards. The rate of change in the information structure and the level of control exerted over the information structure would determine the type of product innovation. Galvin (1999) used the Henderson and Clark framework, which is shown in figure 2 to explain the relationship between information structure and innovation.

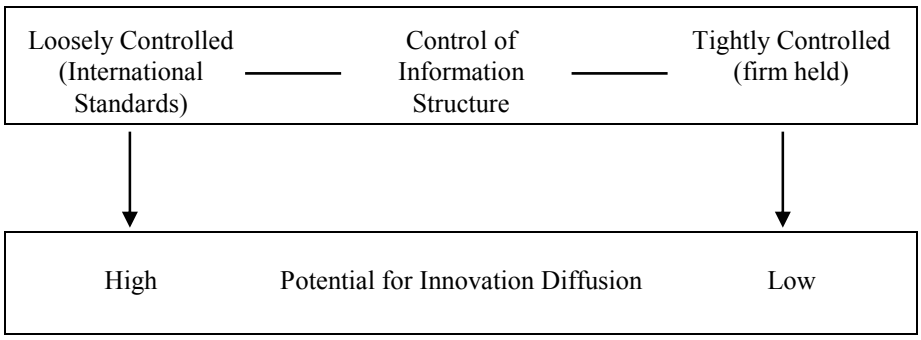

Figure 2: Henderson and Clark framework [pp. 471, Galvin 1999]

The impact of product modularity on innovation is summarised here.

- Architectural and radical innovations require changes to occur at the component interfaces. When there are changes at the component level only, incremental and modular innovations occurs.

- Modular products may enable structured learning and innovation at the component levels to occur within network of organisations and hence facilitate innovation.
- A passive information structure is more likely to result in incremental and modular innovations.
- An active information structure has significant potential for a radical innovation.

Analysis of Technology Flexibility

Technologies may be required to continually adapt during their operating life. However, all technologies are not necessary to be flexible. Technology flexibility are investments that need to be justified. Flexibility is a key characteristic (Nelson and Ghods 1998) desired in both technology and business processes.

Flexibility in systems may be viewed as the interaction and alignment of technology and people. Technology has often made organisations more rigid (Hedberg and Jonsson 1982: cited by Nelson and Ghods 1998) rather than more flexible. Existing technologies can present barriers to business process flexibility. Nelson and Ghods (1998, p.235) provide a theoretical model to describe technology flexibility, which is shown in figure 3.

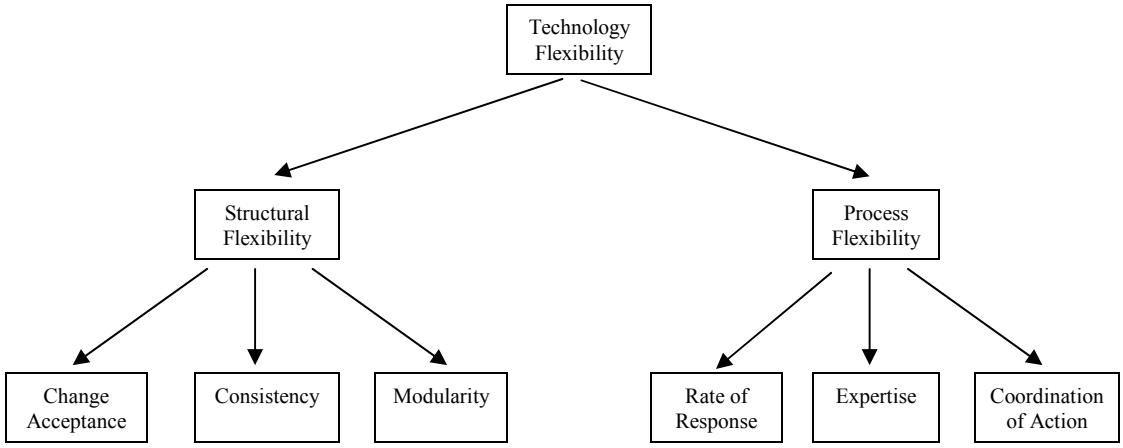

Figure 3: Technology flexibility Model [source Nelson and Ghods (1998, p.235)]

The definitions given by Nelson and Ghods (1998, p.233) for flexibility, structural flexibility and process flexibility are provided here to help understand the above model.

- Flexibility: the ability to adapt to both incremental and revolutionary changes in the business or business process with minimal penalty to current time, effort, cost, or performance.
- Structural Flexibility: the capability of the design and organisation of a technology to be successfully adapted to business process changes.
- Process Flexibility: the ability of people to make changes to the technology using management processes that support business process changes.

The term modularity means that units of programs and hardware are manageable. That is modules are easy to modify when business processes are changed as well as modules are easy to create or destroy. System changes will be easy, if the technology contains built in capacity for change called change acceptance. The ability of data, components or sub systems to be integrated consistently across a technology will also increase the flexibility. The rate of response can be described as the degree to which changes can be made to a technology in a timely manner. The people and management processes used during a technology change impact on the rate of response. An up to date knowledge about the operation and maintenance of a technology should have been disseminated in the organisation so that the system is less dependent on the availability of expert individuals. Further, the technology maintenance and user organisations should operate according to the requirements of each other and the total organisation. People should be given appropriate training to facilitate process flexibility.

SYSTEMIC VIEW OF TECHNOLOGY CHANGE

As seen from the analysis presented above, the management of technology is a complex, interconnected systemic process. When an enterprise fails to analyse a broad proposal of worthy solutions from a systemic viewpoint, sub-optimal solutions should be expected. Technology may interact with internal activities of the organisation and its environment. Business areas of importance for technology change are (Probert and Shehabuddeen 1999, p.653) organisation, customer, regulations, supplier, finance, economy, production and competitor. The

functions and processes in a firm are necessary to be integrated appropriately for a change process to work effectively.

The advantages that may result from a systemic view are (Probert and Shehabuddeen 1999):

- Clearer understanding of the impact of the new technology
- Understanding of commitment required from people for implementation and communication requirements between various disciplines
- Opportunity to enhance business processes improving efficiency
- Company wide view on important issues
- Creation of optimal solutions

The potential consequences of failure to carry out the necessary analyses, as revealed in the literature, are summarised in Table 1. The managerial perspective presented in Table 1 would help to prevent sub optimal solutions whilst facilitating technical change management processes associated with the introduction of new technology.

Table 1: Summary of the Analyses Necessary for Technology Introduction

Type of Analysis	Managerial Perspective (Why the Analysis)
1. Potential technology in a system context for requirements, resources, implementation and strategic goals	Internal and external environmental factors may determine, whether it is necessary to introduce new technology and when and where it should happen. Implementation and utilisation of new technologies may also require specific skills. Furthermore, new technologies may have a wide range of impacts on the existing systems of the organisation. Thus introduction of new technologies are necessary to analyse in respect to requirements, resources and implementation, and these analyses against strategic goals of the organisation. Failure to carry out such analyses successfully may provide inaccurate information of the feasibility of technology introduction and avoid taking necessary actions for the introduction of new technologies. It may result into a project failure.
2. Customer requirements to analyse project viability and to generate specifications	In the requirement analysis, market intelligence is gathered to identify what is required from the development team. Market intelligence is used for technological developments to produce appropriate products (or projects) for the market. Without a through requirement analysis process, false or incomplete assumptions may be made about customer, technical and other requirements, and may generate poor product (or project) specification. Weaknesses in translation of customer requirements at various stages of a project may also contribute to an inefficient project results. The net result is that organisations miss market opportunities or produce technologically sophisticated products, but which may fail to meet market or customer requirements.
3. Characteristics of technology	The characteristics of technology is related to common reasons for failing new technology at various stages from initiation through to implementation and utilisation Attributes of technologies may be analysed in terms of relative advantage, complexity, compatibility, trialability and observability at early stages of a technology introduction project. Analysis of such characteristics may be helpful to propose strategies for minimising failures of the new technological system and also facilitating acceptance of them.
4. System architecture, system interfaces and compliance with standards	It is necessary to consider information structures when selecting technological systems. An information structure may be controlled by an organisation or it may be common knowledge. When an organisation controls an information structure, the product uses an organisation driven product architecture. When a product is well defined in international standards, it may results a common knowledge information structure. When systems are built, using modules defined in international standards, interoperability in a multi-vendor environment can be achievable. It will result

	in a reduction of the risk of project failures and project cost through the availability of products from several sources, while supporting innovation.
5. Structural and process flexibility of the technology	In the current volatile environment characterised by continuous changes in people and processes, flexibility is an essential requirement for successful business operations. However, organisations can become more rigid than more flexible due to the technologies. Technologies may be required to continually adapt during their operating life. Technologies need to be replaced regularly to meet requirements of people and management processes, if technologies are not sufficiently flexible. As such, structural and process flexibility of the technology is a factor to be considered in the decision making process of the introduction of IT systems.

CONCLUSION

The management of information technology (IT) introduction is a complex, interconnected systemic process. The information technologies selected and the means adopted to introduce those technologies, can be crucial to the eventual success or failure of an IT project. The analyses in the following areas are required when introducing new technological systems:

- Potential technology in a system context for requirements, resources, implementation and strategic goals
- Customer requirements to analyse project viability and to generate specifications
- Characteristics of technology
- System architecture, system interfaces and compliance with standards
- Structural and process flexibility of the technology

In this paper various analyses crucial to the management of technological change, that might be carried out in the course of an IT project, have been identified and examined, drawing upon extant technology management literature. Sub-optimal solutions may result when an enterprise fails to analyse a broad spectrum of worthy solutions, taking a systemic standpoint. This will also contribute to a high resistance for accepting new technological systems.

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