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Managing the Technology Life Cycle - a Contextual Approach to Analysis

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Abstract: Organisations need to understand and manage the technology life cycle in order to deliver their business objectives. Technology and systems have an increased role in all organisational forms. Failure to realise the benefits here can have severe impact on these entities and, in the case of the emergence of disruptive technologies in the sector, the business can be destroyed and customers move to competitors, who have embraced these technologies - for example the UK travel industry, evidenced by recent high profile failure [1]. The critical role of IS and IT in the value chain has increased the importance of good management of this area.

This paper considers the main factors for managing the life cycle, in terms of the implementation, support, renewal and disposal of technology. This is based on analysis of key literatures and an empirical study of technology leadership in energy sector projects.

The aim is to improve understanding and awareness of this critical area, providing insights into these factors, which are categorised as 'evolutionary' and 'revolutionary'. These factors are viewed as 'drivers' of the technology life cycle, creating its character and duration also embracing the 'triggers for change', promoting the replacement of the technology and recommencement of the cycle. The critical stages are discussed with the contextual influences, in order to analyse this area, discerning the relevant rationale, as summarised in a conceptual model.

Recommendations for good practice are elicited from this study in terms of identifying the key decisions and thus analysing and managing technological change.

Keywords: Technology, Life Cycle, Project Leadership, Project Management

1 DEFINITION

The Technology Life Cycle is a series of stages to define, select, acquire or develop, implement, maintain, upgrade, dispose and replace the mechanisms, systems and devices used by an organisation to deliver its objectives (based on Needle [2]). The stages utilised depend on the nature of the technology, organisation and its environment together with the choices made by the key stakeholders. The success or failure of the technology depends on the management of this cycle and interaction with the environment. This paper assumes a systems perspective to examine this phenomenon (for example, Blair and Orgee [3]). An empirical study into technology leadership has been accessed to examine this area, considering the project management aspect. The environment and organisation define and select the technologies that are developed and, reciprocally, shape its environment, together with the characteristics of the accompanying cycle.

The rate of technological change allied with society's prioritisation of resources for technological development are important determinants of the technology life cycle. A business will invest in the technologies that are perceived to support or directly deliver its objectives, utilising an appropriate level of its resources. The success or failure of these technologies will be measured by its stakeholders in terms of both objective and subjective measures, for example growth of sales and customer satisfaction. The life cycle links with the organisation's value chain to deliver the requisite products and services. Managing this life cycle can therefore be critical to success.

2 LEADERSHIP

The empirical study, utilised by this paper, is qualitative, based on a thematic analysis of interviews with project managers in the energy sector and allied with themes from key literatures in this area.

The successful leadership of technology can be defined as, the selection of the appropriate technology for the organisation; correct installation and commissioning, avoiding project failure; maintain and upgrade the technology, as needed; remove and replace the technology, as required. The technology should deliver and support the organisational objectives within its environment.

The political aspects of change, in terms of the accommodation and application of power, conflict management and communications are identified as key factors in the leadership of technology. Management style was also viewed as being critical, with transformative and transactional comprising the principal modes [4].

This allows the implementation of technology to be categorised as evolutionary or revolutionary. The incremental change of technology within the organisation is an evolutionary process, aligned with a transformative approach. The complete replacement of technology occurring in a short period is aligned with the transactional method. The latter complements project management techniques, with a radical implementation occurring within a narrow timespan.

3 STAGES OF THE LIFE CYCLE

The technology life cycle comprises a series of linked stages, from initiation to replacement. The actual stages depend on whether the technology is being acquired, developed or possibly both, in the case of in-house customisation of a purchased product. The initial stages of this cycle comprise the project management phases, followed by a period of maintenance and support then decommissioning and disposal. The replacement of the technology then occurs, as this life cycle is repeated. The key stages are

3.1 Project implementation

The project is identified and an organisational commitment made to deliver the new technology. This should include a shared definition of scope and success, both obtaining the commitment and managing the expectations of the principal stakeholders. This should involve the formulation of a detailed specification, for in-house delivery, as required. A plan should also be created for time and budget, to facilitate delivery. All of the contracts should be created, with in-house and external personnel, as needed. This may entail a selection process, to engage the contractor to perform this work, depending on the organisation and value of the products and services. The creation of the new technology can occur using internal or external resources, or a combination. The plan could be serial (such as PRINCE2) or circular (such as Agile Project Management). The technology should then be tested, with both functional and bulk checks, tailored to the existing scenario. The actual implementation can occur as direct replacement, phased approach or operating in parallel and switching to the new technology, when the appropriate reconciliation occurs. The aim is to support the objectives of the organisation with the new technology and deliver the project benefits.

3.2 Support

The end of the project stages should entail transfer of the technology into use, comprising the support and maintenance stage. There needs to be a transfer of learning to the personnel running this stage. The elongation of this stage usually reduces cost to the organisation by increasing the time for the technology to deliver its benefits and deferring replacement cost. The fixing of faults, loading of upgrades and adding changes during this stage will enhance the value of the technology and potentially extend this phase, comprising the useful working life of the technology.

3.3 Renewal

The decision is taken to change the technology. The life cycle is restarted with the selection and initiation of a new technology.

3.4 Disposal

The former technology is deleted, destroyed, overwritten or recycled. This is the end of the life cycle and the start of the next cycle.

All stages of the life cycle should contain review activities in order to obtain learning to aid improvement of the current and future projects [5].

4 'DRIVERS' OF CHANGE

A conceptual model is suggested to assist with analysing this area via the organisational contexts [6]. The 'drivers' of change are the factors that create and characterise the technology life cycle. These can be categorised as being internal and external to the organisation. Technology and Business are also viewed as key areas to analyse. The factors located inside the organisation tend to be evolutionary, in that they are corrections, upgrades and enhancements to current technologies, whereas the factors originating from outside the organisation tend to be revolutionary, in that they can promote radical technological change. The latter therefore are more likely to provide 'triggers for change', removing current technology and promoting its replacement. The internal environmental aspects tend to focus on resourcing decisions. The external environmental aspects provide the rationale for the organisation and help to determine its characteristics. The internal and external factors combine to create the technology life cycle for the organisation and shape its facets, including length, as well as the timing for renewal and recommencement of the life cycle. This model is shown, in diagram 1.

Diagram 1 - Drivers of Change in the Technology Life Cycle

	TECHNOLOGY	BUSINESS
EXTERNAL	NEW PRODUCTS	REGULATION COMPETITION DEMAND
INTERNAL	UPGRADE	EFFICIENCY

5 TECHNOLOGY CHANGE

The key factors for change with a technology focus can be categorised as internal or external to the organisation. Internal factors are principally concerned with upgrading the technology via incremental improvement. The stakeholders here are the in-house IT managers and staff who support and develop the technologies. The external factors comprise technological change generated by external suppliers. They provide upgrades to existing technologies, which organisations can choose to adopt.

There may be consequences of not adopting these technological upgrades, in respect of support, security and competition. Failure to install upgrades to existing technology, for example, may lead to the supplier withdrawing support for the product. There may also be security implications, as the latest defences in the current versions will not be loaded. The technologies created may be disruptive to the sector, providing the potential for revolutionary change. This will have an impact on the organisation if others adopt these technologies. The opportunity may also exist for the organisation to increase its market share or diversify to new markets by adopting the new technologies.

The choices made in respect of technology adopted by the organisation may have an effect on the length of its life cycle [7]. The scope of the project and any increase here is one key factor. Increased scope may lead to project failure, for instance. The absence of important stakeholders' requirements in the scope may shorten the technology life. The use of packaged software (for example payroll systems) can increase system life, as a standard approach is employed, maintained by an external supplier. Excessive customisation of this standard technology for the organisation may reduce its life, by making it harder to maintain. The use of a 'blended' team is identified, containing all of the requisite skills to manage the technology, also increased the lifespan, as this technology was more likely to fit the organisation's needs and be implemented and run successfully. Increased complexity was viewed as reducing the life of the technology, as it would be more difficult to maintain. An improved fit of the technology with organisational technical standards, such as using software tools that were standard in the organisation, was seen as increasing its lifespan.

6 BUSINESS CHANGE

The key factors for change with a business focus again can be categorised as internal or external to the organisation. The internal stakeholders are the business management and workers, comprising the users of the technology to deliver the business objectives. The changes generated here are principally focussed on efficiency, as requests are provided to improve the technology functions incrementally, by the removal of faults and implementation of change requests. These tend to be evolutionary, transforming the technology via gradual change. The external business stakeholders include the Government, competitors and customers. The change generated here tends to be revolutionary, in that it is externally generated and can be compulsory for the organisation to survive. The government or state, for example, could dictate changes to business using regulations to determine behaviour and demand compliance, applied with penalties such as fines or withdrawal of rights to trade. Competitors can also provide compulsory change by adopting disruptive technologies, for example. This may remove some or all of the business, if the organisation does not respond with its own changes to technology. The movement of shopping to online platforms, affecting the high street enterprises in the UK, provides such an example. Customers can dictate change by their behaviour. Changes in demand can affect the organisation and thus the life cycle. The customer view can also be utilised to shape the technology, at the initiation stage, via the Agile project management methodology. The financing of the organisation will thus be affected by customer action and that of financial institutions and shareholders. Data can also be used to help to understand customer purchasing preferences, for example via the use of technologies to gather structured and unstructured data which is then analysed to inform the organisation's decision-making and hence 'shape' the life cycle [8].

The organisation can also apply benchmarking, by comparing its performance to other similar organisations in the sector via key metrics. These standards should help the organisation to develop by providing its relative position in respect of others in the sector. This may help the organisation to determine

strategy in respect of the business and technology 'mix', which determines its outputs and the rate and standards of production. The views of key stakeholders are also important, in that their opinions could increase or reduce the lifespan of the technology. The failure of an important stakeholder to be satisfied with the technology may shorten the lifespan, as it may create a lobby to replace it with what is regarded as 'superior' technology, from their perspective.

7 ORGANISATIONAL MATURITY

The process maturity of the organisation is a key factor in the technology life cycle. The organisation needs to have defined and repeatable processes for operation [9]. These should be stable, documented techniques for addressing organisational matters. The organisation requires robust, secure systems to perform its tasks. This should be integrated with an information system, which acts as a repository of such organisational knowledge for its members. The technology life cycle should be embedded in such process systems, so that the organisation has the capability to plan, create and run such life cycles in a consistent manner. A scheme for benefits realisation should be included in such systems. The process maturity can be graded, for example in the Capability Maturity Model [10]. This can then be used to assess the organisation for contract awards, for instance.

The implication here is that a high level of maturity is reflected in the ability to run projects and hence create the technology life cycle. This may not be the case, however, as such organisations may be structured in a functional, bureaucratic manner that is not conducive to running cross-departmental projects. This may be due to governance issues, as the project managers and teams do not have sufficient authority to operate in the context of strong functional departments. Relatively less mature organisations, for example a technology-based new start-up company with a less hierarchical structure may be superior in respect of running projects, as information is shared more readily among members with relatively equal power. The temporary nature of projects and the sharing of the resultant knowledge is thus accommodated more effectively in such organisations.

8 PRODUCT LIFECYCLE

The life cycles of both the technology and the output, in the form of a product or service, will affect the technology life cycle.

The technology adopted by the organisation will have its own life cycle in the market. This will impact on the organisation's life cycle for that technology, in that it will affect both the duration and the relative performance.

The organisation may choose to retain a technology that is near the end of its product life cycle, for example keeping old laptops. The cost of renewal is thus deferred, however the consequences may be lack of support, more breakdowns and a less efficient workforce. The adoption of a very new technology will also have consequences, such as high cost of learning and potentially engaging in primary testing of the product, although this scenario may provide the most in terms of relative gains and advantage over the competition.

The technology life cycle will also be affected by the life cycle of the business product or service. The former may be used to support the organisation's value chain or may directly deliver the product or service. The life cycle of the product or service in its market may affect the duration of the technology life cycle. If the product or service is no longer commercially viable then the technology life cycle may be shortened. This will depend on whether the successor products or services require the same technology. If the latter is enacted then the life cycle may continue for the prevailing technology with adjustments to accommodate production or support.

The life cycle will thus be affected by the maturity of the technology. Early adopters have advantages in terms of relative gains from usage but may have pay the price of more testing and fault fixing. Later adopters can understand and use the technology more easily, as the initial phase has been completed, however they will have less relative gains from usage than the 'first movers' [11].

9 RECOMMENDATIONS FOR PRACTICE

Key recommendations for practice can thus be defined to help organisations to successfully manage technologies through the life cycle.

9.1 The appropriate leadership should be employed, for example to negotiate the organisational politics in order that the technology is resourced adequately to deliver the required outcomes.

9.2 A full stakeholder analysis should be performed and a communications plan developed to ensure key stakeholders are actively managed.

9.3 Appropriate metrics should be developed for

the technology and utilised for comparison with other organisations to understand the relative performance.

9.4 A plan to realise the predicted benefits of the technology should be formulated and monitored. This should include the regular undertaking of a risk analysis, in order to ensure risks associated with the technology life cycle are understood and accommodated with the appropriate responses.

9.5 The organisation's environment should be scanned regularly to check for new technologies and the actions of competitors.

9.6 The technology should be upgraded regularly and replaced as appropriate.

9.7 A system for requesting fault fixes and changes, then evaluating them, should be implemented.

9.8 A mechanism for collecting Customer, Personnel and Supplier feedback should be created to gather and evaluate comments and issues then decide on appropriate action.

9.9 The organisation should have clear, documented processes, developed for managing the technology.

10 CONCLUSION

The main factors that initiate and shape the technology life cycle have been discussed. A framework for analysing this area has been proposed. Recommendations for good practice have also been outlined, to assist in understanding this area, in terms of commissioning and operation of technology in the organisation. This provides a basis for further research in this area and constructive changes to organisational practice.

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