

Understanding technology management as a dynamic capability: A framework for technology management activities

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Abstract

This paper explores the topic of technology management (TM) through the lens of dynamic capabilities theory. Technological changes are continuously creating new challenges and opportunities new product, service, process and organisational development. However, these opportunities need to be captured and converted into value through effective and dynamic TM. This requires a new way of understanding TM that captures its dynamic nature as well as managerial aspects. A TM framework is presented that is based on dynamic capabilities theory, emphasising the development and exploitation of technological capabilities that are changing on an ongoing base. Dynamic capabilities theory is not primarily concerned with fixed assets, but rather aims to explain the way in which a firm allocates resources for innovation over time, how it generates and deploys its existing resources, and where it obtains new resources. This is highly relevant for developing an approach to TM that can explain how combinations of resources and processes can be developed, deployed and protected for each TM activity. A framework is proposed that positions TM activities with respect to the wider business context, supported by a case study to illustrate the value of the TM framework.

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0. Introduction

This article is a theoretical attempt to understand technology management (TM) using the dynamic capabilities approach. Key concepts are discussed in Section 1, and developments in the field of TM are summarised in order to explain how these have become blurred and confused over the years. The TM framework is then presented in Section 2, demonstrating the context within which TM activities take place, described in more detail in Section 3. The TM framework is illustrated with a case study in Section 4, concluding with an overview of the benefits of the new approach in Section 5.

1. Definitions and history of TM thinking

1.1. Definitions

A widely used definition describes TM as “a process, which includes planning, directing, control and coordination of the development and implementation of technological capabilities to shape and accomplish the strategic and operational objectives of an organization” (NRC, 1987). This definition to some extent combines both ‘hard’ aspects of technology (science and engineering) and ‘soft’ dimensions such as the processes enabling its effective application (Phaal et al., 2004). However, it does not make explicit distinction between technical and managerial issues associated with TM, and is a rather static definition.

Considering that technological changes are continuously creating new challenges and opportunities for new product development and industrial diversification, these opportunities need to be captured and converted into value through

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effective and dynamic TM. This, however, requires a new way of understanding TM that captures its dynamic nature as well as the managerial features. An appropriate paradigm or perspective for understanding TM could be the dynamic capabilities theory. In its most elaborate form, dynamic capabilities are the ability to reconfigure, redirect, transform, and appropriately shape and integrate existing core competences with external resources and strategic and complementary assets to meet the challenges of a time-pressured, rapidly changing Schumpeterian world of competition and imitation (Teece et al., 2000).

There are three main reasons why dynamic capabilities theory could enhance the understanding of TM. Firstly, it is not specific technological innovations but rather the capability to generate a stream of product, service and process changes that matter for long-term firm performance (Rush et al., 2007). Secondly, it becomes possible to break with highly aggregated and static models in favour of observing the dynamics taking place in the organisation of firms since the unit of analysis becomes the capabilities (Best, 2001). Thirdly, this theory does not take the market or the product as given, but as objects of strategic reconstitution, emphasising the key role of strategic management in appropriately adapting, integrating, and re-configuring internal and external organisational skills, resources, and functional competences towards a changing environment (Teece et al., 1997). Putting together these three advantages, the dynamic capabilities theory helps to highlight the most critical capabilities management needs to sustain for competitive advantage.

TM can be conceived as the development and exploitation of technological capabilities that are changing continuously (Best, 2001; NRC, 1987). There are many definitions in the literature regarding technological capabilities. Some consider it as an ability to find and use technology to secure and sustain competitive advantage (Rush et al., 2007), while others use a narrower definition of executing all technical functions entailed in operating, improving and modernising a firm's productive facilities (Lall, 1990). A recent study defines TM as the capability to make effective use of technical knowledge and skills, not only in an effort to improve and develop products and processes but also to improve existing technology and to generate new knowledge and skills in response to the competitive business environment (Jin and Zedtwitz, 2008). This latter definition emphasises the difficulty of managing technology compared with developing technology itself, as indicated by Teece (2007): "the invention and implementation of business models and associated enterprise boundary choices involve issues as fundamental to business success as the development and adoption of the physical technologies themselves".

Capabilities might be dynamic or operational (Helfat and Peteraf, 2003). Dynamic capabilities build, integrate, or reconfigure operational capabilities that are defined as 'a high-level routine (or collection of routines) that, together with its implementing input flows, confers upon an

organisation's management a set of decision options for producing significant outputs of a particular type' (Winter, 2000, p. 983). A routine refers to a 'repetitive pattern of activity'. Similarly, competencies refer to activities to be performed by assembling firm-specific assets/resources such as miniaturisation and systems integration. Considering that competence describes routines/activities and capability comprises both dynamic and operational abilities, these two terms are used interchangeably in the literature (Teece et al., 1997). That is why dynamic capabilities are conceived as routines/activities/competencies embedded in firms (Eisenhardt and Martin, 2000; Bergek et al., 2008). Defined as such, technological capabilities consist of both dynamic and operational capabilities that are a collection of routines/activities to execute and coordinate the variety of tasks required to manage technology. Thus, this article will analyse the core activities by which firms perform in order to achieve effective TM.

Dynamic capabilities theory is not interested in fixed assets *per se*, but rather it aims to explain the way in which a firm allocates resources for innovation over time, how it deploys its existing resources, and where it obtains new resources (Teece et al., 1997). This is highly relevant for understanding TM that aims to explain how combinations of resources and processes can be developed, deployed and protected for each TM activity.

The quest of TM becomes the quest of TM activities that will help to build technological capabilities. Therefore, the main elements of a TM system in this article are TM activities. In order for the performance of an activity to constitute a capability, the capability must have reached some threshold level of practiced or routine activity. Each TM activity is related to a certain technological capability, comprising one or more processes/routines/competencies. Process can be described as an approach to achieving a managerial objective, through the transformation of inputs into outputs. So, the term activity is used interchangeably with process or routine even though it refers rather to an aggregate level as an umbrella term to associate it with the concept of capability.

Every firm is a collection of activities that are performed to design, produce, deliver and support its products and services. Individual activities are a reflection of their history, strategy, resources, approach to implementing their strategy, and the underlying economics of the activities themselves. Dynamic capabilities theory does not imply that any particular dynamic capability is exactly alike across firms. While dynamic capabilities are certainly idiosyncratic in their details, specific dynamic capabilities exhibit common features that are associated with effective processes across firms (Eisenhardt and Martin, 2000).

1.2. Historical developments in TM

The TM discipline has a history of over 50 years, as indicated in the special issues of the IEEE Transactions on

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