

1.1 Definition

The definition of TM includes planning, directing, control and coordination of the development and implementation of **technological capabilities** so that firms can shape and accomplish their strategic and operational objectives (NRC, 1987). This definition attempts to combine 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 an explicit distinction between the technical and managerial issues associated with TM, and is a rather static definition. Technological changes are continuously creating new challenges and opportunities for new product, service, process and organizational development and industrial diversification. In order to capture and convert these opportunities into value through effective and dynamic TM, a new definition is needed.

An appropriate paradigm or perspective on understanding TM could be the **dynamic-capabilities** theory. Capability implies an ability to do something and is constituted both by strategies and operational activities (Teece, 2014). In its most elaborate form, dynamic capabilities are the ability to reconfigure, redirect, transform and appropriately shape and integrate existing **core competencies** with external resources and strategic and **complementary assets** to meet the challenges of a time-pressured, rapidly changing world of competition and imitation (Teece et al., 2000; Teece, 2014). Three main reasons explain why the dynamic-capabilities theory could enhance the understanding of TM (Cetindamar et al., 2009):

- 1 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).
- 2 It is possible to observe the dynamics taking place in the organization of firms, since the unit of analysis is the capabilities (Best, 2001).
- 3 Dynamic-capabilities theory considers the market or the product as objects of strategic reconstruction and thus emphasizes the key role of strategic management in appropriately adapting, integrating and reconfiguring internal and external

organizational skills, resources and functional competencies towards a changing environment (Teece, 2014).

As firms develop and respond to productive opportunities, they alter and further differentiate and, in the process, recharacterize the market parameters, such as those related to technology, product, service or organization (Best, 2001; Teece, 2007). In this evolutionary perspective, the firm shapes the market as much as vice versa. So success is achieved by developing distinctive organizational, technological and production capabilities. These different sets of capabilities affect each other in an evolutionary manner, as described in different production systems developed in the USA (Best, 2001).

Capabilities might be dynamic or operational (Helfat and Peteraf, 2003). Dynamic capabilities build, integrate or reconfigure operational capabilities, which are defined as:

[A] high-level routine (or collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type. (Winter, 2000: 983)

A **routine** describes a 'repetitive pattern of activity'. Similarly, competencies refer to activities to be performed by assembling firm-specific assets/resources. This is why dynamic capabilities are conceived as the routines/activities/competencies embedded in firms (Eisenhardt and Martin, 2000; Bergek et al., 2008). Defined as such, technological capabilities consist of dynamic and operational capabilities, which are a collection of routines/activities to execute and coordinate the variety of tasks required to manage technology. Thus, this book will analyse the core activities that firms perform in order to achieve effective TM.

Dynamic-capabilities theory is not interested in fixed assets per se; 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 relevant for understanding TM, helping to explain how combinations of resources and processes can be developed, deployed and protected for each TM activity.

Although this book will focus mainly on TM activities, resources and skills will be discussed within a specific activity whenever relevant. Therefore, the main elements of a TM system in this book will be TM activities that help to build technological capabilities. In order for the performance of an activity to constitute a capability, the capability must have reached some threshold level of practised 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', and is associated with the concept of capability.

Every firm is a collection of activities 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 distinctive in their details, specific dynamic capabilities exhibit common features that are associated with effective processes across firms (Eisenhardt and Martin, 2000). Thus, each chapter in Part I will describe general processes/routines to illustrate the set of tasks needed to be carried out in order to achieve a particular technological capability.