TECHNOLOGY MANAGEMENT CAPABILITY: DEFINITION AND ITS MEASUREMENT

Ersin Unsal*
Mirsis
Istanbul,34758, Turkey
Email: ersin.unsal@mirsis.com.tr

Dilek Cetindamar
Faculty of Management,
Sabanci University
Tuzla, 34956, Istanbul, Turkey
Email: dilek@sabanciuniv.edu.tr

*Corresponding Author Email: ersin.unsal@mirsis.com.tr

Abstract
Technology Management is employed to adapt changing environmental conditions and technological progress as well as to create these transformations. Based on the dynamic capabilities theory, this paper conceives technology management as a capability and measures it through capability maturity model in order to investigate the relationship between technology management practices and firm performance. The findings of the empirical study confirm that technology management is an important source of competitive advantage and it contributes to firm performance in a positive way.

Keywords: Technology management; strategic management; dynamic capabilities theory; firm performance.

1. Introduction

Companies are facing changing environmental conditions, rapid technological advancements and steadily increasing competitive requirements. Creating sustainable competitive advantage is the only way for firms to make sustainable profit and therefore to survive.

Resource-based theory argues that resources, which are valuable, rare, inimitable and non-substitutable, are the only sources of sustainable competitive advantage. However, it is not always possible to have such resources to create sustainability. In this context, dynamic capabilities theory expands the resource-based theory by emphasizing the role of processes/routines in achieving competitive edge. In other words, it is critical to excel in processes/routines for resource development and renewal. Teece et al. (1997) define dynamic capabilities as *'the ability to integrate, build, and reconfigure internal and external competencies to address rapidly-changing environments'*. Hence, intrinsic and repeatable routines are good candidates to generate a sustainable competition model.

Technology Management (TM) can contribute to sustainable competitive advantage. This is because, creating and sustaining competitive advantage requires more than operational efficiency and cost minimization. For technology intensive companies, creating competitive advantage is related to capability of managing technological assets (Skilbeck and Cruickshank, 1997). TM helps to adapt changing environmental conditions and technological progress as well as to create these transformations itself.

This paper proposes a TM capability model where TM practices are measured empirically. Section 2 presents how this paper considers TM as a capability driven from the recent TM models/frameworks. This conceptual section explains how the capability maturity model could be used to measure TM empirically. Section 3 puts forward the hypotheses of the study, while section 4 presents the methodology. After the analysis of findings in section 5, final section presents the concluding remarks.

2. Technology Management Capability

2.1. *Technology management*

The increasing number of TM related publications indicates the current importance of the field whereas epistemological papers are still rare in the TM literature (Cetindamar et al, 2006). For example, a recent work by Cetindamar et al. (2009a) employs a Venn diagram to define the relations between TM and supporting management disciplines (Innovation Management, Knowledge Management and Project Management) (as presented in Fig. 1). This figure clearly shows the overlaps between different disciplines but also it underlines how TM is distinct from others.

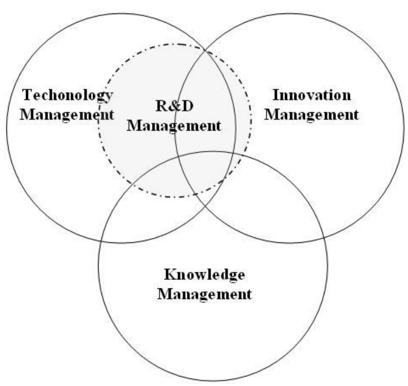

Fig. 1. Technology Management and Related Disciplines (Adopted from Cetindamar et al., 2009a)

In recent years, studies increasingly concentrate on to clarify the scope and boundaries of TM (Beard, 2002; Liao, 2005; Phaal et al., 2006; Pilkington and Teichert, 2006; Brent and Pretorius, 2008; Pilkington, 2008; Cetindamar et al., 2009a, Cetindamar et al., 2010). Moreover, there are some papers that reviews the development of field and give a general understanding of TM (Allen and Sosa, 2004; Roberts, 2004; Rubenstein, 2004; Ball and Rigby, 2006; Merino et al., 2006; Ansal et al., 2008; Cetindamar et al., 2009b). Some empirical studies further proposes new approaches and models for TM field (Rush et al., 2007; Levin and Barnard, 2008; Cetindamar et al., 2009a, Cetindamar et al., 2010). All these efforts have led to a better understanding of the TM field.

In this paper, TM will refer to the development and exploitation of technological capabilities that are changing continuously. Such a dynamic definition will allow not only measuring TM but also observing its impact on competitiveness, two critical gaps in the literature.

2.2. *Technology management activities*

The work of Khalil and Bayraktar (1990) is as an early attempt to build a comprehensive TM model, and then Gregory (1995) developed a model where TM activities are grouped into five main categories: identification, selection, acquisition, exploitation and protection.

A recent research by Rush et al. (2007) includes a measurement model to assess firms' technologic capabilities. The measurement model assesses nine major TM activities: awareness, search, core competence, strategy, assess-selection, acquire, implementation, learning and linkages. The model assesses these activities by using a four-level scale, ranging from unaware (very weak capability), reactive (weak to average capability), strategic (strong capability) and creative (very strong capability).

The model given in Cetindamar et al. (2009a) is based on the models developed by Gregory (1995) and Rush et al. (2007), where main TM are categorized into six activities/capabilities: acquisition, exploitation, identification, learning, selection, and protection.

2.3.*Dynamic capabilities and TM*

Intrinsic and repeatable *routines* lie at the roots of dynamic capabilities theory. Levin and Barnard (2008) list some of the definitions for routines as follows:

- Organizational routines are defined as 'the regular and predictable behavioral patterns within firms that are coping with a world of complexity and continuous change' (Pavitt, 2002).
- Routines are a coordinated, repetitive set of organizational activities (Miner, 1991).
- Routines are often seen as the building blocks of organizational learning and knowledge management (Levitt and March, 1998; Miner, 1991).
- Routines can be designed specifically to enhance innovation and thereby form the basis for dynamic capabilities (Zollo and Winter, 2002).

Although the number of empirical research on dynamic capabilities is limited, Levin and Barnard (2008), for example, identified and organized 27 TM routines as a result of long-term comprehensive project. Levin and Barnard organized these routines within an innovation model (see the complete list at Appendix Table A1). Even though these TM routines (Levin and Barnard, 2008) have important contributions to TM literature, the organization of the routines has some ambiguities and incoherence. As discussed by Cetindamar et al. (2009a), confusion between TM and Innovation Management may result in such ambiguities of classifying what routines fall into what activity set. To organize TM routines within a comprehensive TM model instead of an Innovation Management model would prevent this kind of ambiguities and confusions.

Levin and Barnard argue that *"Any framework for technology management routines must therefore accommodate both the expansion of technological capability and the determination of customer requirements"*. Thus, the TM routines can be organized within the model proposed by Cetindamar et al (2009a) and it might be a good starting point in drafting the list of routines.

This paper makes two additions to Cetindamar et al.'s model. First, we add strategy into the list. Organizing the routines within this TM model is straight forward except for strategy related routines. Cetindamar et al. (2009a) relates strategy with selection activity and Gregory (1995) states that the aim of selection activity is to define relative importance of the technologies. One can therefore argue that strategic decisions may be inputs of selection activity as suggested by Rush et al. (2007). Second, we add knowledge management routine into the model. That is because; none of the TM routines defined by Levin and Barnard can be grouped within knowledge management activity. However, technology managers need to deal with many knowledge management concerns ranging from managing scientists and researchers to building knowledge databases

In sum, we propose expanding TM model as presented in Table 1. The model shows the key TM capabilities and routines related to each capability. The model is based on the previously discussed works of Gregory (1995), Rush et al. (2007), Levin and Barnard (2008) and Cetindamar et al. (2009a).

Table 1. Technology Management Routines (Technology Management Capability)

TECHNOLOGY MANAGEMENT ROUTINES									
TECHNOLOGY MANAGEMENT ACTIVITIES						SUPPORTING ACTIVITIES			
IDENTIFICATION	**SELECTION**	**ACQUISITON**	**EXPLOITATION**	**PROTECTION**	**LEARNING**	**STRATEGY MANAGEMENT**	**INNOVATION MANAGEMENT**	**PROJECT MANAGEMENT**	**KNOWLEDGE MANAGEMENT**
R&D environmental monitoring	Technology roadmapping	R&D technology strategy	Product portfolio management	Intellectual property management	Post-project audit	Corporate business strategy	Ideation	Project execution	*Knowledge Management*
Business unit environmental monitoring	Technology needs assessment	R&D portfolio management	Technology adaptation			Corporate technology strategy	Feasibility	Performance management	
Corporate environmental monitoring	Business unit technology strategy	Technology transfer	Post-project support			Technology alliance management	Initial project/programme selection	Personnel management	
		R&D funding	Business unit business strategy				New business unit development		
			Product line planning						

3. Hypothesis formation: technology management capability definition and its measures

The relationship between TM activities and firm performance is one of the least studied topics in the literature (Khan, 1999; Jilliang et al., 2007; Levin and Barnard, 2008; Cetindamar et al., 2009a). This paper aims to investigate the relationship between TM and firm performance by measuring capability of a firm that is based on routines forming each TM activity.

In our study, we define technology management capability as the dynamic ability of firms to reconfigure their technology base to shape and implement their strategic and operational objectives. The cause-effect relation between dynamic capabilities and competitive advantage is somehow vague and has only been addressed in a limited number of research papers (Pavlou and El Sawy, 2006). Thus, this study is an attempt to define TM as a dynamic capability and understand the relationship between TM and firm performance based on tangible measures.

Thus, we hypothesize:

Hypothesis 1: Higher level of TM capability will lead to higher competitive advantage.

The positive relationship between TM and firm performance is stated in various TM related books and papers, whereas, to the best of our knowledge, empirical research efforts are lacking. This research will be among the first attempts to analyze the relationship between TM and firm performance by means of empirical field study. While analyzing the relationship between TM and firm performance, a measurement tool will be used to assess the capabilities embedded in routines. Measuring the effectiveness of capabilities is a challenging task and the maturity model approach provides tools and techniques to assess capability maturity. Capability maturity model (CMM) is a well-known and widely used technique to assess capabilities especially in information technologies (IT) field (Paulk et al., 1993; Paulk et al., 1995). CMM approach is not limited to IT field and it can be extended to use in different disciplines. Since CMM is a well known model to assess capabilities and it can be extended to use in different disciplines, CMM approach will be employed to assess maturity of TM routines. Fig. 2 presents the proposed research model.

Hypothesis 2: Higher competitive advantages will lead to higher firm performance.

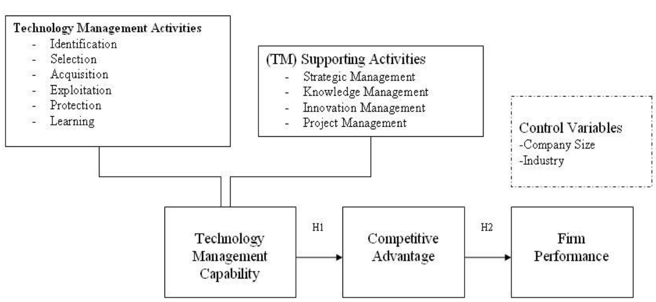

Fig. 2. The Relationship between Technology Management and Firm Performance

4. Methodology: sample and data collection

Turkey is a developing country but considered as one of the important emerging economies since it is 18th largest economy according to the total Gross Domestic Product (International Monetary Fund World Economic Outlook Database – October 2013 Edition). We study Turkish firms for two major reasons. First, TM literature is overwhelmed by research conducted in developed countries (Beyhan and Cetindamar, 2011). Therefore, results from a developing country may have interesting outcomes for TM researchers and practitioners. The other reason is that, both Turkish government and private sector has been increasing their R&D budgets in recent years. This effort results in more research institutions, more R&D centers, more researchers and engineers. As a result, management of technology is becoming more important. If the relationship between TM activities and performance can be shown, practitioners might spend more time in developing their knowledge in TM, resulting in successful management practices. This will improve the gains from technology investments that are rare resources for developing countries like Turkey.

The research data was obtained from a recent survey conducted in Turkey. The survey was sent to 225 Turkish companies performing in four different technology sensitive industries; defense industry, IT industry, telecommunication industry and banking. 86 of the 225 candidate companies provided answers for the survey, indicating an acceptable return rate of 38.2%. Defense, IT, telecommunications and banking sectors are selected for two reasons: first reason is that these sectors are among the most outstanding technology sensitive companies in Turkey and second reason is that the researchers have experience in these sectors.

Turkey has been one of the largest importers of defense products (1.2 billion USD in 2012). However, this situation has begun to change and Turkish defense industry has begun to design and produce most of the weapon systems for Turkish Army on its own. Moreover, Turkish defense industry is becoming an important exporter of defense products in recent years. The R&D budgets of Turkish defense companies are expanding and they've started to design more innovative and unique defense products (SSM Strategic Plan 2012-2016, Version 1.2, http://www.ssm.gov.tr/).

When it comes to IT and telecommunications sectors, Turkey with its high population, is an important market for IT and telecommunication products and services. There are both international and local companies providing successful, innovative products and services in the market. Therefore IT and telecommunication sectors are good candidates for any TM related research. Actually, telecommunication sector may be treated as a subset of IT sector. It this research, we made this distinction to see if there are any important differences in terms of TM practices within these two sectors.

Banking sector is selected as well, since banking is a technology intensive service sector and therefore it may reveal different results compared to other manufacturing sectors.

The capability of TM is measured using the process maturities of TM routines listed in Table 1. Company managers are asked to rank their routines according to the scales existing in CMM. These scales, in general, aim to measure the process maturity with the idea that process maturity is an important metric for company's capability. The scale used for TM is as follows (Paulk et al., 1993; Paulk et al., 1995):

1. Initial (chaotic, ad hoc) – *the starting point for use of a new process.*
2. Managed – *the process is managed in accordance with agreed metrics.*
3. Defined - *the process is defined/confirmed as a standard business process, and decomposed to levels 0, 1 and 2 (the latter being Work Instructions).*
4. Quantitatively measured
5. Optimized - *process management includes deliberate process optimization/improvement.*

TM capability is calculated as a composite index where the maturity of each TM process is measured along the maturity model and the average is taken. One may argue that different approaches may be used to calculate TMC because importance/weight of each routine/process may be different from each other. For example, basic TM routines may be argued to have higher importance compared to supporting routines. Moreover, there may be yet unidentified processes/routines that may contribute to overall TM capability of firms. But still, we believe that the average process maturity can measure TM since the set of TM activities consist of the key processes. It is also important to note that this is a very first attempt to assess TM capability empirically, so we believe that the future studies might expand the measurement further.

Competitive advantage and firm performance are measured using the measurement models existing in the literature. There are two main choices in the literature to gather firm specific competitive advantage and performance data. One approach is to use financial data and employ some mathematical and financial formulas to assess firm performance. The other approach is assessing firm performance by means of questionnaires through the evaluation of managers. In this study, the later approach is preferred. That is because; it is not possible to find comparable and reliable financial data for small and mid-size companies, especially in Turkish context. Moreover, measuring TM activities is qualitative data that does not exist in company accounts. The study concentrates on the average of the last three years of firm performance.

Social research studies, especially the ones focusing on firm, employ three major control variables; firm age, firm size and sector data. Firm size and sector are selected as the control variables for this study. Firm age was not selected as a control size, since most of the technology based companies in Turkey are relatively young firms. Another reason for not selecting firm age as a control variable is that, TM practices are mostly new practices employed in companies.

Table 2 presents variables employed in this study. All the variables are from the literature which is a positive indicator for reliability and validity. Moreover, pilot testing and related statistical analyses are employed for reliability and validity of the field study.

Table 2. Measurement Model

	Variable	Data Collection
Dependent Variables	**Technology Management Processes (Levin and Barnard, 2008)**	**28 Questions**
Independent Variables	**Competitive Advantage (Wu and Wang, 2007)**	**6 Questions**
	Firm Performance (Xiao, 2008)	**7 Questions**
Control Variables	**Firm Size**	**2 Questions**
	Firm Sector	**1 Question**

Collected data is tested against reliability and validity by means of Cronbach's alpha (>= 0.76), ICC (>= 0.44) and factor loading values (>= .69). ANOVA analyses are conducted to analyze the effects of control variables and non-respondent bias. Regression tests are conducted to test hypotheses. Cluster analyses are employed to analyze the relations within TM processes. Statistical analyses are conducted by using SPSS 17.0.1, and Lisrel 8.51 statistical software packages.

5. Empirical findings

5.1.*Descriptive statistics*

Table 3 presents the sector distribution of participants. Almost half of the participants are from defense sector. Telecommunications companies are the smallest group. One important thing to note is that, the distinction between IT, telecom or defense sectors were not so clear for all the participants. To overcome this problem, some ground rules are accepted. Companies which are mainly producing defense products are selected as defense companies although they might also be selected as IT or telecommunication companies depending on the company profile/sales. In addition, companies which are having more than 60% of their sales in telecommunications market are categorized as telecommunication companies.

Table 3. Sector Distribution of Companies

	Banking	Defense	IT	Telecom
# (Count)	21	38	20	7
% (Ratio)	%24,4	%44,2	%23,3	%8,1

Table 4 presents the firm size of the participant companies according to number of employers. The companies with more than 1000 employers are mostly the banks and Telecommunication companies (GSM companies). Defense and IT companies are mostly small to mid-sized companies in Turkey.

Table 4. Number of Employers of Companies

	< 50	50 <x< 100	100 <x< 250	250 <x< 500	500 <x< 1000	> 1000
# (Count)	20	12	13	18	7	16
% (Ratio)	%23,3	%14	%15,1	%20,9	%8,1	%18,6

TM capability of the firms is described as the average maturity of technology management processes in this study. To have a quick overview of survey results in terms of average technology management capabilities, Table 5 has been formed. Table 5 presents the maturities of TM activities and overall capability results across four sectors.

Table 5. Technology Management Capabilities of Firms in Different Sectors

	Avg.	Defense	IT	Telecom	Banking
Identification	3,10	3,00	3,53	3,71	2,65
Selection	3,20	3,06	3,47	3,38	3,13
Acquisition	2,89	2,93	3,13	2,68	2,67
Exploitation	3,35	3,25	3,45	3,71	3,30
Protection	3,10	2,84	3,45	3,29	3,19
Learning	3,27	3,16	3,50	3,43	3,19
Strategic Mgmt	3,26	3,11	3,43	3,81	3,16
Innovation Mgmt	3,16	3,07	3,34	3,39	3,08
Project Mgmt	3,40	3,36	3,40	3,38	3,49
Knowledge Mgmt	3,76	3,84	3,70	4,14	3,52
TM Capability	3,25	3,16	3,44	3,49	3,14

Table 5 has interesting results especially for defense and banking sectors. The results for IT and telecom are as expected, since these two industries are of the most technological and innovative sectors in the entire world.

Defense sector, which is widely known as an important source of technological advancements and innovations in the world, is not performing well enough in terms of TM in Turkey. Turkish industry has gained acceleration with government policies in the last few years, but still Turkey is one of the important importers of defense products in the world. Although Turkey developed capabilities to design and build most of the defense products locally, still Turkey is lacking to develop new innovative technologies and products. So, the results of the survey are parallel with the existing practice. When it comes to the banking sector, Turkish banks are known with their innovative products and their high use of technology. Therefore, it can be concluded that findings of the empirical study are compatible with existing business context.

5.2.*Statistical analyses and hypotheses testing*

When it comes to statistical analyses results, findings are supporting both of the hypothesizes proposed in this study. In other words, we can say that field study results are parallel with theoretical approaches, since the hypothesis proposed in this study are highly dependent to basic strategic management theories. Table 6 presents the correlations, while Tables 7 and 8 present the hypothesis testing results.

Table 6. Correlation Table

	TMA	TMSA	TMC	CA	FP	MP
TM Activities (TMA)	-	,930*	,991*	,458*	,206*	,333*
TM Supporting Activities (TMSA)		-	,971*	,518*	,218*	,388*
TM Capability (TMC)			-	,488*	,214*	,359*
Competitive Advantage (CA)				-	,293*	,730*
Financial Performance (FP)					-	,447*
Market Performance (MP)						-

*p <.05, **p <.01.

The correlation table indicates a very high correlation between TM activities and TM supporting activities. This is an expected result since the distinction of basic processes and supporting processes are done for abstraction of TM thinking purposes only. Moreover, there are significant correlations between TM capability and competitive advantage, and also between competitive advantage and firm performance, especially the market performance.

Table 7. H1: TMC – Competitive Advantage

Dependent Variable	**Competitive Advantage (p-value)**
Model	
R^2	**,238 (<.0001)**
Independent Variable	
TM Capability (TMC)	**,327 (<.0001)**
N	**86**

Table 7 presents the significant relation between TM and competitive advantage. In other words, hypothesis 1 is supported with the results of this field study. Table 8 presents a significant relationship between competitive advantage and firm performance, especially in terms of market performance, confirming Hypothesis 2.

Table 8. H2: Competitive Advantage – Firm Performance

Dependent Variables	**Financial Performance (p-value)**	**Market Performance (p-value)**
Model		
R^2	**,086 (0.006)**	**,533 (<.0001)**
Independent Variable		
Competitive Advantage	**,332 (0.006)**	**,789 (<.0001)**

Moreover, the mediating effect analysis reveals that there is not any directional relationship between TM capability and firm performance. In other words, TM basic processes do not have direct effect on firm performance (β =.13, ns.) but this is also true for TM supporting processes (β =.16, ns.). On the other hand, competitive advantage has direct effect on firm performance (β =.30, $p < .05$). Suprisingly, only supporting processes seem to have a indirect effect on firm performance (β =.20, $p < .05$) where basic TM processes do not. In short, TM capability is directly related with competitive advantage and therefore has an indirect effect on firm performance.

The effects of control variables are also analyzed by means of ANOVA analyses and no significant difference is found in terms of both firm size and sector. Hence, the proposed relationships are verified regardless of firm size and sector differences.

5.3.*Cluster analyses*

Besides descriptive analysis and hypothesis testing, a cluster analysis is carried out by means of the SPSS *classify* method to observe the relationships between TM processes. The TM processes are clustered within three different clusters when we classify them using within-group linkages method based on Euclid distances. The clusters are presented on Table 9. TM processes are grouped into three different clusters: 1) technology development cluster, 2) technology exploitation and innovation cluster, and 3) project management cluster. First cluster is named as technology development cluster because enclosed processes are mostly technology identification, selection and acquisition processes. Identification, selection and acquisition activities are the main activities of technology development. Second cluster is named as technology exploitation and innovation cluster because enclosing processes are mainly with technology exploitation and innovation management processes. Finally, third cluster encloses project management related processes that is why it is named as project management cluster.

This kind of clustering may bring new dimensions to the understanding of TM practices especially for TM practitioners. Together with general TM capability approach presented in Table 1, meaningful subsets of TM routines/processes may guide to TM practitioners in different ways. The interrelations between TM processes/routines may be useful guidelines in organizational transformations. For example, it can be a reasonable choice to assign the routines/processes within a specific cluster/activity to the same business unit. Moreover, depending on the business unit needs, a TM manager may give higher priorities to specific routine clusters. For example, an R&D company may prefer to excel in technology development cluster, whereas a service company may prefer to excel in innovation cluster or project management cluster depending on the situation.

Table 9. Cluster Analyses of Technology Management Processes

Cluster 1 ***Technology Development Processes***	***R&D environmental monitoring, Business unit environmental monitoring, Corporate environmental monitoring, Technology roadmapping, Technology needs assessment, Business unit technology strategy, R&D technology strategy, R&D portfolio management, Technology transfer, R&D funding, Corporate technology strategy, Technology alliance management***
Cluster 2 ***Technology Exploitation and Innovation Processes***	***Product portfolio management, Business unit business strategy, Product line planning, Intellectual property management, Corporate business strategy, Ideation, Feasibility, Initial project/programme selection, New business unit development***
Cluster 3 ***Project Management Processes***	***Technology adaptation, Post-project support, Post-project audit, Project execution, Performance management, Personnel management, Knowledge management***

6. Concluding Remarks

The positive contribution of TM practices to firm performance is widely accepted whereas supporting empirical results are scarce. Besides, TM discipline lacks its *lingua france;* in other words TM literature does not have commonly used and well defined TM models and frameworks.

This study attempts to measure TM capability, one of the neglected questions in the literature. To achieve this goal, TM capability construct is proposed to measure the performance of TM activities base on routines. By measuring TM, it becomes possible to assess the link between TM practices and firm performance.

The empirical study shows positive influence of TM on competitive advantage and resulting firm performance. This result is one of the early empirical studies highlighting the positive relation between TM practices and firm performance. In addition, findings of the field study reveal important results in terms of maturity of TM practices in different sectors. IT and Telecom sectors seem to have similar TM capabilities with a few except ions. In terms of knowledge management and strategic management, telecom sector has higher capabilities whereas IT has higher technology acquisition capability. Technology intensive sectors have mature processes/routines in terms of technology development activities whereas banking sector seems to have poor capabilities in terms of technology development activities. Finally, cluster analysis helps us to understand interrelations between core TM processes and supporting processes. Cluster analysis showed that TM processes/routines can be groped in three main clusters; technology development cluster, technology exploitation and innovation cluster and project management cluster.

Limitations and future research direction

This research, like most of the field studies, has several limitations. First of all, field study is conducted in a limited number of technology-based sectors in a single developing country. Second, the data used in analyzing the competitive advantage and firm performance is obtained from technology managers rather than objective data. That is why, it is necessary to be cautious in generalizing the results of the study. Third, the measurement of TM is based on routines that are listed in only one study (Levin and Barnard, 2008).

New empirical studies are required to overcome the limitations. Future research efforts are also required to incrementally improve proposed TM capability construct. Some suggestions for further research are given as follows:

- Extending the TM routine set (i.e., adding new routines or modifying the current ones),
- Defining the TM routines in a more detailed way (i.e., defining inputs, outputs, owners of routines),
- Integrating TM tools/techniques with TM routines,
- Developing case studies depending on the proposed TM model,
- Empirical research efforts with different set of participants, including middle level managers, researchers and shop-floor employees.

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Appendix A.

Table A1. Technology Management Routines (Adopted from Levin and Barnard, 2008)

Producing scientific and technological knowledge	Transforming knowledge into working artefacts	Matching artefacts with user requirements
Ideation	Technology roadmapping	Business unit environmental monitoring
R&D environmental monitoring	Product line planning	Corporate environmental monitoring
R&D technology strategy	Product portfolio management	Business unit business strategy
R&D portfolio management	Feasibility	Corporate business strategy
Intellectual property management	Project execution	Technology needs assessment
Post-project audit	Technology transfer	Business unit technology strategy
	Technology adaptation	Corporate technology strategy
	Post-project support	Initial programme/project selection
		R&D funding
		New business unit development
Providing organizational support		
Performance management		
Personnel management		
Technology alliance management		