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Does technology management research diverge or converge in developing and developed countries?

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Abstract

The main purpose of this paper is to understand whether the research of developing and developed countries in the technology management (TM) field converge or diverge in terms of topics, approaches, research focus, and methods. International trends are explored based on the comparison of developed and developing countries' academia, conducted through a content analysis of the main TM journals over the period of 1995–2005. The analysis of a random sample of 325 articles indicates a clear differentiation of major topics studied by developing and developed country academics. The paper ends with a call for future studies to focus more on the particularities of developing countries in order to enrich the TM literature by increasing our understanding of TM theory and its applications in developing countries.

Keywords: Technology management literature; Content analysis; Developing countries

1. Introduction

This paper aims to answer the following question: does the research in developing and developed countries converge or diverge in terms of technology management (TM) research agendas, approaches, and methods? In other words, the goal is to generate an overview of TM research that will demonstrate international trends in the field, based on a comparison of the developed and developing countries' academic output. For the purposes of this study, academic output is operationalized as publications in international TM journals.

Management literature, by and large, acknowledges the dominance of US-based theories in management research across the globe (Baruch, 2001; Boyacigiller and Adler, 1991). This general dominance is not verified for different sub-disciplines of management at the empirical level, with few exceptions such as a study carried out for organizational studies (Üsdiken and Pasadeos, 1995). Studies investigating any US or developed country dominance are also lacking for the TM literature.

Early studies analyzing the TM field were Allen and Varghese (1989) and Adler (1989), which were followed by a long gap until the upsurge in the 2000s (Ball and Rigby, 2005; Beard, 2002; Liao, 2005; Pilkington and Teichert, 2006; Roberts, 2004). As one of the pioneers, Adler's (1989) study consists of a systematic literature review identifying the underlying themes and concepts related to technology strategy. More recent review papers analyzed the historical development in specific TM journals (Allen, 2004; Merino et al., 2006; Linstone, 1999; Pilkington and Teichert, 2006; Teichert and Pilkington, 2006). Even though there is a renewed interest in reviewing the TM field, there are no review papers focusing on developing countries per se.[1] In fact, none of the aforementioned TM review papers consider the particularities of developing countries vis-à-vis developed countries, except for a few remarks. This paper is one of the early attempts to analyze the TM literature in order to understand the similarities and

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[1]Steven et al. (2001) is a notable exception.

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differences of research published in major TM journals by authors coming from developing and developed countries. A comparative account of research carried out in developed and developing countries is presented along the following dimensions: (1) the general characteristics of articles, such as author affiliations and methodologies used, and (2) in-depth analysis of the research topics. For this purpose, a content analysis is carried out on 10 major TM journals (Ball and Rigby, 2005; Linton and Thongpapanl, 2004), focusing on the period from 1995 to 2005.

Section 2 of the paper will present an overview of the TM literature, followed by a section on the methodology adopted in the content analysis of the literature. Section 4 presents the results of the content analysis and hence demonstrates the general trends in TM literature, as well as the differences between developing and developed country TM research. The Section 5 ends with concluding remarks, the limitations of this study, and suggestions for future research.

2. A review of TM literature

The TM discipline has a history of almost 50 years, as indicated in the special issue of *IEEE Transactions on Engineering Management* in 2004. TM has become an even more self-sustained discipline in the last 20 years with the emergence of specialized professional organizations, such as IAMOT (International Association for Management of Technology) and PICMET (Portland International Center for Management of Engineering and Technology), and the rapid increase in the number of publications and degree programs in the field after the late 1980s (Allen, 2004; Ball and Rigby, 2005; Roberts, 2004). Some studies clearly point to the US government's 1987 publication (National Research Council, 1987) on the importance of TM for competitive advantage as one of the critical milestones in the development of the TM discipline, as it is believed that TM became one of the topics in management schools after this publication (Pilkington and Teichert, 2006). In fact, in January 2007, the education committee of IAMOT, led by Steven Walsh, announced its accreditation/certifications guidelines for graduate degrees in TM (IAMOT, 2007), further establishing TM as a legitimate field for advanced study. In addition, well-established management associations have special divisions devoted to TM, such as the Technology and Innovation Management Division of the Academy of Management.

The analysis of a body of knowledge might take two forms, namely theoretical papers and systematic reviews (Adams et al., 2006). In recent years, there has been wide acceptance of studying management knowledge by means of a systematic review of academic journals using content analysis, citation analysis, and bibliometrics (Adams et al., 2006; Kostoff et al., 2006; Tranfield et al., 2003). Within this approach, some reviews use ad hoc or experience-based classifications (Allen, 2004; Allen and Varghese, 1989; Ball and Rigby, 2005), while others utilize citation index analysis (Pilkington, 2006; Pilkington and Teichert, 2006; Teichert and Pilkington, 2006) or keyword analysis (Merino et al., 2006). The present work uses a content analysis approach to systematically review the TM literature. A major reason for the selection of a systematic review perspective is the eclectic and diverse intellectual base of TM. TM has an unusually high degree of interaction with other disciplines (Drejer, 1997), which blurs its boundaries with competing fields (Pilkington and Teichert, 2006; Roberts, 2004).

The TM review papers mentioned earlier are, to a large extent, limited to a review of one particular journal. One of the early studies analyzing the TM field is based on the papers published in *R&D Management* (Allen and Varghese, 1989). More recent studies analyze the historical development in *Technovation* (Pilkington and Teichert, 2006), *Research Policy* (Teichert and Pilkington, 2006), and *IEEE Transactions on Engineering Management* (Allen, 2004; Pilkington, 2006). Due to the differences in the techniques used to capture and classify the knowledge generated in the TM field, the review results of extant studies bring forward different sets of results. For example, in the 50th anniversary of the journal *IEEE Transactions on Engineering Management* (IEEE TEM), Allen (2004) categorizes TM topics appearing in IEEE TEM into the following groups: (1) human resources; (2) strategy and policy; (3) product development, project management, and technology problem solving; (4) marketing, organizational and program management; (5) technology transfer and technology communication; (6) university–industry relations; (7) organizational structures and procedures; (8) planning and control, project selection, math modeling; (9) entrepreneurship and new ventures; (10) CAD, CAM, supply chain management. Teichert and Pilkington (2006) use statistical techniques and analyze co-citation patterns at the author level for *Research Policy* and reveal seven major research streams: Technology Strategy, Research Policy for National Systems of Innovation, Application of Theories of the Firm, Econometric Applications and Technometrics, Globalization and International R&D Networks, Reinforcing Evolutionary Dynamics and Lock-in Effects, and Evolutionary Economics of Technological Change.

As noted earlier, there are hardly any review papers specifically focusing on developing countries. The concern of this paper is not merely noting authors coming from developing countries, but also identifying their involvement and contributions to the development of TM. In other words, we try to see if papers coming from developing countries generate a similar body of knowledge compared to their counterparts in developed countries; a question largely left unanswered by previous work. This question brings us to the well-known discussion of convergence or divergence of theories in the management discipline (Alatas, 2003; Baruch, 2001). In the field of TM, available data to pass judgments on the convergence and divergence views are lacking. Is there really convergence of theories

Table 1
Geographical differences in TM interests

North America	Europe	UK	Rest of the world
Dynamic organizations	Alliances and learning	Operation strategy	Diffusion
Resource based view	Learning organizations	Innovation process	Pull/markets
Technology strategy	Resource based view	PCs and electronics case studies	Adaptation of innovations
Evolution and diffusion	Knowledge management	R&D returns in uncertainty	National systems and differences
	Patents		
	Measuring R&D networks		

Source: Pilkington and Teichert (2006).

due to there being universal observations of capitalist economical and industrial infrastructures in developing and developed countries? If the two literatures do converge, however, this might not necessarily mean that all economies, different cultures, or countries resemble each other. The similarity might be because theoretical outlets such as management journals might not accept out-of-the-norm papers in the TM field, as is the case for management studies (Baruch, 2001), limiting the development of a distinct TM literature arising from the actual needs of developing country managers.

According to a study analyzing *Technovation* during the period of 1996–2003 (Pilkington and Teichert, 2006), the research agendas of scholars from different parts of the world differ substantially from each other. Based not on the actual authors of papers published in *Technovation* but authors presented in the reference lists, the authors conclude that the interests of authors diverge significantly depending on their region, as shown in Table 1. This study finds diffusion, adoption of innovation, national systems, and pull/market issues as the main set of research themes for authors coming from a wide range of countries that include developed and developing countries. The cited authors in the "rest of the world" category represent 27% of all cited authors; a ratio close to that of UK authors (22%). Similarly, another study on *Technovation* (Merino et al., 2006) mentions that the majority of papers published in the 25-year history of the journal come from Europe (UK authors alone representing 20% of papers), leaving a small portion of papers coming from developing countries.[2] This study does not report any geographical differences in terms of TM topics.

Since the above results are each limited to one journal, and as Pilkington and Teichert (2006) rely on citation analysis rather than the actual articles published in the journal, it would be a valuable contribution to pursue such investigations on a larger scale in order to understand the international developments and trends in the TM field, focusing on the differentiation of developed and developing country academia. As such, the results will contribute to developing the TM discipline further as a respected academic discipline. It is important to see if academics confronted with developing country conditions might be generating new knowledge to deal with their particular situations. Hence, the original contributions of this paper might be summarized as follows: (1) working with a broader sample than former empirical research examining the differences of developed and developing countries in relation to TM issues, (2) covering a more comprehensive set of keywords and topics, (3) studying a broader period of analysis, and (4) taking a larger number of countries into account (i.e., not simply a US–Europe or US–developing countries comparison).

3. Methodology

Given the diverse nature of TM, identifying the major journals representing the field becomes difficult. There are at least three studies that help come to an agreement on the list of top journals. Both Linton and Thongpapanl (2004) and Franke and Schreier (2005) use different methodologies while focusing on the same journals. The former study uses citation analysis on 50 journals and ranks them based on the number of citations, citations adjusted for publication frequency, citations corrected for age, citations corrected for self-citation, and an overall score. Franke and Schreier (2005) integrate existing journal rankings in the fields of technology and innovation management into a meta-ranking by aggregating heterogeneous ranking information and calibrating the meta-ranking with journal rankings in different disciplines. Along the lines of these studies, Ball and Rigby (2005) identify 11 journals based on their knowledge and experience. Their list includes 10 journals identified by both Linton and Thongpapanl (2004) and Franke and Schreier (2005); the only addition to their list is the *European Journal of Innovation Management*. Since three different studies with varying methodologies identified 10 journals as the top journals of the TM field, we will rely on this list in our study. Hence, we will focus on the following top 10 journals for the TM area: *Journal of Product Innovation Management*, *Research Policy*, *Research-Technology Management*, *R&D Management*, *IEEE Transactions on Engineering Management*, *Technological Forecasting and Social Change*, *International Journal of Technology Management*, *Technovation*, *Technology*

[2]Even though the total number of articles is not known, this study only mentions that Nigeria-based papers represent 6% of its total sample.

Table 2
Distribution of the 6925 articles across the time periods selected

	1986–1994	Percentage in total[a]	1995–2005	Percentage in total[a]	1986–2005	Percentage in total[a]	Percentage increase[b]
Total no. of articles	1903		5022		6925		163.9
Total no. of articles over three pages	1816		4931		6747		171.5
No. of articles on developed countries	1567	86.3	4090	82.9	5657	83.8	161.0
No. of articles on developing countries	210	11.6	841	17.1	1051	15.6	388.5
No. of articles not classified	39						

[a]Total number of articles over three pages.
[b]Increase from the period 1986–1994 to the period 1995–2005.

Analysis & Strategic Management, and the *Journal of Engineering and Technology Management*.

In order to scrutinize the differences among studies made on developed and developing countries in the TM literature, bibliographic data and the abstracts of 6925 articles published from 1986 to 2005 in the 10 selected academic journals were collected through electronic databases. The population of 6925 articles were classified into two groups as "developed country study" and "developing country study." For this, all countries in Europe (except former socialist countries, Cyprus, and Turkey), USA, Canada, Japan, Australia, and New Zealand were categorized as "developed countries," while the rest were treated as "developing countries." Taiwan and Hong Kong, while officially provinces of China, were classified as separate countries. The so-called "East Asian Tigers" (Hong Kong, South Korea, Singapore, and Taiwan), which constituted the first wave of countries identified as "newly industrialized countries" undergoing rapid industrial growth in the 1970s and 1980s, have now reached the ranks of "developed countries" in terms of per capita GDP income (Bożyk, 2006). However, in this study they are categorized as "developing countries" because their TM practices and experiences are more closely related to the circumstances in developing countries rather than developed countries. The classification of the articles is mainly based on a rigorous review of paper abstracts, and in cases where paper abstracts could not be reached, of the article titles. For some articles, however, abstracts and titles alone were not sufficient. These articles were conceptual or merely literature review- or model-based; in others, no country name was mentioned in the abstracts or titles. In these cases, our strategy was to classify such articles according to the country affiliation(s) of the author(s). Another procedure applied in classifying articles was that articles on both developing and developed countries, and articles written by multiple authors from both developed and developing countries were coded as developing country studies.

The study was limited to articles published between 1995 and 2005, due to two reasons. First, due to a lack of electronic access to full texts and abstracts, some articles published before 1995 could not be classified accurately. Second and more importantly, by reducing the size of the total population, the percentage of articles classified as "developing country study" in the population actually increased (as can be seen in Table 2), enhancing our comparative analyses.

In the second stage of the study, a random sample of 163 developing country articles and 162 developed country articles was selected from the population to undergo content analysis. A codebook was generated and tested with three raters (authors of this paper—all working on TM) on a sub-sample of 10 randomly selected articles, five each from developed and developing countries. The revised second version of the codebook was developed after this initial pilot. The second test was conducted on a random sub-sample of 30 new articles, covering an equal number of articles from the two country groups, to detect any problems in the interpretation of the codebook (see Appendix).

Since the first four questions in the codebook consist of bibliographic data on the articles, they were not coded but taken directly from the databases. The next 12 questions which include less subjective questions on the number of authors, the country affiliation(s) of the author(s), the present academic unit(s) of the author(s), the existence of comparative research, the countries investigated, the industry sector focused, technology focus in the articles, research methods used, unit of analysis, sample size, firm type, and time frame were coded by one additional rater (one of the authors). The last two questions regarding the research purpose of the article and primary and secondary topics investigated in the article were coded by three academic raters (each article coded by two raters). The coding disparities across raters were discussed and the final codes were determined via consensus. Great emphasis was given to the classification of the article topics, which were gathered from previous review papers, TM curricula, TM associations, and experts in the field.

4. Scrutinizing the TM literature

This section is divided into two parts. The first part covers the general characteristics of the articles for the total

sample, while the second part focuses mainly on the classification of the research literature by topic while comparing the developing and developed country studies. The analysis will incorporate not only the trends in the number of TM articles and their contents over time, but also the differences among TM journals and their coverage of TM knowledge.

4.1. General trends in TM literature

According to the analysis of the total population of 6925 articles for the period of 1986–2005 (Table 2), the number of articles on developing countries published between 1995 and 2005 is 841; on the other hand, developing country articles published between 1986 and 2005 is 1051. Hence, taking the 1995–2005 period covers 80% of all articles published on developing countries in the last 20 years. In addition, 91 articles with less than four pages were excluded from the population to avoid the inclusion of research notes, book reviews, or commentaries, resulting in a final population of 4931 articles.

An observation of the articles in the two consecutive decades shows that the TM literature grew rapidly, displaying a 164% increase (Table 2), a finding corroborated by Ball and Rigby (2005). However, the total numbers in Table 2 raise a concern[3]: even though the number of articles on developing countries increased by almost four times in a decade, their total number still represents only 17% of the total articles published in 20 years, a finding also supported by Allen and Varghese (1989).[4] The list of countries seen in this study's sample (which consisted of randomly selected 163 developing and 162 developed country articles) are listed in Table 3. The total number of countries is more than the total number of papers, since some articles include two or three countries. As seen in Table 3, more than half of the papers (51%) investigate only six countries; namely USA, India, Japan, the UK, Taiwan, and China.

A detailed study of the sample of 325 articles in terms of author affiliation shows that more than half of the articles (59%) in the total sample are written by authors whose affiliations are in developed countries and 33% of the articles are by authors whose affiliations are in developing countries (Fig. 1). Eight percent of the articles are outputs of collaborations between authors from both developed and developing countries.

When the industrial focus of the articles is investigated, it can be seen that 34.5% of the articles in the sample are not specific to any industrial sector (Fig. 2). Sixty-three percent of the articles that explicitly indicate an industrial focus study manufacturing industries, another 10% of them study services, while the remaining 27.1% analyze a combination of manufacturing and service industries.

Table 3
Countries most frequently studied in the articles (up to five of the countries studied in articles are included)

Country	No. of articles	Percent
USA	54	15.2
India	28	7.9
Japan	28	7.9
UK	27	7.6
Taiwan, Province of China	23	6.5
China	21	5.9
Germany	15	4.2
Republic of Korea	13	3.7
Italy	11	3.1
Israel	9	2.5
Nigeria	8	2.3
Sweden	8	2.3
France	8	2.3
Australia	6	1.7
Singapore	6	1.7
Brazil	6	1.7
Europe	6	1.7
The Netherlands	5	1.4
Canada	5	1.4
Hong Kong	5	1.4
Hungary	5	1.4
Total	355	83.7

The most common TM topics of the papers in the total sample of 325 articles are: (1) the category including "organization, organization culture, organizational learning teams, Chief Technology Officer, competence, knowledge, creativity, ideas management, management of engineers and researchers" (13.5%); (2) the category for "technology policy—national TM policies and systems, innovation systems, national innovation systems, regional innovation systems, sectoral innovation systems, open innovation systems" (10.3%); (3) the category on "technological acquisition, technology transfer, technology diffusion adoption, adaptation, dissemination" (9.2%); (4) the topic of "research and development management, global R&D" (7.7%); and (5) "technology strategy" (7.6%). These areas cover nearly 50% of all topics studied in the papers (Table 4) and are parallel to the headings investigated in Adler's (1989) review of the technology strategy literature. The least studied topics (covered in less than 10 papers) fall into either the category of "MOT (management of technology) education and training" (five articles) or the category of "technology financing and investment issues" (six articles).

Another aspect investigated in the articles is the technology focus. The articles are coded as technology-focused for a unique technology, such as IT or biotechnology, if they discuss specific characteristics of the technology and if their changes depending on the technology

[3]Thirty-nine articles could not be classified as developed or developing country studies due to insufficient bibliographic data.

[4]A study covering 20 years of a particular journal, *R&D Management*, shows an increase in the involvement of international authors, but this increase corresponds to the heavy involvement of US-based authors (Allen and Varghese, 1989). This study also clearly notes that the increased portion of non-European and non-US authors altogether represented only about 10% of all articles published in *R&D Management*.

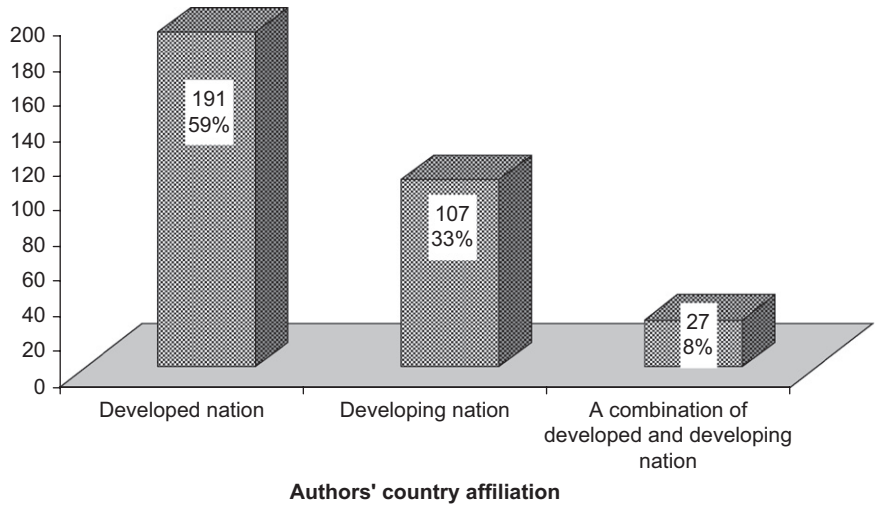

Fig. 1. Authors' country affiliations for the sample of 325 articles.

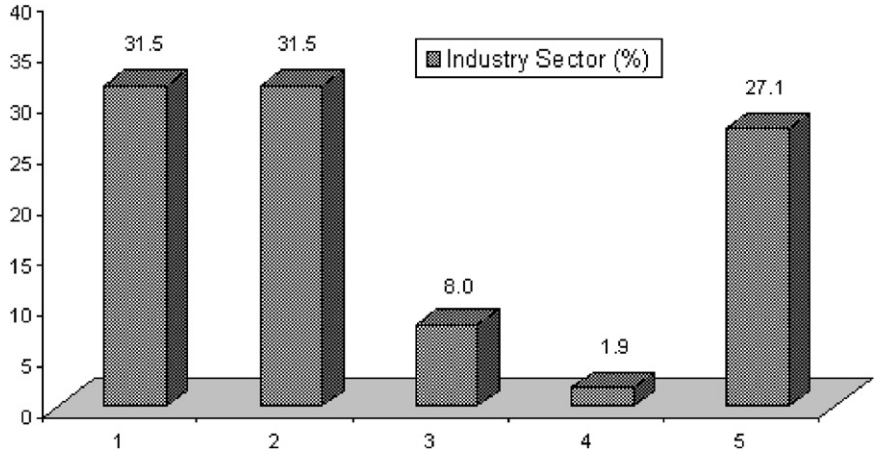

Fig. 2. Distribution of industry sectors studied. 1 = Single manufacturing sector; 2 = multiple manufacturing sectors; 3 = single service or IS-related sector; 4 = multiple service or IS-related sectors; 5 = mixture of manufacturing and service industries.

mentioned. For example, if a paper about early stage problems of companies conducts a survey among biotechnology companies but does not take into consideration the particularities of biotechnology companies, it is not considered a technology-focused paper. The analysis of the technology focus of papers shows that very few articles have any technology focus (close to 6%); interestingly, only 1.9% of all articles are about emerging technologies.

A tabulation of the research methods utilized in the articles shows that almost 40% of articles are in the form of a literature review or are based on the secondary data, while around one-fourth of the articles are field surveys (Table 5). Few papers (5.8%) use more than one research method and there are no papers using more than two methods in the same study. The unit of analysis used in the articles ranges from individual-level to project-level. The most common units of analysis are firms (39%), individuals (11%), and countries (around 10%). Of the articles having firms as their unit of analysis, almost 70% focus on local firms and 19% on multinational firms. Only 9% of the articles utilize longitudinal data, while the remaining papers have data from a single point in time (cross-sectional).

In terms of theoretical contribution, the majority of articles (74%) aim to present, develop, or enhance an existing theory. Thirteen articles (4%) have the goal of developing new theories. Almost 74% of the articles in which library research, literature reviews, archival or secondary resources are used as research methods aim to present, develop, or enhance an existing theory, while nearly 72% of the studies using field surveys and nearly 78% of those using case studies have the same research purpose (Table 5). Of the papers that have policy generation as their aim, 41% of articles use library research, literature reviews, archival or secondary resources, and 34% use field surveys.

4.2. Comparison of developed and developing country studies

In this section, we will focus on the main aim of this paper, which is the comparison of the knowledge generated

Table 4
Topics investigated for the sample of 325 articles

Topics	No. of articles*	Percent
Organization, organization culture, organization structure, organizational learning teams, CTOs, competence, knowledge, creativity, ideas management, management of engineers and researchers	75	13.5
Technology policy (national technology management policies and systems, innovation systems, national innovation systems, regional innovation systems, sectorial innovation systems, open innovation systems)	57	10.3
Technological acquisition, technology transfer, technology diffusion, adoption, adaptation, dissemination	51	9.2
Research and development management, global R&D	43	7.7
Technology strategy	42	7.6
Technological change, technological development	39	7.0
New product development, design innovation	35	6.3
Emerging technologies (nanotechnology, biotechnology, IT), production/manufacturing technologies (CAD, concurrent engineering), supply chain technologies, development and improvement of process technologies (ICT, e-business technologies, virtual operations)	34	6.1
Technological collaborations, technological alliances, networks (intra-firm collaboration), co-operation (relationships, global networks)	27	4.9
Production/manufacturing, supply chain, quality management, operations management (technology utilization efficiency performance implementation)	26	4.7
Not technology management after all	20	3.6
IPR, patents	16	2.9
Technology foresight, technology forecasting, technology planning, road-mapping, technology intelligence	15	2.7
Project management	11	2.0
Technology commercialization, technology marketing, innovation marketing	11	2.0
Entrepreneurship, corporate venturing, entrepreneurship	11	1.8
Technology assessment, evaluation	10	1.8
Subtotal	523	94.2
Total	555	100

*Topics studied at least in 10 articles are included. More than one topic might have been studied in any article.

in developed and developing countries. Firstly, the distribution of the articles in the sample of developed country articles is studied according to their journals and year of publication (Table 6). An interesting and useful observation for developing country academicians is that *Technovation* is the most developing country-friendly journal, with 32% of its articles published in the period 1995–2005 coming from developing countries, followed by the *International Journal of Technology Management* (IJTM) and *R&D Management*. Another interesting finding is that nearly half of the developing country studies are focused on five countries; namely, India, Taiwan, China, South Korea, and Israel. On the other hand, 50% of the developed country studies investigate only three developed countries, namely USA, the UK, and Japan.

Even though the present research primarily aims to explore the convergence or divergence trends in developed and developing country TM research, we might consider the following three reasons as a starting point to discuss the uneven coverage across developing countries.

(1) *Knowledge spillovers and technological convergence*: Foreign direct investments made in some of these countries (such as China) are high compared with other developing countries. With the end of the isolation of firms in protected domestic markets and an increased awareness of technological developments, firms in developing countries benefit from international technology spillovers (Coe et al., 1997; Pamukçu, 2003). This increased awareness and the impact of technology spillovers bring about enhanced academic interest in such countries.
(2) *The higher number of researchers having international networks that increase the knowledge spillovers to developing countries*: The researchers in the five most studied developing countries might have strong international networks. A high number of graduate students from such countries studying abroad might be a reason for the uneven distribution of countries in developing country studies and the convergence between developed and developing country studies. Eighty-eight percent of the articles written by a combination of authors from developed and developing countries are about these five countries. This ratio may imply that researchers in these developing countries have stronger ties with their colleagues in developed countries.
(3) *Technology leapfrogging*: Some countries such as South Korea and Taiwan have managed to become technology leaders in a number of technology intensive industries, increasing academic interest in these countries (Kim, 1997).

A χ^2-test indicates a significant relationship between the authors' country affiliation and the classification of articles as developed or developing country studies. Descriptive statistics show that 98% of the developed country papers have been written by authors based in developed countries. In contrast, 64% of the developing country articles have authors based in developing countries; 20% of the developing country articles have authors from developed countries, and the remaining articles have authors coming from both developed and developing countries. Researchers in developed countries might have access to developing country sources due to graduate students coming from developing countries, increasing the number of developing country studies written by authors from developed countries or a combination of developed and developing country authors.

Table 5
Number of articles as distributed according to research purpose and research methods used

Research methods	Research purpose				Total (percentage in total)
	0	1	2	3	
Speculative/advocacy/opinion-based	4	2	5		11 (3.4)
Library research/literature reviews/archival/secondary data studies	10	18	91	5	124 (38.2)
Conceptual/theoretical pieces		1	8	1	10 (3.1)
Case study	6	5	42	1	54 (16.6)
Field surveys	5	15	58	3	81 (24.9)
Simulation	2	1	21	2	26 (8)
Multi-method studies	1	2	15	1	19 (5.8)

Research purpose: 0 = unclear/no mention of a theory/no policy implications/informative paper; 1 = policy generation; 2 = presentation/development/enhancement of existing theory; 3 = new theory development.

Table 6
Distribution of articles in the sample according to journal and year of publication (developed and developing countries)

Journal name	Classification	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Subtotal	Total
(1) International Journal of Technology Management (IJTM)	Developed	4	2	4	3	4	4	3	2	4	3	2	35	77
	Developing	7	1	6	3		3	6	3	4	4	5	42	
(2) Technovation (TVN)	Developed	1	1	1		1	1	3	5	3	1	3	20	66
	Developing	2	4	4	2	7	6	3	4	7	4	3	46	
(3) Research Policy (RP)	Developed	2	4	2	4	2	2	3	3	3	3	2	30	45
	Developing	1	2		2			2	1	3	2	2	15	
(4) Technological Forecasting and Social Change (TFSC)	Developed	1	2		2	1	2	1	2	2	1	1	15	40
	Developing	3	2		2	6	2	3	2	1	3	1	25	
(5) R&D Management (RDM)	Developed				2	2	1		1	1		4	11	29
	Developing		3	4	1	1	3		3		2	1	18	
(6) IEEE Transactions on Engineering Management (IEEE)	Developed	3	1	4	1		2		1		3		15	24
	Developing		1		3	1		1	2			1	9	
(7) Technology Analysis & Strategic Management (TASM)	Developed		3	2	2	1	2	3	1	2	3		19	22
	Developing			1	2								3	
(8) Research-Technology Management (RTM)	Developed	1			1	1		2				3	8	10
	Developing		2										2	
(9) Journal of Product Innovation Management (JPIM)	Developed	2	2	2		1	1						8	9
	Developing						1						1	
(10) Journal of Engineering and Technology Management (JETM)	Developed										1		1	3
	Developing	2											2	
Total developed country articles in the sample		14	15	15	15	13	15	15	15	15	15	15	162	325
Total developing country articles in the sample		15	15	15	15	15	15	15	15	15	15	13	163	

Our comparative study verifies the fact that developed country authors are the dominating actors in the creation of TM knowledge at the global level.

The analysis of the authors' affiliated academic units (Fig. 3) shows that management-related departments come first with 27.1% and 26.4% of authors coming from

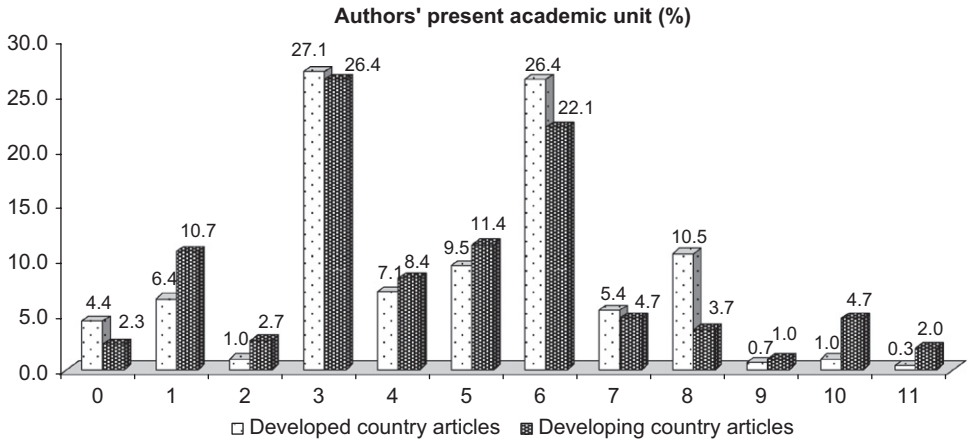

Fig. 3. Authors' present academic units (limited to first three authors)—total sample of 325. 0 = No information; 1 = engineering; 2 = basic sciences; 3 = business administration/management 4 = industrial management/technology management/engineering management; 5 = other social sciences 6 = research institute; 7 = dual appointments in multiple departments/organizations; 8 = non-academic consultant/businessperson; 9 = international organization; 10 = state/governmental offices; 11 = other.

Table 7
Most common five topics in industrialized and developing country articles

Developed country studies	Developing country studies
Organization (15%)	Technology policy (12.8%)
Technology strategy (9.9%)	Organization (12.1%)
New product development, design innovation (8.4%)	Technological acquisition (11.4%)
Technology policy (7.7%)	R&D management (8.5%)
Technological acquisition (6.9%)	Technological change, technological development (7.8%)

developed and developing countries, respectively, followed by authors working in research institutes (26.4% and 22.1%) and in other social sciences such as economics (9.5% and 11.4%). The χ^2-test results indicate that there is a significant relationship between the classification of an article as a developed or developing country study and the authors' present academic unit. Further analysis indicates another interesting comparison: the majority of authors working in state and governmental offices study developing countries, while the majority of non-academic consultants/businesspeople prefer to study developed countries.

The most studied topics in developed and developing country articles are given in Table 7. These top five topics cover nearly 48% of all topics for developed country studies, while they correspond to 53% of all topics for developing country studies. The two topics in developing countries that do not appear in developed countries are "R&D management" and "technological change and technological development." Similarly, developed country studies have two topics that are different from developing country studies, namely "technology strategy" and "new product development & design innovation." The topics studied in developed country articles parallel the findings of Pilkington and Teichert (2006). On the other hand, the topics that appear in both developed and developing countries' research agendas are "organization," "technology policy," and "technological acquisition" (Table 7). However, as mentioned earlier in Table 1, developing country studies are more concerned with technology policy and technology acquisition issues (such as technology adaptation and diffusion), while developed country studies give higher priority to organization issues.

Among the developed country articles, the topics which are discussed in less than five articles are the same as the least common topics in the total sample, while in developing country studies the number of topics which are investigated in less than five articles increases (to four), with two additional categories including "social and ethical aspects of technology management" and "university–industry spin-offs (technoparks, science parks, technological incubators)." A partial χ^2-test to check whether there is a significant relationship between an article's classification as a developed and developing country article and its focus on the five most common topics in the total sample indicated a significant relationship. In other words, developed and developing country articles differ significantly in terms of investigating the five most common topics of the total sample (Table 8).

For the year 2005, the most studied topic for developed country studies is "Organization" and related topics, but this topic loses almost half of its coverage in the 10-year period studied. After 2000, this category is investigated more in developing country studies and is the second important topic for developing country studies in 2005, behind "technology policy." The study of technology policy increases by 102% in the last 10 years for developing countries, while its ratio in developed country studies drops by 42%. As developing countries are lagging in many technology fields, their emphasis seems to be put in technology policies that can help close the gap (Kim, 1997). This might explain why technology policy is studied more in developing country studies. Another interesting contrast arises when the topic of "R&D management" is

Table 8
Changes in the percentages in the five most common topics (a comparison)—sequenced from the first most common topic to the least common topic

	1996–1997 (%)	2004–2005 (%)	Change (%)
(1) Organization			
Developed country studies	21.2	13.0	−39
Developing country studies	17.4	15.7	−10
(2) Technology policy			
Developed country studies	9.6	5.6	−42
Developing country studies	8.7	17.6	102
(3) Technology acquisition			
Developed country studies	7.7	5.6	−27
Developing country studies	8.7	11.8	36
(4) R&D management			
Developed country studies	5.8	11.1	91
Developing country studies	21.7	11.8	−46
(5) Technology strategy			
Developed country studies	11.5	7.4	−36
Developing country studies	10.9	2.0	−82

examined. While the ratio of papers about R&D management drops by 46% for developing country studies in the 10 years studied, it increases by around 91% for developed countries. This shift in focus might be related to increased R&D activities in the new technologies in developed countries. Although the topic of "technology strategy" loses its importance both for developed and developing country studies, its share in developing country studies drops by 82%. A logical explanation might be the increased division of labor in technology creation in advanced technologies (such as nanotechnology) in developed countries, while developing countries are followers/imitators/transferees of these advanced technologies. This also explains why the percentages of articles discussing the category for "technological acquisition, technology transfer, technology diffusion adoption, adaptation, dissemination" is in the top five topics for developing country studies, while it loses its importance for developed countries. An important implication of the distribution of topics across journals is the confirmation that the TM literature is a highly segmented field, and journals give varying importance to topics. Authors from developed and developed countries study clearly varying topics, which confirms that there is a divergence of topics among knowledge generated in developed and developing countries.

5. Conclusions

This paper mainly investigated the trends in the TM field based on the differentiation of developed and developing country academia. By generating an overview of the TM field, the goal was to compare trends in the developing and industrialized country knowledge bases. The overall analyses produced two important findings: (1) the TM field is dominated mainly by developed countries and (2) there are substantial differences among the topics investigated in developed and developing country studies.

Eighty-three percent of all papers published in the 10 main TM journals in the period of 1995–2005 are developed country articles. This dominance is further confirmed by the result that 36% of the developing country articles are written either by developed country authors or by a collaboration of developing and developed country authors. This is in line with the findings of Riesman's (1994) study on the 40-year history of the TM discipline. Riesman (1994) urges scholars and scientific institutions to be reflexive about the phenomenon of "*natural drift*," which denotes the "*natural tendency towards professional regression where a small professional elite core maintains intellectual control over a much wider jurisdiction*." Due to the dominance of developed country authors, it is not surprising to observe their influence on determining the research agenda to which both developed and developing country academics oblige. In our study, we particularly observe that even though the relative importance of the topic varies among developed and developing country articles, there are at least three major common topics, namely "organization," "technology policy," and "technology acquisition."

Although our study revealed that developed country authors are the dominating actors in the creation of TM knowledge, this has not led to a total convergence of developing and developed country studies. A significant relationship was found between an article's classification as a developed or developing country study and its focus on the five most common topics. Apart from the differences in the rankings of the most important topics for developing and developed country studies, there are some topics that do not take place in their individual lists. The two topics that do not appear in the list of developed countries are "R&D management" and "technological change & technological development." Similarly, developed country studies have two topics that are different from developing country studies, namely "technology strategy" and "new product development & design innovation." This is an indication that there is a divergence of topics of interest for developed and developing countries.

The major difference between developed and developing countries in terms of the TM research agenda may be due to the different levels of national technological capabilities, as it has been stated that the "mastering of existing technologies" is a major concern for developing countries while the "boosting innovative performance" is important for developed countries (Amsden and Hikino, 1994; Dahlman et al., 1987; Lall, 1998, 2000, 2001). The different experiences and peculiarities of developing countries' problems in terms of transfer and adaptation of technology

as well as technological capability accumulation processes might require different managerial/organizational practices. This may very well generate context-dependent practical needs that are likely to be reflected in the local researchers' agenda.

There might be many other reasons behind the observed divergence; however, a full discussion is out of the scope of this paper. Nonetheless, this paper aims to show that it is important to pay attention to cross-cultural researchers who argue that there is no universal theory of TM as argued (Hafsi and Farashahi, 2005; Hofstede 1993; Jaeger, 1990). Understanding divergence is critical for two main reasons. (1) Meta-theoretical assumptions supporting US-based management theories and practices should be questioned, particularly in regards to their deployment in non-Western contexts. (2) The emphasis of research on "cultural differences" imply "separation," which would also conceal other social and cultural formations established through global relationships (Boyacigiller and Adler, 1991; Doktor et al., 1991; Özkazanç-Pan, 2008). Thus, there is a need to understand the particularities of developing countries in order to increase our understanding of TM theory and its applications.

Conclusive comments about the convergence of academic disciplines and their reasons such as increased globalization call for further scrutiny. Even though some literature reviews for the TM field exist, data necessary to pass judgments on the convergence and divergence views is lacking. Knowing that the TM literature does not simply consist of topics of interest solely to advanced nations might motivate an understanding of the distinction of developed and developing countries. This, in turn, will improve the incorporation of particular TM issues and problems of developing countries into the academic arena. As this paper focused on identifying the trends in the TM literature with an emphasis on whether developing and developed country studies differ, the purpose was not to attempt to explain why these differences exist. However, the proposed reasons behind the differences noted here are worth studying further. An additional avenue of research might be why many TM topics, such as "social and ethical aspects of technology management," do not have enough coverage in TM journals. This might open up questions of what really constitutes the TM field.

Before concluding, it is important to mention of a limitation of the study arising from the selection of journals as TM outlets. As noted by Pilkington and Teichert (2006), the establishment of the TM discipline has been a slow process, perhaps due to TM researchers preferring to publish their best work in more established general journals rather than in TM-specific journals. Thus, an extension of this study might be to incorporate influential management journals rather than just focusing on TM journals. We hope that this paper will attract enough interest in knowledge differences in the TM field across the globe, and by doing so, there will be follow-up studies to understand the knowledge generation drivers in developing countries. Combining research themes in developed and developing country studies will contribute to developing the TM discipline further as a respected academic discipline.

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Appendix. CODEBOOK

1. **Article Number** Given article number in database
2. **Article Year**: Enter year of publication.
3. **Article Source**

   The journal shorthand will be entered.

1. Journal of Product Innovation Management	JPIM
2. Research Policy	RP
3. Research-Technology Management	RTM
4. R&D Management	RDM
5. IEEE Transactions on Engineering Management	IEEE
6. Technological Forecasting and Social Change	TFSC
7. International Journal of Technology Management	IJTM
8. Technovation	TVN
9. Technology Analysis & Strategic Management	TASM
10. Journal of Engineering and Technology Management	JETM

4. **Full title** of the article will be entered.
5. **Number of authors** of the article will be entered.
6. **Authors' country affiliation**:

   0 = No information

   1 = Developed nation: Author's affiliation (university, research institute, consultancy) is based in developed parts of the world (U.S., Europe, Australia/New Zealand, Japan, Canada, etc.)

   2 = Developing nation: Author's affiliation (university, research institute, consultancy) is based in developed parts of the world (India, China, Hong Kong, Brazil, Taiwan, Israel, Nigeria, S. Korea, S. Africa, Hungary, Kuwait, Poland, Turkey, etc.)

   3 = A combination of developed and developing nations

1. **Authors' present academic unit**: Up to the first three co-authors

   0 = No information

   1 = Engineering

   2 = Basic sciences (physics, chemistry, mathematics)

3 = Business Administration/Management
4 = Industrial management/technology management/engineering management
5 = Other social sciences (e.g. psychology, sociology, economics, industrial relations)
6 = Research institute (advanced studies/research)
7 = Dual appointments in multiple departments/organizations
8 = Non-academic consultant/businessperson
9 = International organization, such as UN, UNCTAD, OECD, etc.
10 = State/governmental offices
11 = Other (Write in parentheses)

2. **Comparative Research**
0 = Not clear/Not specific to any country
1 = Single developed country study
2 = Single developing country study
3 = Two or more developed countries investigated
4 = Two or more developing countries investigated
5 = Developed and developing countries investigated together
3. **Names of the countries studied**: If Comparative Research is ***not*** coded as 0, up to five of the countries studied will be entered.
4. **Industry Sector**
0 = Not specified
1 = Single manufacturing sector
2 = Multiple manufacturing sectors
3 = Single service or IS-related sector
4 = Multiple service or IS-related sectors
5 = Mixture of manufacturing and service industries [NOTE: Code as 5 if all companies in a region/country have been studied ***and*** no specific industry sector has been identified]
5. **Technology Focus**
0 = No technology focus
1 = Emerging technologies (biotechnology, nanotechnologies)
2 = Production/manufacturing technologies
3 = IT-related technologies
6. **Research Methods** (based on Arnold, 1996; Scandura & Williams, 2000):
0 = Speculative/advocacy/opinion-based [Authors present **normative** views of a phenomenon as the core of the article or even try to persuade the reader to buy into their beliefs. There is an **uncritical** treatment of a phenomenon, **not supported** by empirical data or theoretical starting points]
1 = Library research/literature reviews/archival/secondary data studies
2 = Conceptual/theoretical pieces [going beyond literature review to offer propositions among variables, develop a theoretical framework, critically discuss/challenge existing notions, discuss new constructs, etc.]
3 = Case study [in-depth study of one or several cases aiming for a holistic understanding of a phenomenon, usually drawing on a number of different data sources, using mostly qualitative data but sometimes combined with quantitative data] **or** ethnography [studying people's behaviour in everyday contexts rather than in experimental conditions; gathering data from a range of sources, with observation and/or relatively informal conversations being the main ones; focusing on a single setting or group. Analysis involves interpretation of meaning]
4 = Field surveys
5 = Simulation [Studies designed to model/replicate naturally occurring systems, phenomena or real-life problems (e.g., computer simulations)]
6 = Multi-method studies
NOTE: If **multi-method/multi-study**, code a single article as two or more studies in terms of the other methods codes
7. **Unit of analysis**: (Enter for first three types of studies for multi-method studies)
0 = Unclear
1 = Individual (person) level
2 = Firm level
3 = Project level
4 = Industry level
5 = Regional level
6 = National level
7 = International level
8 = OTHER (Write in parentheses)
8. **Sample size**: If *Research Methods* coded as 1, 3, 4, 6, enter number of units of analysis in sample.
9. **Firm type**
(NOTE: Code only if *Research Methods* coded as 1, 3, 4, 6 **and** *Unit of Analysis* = 2)
0 = Unclear
1 = Local companies
2 = Multinational companies
3 = Local and multinational companies
10. **Time frame**: Code only if *Research Methods* coding is 3, 4, 6 [NOTE: May not be applicable to simulations; in that case write NA]
0 = Cross-sectional (Variables measured/observed at a single point in time)
1 = Longitudinal (Variable measurements/observations of the same items over long periods of time)
11. **Reader code**
0 = Dilek
1 = Hacer
2 = Nazli
12. **Research Purpose:**
0 = Unclear/no mention of a theory/no policy implications/informative paper
1 = Policy generation
2 = Presentation/development/enhancement of existing theory
3 = New theory development
NOTE: If Research Purpose = 4, enter name of new theory (up to 3 theories).
13. **Topics investigated (TOPIC 1 AND TOPIC 2)**:

Keyword Number	Keyword (English)
1	Technological change, technological development
2	Technology strategy
3	Technology foresight, technology forecasting, technology planning, road-mapping, technology intelligence
4	Technology assessment - evaluation
5	Technological acquisition, Technology transfer, Technology diffusion adoption, adaptation, dissemination
6	Research and development management, global R&D
7	Project management
8	New product development, design innovation
9	Technological collaborations, technological alliances, networks- intra-firm collaboration, co-operation – relationships, global networks
10	Technology commercialization, technology marketing, innovation marketing
11	Technology financing and investment issues
12	University-industry spin-off (Technoparks, Scienceparks, technological incubators)
13	IPR, patents
14	Production/ manufacturing, supply chain, quality management, operations management (Technology utilization efficiency performance implementation)
15	Organization, organization culture, organization structure, organizational learning teams, CTOs, competence, knowledge - creativity - ideas management – management of engineers and researchers
16	Emerging technologies (Nanotechnology, Biotechnology, IT), production/ manufacturing technologies (CAD, concurrent engineering), supply chain technologies, Development and improvement of process technologies – ICT – e-business technologies – virtual operations
17	Entrepreneurship, corporate venturing – entrepreneurship
18	Social and ethical aspects of technology management, sustainability
19	MOT education and training
20	Technology policy—National technology management policies and systems, innovation systems, national innovation systems, regional innovation systems, sectorial innovation systems, open innovation systems
21	*OTHER TECH. MGT. TOPICS*
22	*NOT TECHNOLOGY MANAGEMENT AFTER ALL*

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