Journal of International Business and Economy (2008) **9**(1): 37-58

Journal of International Business and Economy

K. Momaya

EVALUATING COUNTRY COMPETITIVENESS IN EMERGING INDUSTRIES: LEARNING FROM A CASE OF NANOTECHNOLOGY

ABSTRACT

Many leading countries have strategy for important emerging industries such as nanotechnology and biotechnology. Evaluating country competitiveness in such industries is a complex process, but findings can be very valuable. This article shares findings and learning of an attempt to address this vital need about competitiveness. Strategy concept of critical success factors is being extended to country level to evolve simple but effective approaches. For the purpose, this article leverages the data from the IPS National Competitiveness Report for benchmarking. The learning and insights derived through the research are used to introduce simple matrix of industry life cycle and segments to help make strategic choices for differentiated positions and also draw strategic implications.

Key Words: country competitiveness, APP, emerging industries, nanotech, dual double diamond model, strategic management, leadership

K. Momaya
Indian Institute of Technology, Delhi

Correspondence: K. Momaya
Strategic Management Group, Department of Management Studies (DMS), Vishwakarma Bhavan, Indian Institute of Technology (IIT), Delhi, New Delhi-110016
E-mail: momaya@dms.iitd.ac.in
Tel: +91-11-2685 5298

First Received: Aug. 5th 2007
Final Revision Accepted: Dec. 12th 2007

EMERGING INDUSTRIES AND COUNTRY COMPETITIVENESS

Technology and innovation-based emerging industries have been a key driver of competitiveness for pioneering countries. Emerging industries such as nanotechnology offer a huge potential applications and economic benefits for countries and firms. Many researchers have addressed different dimensions of competitiveness across levels: country, industry and firm. Role of industries in country competitiveness is a key issue. While different kind of industries can contribute to country competitiveness depending on context (e.g., size, physical and human factors), technology and innovation-driven emerging industries of recent origin such as nanotechnology are expected to make massive contributions due to profound impact they have on many other industries. Several examples of leverage of emerging industries of specific era (from textiles and railroad in 19th century to automobile and computer in 20th century) for competitiveness by the pioneering countries are there. Despite availability of several competitiveness reports, the need for better approaches to measure competitiveness has been suggested by several researchers recently (Siggel 2006, Cho, Moon, and Kim 2007). Attempts are being made in our research to evolve relevant definitions and frameworks of competitiveness in context of emerging industries and evolve approaches to evaluate competitiveness.

Competitive countries often make careful choices about sources of competitiveness. An important dimension is choice of industries. Some countries such as the United States of America (U.S.) are quite competitive in creating new technologies and industries based on that. They lead the world in such emerging industries for decades. Dominant position the U.S. has achieved in important industries such as computer services and software (e.g., 3 out of 3 firms in Fortune Global 500 in 2007 were from the U.S.) and pharmaceuticals (7 out of 12) can be partly attributed to such strategic choices and execution.

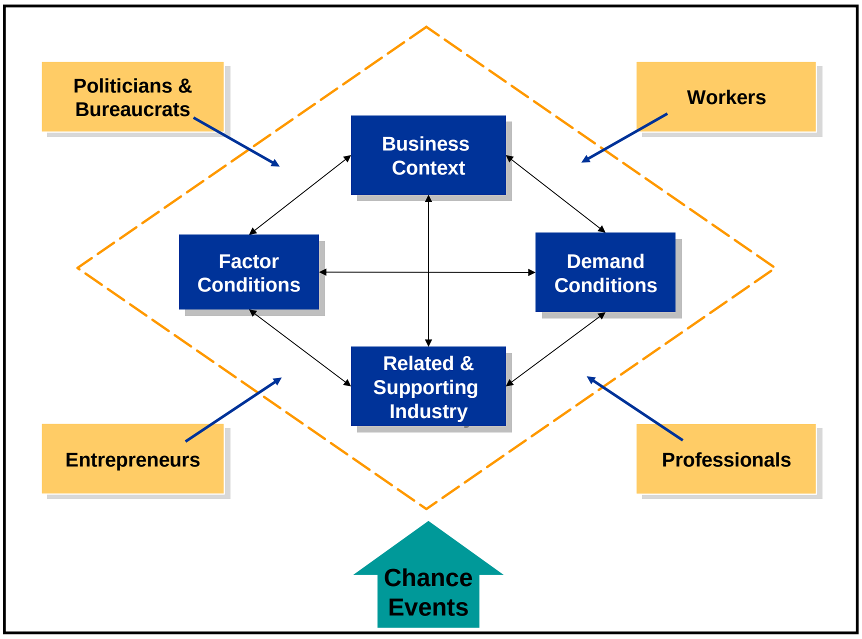
Nanotechnology is a leading emerging industry with high impact it can have on so many other industries and hence is focus of our research. The nanotech industry is heralding a new world order (Bhat 2003) and has increasingly received attention to sustain competitiveness in many parts of the world. Considering the huge contributions that nanotechnology is expected to make towards improving our quality of life, in particular, for sectors such as materials sciences, healthcare, information technology and the environment, most leading countries have been focusing on nanotech and have explicit strategy (EC 2004 in Europe, NSTC 2004 and NNI 2007 in the U.S). For instance, since its inception in Fiscal Year 2001, the National Nanotechnology Initiative (NNI), through the participating agencies, has advanced the knowledge and made progress toward establishing the infrastructure needed to allow further scientific and technological breakthrough (National Science and Technology Council; NSTC 2004). By implementing the plan described in above report over the next five years and beyond, the NNI will ensure that the U.S. remains a world leader in nanotech R&D and will facilitate commercialization to strengthen the U.S. economy and to address national needs. However, the changing global situation in last few decades may encourage multiple clusters across different countries in emerging industries, and hence the need to understand their competitiveness dynamics.

Key objective of our research is to evolve frameworks to evaluate competitiveness by leveraging strength of available related models, frameworks and concepts. In this article, enhancements to generic assets-processes-performance (APP) framework of competitiveness (Momaya 2001) are explored by leveraging strength of concepts and data given in *IPS National Competitiveness Research 2005 Report* (IPS 2005), published annually by the Institute for Industrial Policy Studies, and the strategy concept of critical success factors (CSF). This small article has two parts: identifying refinements to the generic APP framework and synthesize learning from its quick application. In the first part, emerging perspectives on competitiveness are explored very briefly and working definitions of key terms are evolved. Then the country competitiveness in nanotechnology is evaluated on benchmark CSF-aided APP framework and compared with results from macro and micro views of diamond model and human factors model to discuss predictability of these, and synthesize learning.

EMERGING PERSPECTIVES ON COUNTRY COMPETITIVENESS

Country competitiveness has been increasingly receiving attention as progressive countries successfully implement strategies for development. Competitiveness perspectives have seen tectonic shifts from Adam Smith to Michael Porter (Cho and Moon 2000). Going beyond the traditional trade-based models such as one by Adam Smith and David Ricardo, Porter (1990) introduced the diamond model in his book, The Competitive Advantages of Nations. The dynamic and comprehensive model, incorporated four important endogenous variables (Factor Conditions, Demand Conditions, 'Firm Strategy, Structure, and Rivalry', and Related and Supporting Industries). Among several attempts to improve the model, the nine-factor model (Cho and Moon 2000) and dual double diamond (DDD, Cho, Moon, and Kim 2007) are the most remarkable extensions. The nine-factor model introduced important dimensions of human factors (Figure 1) to overcome some limitations of Porter's single diamond model such as bias for advanced countries. The human factors in the nine-factor model drive the national economy forward by creating, motivating, and controlling the four physical factors in Porter's diamond model and, therefore, play an important role in explaining country competitiveness by offering strategic options to match different situations. Many elements of the nine-factor model, the dual double diamond (DDD) model and other related concepts are demonstrated in a more reliable country competitiveness report, the IPS National Competitiveness Research 2005 Report (IPS 2005) (often referred to as IPR report in this article), published annually by the Institute for Industrial Policy Studies.

Figure 1: The Nine-Factor Model of Competitiveness



Source: Cho and Moon (2005)

While several researchers of strategy and competitiveness such as Porter (1998), Hamel and Prahalad (1994) had divergent views on role of country for competitiveness, Garelli (2003), Cho and Moon (2005) and Kim (2006) had more clearer views about very important role for the country. A significant part of the competitive advantage for a country stems from far-reaching incentive policies and human factors it nurtures. The U.S. employs a large array of policy instruments affecting the competitive position of specific industries or activities (Ketels 2007). National Nanotechnology Initiative (NNI 2007) discussed above can be considered as a good example of the recent U.S. attempt to shape competitiveness in an important industry-nanotechnology.

Pioneering work on competitiveness being done by researchers in Asia may provide lasting concepts and pragmatic strategies. Recent learning and new research priorities on Porter's competitiveness framework have been discussed by Ketels (2006), but are less relevant for the context of emerging industries. While there are several reports on country competitiveness, some give quite contrasting pictures, due to weaknesses in theory and framework. Their utility in context of emerging industries is limited. Two most popular reports were the Global Competitiveness Report published by the World Economic Forum (WEF) and the World Competitiveness Yearbook published by the International Institute for Management Development (IMD). Weaknesses in theoretical background of these reports have been reported by Cho and Moon (2005). They redefined competitiveness, developed the nine-factor model incorporating human factors explicitly to provide stronger theoretical base and the dual double diamond model to evolve the IPS Competitiveness Report with several advantages. Typology for grouping of countries by competitiveness and size (Figure 2) developed by Cho and Moon (2005) can be valuable in strategic choices about competitiveness. The countries were classified as in a portfolio based on their size and competitiveness. For instance, India was classified as a large country with intermediary competitiveness as per that typology in the IPS report (2005).

Moving down from macro perspectives, more important issues about strategic choices come at an important intermediate industry level between country and firm levels. Many examples of why a specific country is more competitive in a specific industry were given by Porter (1990) to support the diamond model. The Assets-Processes-Performance (APP) framework (glimpse given in Figure 3) developed to extend the diamond model has been applied in multiple contexts in North America, India, Japan and Korea (e.g., Momaya 1998, Momaya 2001) including in an emerging industry context (Ambastha and Momaya

2004). Attempt is being made in this study to evaluate competitiveness after evolving critical success factors for the context. Such factors can facilitate quick competitiveness evaluations by identifying few most relevant factors of APP and data provided in competitiveness reports such as the IPS report (IPS 2005).

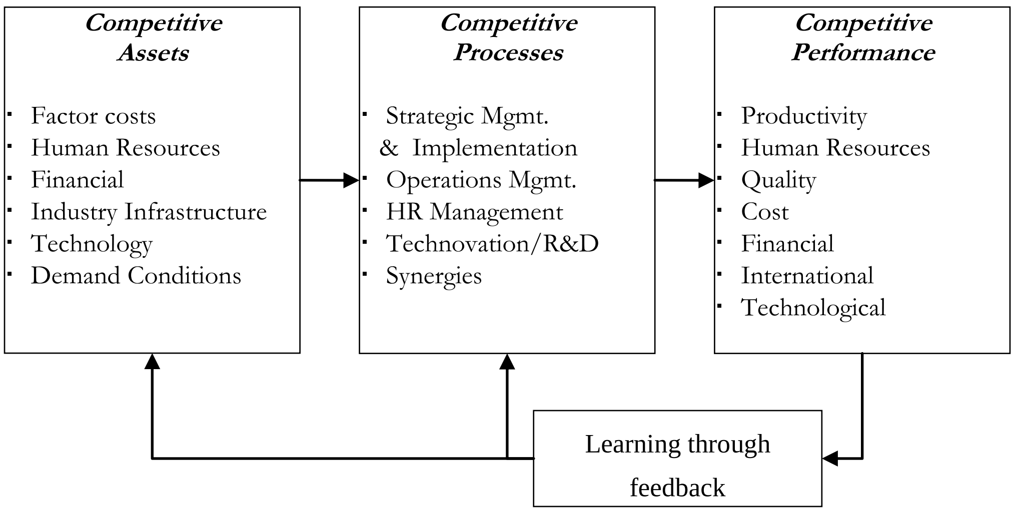
Figure 2: Typology of Country Groups from Competitiveness Perspective

Competitiveness \ Size	Small	Medium	Large
Strong	Strong-Small Countries (SSC)	Strong-Medium Courtiers (SMC)	Strong-Large Countries (SLC)
Intermediary	Intermediary-Small Countries (ISC)	Intermediary-Medium Countries (IMC)	Intermediary-Large Countries (ILC)
Weak	Weak-Small Countries (WSC)	Weak-Medium Countries (WMC)	Weak-Large Countries (WLC)

Source: Cho and Moon (2005)

Countries with intermediary competitiveness need to make careful choices about competitiveness for industries and segments. Since, nanotech is a vast industry for even large countries such as the U.S. to achieve competitiveness across segments and industry life cycle, a simple matrix was developed to help make strategic choices. The industry life cycle is defined in terms of key capabilities from R&D up to commercialization. An illustrative example in context of nanotech is given in Table 1. While firms from the U.S. can lead in segments such as nanomaterials and nanobio, they may find it difficult to compete in nanoelectronics, where firms from countries in East Asia have developed superior capabilities. The matrix framework can be used for factual competitiveness evaluation at segment level based on secondary data, or for delphi and other forecasting techniques to facilitate expert opinion. A temporal attractiveness analysis of the industry or any segment over well defined intervals can provide very useful insights.

Figure 3: Glimpse of Facets and Factors of the Generic Assets-Processes-Performance (APP) Model of Competitiveness



Source: Adapted from Momaya (1998)

Table 1: Illustrative Example of Matrix of Industry Life Cycle Phases and Segments for Competitiveness Evaluation or Strategic Choices

Phase / Industry Segment	R&D Capabilities	Investment Capabilities	Engineering Capabilities	Commercialization	
				Local	Global
Nanotech					
Nanomaterials					
Nanoelectronics	U, J, G	U, J, C, K	J, G, U, K, C	K, J, G	K, J, C
Nanobiotech	U, G, J, F	U, J, G, F			

Notes: 1. Factual data or expert opinions can be used to identify leading countries. 2. Codes such as China-C, France-F, Germany-G, India-I, Japan-J, Korea-K, US-U can be used. 3. Engineering Capabilities includes design and manufacturing.

THE RESEARCH METHODOLOGY AND DATA

Simple yet pragmatic methodology was adapted for this exploratory research. Review of relevant competitiveness literature was done to evolve context and concepts. Efforts were made to balance the sources from multiple countries for richer perspectives. Considering the complex and high risk nature of emerging industries and continuing trend towards scale advantage as reflected in community integration in Europe and several parts of the world, it was assumed that large countries will play a key role in bringing nanotechnology to mass applications. Among the largest countries (economically)/communities of the world, top three (the U.S., Japan and Germany respectively) and China and India (due to their being in top 5 ranks on PPP basis) were selected for benchmarking. Criteria of competitiveness for success of a country/community in nanotech were identified from content analysis of strategic reports from competitive countries (e.g., NSTC 2004, EC 2004). The large number of criteria identified were clustered into few factors as a step to identify Critical Success Factors (CSFs). Then, criteria that can act as good proxies for the factors were selected for benchmarking.

Comparable data across countries in nanotech are still very difficult all the time, yet best efforts were done and comparable facts were collected for the five countries for direct evaluation of nanotechnology competitiveness. Objective data and flexibility developed in the IPS National Competitiveness Research Report (IPS 2005) were leveraged extensively for benchmarking across levels. Published annually by the Institute for Industrial Policy Studies, the scientific report covered 66 countries and collected statistical data for 275 criteria comprising physical and human factors in both the domestic and international contexts. The report uses the most up-to-date 137 hard data collected through various statistical sources published by international or government organizations, and 138 soft data collected by the Korea Trade-Investment Promotion Agency (KOTRA), which had 105 offices abroad.

The countries were ranked on a scale of 1-10 on the criteria while evaluating objective or qualitative data or views in strategy reports of countries (e.g., EC 2004). Finally, the averages for the countries were calculated to overcome gaps that arise in any such effort with limited resources. For instance, it is very difficult to get reliable data about China without many field visits in China; it was not possible with our limited resources for research, so gaps do arise.

WORKING DEFINITIONS

Definitions of key terms used in this article can help the reader make better sense. Here an attempt is made to evolve working definitions of key terms. Competitiveness has relevance at many levels from country and industry and firm up to product/service level. In the present article, the country level definition in context of the industry is given. It is adapted from competitiveness definitions that have been evolving in our ongoing competitiveness research (Momaya 2001, Banwet, Momaya, and Shee 2002, Ambastha and Momaya, 2004).

Country Competitiveness in an Industry

In very generic terms, it can be defined as the ability of a country to provide nurturing environment for healthy evolution of the industry. This basic definition can be developed by adaptation of key concepts for more tangible definitions for the given context and objective of competitiveness evaluation. Hence, a specific definition can be: capabilities of the country to nurture an emerging industry or its segments, organizations (including institutions) and firms that produce goods and services that meet the needs of domestic and international markets while citizens earn a standard of living that is both rising and sustainable over long-run. Countries such as the USA, France, Germany, Japan and now China, India and Korea have several examples of competitiveness in specific industries.

Critical Success Factors (CSFs)

The concept of CSFs has been used more successfully in context of strategy. Thompson et al. (2006) used the term Key Success Factors (KSFs) in context of firms. They concluded that identifying KSFs is always a top priority analytical and strategic consideration. They provided a list of common types of industry KSFs to help identification. A sound strategy incorporates the intent to stack up well on all of the industry's KSFs and to excel on one (or two) in particular.

CSFs for a Country in an Industry

CSFs are those factors that determine strategic success or failure of a country in an industry. These can be competitive capabilities (in assets or processes) with the greatest impact on future competitive success in the industry in the global market place.

Nanotechnology

There are many definitions of nanotechnology depending on the context. After careful review of several definitions (European Commission 2004, National Science and Technology Council 2004, Bhat 2003) following working definitions were adapted for our context.

Nanotechnology is concerned with materials and systems whose structures and components exhibit novel and significantly improved physical, chemical, and biological properties—that enables the exploitation of novel phenomena and processes due to their nanoscale size. Many countries share an understanding of this broad definition of nanotechnology, though many have more specifically delineated the areas that are covered.

Nanosciences and nanotechnologies are new approaches to research and development (R&D) that aim to control the fundamental structure and behavior of matter at the level of atoms and molecules (European Commission 2004). These fields open up the possibility of understanding new phenomena and producing new properties that can be utilized at the micro- and macro-scale. Applications of nanotechnology are fast emerging and will impact on the life of masses.

EVALUATING COUNTRY COMPETITIVENESS IN NANOTECHNOLOGY

Let us begin from macro perspectives of country competitiveness as prelude to the specific context of nanotech. Emerging pictures of competitiveness of countries provide a contrasting view. For years, the U.S. has retained top slot in most country competitiveness reports, leaving other large countries such as China, India, and Japan far behind, often beyond rank 10. Glimpse of the trends in the ranks in two major reports IPS National Competitiveness Research 2005 Report (IPS 2005) and World Competitiveness Yearbook is given in the Table 2. The top slot of the U.S. is constant, irrespective of report for several years. This may be true by one perspective, but increasing imbalances in the U.S. raise concern about such competitiveness position of the U.S. in future. For instance, the twin deficits (budget and current accounts deficits) in the U.S. have reached record levels, triggering concern about sustainability in the mid- and long- term and implication for global economy.

Rise of large emerging economies will influence competitiveness in nanotech also. On Asian front, China seems to be enhancing competitiveness rapidly. In contrast, despite improvements, Japan seems to stagnate (19th rank in 2005 is quite low for a competitive country). Low and declining rank for India hints at complex problems behind so called excellent growth, despite favorable factor conditions.

While such global competitiveness reports often use more than 180 criteria and have relevance for macro picture, they were not found to be of much use for our need of country competitiveness in context of emerging industries. Hence, it was decided to take a different approach in our research. Instead of too many criteria of country competitiveness, carefully selected few criteria that are good proxies for overall competitiveness were identified and used. The criteria were selected from each major facet of diamond model and human factors model, leveraging empirical research findings, wherever possible. For instance, "Scientists & engineers" has high relevance for emerging industries and emerged as a key variable with high coefficient (Kim 2006), so it was selected (please refer to Table A2 in Appendix for the list of criteria that were selected after such review). The key consideration for selection of the criteria was fit with the critical success factors that evolved for the industry in content analysis of strategy reports of leading countries (e.g., EC 2004, NCST 2004, Bhat 2003).

Table 2: Trends in Competitiveness Ranks of Select Countries as per Country Competitiveness Reports

Country	IPS-NCR		World Competitiveness Yearbook		
	2005	2004	2002	2001	2000
USA	1	1	1	1	1
Canada	2	3	8	9	8
Australia	15	16	14	11	10
Japan	19	19	30	26	24
Korea	22	25	27	28	28
Malaysia	32	28	26	29	27
China	24	32	31	33	30
India	47	42	42	41	39
No. of Countries	66	68	56	56	52

Sources: IPS (2005) and IMD (2002)

Let us have a glimpse of more focused view of competitiveness in emerging industries. The Assets-Processes-Performance (APP) framework of competitiveness (Momaya 2001) that incorporates key constructs of other rich frameworks (e.g., Porter's diamond) provides a good canvass. The framework has been tested in several contexts (e.g., Momaya 1998, 2001, Banwet, Momaya, and Shee 2003, Ambastha and Momaya 2004) and provides ample flexibility to select and prioritize different factors and criteria for specific context. Classified menu of factors in assets and processes provides hints to possible criteria. By characteristic of emerging industries, the performance factors are often less evolved and hence are less relevant. Hence, assets and processes facets dominate in evaluation (Table 3). The criteria that emerged from content analysis are clustered to evolve factors. Glimpse of approximate positions of select countries on the factors that are proxy for the critical success factors is given here in the Table 3 below. While factual data were available for some criteria, the rating on other factors is based on content analysis of relevant nanotech or related strategy reports or papers of the U.S., Europe and Japan (e.g., NNI 2007, NSTC 2004, EC 2004).

Table 3: Glimpse of Approximate Evaluation of Competitiveness of Select Countries in Nanotechnology leveraging APP Framework

Facet of APP Framework*	Factors of Competitiveness (Examples of Criteria)	China	EU	India	Japan	U.S.
Assets	Investment (public investment, private investment as %)	3	5	1	7	8
Processes	Cooperation (among various stakeholders)	8	7	4	8	6
Assets	Companies (No. of anchor firms)	5	6	2	7	7
Assets	Technological (patents, publications)	4	8	1	6	9
Processes	Market/Customer (No. of products developed)	5	6	2	7	8
	Total score	28	32	10	35	38
	Standardized Score	-0.05	0.31	-1.69	0.58	0.85

Sources: Developed based on data from multiple sources including NNI, 2007; NSTC, 2004; EC, 2004.
Notes: 1. Scale is 1-10. 1=Extremely Low, 10=Extremely High. 2. For a glimpse of data that supported above scoring, please refer to Appendix 1. * Representative mapping on a facet considering definitions of factors.

Unlike the macro picture of lead by a single country, different countries seem to be ahead on different factors in context of nanotechnology. While the U.S. still leads in overall picture due to strong positions on investment, technological and market/customer factors, other large countries are not too much behind. In fact, with strong desire for cooperation, China and Japan are very keen to compete, at least in select segments. In line with macro picture, huge opportunities of improvement for India become evident on almost all factors due to relatively very low scores.

Having established the benchmark positions, let us explore the scenario from two important models—diamond and human factors. Findings from snapshots of quick evaluations in macro and micro context of emerging industries are summarized in Table 4, which shows relative positions of the five large countries as per the diamond model and human factors model. Scores are given at two levels: factor and criteria. Total factor scores are aggregate scores of many factors being considered in the IPS report and provide a macro picture. Detailed table listing factors and criteria considered for the diamond and human factors model are given in the Appendix 2 (Table A2 and Table A3 respectively).

Total criteria scores are aggregation of scores on select criteria that were perceived to be good proxy for critical success factors for a country in emerging industries. Standardized scores are also calculated for both the models and levels to facilitate comparisons on a uniform scale. Consistent low position for India, particularly on human factors model, should be a cause of concern.

Table 4: An Example of Approximate Country Competitiveness Evaluation in Context of Emerging Industry Using Data from IPS-NCR

	China	Germany	India	Japan	US
Physical Factors					
Total factor score	152.29	171.99	125.77	128.04	234.64
Standardized score	-0.23	0.21	-0.83	-0.77	1.62
Total criteria score	330.02	413.85	196.61	566.49	465.14
Standardized score	-0.46	0.14	-1.41	1.23	0.51
Human Factors					
Total factor score	221.01	244.14	180.55	240.93	290.75
Standardized score	-0.36	0.22	-1.37	0.14	1.38
Total criteria score	440.82	501.37	354.03	492.20	594.80
Standardized score	-0.41	0.28	-1.39	0.18	1.34

Source: Developed based on data from IPS report (2005).
Notes: Please refer to Appendix 2 for explanatory detailed tables for summary scores given in this table.

Comparison of the above specific picture from APP framework with the pictures that emerge from adaptation of IPS competitiveness report (IPS 2005) provides useful learning. While all the three models-APP (Table 3) and diamond model and human factors model (Table 4)-indicates lead for the U.S., the relative positions are quite different as per different models. While Germany and Japan were in distant second and third positions respectively as per macro picture (total factor score in Table 4) in diamond model the gap seems quite less in nanotechnology as per APP framework (Table 3). Total factor score in diamond model, despite being quite comprehensive, seems to provide the most divergent picture from current reality. For instance, very low total factor score for Japan (almost close to India) is at big divergence from direct competitiveness picture of nanotech (Table 3). Hence, macro picture on diamond model can be of little use for context of emerging industries.

DISCUSSION

Pictures of macro to micro competitiveness given in this article give many useful inferences depending on context; few critical ones are discussed here. While macro pictures provide a good backdrop, micro pictures in specific contexts are becoming important for decisions related to technology-based emerging industries.

The generic APP framework provides flexibility to evolve context-specific insights about competitiveness of a country and valuable suggestions for leadership in firms by leveraging strength of comprehensive IPR report. Of the five CSFs evolved (Table 3), three—investments, companies and technological—are close to assets facet of APP and the remaining two are close to the processes facet. The competitiveness positions that emerge were justified in our interactions with several experts in India and abroad.

This research proposes improvements in the generic APP framework to enhance reliability of competitiveness evaluation. In-build flexibility designed in APP framework allowed two major process enhancements. Firstly, developing an approach to enhance selection of factors used in APP through extending strategy concept of critical success factors. Secondly, proposing a process to enhance quality of data for evaluation by use of more reliable IPS report.

Considering all the five countries and emerging ground realities, criteria score seems to provide more realistic picture. That picture is the most closest to the direct picture of country competitiveness in nanotechnology (Table 3). The picture between factor score and criteria score are quite contrasting in diamond model. The U.S., China and India see massive decline in relative positions in criteria score and best gains emerge for Japan. Such divergences indicate the differences in strategic choices and factor positions of these countries. The picture between factor score and criteria score are less contrasting in human factors model. One reason may be more macro nature of criteria selected in human factors model in our evaluation. It also hints at better quality of variables in human factors model as compared to the diamond model. Over all there is also need for more research to evolve better CSFs and more relevant criteria in IPS or other country competitiveness report that can be used as source of data.

Typology of country groups to leverage the classical distinction of two generic strategies (Porter 1996) to country level developed by Cho and Moon (2005) can provide useful inferences. The large country sample in this paper can be divided into three groups—strong (Germany, Japan and the U.S.), intermediate (China) and weak (India) as per 3 X 3 typology of country groups. The typology is valid in context of nanotechnology also. Low position for India in comparison to the strong countries is understandable, more useful implications can emerge from comparison with intermediary country such as China. India had lower position than China on almost all factors in 2005 by difference of 2 to 4 (Table 3). India had best score on cooperation, still the vast gap with China and Japan hints at huge opportunity.

While the competitive large countries selected in this case can have ambitious strategy to compete across different segments of an industry and industry life cycle (Table 1), intermediary and weak countries should make careful choices. Countries in Asia can exercise their choices carefully individually as well as collectively. Countries such as India and Korea need to be more focused, where as strong countries such as Japan can make more challenging choices. Successes of Japan in emerging industries at one time, indicate their capabilities to make right strategic choices and achieve success by effective implementation. India faces much tougher challenges as successes of its industries have yet to make remarkable impact commensurate with much better factor and demand conditions it has.

Research in context of competitiveness of an emerging industry—software—hints that careful choices about cost and differentiation are necessary for India. Only few software firms were found in 'leadership' quadrant and majority in 'laggards' (Ambastha and Momaya 2004). While many firms will continue with popular cost strategy, they may not be able to sustain it in face of competition from China on many segments. The differentiation strategy is considered more sustainable for many progressive firms, but sources of competitiveness need to be carefully identified and competencies build. Technological processes that have shown high positive correlation with competitiveness in emerging industry context in India (Banwet, Momaya, and Shee 2003) can be of great value in nanotechnology and other emerging industries also. Slow competitiveness progress as a country for India as well as many of its leading industries hint at the need for innovative strategies: choices and implementation.

The study explores the utility of IPS National Competitiveness Research 2005 Report (IPS 2005) for approximate evaluation of country competitiveness in specific context of emerging industries by taking case of nanotechnology. If the evolved CSFs are correctly identified and mapped on few best proxies from the criteria given in the IPS report, the need of evaluating country competitiveness in specific contexts can be addressed. At the same time, the utility of IPS report can be extended considerably for competitiveness and related strategic decisions across the levels. Another contribution of this article is the strategic choices on industry life cycle. If less capable, the intermediary countries need to make better choices on the life cycle to focus on specific part(s) and segment(s), and complement to leverage double diamond with partner countries. Increasing internationalization of production networks, supply chains and even R&D in ICT-enabled era can create opportunities for such cooperation.

CONCLUDING COMMENTS

This article evaluates country competitiveness in context of an important emerging industry—nanotechnology. The findings of this research are indicative only, yet have clues for key strategists in governments, industry and academia. Emerging industries such as nanotechnology are increasingly receiving attention for competitiveness in many countries. Empirical findings and tremendous efforts to evolve and implement strategies at the country and community (such as European Community) level support the proposition that countries can play a key role in competitiveness of emerging industries. The evaluation of country competitiveness in such specific contexts is often needed, but is less addressed and overall country ranks are of limited utility, this article makes a small attempt to address the vital need. The quick evaluation indicates that the U.S. is leading the world and is likely to sustain leadership due to strengths in competitiveness processes including strategic leadership and technovation. Critical success factors may reside in the competitiveness processes of nurturing emerging industries, particularly creating enabling environment, collaborative advantages, strong commercialization capabilities, infrastructure creation, mass awareness and attract global resources through alliances. Thus it reinforces the role of process factors (Momaya 1998), however the specific factors and their definition need to be evolved carefully.

With the enhancements, the Assets-Processes-Performance (APP) framework provides a simple, yet powerful approach to make sense of competitiveness and flexibility to evaluate it quickly. Major contribution of this study to strategy areas is the attempt to evolve generic critical success factors for countries in context of emerging industries and leverage them to evaluate competitiveness. Identification of country CSFs can be of tremendous value to stakeholders for strategic decisions. Countries can assess their positions and sustainability on such factors to make more objective strategic choices.

There is need for considerable research to understand the dynamics of competitiveness across levels and strategic management to implement cooperative strategies to bring promised benefits of nanotech to many. Very low position for India on human factors model hints at the need of major intervention, if India is to make any significant contribution. Basics of competitiveness need to be diffused to professionals in industry, government and academia. Theories will need improvements in cooperation with practice to give better results. Progressive governments should evolve specific definitions and factors of competitiveness to enhance the quality of policies. Corporate leaders should develop proactive strategies based on factual views about competitiveness positions of leading countries on specific segments. Success will depend on effective implementation of proactive strategies to build capabilities and cooperation among key stakeholders.

ACKNOWLEDGEMENTS

The author wishes to thank the editor and anonymous reviewers of JIBE for valuable feedback and constructive comments. The support and encouragement of several of colleagues at the Department of Management Studies (DMS), Indian Institute of Technology (IIT), Delhi is gratefully acknowledged. Financial support for competitiveness research by the Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology, Government of India is acknowledged. I am grateful to Mrs. Jyoti S. A. Bhat, Advisor, DSIR, Mr. Ram Khilari and several professionals in industry, academia and government who gave feedback in our research.

REFERENCES

Ambastha, A. and K. Momaya 2004. Challenges for Indian software firms to sustain their global competitiveness. *Singapore Management Review* 26 (2): 65-77.

Banwet, D. K., K. Momaya, and H. K. Shee. 2002. Competitiveness: Perceptions, reflections and directions. *IIMB Management Review* 14 (3): 105-116.

Banwet D. K., K. Momaya, and H. Shee. 2003. Competitiveness through technology management: An empirical study of the Indian software industry. *International Journal of Services Technology and Management* 4 (2): 131-155.

Bhat J. S. A. 2003. Heralding a new future—Nanotechnology? *Current Science*. 85 (2): 147-154.

Cho, D. S. and H. C. Moon. 2000. *From Adam Smith to Michael Porter*. Singapore: World Scientific.

Cho, D. S. and H. C. Moon. 2005. National competitiveness: Implications for different groups and strategies. *International Journal of Global Business and Competitiveness* 1 (1): 1-11.
Cho, D. S., H. C. Moon, and M. Y. Kim. 2007. Characterizing international competitiveness in international business research: A MASI approach to national competitiveness. *Research in International Business and Finance* 22 (2): 175~192.
European Commission. 2004. *Towards a European strategy for nanotechnology*. Brussels: Office for Official Publications of the European Communities.
Garelli, S. 2003. Competitiveness of nations: The fundamentals. In the *world competitiveness yearbook*. Lausanne, Switzerland: International Institute for Management Development.
IPS. 2005. *IPS National Competitiveness Research 2005 Report*. Seoul: The Institute for Industrial Policy Studies (IPS) and The Institute for Policy & Strategy on National Competitiveness (IPS-NaC).
Ketels, H. M. Christian 2006. Michael Porter's competitiveness framework: Recent learnings and new research priorities. *Journal of Industry, Competition and Trade* 6 (2): 115-136.
Ketels, H. M. Christian. 2007. industrial policy in the united states. *Journal of Industry, Competition and Trade* 7 (3-4): 143-323.
Kim, M. Y. 2006. Inequality in globalization: An extension of the Gini index from the perspective of national competitiveness. *Journal of International Business and Economy* 7 (1): 119-140.
Hamel, G. and C. K. Prahalad. 1994. *Competing for future*. Boston: Harvard Business School Press.
Momaya, K. 1998. Evaluating international competitiveness at the industry level. *Vikalpa-The Journal for Decision Makers* 23 (2): 39-46.
Momaya, K. 2001. *International competitiveness: Evaluation and enhancement*. New Delhi: Hindustan Publishing.
National Nanotechnology Initiative. 2007. *National nanotechnology initiative: FY 2008 budget and highlights* (http://www.nano.gov/)
National Science and Technology Council. 2004. *The national nanotechnology initiative: Strategic plan*. Washington, DC: Office of Science and Technology Policy.
Porter, M. E. 1990. *The competitive advantage of nations*. New York: The Free Press.
Porter M. E. 1996. What is strategy? *Harvard Business Review* 74 (6): 61-78.
Porter, M. E. 1998. *On competition*. Boston: Harvard Business School Publishing.
Siggel, E. 2006. International competitiveness and comparative advantage: A survey and a proposal for measurement. *Journal of Industry, Competition and Trade* 6 (2): 137-159.
Thompson, A. A. and A. J. Strickland, J. E. Gamble, and A. K. Jain. 2006. *Crafting and executing strategy: The quest for competitive advantage*. New Delhi: Tata McGraw-Hill.
IMD. 2002. *The world competitiveness yearbook*. Lausanne, Switzerland: International Institute for Management Development.

APPENDIX 1
AN EXAMPLE OF SELECTION OF CRITICAL SUCCESS FACTORS (CSFS)

Building of learning from research, publications (e.g., strategy reports of EU and several leading countries) and discussions, relevant criteria of competitiveness that can emerge to be CSFs in context of emerging industries at country level were identified. For instance, in the 2006 final European Parliament report on Nanosciences and nanotechnologies: An action plan for Europe 2005-2009 (RR\369838EN.doc, p. 10), it was clearly concluded:

World-class R&D infrastructure and 'poles of excellence' are essential for the EU to remain competitive in this highly promising sector.

But this is not enough. European industry, R&D organisations, universities and financial institutions should work together to ensure that excellence in research is translated into commercially viable and inherently safe products and processes. Without this 'commercialisation of knowledge', Europe does not fully reap the synergy between education, research, and innovation, the 'triangle of knowledge' so desperately needed for the European Research Area.

Such conclusive statements in final reports were given more weight in selection of CSFs. Since creating such infrastructure demands investment, several criteria related to investment (e.g., absolute public and percentage investments, Table A1) were grouped under the factor investment. Multiple criteria (e.g., percentage share of worldwide investment) were explored and the most relevant criteria (highlighted in italics in Table A1) were used to calculate average standardized score to help decide relative scores (on scale of 1-10) for the countries. Illustrative example of the process of assigning scores to CSF (Table 3) is given in Table A1 taking case of investment. At the same time, the enormous importance the EU parliament has assigned to cooperation helped cooperation to emerge as a CSF, even though it is much tougher to define and evaluate this factor. It can be seen that gaps are there, if one looks for comparative data from reliable sources.

Table A1: An Example of Approximate Country Competitiveness Evaluations while Evolving a CSF (Investments from multiple criteria)

Factor & Criteria	China	EU	India	Japan	US
Investment					
Public Invest.Budget in Nano/related R&D (euro in 2004)	83.3	1285	3.8	750	1243
Absolute world public exp. In 2004 (PPP corrected)	377.1		20.3	624.2	1239.4
Private Invest. In 2004		580		1540	1700
Percentage share of worldwide private expenditure in 2004		*14*		*37*	*40*
Percentage share of worldwide public investment in 2004		35		19	32
Percentage share of overall (private+public) worldwide expenditure in NT	*> 2?*	*24*	*<0.5?*	*28*	*37*
Average (public invest-ppp, private invest) standardized scores	-0.66	0.26	-1.05	0.65	0.79
Converting on scale of 1-10	3	5	1	7	8

Sources: Country / Strategy reports about nanotech (e.g., EC, 2004; NNI, 2007) sites.
Notes: More detailed about logic and formulae of standardized score can be found in Momaya (2001)

APPENDIX 2
EXAMPLES OF FINDINGS FROM DIFFERENT COMPETITIVENESS FRAMEWORKS

Examples of factors, criteria and positions of the large countries are given in tables below for two important models: diamond model and human factors model. The data for the tables are taken from the IPS National Competitiveness Report (IPS 2005). Standardized scores are calculated below each criteria to provide quick relative comparative position on a scale that is neutral at zero. This facilitates comparison across different models.

Table A2: An Example of Approximate Country Competitiveness Evaluation in Context of Emerging Industry using Physical Factors Model (Detailed Table)

Factors & Criteria of Competitiveness	China	Germany	India	Japan	US
Factor conditions	32.36	6.19	14.10	3.47	40.04
Standardized score	*0.81*	*-0.80*	*-0.32*	*-0.97*	*1.28*
Skilled human & knowledge resources					
(scientists & engineers/million, 2002) (C) #1	583.93	3153.01	98.85	5320.77	4099.39
Standardized score	*-0.92*	*0.22*	*-1.13*	*1.19*	*0.64*
Index	8.48	43.34	1.28	68.42	55.15
Capital resources					
(international reserves, US $ billion, 2003) (C) #1	408.20	50.70	98.90	663.30	74.80
Standardized score	*0.55*	*-0.78*	*-0.60*	*1.50*	*-0.69*
Index	73.67	5.78	15.12	100.00	9.03
Advanced infrastructure (communication) (index)	28.80	56.50	9.87	56.85	72.39
Standardized score	*-0.64*	*0.46*	*-1.39*	*0.48*	*1.10*
Demand conditions	38.64	54.98	64.23	23.75	62.68
Standardized score	*-0.59*	*0.35*	*0.89*	*-1.45*	*0.80*
Quantity (Demand size) (aggregate, index)	33.72	48.13	18.34	48.02	52.90
Standardized score	*-0.46*	*0.56*	*-1.54*	*0.55*	*0.89*
Sophisticated nature of buyers (C)	45.42	60.58	29.94	86.51	76.13
Standardized score	*-0.63*	*0.04*	*-1.31*	*1.18*	*0.72*
Related and supporting industries	44.91	60.12	27.20	57.71	70.01
Standardized score	*-0.43*	*0.49*	*-1.50*	*0.35*	*1.09*
Related industries (S&T) (aggregate, index)	37.31	60.20	22.52	76.21	70.92
Standardized score	*-0.71*	*0.30*	*-1.35*	*1.00*	*0.77*
Business context (old-Firm strategy, structure & rivalry)	36.38	50.70	20.24	43.11	61.91
Standardized score	*-0.39*	*0.53*	*-1.42*	*0.04*	*1.24*
Leadership & commitment to future competitiveness	80.00	85.00	55.00	75.00	65.00
Standardized score	*0.66*	*1.08*	*-1.41*	*0.25*	*-0.58*
Firm strategy	22.62	54.32	44.54	55.48	63.62
Standardized score	*-1.62*	*0.39*	*-0.23*	*0.47*	*0.98*
Total factor score	**152.29**	**171.99**	**125.77**	**128.04**	**234.64**
Standardized score	*-0.23*	*0.21*	*-0.83*	*-0.77*	*1.62*
Total criteria score	**330.02**	**413.85**	**196.61**	**566.49**	**465.14**
Standardized score	-0.46	0.14	-1.41	1.23	0.51

Sources: Developed based on data from IPS National Competitiveness Research 2005 (IPS, 2005).
Notes: 1. Factor scores are mostly aggregate. 2. Criteria scores are also aggregate, unless specified (C) in bracket after description. 3. For details about concept and calculation of standardized scores, please refer to Momaya (2001). #1 Actual values are given just for illustration for two criteria. Index values are used in calculation of total criteria score.

Table A3: An Example of Approximate Country Competitiveness Evaluation in Context of Emerging Industry using Human Factors Model (Detailed Table)

Factors & Criteria of Competitiveness	China	Germany	India	Japan	US
(Unskilled) Workers	78.54	46.98	77.86	48.14	46.68
Standardized score	*1.12*	*-0.75*	*1.07*	*-0.68*	*-0.76*
Quantity of labor force	79.02	26.89	80.68	25.71	32.90
Standardized score	*1.06*	*-0.78*	*1.12*	*-0.83*	*-0.57*
Quality of labor force	77.84	77.11	73.64	81.78	67.36
Standardized score	*0.42*	*0.29*	*-0.35*	*1.15*	*-1.51*
Politicians & Bureaucrats	57.98	63.93	34.71	65.69	74.91
Standardized score	*-0.10*	*0.30*	*-1.64*	*0.41*	*1.02*
Politicians	54.19	66.36	36.11	63.94	76.33
Standardized score	*-0.34*	*0.46*	*-1.53*	*0.30*	*1.11*
Policy	59.29	63.09	34.23	66.29	74.42
Standardized score	*-0.01*	*0.24*	*-1.66*	*0.45*	*0.99*
Entrepreneurs	46.00	60.34	32.21	50.17	83.92
Standardized score	*-0.44*	*0.30*	*-1.16*	*-0.23*	*1.52*
Personal competence	38.94	58.21	58.20	51.27	78.88
Standardized score	*-1.25*	*0.08*	*0.08*	*-0.40*	*1.50*
Social context	54.48	62.89	1.03	48.84	89.98
Standardized score	*0.09*	*0.35*	*-1.56*	*-0.08*	*1.19*
Professionals	38.49	72.89	35.77	76.93	85.24
Standardized score	*-1.01*	*0.48*	*-1.13*	*0.65*	*1.02*
Personal competence	38.09	66.70	44.12	73.80	84.05
Standardized score	*-1.19*	*0.27*	*-0.88*	*0.64*	*1.16*
Social context	38.97	80.12	26.02	80.57	90.88
Standardized score	*-0.84*	*0.58*	*-1.29*	*0.60*	*0.96*
Total factor score	**221.01**	**244.14**	**180.55**	**240.93**	**290.75**
	-0.36	0.22	-1.37	0.14	1.38
Total criteria score	**440.82**	**501.37**	**354.03**	**492.20**	**594.80**
	-0.41	0.28	-1.39	0.18	1.34

Sources: Developed based on data from IPS National Competitiveness Research 2005 (IPS, 2005).
Notes: 1. Factor scores are mostly aggregate. 2. Criteria scores are also aggregate, unless specified (C) in bracket after description. 3. For details about concept and calculation of standardized scores, please refer to Momaya (2001).