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701 E. Chocolate Avenue, Suite 200, Hershey PA 17033-1240, USA
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ITB12799

This paper appears in the book, *Emerging Trends and Challenges in Information Technology Management, Volume 1 and Volume 2* edited by Mehdi Khosrow-Pour © 2006, Idea Group Inc.

Validating the Indicators for the Knowledge-Based Economy: A Case Study of Economic Development Board of Singapore

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ABSTRACT

The Knowledge Based Economy (KBE) and its effects are often recognized and discussed, but there are generally no agreed upon means to measure the progress towards a KBE or the lack of it. Focus group discussions at the Economic Development Board of Singapore helped validate knowledge indicators used by countries over the years against Singapore's economy in order to validate these indicators and propose new measures. The validation process also yielded specific recommendations for building up knowledge capabilities in terms of knowledge creation, acquisition, dissemination and application which will aid Singapore in formulating strategies for the KBE.

INTRODUCTION

The concept of knowledge based economy (KBE) was first introduced by the Organization for Economic Cooperation and Development (OECD), defining it as an economy which is "directly based on the production, distribution and use of knowledge and information" (OECD, 1996). The APEC (Asia Pacific Economics and Cooperation economic committee referred to KBE as "an economy in which the production, distribution and use of knowledge is the main driver of growth, wealth creation and employment across all industries" (APEC, 2000 and 2004). Individuals, enterprises, and communities must base the successful economies of the present and future on the creation, acquisition, dissemination and effective use of knowledge if it is to grow successfully in social, economic and political domains. Sigurdson (2000) highlighted that in order to build, maintain and develop such a knowledge-based economy, there were several requirements. These include the presence of an institutional government, an educated and skilled population, an information and communication infrastructure, and a system of innovation.

There is currently no internationally agreed upon framework for measuring the extent to which an economy is knowledge based. OECD embarked on the Growth Project in 1999 to analyze the causes underlying the differing economic growth of member nations within the OECD. The APEC commissioned a project in 1999, which aimed to provide a basis for promoting the creation, dissemination and application of knowledge among APEC economies. The OECD and APEC studies chose only those indicators that were applicable for majority of the countries included in the case study .This criteria limited the choice of indicators. In addition, as KBE is constantly changing, indicators used in the past may no longer be appropriate as an economy progresses. If such indicators are not re-evaluated, they can lead to misinterpretation and may give a different picture of reality. There is a need to find out which indicators are appropriate to measure progress of different societies and countries in terms of their preparation to take advantage of the KBE. The study was aimed at finding appropriate indicators that can be used to monitor the effectiveness of an economic system in becoming a KBE with the following specific objectives:

- To review the various KBE measurement and assessment models and their associated indicators discussed in the literature.
- To conduct a case study in the Economic Development Board (EDB) of Singapore to validate the indicators and assessment framework developed by international organizations.
- To identify new indicators more appropriate for monitoring the progress of Singapore's economic system toward a KBE.

While several initiatives have been undertaken to employ a variety of approaches for measurement of knowledge management in organizations, this study focused on the indicators that are more appropriate in a broader context.

LITERATURE REVIEW

This literature review focuses only on organizations that developed indicators for KBE. Knowledge management measurement approaches used in the context of specific organization are not within the scope of this study. Several assessment models with numerous indicators have been developed to provide a framework for measuring the progress toward the knowledge-based economy. These models describe the environment necessary for the KBE and the indicators used to measure the various characteristics of the environment. OECD started work in the area of KBE in early nineties. Its report on the Growth Project (OECD, 2001) emphasized the importance of a *stable and open macroeconomic environment with effective functioning markets; diffusion of ICT; fostering innovation; development of human capital; and stimulating firm creation.* The OECD Science, Technology and Industry Scoreboard in 1999 revealed indicators for benchmarking KBE among the OECD economies. The APEC framework (1999) was developed as part of a report commissioned by the APEC leaders. This report strives to provide the analytical basis useful for promoting the effective use of knowledge, and the creation and dissemination of knowledge among APEC economies (APEC Economic Committee, 2000). The Australian Bureau of Statistics (ABS) framework (2001) was developed to measure knowledge in the Australian economy and society. The framework draws on the work of the APEC Report (2000) and the OECD Model (1996) except that it explicitly includes the concept of the knowledge based society because of the presumed importance of societal factors and the potential positive and negative impacts on society with the increasing emphasis on knowledge. The World Development Report (1998/99) proposed that problems of development should be looked upon from the knowledge perspective. It identified two types of knowledge that are critical for countries looking to become knowledge based economies or societies. The Report proposed certain policies to increase both types of knowledge through *knowledge creation, knowledge acquisition, absorbing knowledge and communicating knowledge*

These models and frameworks have one common trait in that they all give a basic analysis of the environment a KBE should possess and an

Table 1. Indicators presented for validation

Knowledge Activities	Indicators
Knowledge Creation	• % of GDP spent on R&D • Researchers per capita • Number of patents registered
Knowledge Acquisition	• International Mobility of workers • Number of head and regional offices in Singapore • Foreign Direct Investment Flows
Knowledge Dissemination	• ICT spending as a percentage of GDP • Internet access cost as a % of per capita GDP • % of workforce with at least secondary school education
Knowledge Application	• % of workforce with university education • Presence of venture capital funds • World Competitiveness Yearbook rating of entrepreneurship

understanding of the conditions a KBE should encompass. From this understanding, different organizations attempted to develop indicators that each felt could best measure the countries that they represent. The indicators chosen by the OECD had to be applicable to all the member countries in the OECD involved in the study hence this could be a limiting factor to the indicators chosen. Subsequently, the OECD model and its indicators were used as a basis for other models like APEC (although it measured countries in a different region compared with the OECD) and World Development Model. The ABS framework was aimed specifically at Australia but was built upon the work of both the APEC Report and the OECD Model. The Economic Survey of Singapore in 2002 discussed about the ability of Singapore's economy to create, acquire, disseminate and apply knowledge using the World Development Model as a basis. Many of the KBE models were built upon the OECD framework hence there had been many overlaps in the indicators and because the indicators introduced were specific for OECD countries, applying them directly to measure countries in a different region with different characteristics at a later stage would yield some mismatch.

RESEARCH METHODOLOGY

The Economic Development Board of Singapore was used as a locale for this study. Two groups with six participants each formed the two separate focus discussion groups. Among the more common indicators, three proxy indicators were selected to map each of the four knowledge activities. These indicators were validated by the participants in the focus group on whether they were appropriate in providing an indication to Singapore's progress towards becoming KBE. These tentative indicators also formed a basis for participants to identify new indicators. The discussions on the indicators were used as a basis to identify the strengths and weaknesses of Singapore's knowledge capability within the economic system. A summary of these indicators is show in Table 1.

These indicators were taken from a variety of KBE assessment models described elsewhere in this paper (OECD, APEC, ABS and Economic Survey of Singapore). A set of questions were identified for each knowledge activity to help participants understand the indicators used to measure them better and act as an enabler for more in-depth discussions.

FINDINGS

Knowledge Creation Indicators

Participants felt that all the three indicators seemed geared towards measuring knowledge creation in the high technology sectors, which is restrictive in scope as knowledge can also be created in the non-technical sectors. Although the indicator % of GDP spent on R&D was valid for measuring R&D activities, many participants felt that the non-technical aspects such as amount of money invested in marketing research can still create much knowledge for the company but often not captured in the form of R&D expenditure. Participants felt there was a need to extend this indicator to include a measure of the number of innovative services introduced in Singapore. Participants felt that the indicator of number of researchers per capita is also restricted in scope. Table 2 provides a summary of the indicators that were validated by the focus groups and the new indicators that were proposed for knowledge creation in the Singapore economy.

Table 2. Summary of proposed for knowledge creation

Indicators Discussed	Comments	New Indicators Proposed	Comments
% of GDP spent on R&D	Valid but restricted in scope	**% of GDP contributed by different service industries**	measures the number of innovative services introduced in Singapore
number of researchers per capita	Valid but restricted in scope	**Number of knowledge managers**	measures the number of workers managing the aftermath of knowledge creation
number of patents registered	Valid but restricted in scope	**Number of Singapore brands registered**	indication of the knowledge content in the products created in Singapore

Knowledge Acquisition Indicators

Participants were in agreement that the three indicators were valid indicators to measure knowledge acquisition in the Singapore context but the extent of correlation with knowledge acquisition may not be that tight. New indicators that participants felt were more aligned with knowledge acquisition were proposed. Participants felt that the indicator international mobility of workers could be used in Singapore's context as it can be assumed that foreign executives bring their skills, technology and experience when they come into Singapore. These capabilities can then be acquired by the base of local workers in Singapore. There was a consensus that the indicator number of headquarters and regional offices in Singapore provided an indication that firm specific knowledge brought in by the Multinational Corporations (MNCs) could be acquired by local companies in Singapore when they interact with these MNCs. To extend this indicator, participants suggested keeping track of the number of mergers and acquisitions activities in the economy. The indicator foreign direct investment flow was considered valid. Another indicator suggested was the amount of money used to purchase foreign patents, franchises, licenses and rights for use in Singapore companies for the purpose of improving processes or products. Table 3 provides a summary of the indicators that were validated by the focus groups and the new indicators that were proposed for knowledge acquisition in the Singapore economy.

Knowledge Dissemination Indicators

Participants pointed out that the indicators stated in Table 3 did not reflect the situation in Singapore and the Internet seemed to be recognized as the only form of knowledge dissemination, which does not reflect reality. Participants indicated that the indicator ICT spending as a % of GDP was aimed at measuring the absolute value of ICT spending. They were of the view that the majority of ICT spending would be on

Table 3. Summary of indicators proposed for knowledge acquisition

Indicators Discussed	Comments	New Indicators Proposed	Comments
International Mobility of workers	Valid	**Number of mergers and acquisitions activities**	Mergers & acquisitions allow acquisition of knowledge, expertise and resources that a single company would otherwise not be able to have access to
Number of Head and Regional Offices in Singapore	Valid	**Total dollar$ value of Intellectual property owned by Singapore firms.**	Adding of all the $value of foreign legal or economic ownership transferred to Singapore gives indication of the knowledge acquired by the economy
Foreign Direct Investment Flows	Valid	**Amount of money used to purchase foreign patents, franchises, licenses and rights for use in Singapore**	Measure the amount of technology or know-how that is acquired from outside Singapore
		Companies' total investment in training	Training is a process of acquiring new knowledge or know-how
		Number of hours spent on training per worker per year	Increase in number of hours spend on training reflect the companies' emphasis on knowledge acquisition

Table 4. Summary of indicators for knowledge dissemination

Indicators Discussed	Comments	New Indicators Proposed	Comments
ICT Spending as a % of GDP	Not Valid	**Government expenditure on ICT**	Government spending reflects spending on ICT infrastructure for the economy
Internet Access cost as a % of per capita GDP	Not Valid	**Business investment in ICT, hardware and software**	Business spending reflects spending on ICT products for knowledge dissemination
% of workforce with at least secondary school education	Not Valid	**Number of homes with Internet access**	Reflects the extend Internet is used in Singapore for knowledge dissemination
		Number of newspapers subscribers	Newspapers is another medium for knowledge dissemination
		Number of community of practices	Knowledge disseminated is specialized and disseminated to people who have an interest in the knowledge hence more likely to use the knowledge
		Number of seminars, conventions and conferences	Knowledge disseminated is specialized and disseminated to people who have an interest in the knowledge hence more likely to use the knowledge
		Openness of ICT and Media regulations	Measure the ease of information flow

developing the ICT infrastructure which results in spending concentrated within a few big firms in the economy such as Info-com Development Authority (IDA) and Singapore Telecoms. It was suggested that this indicator be replaced with two alternative indicators: government expenditure on ICT and business investment in ICT, hardware and software. Participants felt that a large portion of Government spending on ICT would be related to infrastructure investments which would taper off once the infrastructure has matured. The costs after would be in the maintenance of the infrastructure or until the entire infrastructure needs to be changed to support a different network The indicator number of homes with Internet access was considered better indicator for Singapore as opposed to internet access cost. Many felt that the cost of Internet is not a critical barrier for most Singapore families. The indicator internet access cost as a % of per capita GDP reflects the affordability of the Internet which depends very much on the income per household hence it would be more suitable for measuring knowledge dissemination in countries with lower income per household. The indicator % of workforce with at least secondary school education was debated on as none of the participants felt this indicator had a good correlation to knowledge dissemination. Table 4 provides a summary of the indicators that were validated by the focus groups and the new indicators that were proposed for knowledge dissemination in the Singapore economy.

Knowledge Application Indicators

Participants felt that the indicators were too restrictive in scope and put forward recommendations to replace indicators more aligned with the knowledge application activity. Participants felt that to a certain extent the indicator % of workforce with university education was valid as higher tertiary education enabled the workforce to seek out, process, and use relevant education. And yet there had been instances where a successful entrepreneur with only high school education was able to come up with an innovative business model. Hence many participants felt that this indicator only measured a small portion of knowledge application activity in the economy. They felt that the indicator presence of venture capital funds only measured the existence of venture capital funds or venture capitalists, which were, related more to an infrastructure available to support entrepreneurship activities. They proposed another indicator $value of funds invested in Singapore based companies be used instead. Many felt that this indicator has a much tighter relationship with knowledge application as compared to presence of venture capital funds. Other indicators proposed include number of startups in Singapore, $value of Intellectual Property (IP) commercialized by companies in Singapore. Participants felt that to own IP such as patents is great but only by applying the IP to create new products or services then it is truly generating wealth from knowledge application. An interesting indicator proposed was to keep track of the number of companies applying for IPO in Singapore. Participants had no objections of using the indicator World Competitiveness Yearbook rating of entrepreneurship to measure knowledge application. Table 5 provides a summary of the indicators that were validated by the focus groups and the new indicators that were proposed for knowledge application in the Singapore economy.

Table 5. Summary of indicators for knowledge application

Indicators Discussed	Comments	New Indicators Proposed	Comments
% of workforce with university education	Valid but restricted in scope	**$value of funds invested in Singapore based companies**	Measure the total amount of money invested into start-ups
Presence of venture capital funds	Not Valid	**Number of startups in Singapore**	Measure the entrepreneurship of people in Singapore
World Competitiveness Yearbook rating of entrepreneurship	Valid	**$value of IP commercialized by companies in Singapore.**	Measure the extent companies apply IP to generate wealth
		Number of companies applying for IPO in Singapore	Measure the expansion of companies in Singapore which indirectly measures the effectiveness of knowledge application
		Return of investment (ROI) spent on training	Measure the knowledge application capability of the workforce

CONCLUSION

Assessment frameworks developed by international organizations like OECD, APEC, and World Bank were considered relevant and useful for developing performance measure for individual countries like Singapore. However, adjustments to make these guidelines useful for implementing indicators for measuring the success of organization and countries were considered necessary. Participants in focus group discussion from the Economic Development Board of Singapore considered that indicators for knowledge creation seemed to center on R&D activities and high technology areas. Indicators from the service sector need to be added to balance the view. Indicators for knowledge dissemination seemed centered around ICT with the Internet as the primary medium for transferring knowledge. The analysis also brought to light weaknesses in Singapore's education system and 'fear of failure' culture that in one way or another affects the knowledge creation and application capability. In terms of knowledge acquisition, the recommendation was to continue to build on industry networks to create a compelling ecosystem of creators and manufacturers so as to attract more companies to invest and do business in Singapore. In terms of knowledge dissemination, the recommendation was on the ways in which the nation can get around the information overload problem. Skills need to be upgraded, workers need to be equipped with the necessary tools to collate, organize and make sense of large volumes of data. Characteristics of knowledge make the measurement of knowledge a particular problematic issue when weighing the case for or against a KBE. Singapore's knowledge capabilities in creating, acquiring, and disseminating and applying knowledge, these indicators are not static, they are dynamic and will change as the acceleration of technological advancements caused obsolescence to some existing knowledge base and skill sets. There must be continuous review to ensure that these indicators are still valid and while carrying out this validation, knowledge gaps will become apparent and steps should be taken to address them.

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