Measuring Knowledge Assets of a Nation: Knowledge Systems for Development

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ABSTRACT: Ongoing transition of the United Nations Member States to knowledge-based economies is a watershed event in the evolution of the global knowledge economies. This transition marks a paradigmatic shift from energy-based economies with traditional factors of production to information-based economies based upon knowledge assets and intellectual capital. As envisioned in the UN Millennium Declaration, development of national knowledge societies should encompass social, cultural, and human development besides economic growth. Accordingly, one objective of this study is to develop the theoretical and pragmatic foundations for management and measurement of knowledge assets to facilitate this vision of holistic growth and development. Based upon a review of theory, research, practices, and national policies, we critically analyze and contrast the most popular models available for measurement of national knowledge assets. Our review includes knowledge modeling and measurement frameworks and their applications by reputed developmental organizations and national governments. There are two other key outcomes of the above review and analysis. First, to build the capacity of the public sector for measuring and managing knowledge assets, we propose, develop, and define specific frameworks, methodologies, models and indicators with illustrative real world applications. Second, we make specific recommendations for necessary improvements needed in knowledge assets management and measurement models and indicators. Prudent and effective policy directives depend upon pragmatic but theoretically and psychometrically valid measurement models for their success. We recommend that the future development of such models be based upon better understanding of human capital and social capital as well as their synthesis with existing intellectual capital frameworks and models. The findings and recommendations of this study will provide the cornerstone for measuring and managing national knowledge assets for United Nations Member States toward holistic socio-economic development.

Keywords: Knowledge Assets, Intellectual Capital, Knowledge-Based Economy, Knowledge Society, Measurement Methods, Measurement Models, Human Capital, Social Capital, National Economies, Holistic Development, National Policy, Developmental Policy, Socio-Technical Systems, Knowledge Management.

TABLE OF CONTENTS

Measuring Knowledge Assets of a Nation:

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Introduction

"For countries in the vanguard of the world economy, the balance between knowledge and resources has shifted so far towards the former that knowledge has become perhaps the most important factor determining the standard of living - more than land, than tools, than labor."

- World Development Report, 1998

The World Bank's prospectus document for national knowledge assessment notes that: "Knowledge assessment is a tool for assisting countries to analyze their capabilities for participating in the knowledge revolution. It focuses on those areas of the economy and society that directly benefit from knowledge and learning." A key motive for the current study is to develop better conceptualization, measurement, and evaluation of national knowledge assets to inform national and institutional policy making. It is generally understood that countries that are rich in knowledge assets and intellectual capital fare better in terms of higher levels of growth and development. Existing policy development directives and empirical studies of national knowledge assets, however, are still at a nascent stage given their recently started evolution beyond the assumptions and premises of the agrarian and industrial economies. It is therefore anticipated that the process of devising valid measurement frameworks and models will also generate insights for developing better theoretical, conceptual, and pragmatic understanding about the knowledge economy. This study starts with a review of existing empirical research studies, national policy frameworks, and measurement models used by developmental organizations. Specific measurement models, frameworks, and methodologies are then developed to facilitate building of public sector capacities for knowledge assets management and measurement. Future directions of research and development for improving extant measurement models of knowledge assets are outlined. Suggestions are offered for future theory development and research that can result in superior knowledge management and measurement models.

Knowledge assets represent the fount of a nation's competences and capabilities that are deemed essential for economic growth, competitive advantage, human development, and quality of life. United Nations Member States are undergoing fundamental changes with important implications for how knowledge assets are acquired, sourced, created, and utilized. The current study is concerned with understanding the relationship between national knowledge assets and economic growth as well as related human, social, cultural, and political development at the national level. Informed by recent theory, research, and developmental applications related to intellectual capital, social capital, and human capital, this study also attempts to define the future trajectory of knowledge assets measurement and management.

Many recent international comparisons of economic growth and performance are built upon accounting or information and communication technologies (ICT) based perspectives. Many such measures have also focused on structural inputs such as ICT investments with lesser consideration for the social and human capital that determines quality of performance outcomes. Fortunately, there is growing awareness about the role of social and human capital as the critical links between structural inputs and policy outcomes. Simultaneously, developmental organizations are adopting a more holistic perspective of national growth that goes beyond just economic performance and includes human, social, cultural and political development and general well being. Theoretical dimensions of social and behavioral behaviors and actions relevant to value-added performance however need to be better understood and applied.

Concerns about efficiency and effectiveness of knowledge assets are evident in questions about the return on investments in such assets. However, a more important and immediate issue that precedes such concerns is about how we conceptualize, understand, assess and measure knowledge assets. A critical and comparative analysis of existing measurement models is expected to reveal their strengths and limitations for public administration and development. Such analysis will also help in determining if, and how, any of the existing models may be adapted to meet the developmental needs of the public sector. A review of the models for national knowledge assets measurement and benchmarking used by major developmental organizations can provide additional insights about improving current measurement frameworks.

In Section 1, we define the constructs of knowledge assets and intellectual capital and outline key challenges in their measurement. A comparative analysis of popular knowledge assets measurement models in Section 2 assesses their strengths and limitations to determine their fitness for use in public sector developmental contexts. Measurement frameworks and models used by developmental organizations are reviewed in Section 3 and recommendations offered for improving measurement constructs and indicators. Suggestions are also offered for refining and integrating the human capital and social capital dimensions in knowledge assets measurement to better meet the needs of holistic development. Section 4 develops one national knowledge assets measurement model deemed appropriate for this developmental focus and discusses how it is applied for measuring national knowledge assets. In Section 5, a methodology for defining actionable performance measures and an action blueprint based upon the balanced scorecard are developed for building public sector competencies in measuring knowledge assets. The final section on conclusions and recommendations provides a synopsis of suggestions for improving measurement of national knowledge assets made in the paper. It also outlines a future knowledge assets measurement framework for holistic development based upon more sophisticated understanding of human capital and social capital.

Section 1. Measures of the New Wealth of Nations

Knowledge measurement tools and methodologies assist nations in analyzing and benchmarking their competences and capabilities as knowledge-based economies. Such assessments can facilitate adoption of good policies and practices as well as growth of national knowledge systems for holistic development. Knowledge systems consist of national institutions, frameworks, and infrastructures that can facilitate effective use, sharing, creation, and renewal of knowledge for socio-economic growth. This section develops a preliminary understanding of knowledge assets and intellectual capital and outlines the challenges involved in their measurement.

What are Knowledge Assets?

Accountants define an asset as a stock from which a number of future services are expected to flow. Accordingly, *knowledge assets* are defined as (Boisot, 1998, p.3}: "stocks of knowledge from which services are expected to flow for a period of time that may be hard to specify in advance." In contrast to physical assets that may have a limited life because of wear and tear, knowledge assets may in theory last forever. Given their open-ended value, there is no one-to-one correspondence between the effort required to create knowledge assets and the value of services they yield. In other words, they are non-linear with respect to the effects they produce.

Distinction between the three terms – data, information, and knowledge – is relevant for explaining the contrast between physical assets and knowledge assets. Knowledge builds upon information that is extracted from data (Boisot, p. 12). In contrast to data that can be characterized as a property of *things*, knowledge is a property of *agents* predisposing them to act in particular circumstances. Information is

that subset of the data residing in things that activates an agent through the perceptual or cognitive filters. In contrast to information, knowledge cannot be directly observed. Its existence can only be inferred from actions of agents. Similarly knowledge assets cannot be directly observed in nature – they need to be apprehended indirectly (Boisot, p. 12). Hence, in contrast to the emphasis on tangible input-focused measures of physical assets, knowledge assets require understanding in terms of quality and content of performance outcomes.

Boisot (1998) notes that knowledge assets are manifested in terms of technologies, competences and capabilities. *Technology* is defined a "socio-physical systems configured so as to produce certain specific types of physical effects." *Competence* denotes "the organizational and technical skills involved in achieving a certain level of performance in the production of such effects." *Capability* is interpreted as "a strategic skill in the application and integration of competences."

Knowledge assets can be thought of as a subset of dispositions to act, or 'potential for action' (Malhotra, 2004; Malhotra, 2002a; Malhotra, 2000a; Malhotra, 2000d) embedded in individuals, groups, or socio-physical systems with future prospects of value creation. National knowledge assets are the "intangible" assets of a country that have significant implications for future national growth and future value of the country to various stakeholders. There is growing realization about knowledge management (KM) as the enabler of innovation and learning (Malhotra, 2000c; Malhotra, 2000d) as well as national gross domestic product (GDP) (Malhotra, 2000b; Malhotra 2003c).

What is Intellectual Capital?

OECD (1999) defines intellectual capital as the economic value of two categories of intangible assets of a company: organizational ("structural") capital; and human capital. Structural capital refers to things like proprietary software systems, distribution networks, and supply chains. Human capital includes human resources within the organization and also customers and suppliers of the organization. Often, the term "intellectual capital" is treated as being synonymous with "intangible assets" or "knowledge assets." However, OECD considers 'intellectual capital' as a subset of overall 'knowledge assets' and this study proposes an identical perspective.

Stewart (1997) defines intellectual capital (IC) as "the intellectual material -- knowledge, information, intellectual property, experience - that can be put to use to create wealth". Alternative definitions (at firm level) interpret IC as the difference between the firm's market value and the cost of replacing its assets. Existing conceptualizations of IC and its various models share some common overall characteristics while maintaining substantive differences in details of implementation Malhotra (2003c). Some of the more popular measurement frameworks and models used for assessing firm level and national knowledge assets are discussed later. The differences between the current models arise from their effort at managing the complexity of measuring the intangibles. Some models focus primarily on financial metrics and offer a restricted notion of knowledge assets. Others take a more holistic view but require subjective judgment in determining a composite index that may be used for objective comparisons.

Challenges in Measuring Knowledge Assets

The compelling reasons for valuation and measurement of knowledge assets include understanding where value and its potential exist in the various sectors of the national economy. The accounting- and economics-based perspective of knowledge assets and intellectual capital can be appreciated by clarifying the two terms 'assets' and 'capital.' Assets are economic resources controlled by an entity whose cost at the time of acquisition can be objectively measured (Anthony and Reece, 1983). Valuation and measurement of assets is often based upon the comparison of expected flows of expenditure with

potential revenues. The objective of evaluative criteria is to determine whether estimated rate of return is higher than alternative uses of an existing asset or purchase of a new asset. An asset – physical or non-physical – does not exist from a transaction perspective without some way of recording the fact that the asset acquired in one period generates revenue in future periods. For instance, in a system of accrual accounting, the accountants "record the prospect of future cash inflows as an increase in assets and as revenue whenever they have objective evidence of the future cash receipt" (OECD 1996a, p. 38-39). Hence, accounting conventions determine how the inter-temporal nature of investment is treated and assessed. Accountants realize that "the valuation of all assets is a subjective process – especially for intangible assets" (OECD 1996a, p. 43). Therefore, adequate guidelines and standards must be in place regarding valuation criteria, methods and disclosures to inspire confidence in the reliability and consistency of intangible asset valuations.

In the case of physical capital, present and future benefits are made comparable through the use of discount rates, while costs are measured through depreciation. However, in the case of knowledge assets, there is no way of counting costs and benefits over any period of time except in the immediate accounting period. Economic uncertainty characterizing the choice about how to use or invest in 'assets' is magnified in the case of knowledge assets. Fundamental challenges involved in parallel accounting treatment of knowledge assets and physical capital are attributable to the specific characteristics of human knowledge. As noted in an OECD report (1996a, p. 43), human-embodied knowledge is (i) non-physical, (ii) non-appropriable, (iii) not measurable directly, and (iv) incompatible with conventions and institutions that guide the day-to-day transactions recorded by financial accounting and reporting. Interestingly, these challenges reflect, in part, the three-part definition of an asset. An asset must be an economic resource, the resource must be controlled by the entity, and its cost at the time of acquisition must be objectively measurable (Anthony and Reece, 1983, p. 36).

Measurement of National Knowledge Assets

Measurement of national knowledge assets is relevant to the valuation, growth, monitoring and management of intangible assets (Malhotra, 2000b). Such intangible assets include constructs such as information, knowledge, ideas, innovation, and creativity and other derivatives. These constructs were not treated as assets by traditional accounting standards. Interest in knowledge assets initially arose from the significant differences between the market value of firms and their book values that were based upon measures of their tangible or physical assets. Similar comparisons of national growth among various developed and developing countries suggested that economic growth cannot be explained just on the basis of tangible assets. In many such cases, high growth rates were often attributed to national investments in knowledge-based and information-based infrastructure, goods, and services. In this respect, knowledge assets represent the identifiable aspects of the nations that although "intangible" can be considered as adding some kind of value to it.

The initial focus of national developmental indicators related to information- and knowledge-based assets was on investments in tangibles, and availability of specific information- or knowledge-based 'devices' such as computers, servers, and other structural elements. However, there is growing realization about the amorphous nature of such structural elements wherein their management and utilization rides supreme over *mere* possession. For instance, in the recent *Business Week* special report on IT (August 25, 2003), Microsoft Corp. Chairman William H. Gates notes: "Everybody has always had access to the same technology. There's nothing new there. The fact is that some companies have taken technology and used it more effectively than others." Recent empirical research and theory development has dissected this issue in greater depth to understand the critical human and social processes underlying effective and ineffective utilization of ICT based systems, information, and knowledge (Malhotra 2004, 2001, 2000a, 2002a, 2002b, 2000d, 1999, 1998a, 1998b, 2002c; Malhotra and Galletta 2003, 1999, in press). Interestingly, understanding of these human and social processes – missing from most socio-economic

developmental frameworks of human capital and social capital – may hold the key to alleviating 'knowledge gaps' and 'information problems' (World Bank, 1998) that must be overcome in the progress toward knowledge-based economies. Refined understanding of these behavioral and sociological dimensions of information and knowledge appropriation and use for value-creation can also inform national, governmental, and institutional policy initiatives.

While importance of knowledge assets has increased, understanding of the knowledge economy is shrouded in relative ignorance because of its treatment as a 'residual', something that could not fit the category of tangibles, industrial and agricultural. Often, characterized as the 'service economy,' this *residual* category accounts for 70% or more of most developed nations' economies. This definition introduced heterogeneity in the definition of the service economy from the beginning that has become more prominent in the 1990s. Accordingly, the increasing attribution of economic growth based upon multifactor productivity seems to reflect our increasing ignorance about measurement of uncharted macro-economic as well as micro-economic drivers of growth (Boisot, 1998).

Boisot (1998) provides an interesting distinction that highlights the transition in the role of the 'invisible' assets:

> "In the energy-based economy, knowledge and information had an important role to play, but it was a supporting role, and they were not the central focus of the transaction or exchange as an object in their own right. The function of information was to describe the object of the transaction as well as the terms on which it would take place. It was rarely itself an object of exchange."

He observes that information goods, even when difficult to produce, may be easily and inexpensively replicated, therefore they require different valuation procedures than those used for physical goods. Mere access to information or knowledge may not automatically result in value creation. Rather value has to be extracted from these assets through human and social actions that focus on meaningful value-creation. Accordingly, valuation of knowledge assets poses major theoretical and practical problems that need to be addressed (Romer, 1994). As economic growth is more dependent upon intangible or immaterial assets (Romer, 1996), there is imperative need for assessing the validity of existing measurement models and underlying theoretical frameworks. Such a review can help identify immediate areas for improvement and also provide a base for adapting appropriate tools for developmental needs of the public sector. This objective constitutes a primary focus of this study. The review can also help in appreciation of the challenges that must be met for more far-reaching improvements through definition of newer measurement models. This is the subject of recommendations discussed in the concluding section. The next section provides an overview of the more popular measurement models for knowledge assets and intellectual capital and knowledge assets.

Summary: Section 1 provided preliminary conceptualization and definitions of knowledge assets, intellectual capital, and national knowledge assets. Based upon an overview of the differences between physical assets and intangible assets, it also highlighted the challenges that are inherent in the process of measuring national knowledge assets. Section 2 and 3 focus on a comparative analysis of measurement models for knowledge assets and intellectual capital observed in current research and practice.

Section 2. Popular Measurement Models in Research and Practice

The central focus of this section is on review and comparison of some of the more popular measurement frameworks and models for assessing knowledge assets and intellectual capital (Malhotra, 2003; Malhotra, 2003). Most existing methodologies for measuring knowledge assets and intellectual capital are motivated by research and practice in domains of accounting, economics, human resource accounting, intellectual property, and, real options, among others. Prior reviews of such models have focused at the firm level analysis with an accounting, economic, or strategic lens (cf: Bontis et al. 1999, Bontis 2000, Housel and Bell 2001, Sveiby 2002, Liebowitz and Suen 2000). Most of these models have not been directly applied for assessment of national knowledge assets. Many empirical research studies and institutional policy frameworks do however relate to the key elements of these models in their conceptualization. Despite increased awareness about social and behavioral issues relevant to national performance, surprisingly, there is sparse focus on integrating the sociological and behavioral perspectives. One objective of this study is to assess what we can learn from these models and how we can adapt their key elements in congruence with the public sector focus on holistic national growth and development. The outcome of this process will be some form of measurement frameworks, methodologies, and models that are appropriate for developing public sector competencies for knowledge asset measurement. This process starts with a review of how existing measurement models deal with the 'intangible' aspects of knowledge assets, in particular intellectual capital.

Historically, intangibles were classified as 'goodwill' in accounting practices and intellectual capital was a part of the goodwill. A number of contemporary classification schemes have refined the distinction and classified intellectual capital into categories such as external (customer-related) capital, internal (structural) capital, and human capital (e.g. Sveiby, 1997; Roos et al., 1997; Stewart, 1997; Edvinsson and Sullivan, 1996; Edvinsson and Malone, 1997). However, traditional accounting practice does not provide for the identification and measurement of these "new" intangibles in organizations. In response, the new measurement models proposed for firm level analysis attempt to synthesize the financial and non-financial value-generating aspects of the company for external reporting. Some of these new models are the intangible asset monitor (Sveiby, 1997); the balanced scorecard (Kaplan and Norton, 1992; 1996; 2000); and, the Skandia value scheme (Edvinsson and Malone, 1997). Most of the above models consist of three broad categories of intellectual assets - human, customer and structural capital.

The most common models for measuring intellectual capital emphasize that non-financial measures must complement the financial measures. Specific aspects of knowledge assets also need to be integrated in strategic analyses and execution so that relevant attributes are available for assessment and measurement. Most of these models consider intellectual capital as something that is not visible; that is based upon knowledge and experiences embedded in employees; and that offers better opportunities for future organizational success. In many of these conceptualizations, IC includes value embedded in the skills of the employees, the processes of an organization and the firm's customer relationships. Financial assets are not included as a part of IC. A key difference between various models is in terms of the priority given to measurement of internal and external human capital and social capital. Some of the models tend to focus more on customer capital, but these metrics can be adapted to include other stakeholders such as employees and suppliers. The following discussion provides an overview of some of the most popular models followed by a comparative analysis.

Skandia Navigator

Skandia is most known for its efforts for measuring knowledge assets. It developed its first internal intellectual capital report based upon the measurement model proposed by Edvinsson and Malone (1997) in mid-1980s. The company's later efforts at measuring knowledge assets and intellectual capital have

relied upon this model for conceptualization of organizational value and performance. The Skandia Navigator defined by Edvinsson and Malone (1997, pp. 11, 34 – 37) divides the intellectual capital of an organization into three basic forms: *human capital*, *structural capital* and *customer capital*. Human capital includes collective competence, capabilities, skills and experiences of employees and managers as well as their creativity and innovativeness. Structural capital is the supporting infrastructure for human capital and includes organizational processes, procedures, technologies, information sources, and intellectual property rights. Customer capital includes the value embedded in firm's relationship with customers, suppliers, industry associations and market channels.

Early conceptualization of this model focused on five areas for improvement: financial, customer, process, renewal and development, and human capital. In the latest scheme, intellectual capital is a composite of human capital and structural capital. Structural capital in turn consists of customer capital and organizational capital that in turn is composed of innovation capital and customer capital This model is the subject of in-depth discussion and application in the subsequent section on developing a model for measuring national knowledge assets.

Balanced Scorecard

The Balanced Scorecard (Kaplan and Norton, 1992, 1996, 2000) aims to balance the traditional perspective of accounting for intangibles by adding four perspectives related to: innovation and learning, business process improvement, customer relationships, and, value creation in financial and intangible terms. In contrast to other tools, this model provides an integrated focus on both management and measurement of knowledge assets. It is one of the early tools that developed an integrated vision of measurement systems for management with focus on financial and non-financial indicators (market, internal processes and learning) relevant to organizational performance. The Balanced Scorecard (BSC) complements information provided by other tools with its process-based focus on how specific actions relate to organizational performance outcomes. Given that this model is particularly conducive for relating the strategic vision to core competencies and related success factors for organizational success, it provides one possible basis for developing an action blueprint for the public sector. The performance outcomes oriented actionable blueprint is developed in the subsequent section on building public sector capacity for measuring knowledge assets.

Intangible Assets Monitor

Intangible Assets Monitor was developed by Sveiby (1997) and defines three types of intangible assets that account for the book value-to-market value discrepancy in the valuation of a firm. The 'residual' that is not accounted for by the book value is attributed to individual competence of employees, internal structure, and external structure. While Skandia Navigator treats culture and the management philosophy of the organization as a part of human capital, Intangible Assets Monitor classifies them under the internal structure. With its primary emphasis on people, this model is based on the premise that people are the only true agents in business and all aspects of structure, internal and external, are embedded in human actions. Application of this model is very context-specific and the indicators are chosen as polar descriptors (such as good or bad) that are specific to the contextual objectives that may make sense differently across organizations.

IC-Index Model and HVA Model

Roos and colleagues (Roos et al., 1997) proposed an IC-Index model which consolidates all individual indicators into a single index in contrast to prior models that provided for assessment of separate components of intellectual capital. More recently, Roos and his colleagues have proposed a Holistic Value Approach (HVA) based on the view that a narrow asset perspective, using traditional accounting

methods without considering the usefulness of these in business performance is of little use as a strategic management tool.

Technology Broker Model

Technology Broker Model developed by Brooking (1996, pp. 13-14) divides organizational knowledge assets into four categories: human-centred assets, infrastructural assets, intellectual property assets and market assets. Each component of the model is examined through specific audit questionnaires about variables related to the specific asset category. In contrast to the other frameworks, this framework splits the second component (structural capital or internal structure) into infrastructural assets (processes, methods and technologies) and intellectual property assets (copyrights, patents, trade marks, and, trade secrets).

Other Measurement Models for IC and Knowledge Assets Assessment

There are other measurement models available in the IC literature such as Tobin's Q, economic value added (EVA), Market-to-Book Value, Intellectual Asset Valuation, Total Value Creation, Total Value Creation, Knowledge Capital Earnings, citation weighted patents, etc. (see for instance: Stewart (1997); Bontis (2001); Bontis et al. (1999); Lev (1999); Sullivan (2000)). These models are relevant to firm-level analyses of knowledge assets based upon market capitalization, return on assets, and other monetary valuations. However, they are of little relevance to our objective of developing national knowledge asset measures for holistic national performance. A brief description of most popular models is provided in Table 1. Some other 'tools' – such as the Knowledge Management Assessment Tool (KMAT) developed by APQC – had focused on attributes such as leadership, culture, technology, and management that have been integrated in the more recent models.

Table 1 provides a comparative overview of the measurement models discussed above. Summary description of each of the measurement models is given along with comparative analysis about their strengths and limitations. The comparison helps in determining the suitability of available models for national and public sector contexts of holistic development.

Two of the more popular measurement models are of specific interest for the public sector given their early application in national knowledge asset measurement and in devising knowledge metrics in the public sector. Scorecard based techniques such as Skandia Navigator and Balanced Score Card can accommodate both quantitative and qualitative assessments based upon a mix of scientific measurement and judgment. Skandia's IC model has been already applied in assessment of knowledge assets of some nations and national regions (Malhotra 2000b, 2003d). Balanced Scorecard has emerged as a popular tool for development of holistic knowledge management and measurement and has been applied in hundreds of organizations across various economic sectors.

Summary: This section provided an overview and a comparative assessment of most popular measurement methodologies and models for assessing knowledge assets and intellectual capital that are discussed in research and practice literatures. This discussion focused on measurement models that have been applied in performance assessment of individual firms and private sector. Some of these models have been gaining increasing interest in government and public sectors and have been implemented in those contexts. In later sections, we develop the methodology for implementing these models for national knowledge assessment and development of public sector capacities.

Table 1. Existing Models For Measuring Knowledge Assets – A Comparative Analysis

Measurement Model	Overview of the Knowledge Assets Measurement Model	Strengths and Weaknesses for Public Sector Applications
Skandia Navigator *Edvinsson and Malone (1997)*	Like the Balanced Scorecard, it is a holistic reporting model with focus on human capital, structural capital, customer capital, and organizational capital. Analyzes each component of IC separately to ensure greater focus. The specific foci used for analysis include: financial focus, customer focus, process focus, renewal and development focus and most importantly human focus. Intellectual capital is measured through the analysis of up to 164 metric measures (91 intellectually based and 73 traditional metrics) that cover five components: (1) financial; (2) customer; (3) process; (4) renewal and development; and (5) human. Uses a balance sheet approach that provides a static snapshot and cannot represent dynamic flows in an organization. Inclusion of structural capital may provide incorrect impression that availability of resources (such as ICT) by itself results in competitive advantage (*regardless* of effective utilization).	These models are based upon **scorecard methods** wherein various components of intangible assets or intellectual capital are identified and indicators and indices are generated and reported in scorecards or as graphs. Composite index based upon synthesis of all components of IC may or may not be created. No estimates are made of dollar values of intangible assets. Given the objective of this study to develop models and measures of national knowledge assets for socio-economic development and human development, these models seem particularly relevant. *Strengths*: These models can provide a more comprehensive analysis of national knowledge assets and of national performance than other models based upon financial metrics. These models allow measurement closer to actual inputs, processes, and outcomes, and reporting can therefore be faster. Hence, they are particularly suitable to the task of 'detection and correction of errors' in aligning the inputs and processes with outputs and outcomes. The indicators capture contextual nuances and result in 'rich' data analyses of which can provide useful insights for policy making. *Weaknesses*: The strengths of these measures that make them particularly effective can also be interpreted in terms of
Balanced Scorecard *Kaplan and Norton (1992, 1996)*	Translates an organization's mission and strategy into a comprehensive set of performance indicators for strategic management and measurement. Has focus on both financial objectives as well as building of capabilities and acquiring intangible assets for future growth. The scorecard attempts to seek balance between external measures for shareholders and customers, and internal measures of critical business processes, innovation, and of learning and growth. Balance is also sought between relatively objective outcome measures and subjective / judgmental measures of performance. A company's performance is measured with indicators covering four major focus perspectives: (1) financial perspective; (2) customer perspective; (3) internal process perspective; and (4) learning perspective. The indicators are based on the strategic objectives of the firm.	
Intangible Asset Monitor *Sveiby (1997)*	Shares many similarities with Skandia Navigator and Balanced Scorecard, but the primary emphasis is on people who are considered as the organization's only profit generators. Accordingly, *people's competencies* (similar to Skandia's human capital) are the key focus of the model and are converted in *external structures* (similar to Skandia's organizational capital) and *internal structures* (similar to Skandia's customer capital). Management selects indicators, based on the strategic objectives of the firm, to measure four aspects of creating value from intangible assets by *growth*, *renewal*, *efficiency*, and *stability*.	

IC-Index *Roos, Roos, Dragonetti and Edvinsson (1997)*	Focus is on monitoring the dynamics of IC. Provides a single index of several indicators based on correlating changes in IC with market changes. The four indices are: relationship capital, human capital, infrastructure capital and innovation capital. Consolidates all individual indicators representing intellectual properties and components into a single index. Changes in the index are then related to changes in the firm's market valuation. Very context specific and limited in universality. Like other measures, depends upon value judgments. Takes past performance into account and may be influenced by major transitions that occurred in the past years.	weaknesses of efficiency. Contextual influences that facilitate more corrective policy responses make comparison across different contexts somewhat challenging. Also, rich data that yield insightful observations on in-depth analysis may not be efficient in terms of quick analysis and may not easily yield a single 'standard' numeric or financial composite index.
Value Chain Scoreboard *Lev (2002)*	A matrix of non-financial indicators arranged in three categories according to the cycle of development: Discovery/Learning, Implementation, Commercialization.	
Human Capital Intelligence *Fitz-Enz (1994)*	Sets of human capital indicators are collected and benchmarked against a database. Similar to HRCA.	
Technology Broker *Brooking (1996)*	Assesses the value of a company's IC through a diagnostic analysis of the company wherein IC is considered a composite of market assets, human-centered assets, intellectual property assets, and, infrastructure assets. First round of 20 questions to establish the need for strengthening IC and follow-up IC audit including 178 questions related to the four categories of IC. Requires a 'big leap' between qualitative results and financial monetary values. There are many similarities between Technology Broker IC audit questions which are subjective in nature and Skandia's IC measures that re objective in nature.	These models are based on direct intellectual capital methods, i.e., they estimate the dollar value of the intangible assets by identifying its various components. Some of these models have limited use for assessing and analysing specific aspects of IC and knowledge assets. They may be used in conjunction with the scorecard methods when objective is to derive composite 'standard' financial or numeric indicators. However, such standards must be adopted with caution to ensure valid and reliable measurement and
Citation- Weighted Patents *Bontis (1996)*	A technology factor is calculated based on the patents developed by a firm. Intellectual capital and its performance is measured based on the impact of research development efforts on a series of indices, such as number of patents and cost of patents to sales turnover, that describe the firm's patents.	

Inclusive Valuation Methodology (IVM) *McPherson (1998)*	Shows the relationship between the company value, IC, and monetary measurements to provide an inclusive business valuation. Uses three value categories: intrinsic value representing the internal effectiveness of the company; extrinsic value measured by the delivery effectiveness of the company; and instrumental value that reflects impacts on the competitive environment. Attempts to provide an overall business value as reflected by the sum of IC and company's cash flows. Combined Value Added = Monetary Value Added combined with Intangible Value Added.	comparison. *Strengths:* These models allow valuation of separate components of IC; they allow for combinations of monetary and non-monetary valuations; they provide a comprehensive view of the organization's intellectual wealth; these are event-based measures and therefore better at relating cause and effect compared with financial metrics. *Weaknesses*: These measures are company specific and may be difficult to compare and benchmark; Given much financial and non-financial data, they involve more effort and judgment in analyses.
The Value Explorer *Andriessen & Tiessen (2000)*	Accounting methodology proposed by KMPG for estimating the value of IC attributable to a company's core competencies. Based on allocation of value to following intangibles: assets and endowments, skills & tacit knowledge, collective values and norms, technology and explicit knowledge, primary and management processes.	
Intellectual Asset Valuation *Sullivan (2000)*	Methodology for assessing the value of Intellectual Property.	
Total Value Creation, TVC *Anderson & McLean (2000)*	A project initiated by the Canadian Institute of Chartered Accountants. TVC uses discounted projected cash flows to re-examine how events affect planned activities.	
Accounting for the Future (AFTF) *Nash (1998)*	A system of projected discounted cash flows. The difference between AFTF value at the end and the beginning of the period is the value added during the period.	
Tobin's q *Stewart (1997)*	Tobin's q is similar to the market-to-book value except it substitutes book value with the replacement cost of tangible assets. A company with Tobin's q greater than 1 and greater than competitor's q is presumed to produce higher profits resulting from advantage that is attributed to IC. Allows for adjustments to be made to overcome limitations of market-to-book value.	These models are based upon **market capitalization**, i.e., they compute the IC as the difference between the firm's market capitalization and stockholder equity. These are not of much relevance for IC and KA assessment for nations or for government and public sector organizations.
Investor assigned market value (IAMV) *Standfield (1998)*	Takes the Company's True Value to be its stock market value and divides it with Tangible Capital + (Realised IC + IC Erosion + SCA (Sustainable Competitive Advantage)	

Market-to-Book Value *Stewart (1997)*	The market-to-book value is based on the difference between a company's market capitalization and its book value. Therefore, the key premise is that the market value represents the true value of the company including both tangible assets and intellectual capital. Generally accepted method in accounting and easy to apply.	*Strengths*: Good for illustrating the financial value of IC; Good for inter-firm benchmarking within an industry. *Weaknesses*: Do not contain information about the components contributing to IC; Exclusive monetary focus provides only partial perspective; Not suitable for the holistic socio-economic and human development approaches sought for this study.
Economic Value Added (EVA) *Stewart (1997)*	Calculated by adjusting the firm's disclosed profit with charges related to intangibles. Changes in EVA provide an indication of whether the firm's intellectual capital is productive or not. It is a 'surrogate' measure of IC as it does not provide specific information of what is the contribution of IC to the firm's performance.	These measurement models are based upon **return on assets** or ROA. ROA is computed by dividing the pre-tax earnings of the firm by the average tangible assets and then comparing with the industry average. The difference is then multiplied by the company's average tangible assets to calculate an average annual earning from the Intangibles. Dividing this average earning by the company's average cost of capital or an interest rate gives the value of a company's IC. These models are not of much relevance for IC and KA assessment for nations or for government and public sector organizations. *Strengths*: Good for industry benchmarking and for illustrating financial value of IC; Built on traditional accounting rules and thereby easily communicated between accountants *Weaknesses*: Do not contain information about the components contributing to IC; Exclusive monetary focus provides only partial perspective; Not suitable for the holistic socio-economic and human development approaches sought for this study.
Human Resource Costing & Accounting (HRCA) *Johansson (1996)*	Calculates the hidden impact of HR related costs that reduce a firm's profits. Adjustments are made to the P&L. Intellectual capital is measured by calculation of the contribution of human assets held by the company divided by capitalized salary expenditures.	
Calculated Intangible Value *Stewart (1997)*	Calculates the excess return on hard assets then uses this figure as a basis for determining the proportion of return attributable to intangible assets. May be used as an indicator of profitability of the investments in knowledge assets.	
Knowledge Capital Earnings *Lev (1999)*	Knowledge Capital Earnings are calculated as the portion of normalised earnings over and above expected earnings attributable to book assets.	
Value Added Intellectual Coefficient (VAIC) *Pulic (1997)*	Measures how much and how efficiently intellectual capital and capital employed create value based on the relationship to three major components: (1) capital employed; (2) human capital; and (3) structural capital.	

Section 3. Developmental Models of National Knowledge Assets

Several national governments have launched national knowledge initiatives for developing and benchmarking measurement models to guide industry practices in managing and measuring knowledge assets (Malhotra, 2003c). The Government of Netherlands invited four accounting firms to conduct a "practice-oriented study of the intangible assets of a number of their clients, and to produce a trial appendix to the external financial annual report without allowing themselves to be influenced by existing conventions, legal regulations and accounting principles." The Danish Agency for Trade and Industry sponsored the preparation of a report to prepare firm-level "intellectual capital accounts" and development of more comprehensive IC indicators, based on the experience of several Nordic and Danish companies. Based on similar spirit of participation, the Government of Norway has sponsored development of a competence capital model including intellectual capital. Hence, the models discussed in prior sections also provide a broad foundation for government initiatives aimed at enabling the private sector for contributing to the national knowledge economies. As evident from successful transition of some European and Asian countries into vibrant knowledge economies, collaborative relationships between the public sector, private sector, and educational and research institutions play an important role in the success of the overall process. The primary focus of this study is on enabling the public sector's knowledge management and measurement capabilities and competencies. This section and the subsequent section provide an in-depth perspective on this theme. We begin with a review of the existing measurement models and indicators that more directly focus on the public sector and on national and regional socio-economic development.

Several knowledge assets measurement models – as well as models and indicators on related themes of intellectual capital, social capital, and human capital – have been proposed by world development organizations such as World Bank, OECD, and United Nations agencies. Some of these models constitute the knowledge assets management and measurement fabric for many countries and regions of the world. Originally, developed for the era of industrial and agricultural economies, these models do allow assessment, comparison and benchmarking of national economies of the world. However, their primary focus seems to be on tangible assets and structural capital. While some of these models have assessed national growth in terms of investments in ICT or investments in other structural artifacts that at best describe input- or process- related measures. Being relatively disconnected from the outputs and outcomes that determine national growth and performance, the validity and reliability of such indices and indicators needs to be re-assessed for holistic socio-economic and human development. The objective of the current review is twofold. First, an assessment of existing methods, models, measures, and indicators can build some perspective about their strengths and limitations. Second, critical analysis of extant measurement models and artifacts can help reconcile discrepancies between theory, practice, and policy which in turn can facilitate development of more valid and reliable measures and models. The remaining discussion in this paper builds on the first objective to suggest incremental improvements in existing models and measures. The lessons learned from reviews of various models are then used for developing a performance-outcomes-driven measurement methodology for the public sector. The concluding discussion suggests necessary but more fundamental improvements required in measurement models based upon better theories and understanding of practices and policy relevant to the knowledge economy.

World Bank's Knowledge Assessment Methodology (KAM) and Scorecards

World Bank's Knowledge Assessment Methodology and Scorecards represent a very comprehensive tool for reviewing world development data aggregated and compiled from several "authoritative" sources. Their methodology consists of a set of 69 structural and qualitative variables and they note that it can be used for benchmarking "how an economy compares with its neighbors, competitors, or countries it wishes to emulate" (World Bank Institute, 2002). The intent of the methodology is: "to identify the problems and

opportunities that a country faces, and where it may need to focus policy attention or future investments." The comparison of the 69 variables is available (through an interactive web site) for a group of 100 countries that includes most of the developed OECD economies and about 60 developing economies. The set of 69 variables serve as proxies for the four areas that are considered critical in the development of a knowledge-based economy:

- An economic and institutional regime that provides incentives for the efficient use of existing and new knowledge and the flourishing of entrepreneurship.
- Educated and skilled populations of citizens who can create, share, and use knowledge well.
- A dynamic information infrastructure that can facilitate the effective communication, dissemination, and processing of information.
- An efficient innovation system of firms, research centers, universities, consultants and other organizations to tap into the growing stock of global knowledge, assimilate and adapt it to local needs, and create new technology.

Knowledge Assessment Methodology also includes several variables that track the overall performance of the economy which "illustrate how well an economy is actually using knowledge for its overall economic and social development."

The main focus of KAM is on only 14 of the 69 variables compiled in the "standard" scorecards. The chosen 14 variables are expected to capture the four "critical" areas listed above as well as some performance variables. These "standard" scorecards attempt to capture "the essence of a country's preparedness for the knowledge-based economy." It cannot be determined from available information if the choice of variables resulted from judgment or from a causal modeling methodology based upon theory- and policy-based analysis. The 14 "standard" variables are listed in **Table 2**, followed by a critical analysis of some illustrative indices ("constructs") and indicators ("measures").

Table 2. Variables used in the "Standard" 14-variable scorecards

Performance Indicators

1. Average annual GDP growth 1990-99 (%) (World Development Indicators, 2001)
2. Human development index 1999 (Human Development Report, UNDP, 2001)
   - Longevity (measured by life expectancy)
   - Knowledge (adult literacy rate and mean years of schooling)
   - Standard of living (real GDP per capita in purchasing power parity)

Economic Incentive and Institutional Regime

3. Tariff and non-tariff barriers 2002 (Heritage Foundation, 2002)
4. Property rights 2002 (Heritage Foundation, 2002)
5. Regulation 2002 (Heritage Foundation, 2002)

Education and Human Resources

6. Adult literacy rate (% age 15 and above) 1999 (Human Development Report, UNDP, 2001)
7. Secondary enrollment 1997 (World Development Indicators, 2001)
8. Tertiary enrollment 1997 (World Development Indicators, 2001)

Innovation System

9. Researchers in R&D (UNESCO, 1999)
10. Manufacturing trade as percentage of GDP (SIMA, 2002)
11. Scientific and technical journal articles per million people (World Development Indicators, 2001)

Information Infrastructure

12. Telephone per 1,000 persons, 1999 (telephone mainlines + mobile phones) (ITU, 2000)
13. Computers per 1,000 persons, 1999 (International Telecommunication Union, 2000)
14. Internet hosts per 10,000 persons, 2000 (International Telecommunication Union, 2000)

Re-Assessing Existing Constructs and Indicators for Valid Measurement

The indicators used in KAM seem relevant to analysis of national performance in terms of overall economic and social development. However, some questions still need to be addressed about *what* the indices and indicators measure. This discussion's focus is on the above model, but *the critique is applicable for any other measurement model* as well. The questions posed in this discussion are pertinent to the validity of the measuring instrument.[1] They are also critical for the justification, or the lack thereof, of measurement modeling efforts (Churchill and Iacobucci 2001) and in retrospective determine the success or failure of such efforts.

Validity is synonymous with accuracy or correctness. The validity of a measuring instrument is defined as "the extent to which differences in scores on it reflect true differences among [nations] on the characteristic we seek to measure, rather than constant or random errors." First, we need to understand the rationale behind the selection of 14 "standard" variables? Why are these indicators most relevant? What is the rationale behind their selection? As noted by Churchill and Iacobucci (2001): "One of the most critical elements in generating a content-valid instrument is conceptually defining the domain of the characteristic… If the included domain is decidedly different from the domain of the variable as conceived, the measure is said to lack content validity." The question arises if the measures are derived from theory or policy about the knowledge economy: as the absence of theory (framework of justifiable and believable assumptions) that can support such measures would result in incorrect measures.

An additional concern is about the focus of most indices and indicators on inputs that may *or* may not be valid 'proxies' for outcomes that really matter. The challenge raised by the problem of using proxies is that measures may lack 'construct validity' which is "most directly concerned with the question of what the instrument is, in fact, measuring." Is the measure of investments in ICT a reliable and valid proxy for effective utilization of those 'structural' and 'process' resources or for real performance outcomes? There is increasing agreement between researchers and practitioners that this is not a valid assumption (See for instance, Malhotra (2004), Malhotra and Galletta (in press)). The same rationale is applicable for other structural resources – including those embodied in current metrics for social capital and human capital – that depend *upon* 'users' for their appropriation and effective utilization.

A related issue is that of causal influence on the processes, outputs, or outcomes, i.e., the issue of 'predictive validity.' This issue is *critical* as most investments in the public sector are based on the cause-effect rationale in terms of achievement of specific policy goals and targets. The missing focus on the inputs-processes-outputs-outcomes[2] in measurement models would make investments in public development projects hit-or-miss propositions. The question arises if these indicators do indeed represent "how well an economy is actually using knowledge for its overall economic and social development." Even if all the links in the causal chain cannot be measured, measurement models must be based on justifiable and believable measures that bear some relationship to expected performance outcomes. "Predictive validity is ascertained by how well the measure predicts the criterion: it focuses on the usefulness of the measuring instrument as a predictor of some other characteristic or behavior. It is determined strictly by the correlation between the two measures; if the correlation is high, the measure is said to have predictive validity." A more critical issue that is apparent from current knowledge policy documents is if what we are trying to measure as 'effect' may in fact be the 'cause.' This is an important question as the shifting focus to social capital and human capital imposes need for better understanding of sociological and behavioral issues. It may be probable, for instance, that human well being and human development may represent the 'cause' *as well as* 'effect' for developmental models. Interestingly, the OECD (2001d, p. 9) report *The Well-Being of Nations* opens with the following note: "This report is concerned with human and social capital, not as ends in themselves, but as resources which can be used to support economic and social development."

There are additional concerns from the standpoint of valid measurement that can be easily solved with simple statistical tools such as regression analysis and factor analysis. For instance, existing indices suggest that there are multiple constructs and variables that overlap and interact with each other. Are we capturing the same variance multiple times that may artificially inflate the explanatory power of some measures? Are the five different categories (constructs) indeed distinct constructs with minimal overlap of variance? How do we explain the occurrence of same, similar, or identical variables (indicators) in multiple constructs? How do we 'explain away' the interactions, influences, and correlations of variables within same constructs and across different constructs? Given increasing emphasis on 'experiential learning' and 'real life learning' by various national governments (see for instance, OECD report on *Human Capital Accounting*), what matters more: "years of schooling" or "years of job experience"? It is possible, that the answer to such 'wicked' questions would depend upon further scrutiny of the context and additional variables that may not have been addressed in prior measurement models.

Existing 'mixed' units of analyses in current indicators pose an additional reason for concern. What is the rationale behind choice of different units of analysis for different indicators? Are 'per capita' measures a true measure of "national" performance? This is a very critical concern particularly for economies that are characterized by extreme variances[3] such as: very rich and very poor, very educated and illiterate, and, very positively productive and very 'negatively' productive. Given that the significant percentage of world population lives in countries characterized by such extreme contrasts (such as India and China), such 'per capita' measures could present significantly skewed view of the real state of development. *Human Development Report* (OECD 1999) notes that a decade ago, "20% of the richest humans owned more than 80% of global wealth and 20% of the poorest humans owned only 1.4% of the world riches. However, at the beginning of the 20th century, the ratio of the wealth ownership between the richest 20% and poorest 20% of the global population was about 10:1. Today, as we are about to enter the 21st century, the ratio stands at 75:1, and the gap is growing. The rich-poor gap is apparent within nations and among nations, irrespective of developed or developing nation status."

The scope of this paper allows discussion of only few illustrative issues about validity and reliability of the measurement models. There may not be easy answers to many of the questions that we raise. However, awareness about the critical issues that can determine the success or failure of measurement models is necessary for informing any attempt to devise such methodologies. In sum, the ongoing *assessment of measurement models and tools is as important as the specific phenomena that are the subject of measurement.*

The above discussion just scratched the surface in terms of pointing out the needed reforms in the measurement modeling processes and frameworks necessary for justifying the investment and effort. The current analyses would help address issues of feasibility and implementation for incremental and radical improvements in measurement models for knowledge assets: Is it doable? What it will entail to do well? What compromises are involved in balancing the need for 'effectiveness' and for finding 'efficient' solutions?

Previous discussion focused on the measurement issues with primary focus on the 'process' of measurement. The following discussion follows up on the 'subject' of measurement, i.e., *what* is measured. Here the focus is on developing theoretical frameworks for understanding the knowledge economy that are critical for developing valid measurement models. Many scholars, including Boisot (1998), have observed that, economics has no adequate theory for handling data – or information goods in general – as a factor of production.

OECD Measurement Models for Knowledge Assets and Intellectual Capital

The Organisation for Economic Co-operation and Development (OECD) has conducted several studies and produced several reports related to the development of knowledge-based economies. While their focus is primarily on developed countries, their reports are relevant to the concerns of underdeveloped and developing countries as well. The following discussion outlines some initial developmental work where progress is being made to devise better theoretical foundations for more appropriate measurement models.

The *OECD Science, Technology, and Industry Scoreboard 2001: Towards a Knowledge-Based Economy* (2001c) report recognizes at the outset that: "Investment in knowledge is by nature much more difficult to measure. A rough indication can be gained by including public and private spending on higher education, expenditure on R&D and investment in software. Investment in knowledge accounts for about 4.7% of OECD-wide GDP and would exceed 10% if education expenditure for all levels were included in the definition of investment in knowledge."

Their interpretation of what constitutes a "knowledge-based economy" seems to be guided by emphasis on the following indicators in terms of percentage of GDP investments:

- Higher education,
- Expenditure on R&D, and,
- Investment in software

In the formative phase of developing theoretically sound measures, OECD interprets the inputs -- rather than outputs or outcomes -- as represenatative of a knowledge-based economy. Their report notes that: "Sweden, the United States, Korea and Finland are the four most knowledge-based economies, as their investments in knowledge amount to 5.2-6.5% of respective GDP." In other words, the more a country spends on higher education, on R&D and on software, the more it represents a knowledge-based economy. This rationale seems problematic given that similar assumptions about firm-level investments in input resources (ICT) have been questioned and emphasis has shifted from financial investment to management and utilization of those inputs (See for instance, (Collins, 2001), (Malhotra 2004, Malhotra and Galletta (in press), (Carr 2003)). Many of the developmental organizations are equally concerned about the returns on their investments in terms of effective utilization of resources in pursuit of expected performance outcomes. Given the increasingly critical role of human and social processes in realizing the performance potential of structural capital, the following discussion reviews the progress made by OECD on this front and makes recommendations for further improvement.

Reconciling Knowledge Assets and Human Capital

What represents "production of knowledge" needs to be reconciled in terms of inputs-performance-outputs-outcomes indicators as well as interpretations offered across developmental frameworks with shared focus. The above OECD report observes that: "By this measure, most OECD countries are moving towards a knowledge-based economy, especially the Nordic countries, Ireland and Austria, which are allocating more and more resources to production of knowledge." This implies "investments in higher education, expenditure on R&D and investment in software" *in fact* result in "production of knowledge." This is a problematic conclusion, given that what is being measured are *inputs* that may have potential for being utilized for production of knowledge. However, they do not in themselves represent "production of knowledge." The above critique is of interest given that another OECD report *Measuring What People Know: Human Capital Accounting for the Knowledge Economy* (1996b) notes: "Even though in practice the rates of investment appear to be increasing, little consideration has been given to either the content or quality of the investments being made in human capital." Interestingly, it also presents another interpretation of "human capital" as (p. 22) "the knowledge that individuals acquire during their life and

use to produce goods, services, or ideas in market or non-market circumstances."

With its emphasis on "achievement-based evaluation" and "competence-based prior learning assessment," the second OECD report clearly recognizes need for assessing "prior learning, *regardless of the source*" (p. 60, emphasis added). In this perspective, regardless of investments made in formal education structures, formal or informal on job is equally relevant and important. This report also discusses case studies of countries such as Australia, Canada, France, and United Kingdom that now focus less on "traditional exams" and more on "judging people by what they do at work" (p. 63).

Measuring What People Know (OECD 1996b) report had recognized that: *inputs* with potential for economic growth need to be differentiated from the *real* performance outcomes achieved, that could be achieved *regardless* of those inputs. In other words, formal education is just another means for achieving the goals of 'lifelong learning' focused on performance outcomes. The 2001 scorecard however still focused on the 'inputs' and assumed them simply as proxies for performance outcomes. Investments in formal structures of education are important socioeconomic indicators in development schemes of most major development organizations, especially with focus on reducing illiteracy. Often out-of-date premises about school-bound education are used to advance the future of the knowledge economy. A review of existing education literatures would reflect that the new economy depends more on lifelong-learning, learning-on-demand, and, continuous learning and unlearning (OECD 2001, King and Malhotra 2001).

Important questions about the role and contributions of such investments go unanswered. Here are questions about some key indicators evident in most developmental premises but need to be reconciled with reality. Why are the systems of K-12 education in a state of disrepair in the most developed economies (such as the United States) despite higher level of investments? Why do the science and technology achievement scores for the most developed economies lag those for the less developed and developing countries (such as India and China) despite their lower teacher-student ratios? Why are the higher education programs in most developed economies (such as the United States), particularly in business management, reassessing their priorities given growing recognition of diminishing relevance of education that contributes to real performance and growth? (See for instance, Malhotra 2003b). These questions are not intended to be exhaustive, but are representative of reconciling the discrepancies between policy and reality as evident in the *real* outcomes.

These questions are relevant given OECD's (2001d, p. 20-22) observations that: "Qualification measures are a simple but weak proxy for human capital… and the measurement of human capital needs to recognize the limitations of many proxies. Investment in skills takes place in many different settings and stages of lifecycle… and cultural context affects learning. Increased expenditure on education needs to be complemented by other strategies to enhance performance. There may be diminishing returns to spending on education for higher levels of economic development. Lower class sizes do appear to yield higher attainment, but the effect sizes are modest... Social networks are important to learning [and] help to foster learning throughout life." Social capital and human capital seem to have shared effects on some indicators such as value-added learning.

Reconciling Knowledge Assets and Social Capital

There is growing recognition of human capital and social capital as two key aspects of national "well-being" (OECD 2001d). However, indicators of non-economic aspects of "well-being" are missing from most existing developmental models in use by development organizations. The OECD report defines 'well-being' in the following terms: "Well-being includes economic well-being but also extends to the enjoyment of civil liberties, relative freedom from crime, enjoyment of a clean environment and individual states of mental and physical health." There are remarkable similarities between the holistic development pursued by the United Nations Millennium declaration – developed in the current study –

and the broader interpretation of well-being. To advance the understanding about social capital, OECD has produced a Social Capital Assessment Tool (SOCAT, for short) and a related guide in collaboration with the Social Capital Initiative at the World Bank (World Bank, 2002).

In contrast to the human capital focus on the individual, the focus of social capital is on collective action and outcomes based on the themes of cooperation, collaboration, and coordination. Developmental efforts often rely upon specific communities of individuals who share specific concerns and interests facilitated by governmental and public sector initiatives. Social capital represents social structures and underlying attitudes based upon social interaction, trust, and reciprocity for producing collective outcomes to enhance human well being, and, promote opportunity through grass roots level empowerment. OECD defines social capital as the "institutions, relationships, attitudes, and values that govern interactions among people and contribute to economic and social development" (World Bank, 2002; p. 2). Government-mandated and facilitated social structures and organizations, networks, associations, and institutions represent the *structural social capital*. Public sector capacities can facilitate development of such entities by providing developmental support, legitimacy, and stability. More subjective intangible and subjective elements such as generally accepted attitudes and norms of behavior, shared values, reciprocity, and trust represent the *cognitive social capital*.

The social capital measurement proposed in the above guide combines qualitative and quantitative assessment by observing collective activities. The methodology includes focus groups, community mapping, institutional diagrams, key respondent interviews, household surveys, interviews, and scoring on quantitative and qualitative questionnaires related to three types of proxy indicators listed below. The three indicators may be combined into a single index, however, separate analysis of each dimension is recommended.

- *Structural Social Capital*: Memberships in local associations and networks (input indicator)
  - Measured in terms of
    - Density of membership,
    - Diversity of membership, and
    - Participation in decision-making.
- *Cognitive Social Capital*: Indicators of trust and adherence to norms (input or output indictor)
  - Measured in terms of
    - Solidarity
    - Trust and Cooperation
      - Generalized trust or overall trust
      - Extent of trust in the context of specific transactions
      - Extent to which they would receive assistance from others
    - Conflict and Conflict resolution
      - Extent of conflict
      - Conflict avoidance
      - Contribution to common development goals
      - Extent of harmonious relations
- *Collective Action* (output indicator)
  - Measured in terms of
    - Extent of collective action
    - Type of collective activities
    - Overall assessment of collective action

Grounded in some empirical and applied work, the measurement model for social capital is a relatively new tool that needs further improvements. As in the case of intellectual capital and human capital,

different (but compatible) interpretations from economic, sociological, and behavioral perspectives of social capital are yet to be reconciled.

Other Developmental Models for National Knowledge Assets

There are few other developmental models that are visible in the international, regional, and, national socio-economic development initiatives. Many of these models are at a conceptual stage and may lead to specific methodologies and indicators in the future. A handful of such measurement methodologies that have received exposure for international replication or for innovativeness are briefly reviewed here.

United Nations Economic Commission for Europe (ECE) Models

To facilitate innovation and commercialization of knowledge assets, UNECE conducted a review of existing practices and methodologies for valuing intellectual capital. The review focused on valuation of intellectual assets (inventions), intellectual property rights (patents), valuation of managerial flexibility, stock market valuation of companies, and R&D project valuation (United Nations Economic Commission for Europe, 2003). While the primary emphasis was on valuation of intellectual property rights (such as patents), recommendations were made for a holistic realization of sustainable innovation processes. The holistic development view recognized that innovation was more about the human resources – it starts with them and ends with them. They urged governments to support human resource development, innovation and continuous adaptation of institutional, information and innovation systems. Realizing that "innovation and technological capabilities of a country are clearly correlated with long-term growth and social progress," this initiative emphasized that innovation and technological polices must promote value generation from knowledge assets. The concepts outlined in the above review have yet to be crystallized into specific measurement models and measures.

eEurope National Knowledge Assets Measurement Models

The eEurope action aims to create an information society for all and the 'most competitive economy in the world' based on knowledge. Its focus is on digitization of the government and everyday work life. It aims to achieve this by promoting an innovative entrepreneurial culture and a socially inclusive process for sustaining consumer trust and social cohesion. With primary emphasis on the inputs (means) for accelerating digitization, the plan explicitly specifies its focus on ICT related inputs:

> "At the heart of the knowledge-based economy, knowledge itself is particularly hard to quantify as well as price. While new knowledge will generally increase the potential output of the economy, the quantity and quality of its impact are not known in advance. There is no production function, no input-output formula that could approximate, however roughly, the effect that one unit of knowledge would have on economic performance."

Most of the metrics and indicators used in this plan, already adopted by some European countries, are similar to those included in the World Bank and OECD models.

European KM Forum Assessment Model

The European KM Forum attempted to develop a comprehensive KM assessment model and tool. Although the tool described itself as the "the initial concepts for assessing the maturity of organizations towards KM," it identified several socio-technical aspects of KM assessment that are relevant to the current study. Interestingly, it also focused on the human motivation issues that have been generally neglected in other tools for knowledge assets measurement. Although interesting, most metrics and indicators from this forum are yet to be developed based upon a very comprehensive knowledge audit questionnaire.

e-Readiness Index

The Economist Intelligence Unit produces a comparative index of e-readiness rankings for countries "to compare and assess their e-business environments." 'E-readiness' is defined as the extent to which a market is conducive to Internet-based opportunities to demarcate areas where government policy can guide investment for growth. The popular interest in Internet and Web based interconnected infrastructures started with the worldwide discussions on development of National Information Infrastructures in early 1990s (Malhotra et al. 1995). Other countries have followed suite motivated by World Bank's recommendation for national digitization. There are many overlaps in the indices and indicators used in these comparisons with the structural and process aspects of ICT infrastructures evident in World Bank and OECD indices. However, ICT represents one of the structural inputs that must be leveraged by human appropriation and utilization for performance (Hildebrand, 1999).

There are other innovative national knowledge assets measurement and modeling efforts that are at a preliminary stage, such as Malaysia's *Knowledge Imperative Index* (KIX). Most such models show a growing appreciation of the socio-technical focus on holistic national development.

Summary: This section discussed some of the significant measurement models for national knowledge assets being applied for international and national socio-economic development. Models proposed and applied by World Bank and OECD, among others, were reviewed and critically analyzed to develop a foundation for building valid and reliable measurement frameworks and methodologies. The review indicates a growing interest in the social capital and human capital components of national knowledge assets. There is clear and growing recognition of these components as critical enablers of potential performance of structural capital, which had been the main focus of attention in prior models.

Section 4. A Model for Measuring National Knowledge Assets

Measurement frameworks, models, and methodologies facilitate not only measurement but also management of knowledge assets. Most measures of economic performance have relied upon GDP and factors of production – land, labor and capital – for analysis. The last few years have seen growing appreciation for adopting a more holistic focus of national socio-economic growth. The OECD (2001, p. 9) report, *The Well-Being of the Nations*, opens with the following statement: "Distinctions must be kept in mind between quantity and quality of growth, between its costs and return, and between the short and the long run… Goals for 'more' growth should specify more growth of what, and for what." The OECD study observes that in the case of developed economies: "Rapid economic growth has reduced absolute poverty… but well-being is broader than economic well-being… and economic well-being is broader than measures such as GDP. But review of data for developed countries suggests that well-being has lagged behind GDP. " Based upon prior observations about knowledge assets, we believe that a holistic focus on human capital, social capital, and well-being of nations is equally relevant to developed and developing economies. Skandia's Navigator reviewed in prior discussion offers one such measurement model for assessing both tangible and intangible assets. Based upon this model, the following discussion aims to develop a blueprint of a model for measuring national knowledge assets. The application of the model is then illustrated based on an empirical study sponsored by the United Nations Development Project (Bontis 2002).

Although modeling and measurement of national knowledge assets is still in its infancy, there have been prior efforts to measure related components such as country-level and regional human development (See, for instance, http://www.undp.org/rbas/ahdr/.). Building upon prior intellectual capital frameworks (Edvinsson and Malone 1997; Pasher, 1999), Malhotra (2000) advanced the policymaking imperative for reliable measures of national knowledge assets to understand how they relate to future performance. In

this model, there are four components of intellectual capital: market capital (also denoted as customer capital); process capital; human capital; and renewal and development capital. While financial capital reflects the nation's history and achievements of the past; intellectual capital represents the hidden national potential for future growth. According to Edvinsson and Malone (1997, p. 11), the relationships between the various components of intellectual capital are depicted in the following terms

Market Value = Financial Capital + Intellectual Capital where,

Intellectual Capital = Human Capital + Structural Capital

Human Capital: The combined knowledge, skill, innovativeness, and ability of the nation's individuals to meet the tasks at hand, including values, culture and philosophy. This includes knowledge, wisdom, expertise, intuition, and the ability of individuals to carry out value creating tasks and goals. Human capital is the property of individuals. An OECD report notes (OECD, 2001d) that this wealth is multifaceted and includes knowledge about facts, laws, and principles, as well as the less definable knowledge of specialized, teamwork and communication skills. The same report also cautions that metrics should include both the quality and quantity of individual stores of knowledge as well as the collective knowledge stores found within groups and collectives.

Structural Capital: Structural capital represents the knowledge assets that remain without consideration of human capital. It includes organizational capital and customer capital [also known as market capital]. Unlike human capital, structural capital can be owned by the nation and can be traded.

Structural Capital = Market Capital + Organizational Capital

Market Capital: In the original conceptualization, this component was referred to as customer capital to represent the value embedded in the relationship of the firm with its customers. In our conceptualization, it signifies the market and trade relationships the nation holds within the global markets. Relationships within and across countries enhance the ability to create, use, and create value from knowledge.

Organizational Capital: Organizational capital refers to the capabilities such as organizational structures, hardware, software, databases, patents, trademarks, and everything else that supports innovation and productivity through sharing and transmission of knowledge. Organizational capital consists of two components: process capital, and renewal and development capital.

Organizational Capital = Process Capital + Renewal & Development Capital

Process Capital: Processes, activities, and related infrastructures for creation, sharing, transmission and dissemination of knowledge for contributing to individual knowledge workers' productivity. It is defined in terms of the non-human storehouses of a nation's knowledge assets embedded in technological, information and communications systems: as represented by its hardware, software, databases, laboratories and organizational structures which sustain and externalize the output of human capital (UNDP, 1998).

Renewal and Development Capital: This component of intellectual capital reflects the capabilities and actual investments for future growth such as research and development, patents, trademarks, and start-up companies that may be considered as determinants of competence in the future.

While financial capital reflects the history and achievements of the past,

- Process capital and market capital are components upon which present operations are based;
- Renewal and development capital determines how the nation prepares for the future; and,
- Human capital lies at the crux of intellectual capital. It is embedded in capabilities, expertise and wisdom of the people and enables value creation from all other components.

The adapted framework for measurement of national knowledge assets is depicted in **Figure 1**.

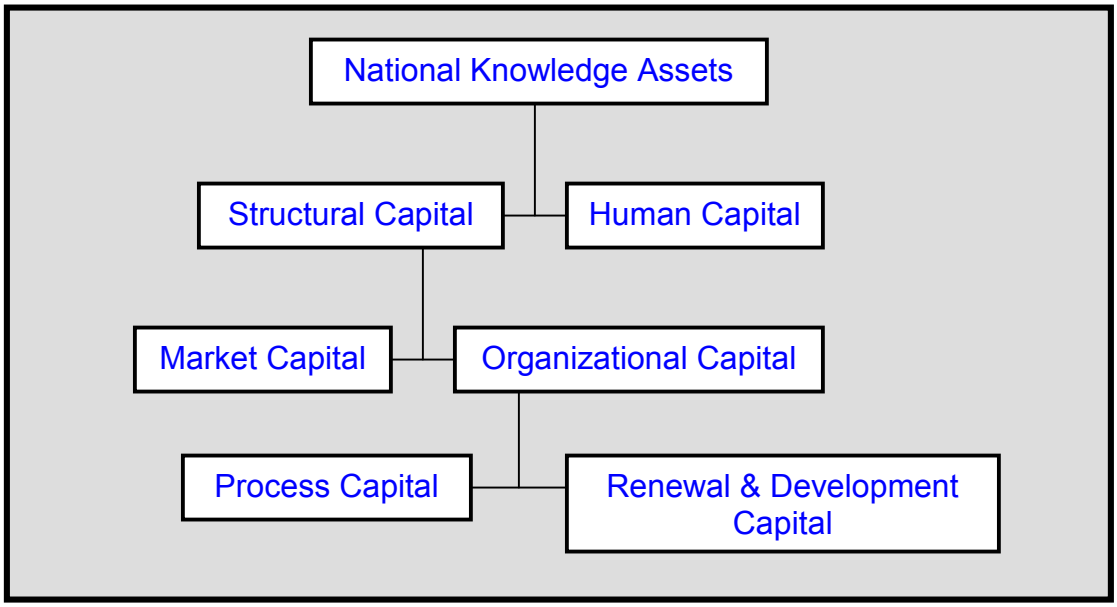


Figure 1. Components of National Knowledge Assets

(Based upon Malhotra, 2000b)

Application of the Measurement Model

The above measurement model is based upon lessons learned from prior applications for assessing national knowledge assets and intellectual capital (Pasher, 1999; Malhotra, 2000b). The national intellectual capital includes knowledge assets of individuals, firms, institutions, communities, and government that represent current and potential sources for wealth creation and improved quality of life. Bontis (2002) adapted this methodology for measuring knowledge assets of the Arab region. The transformation resulted in four separate national indices for knowledge assets, one each for human capital, process capital, market capital, and renewal capital. A list of the specific indictors used for the four indices is given in **Table 3**.

Table 3. Indices and Indicators of National Knowledge Assets

(Based upon Malhotra, 2000b; Pasher, 1999; Bontis, 2002)

Human Capital

Original Indicators	*Proposed Indicators*
Literacy rate	Organizational training and development per capita
Number of tertiary schools per capita	Training and development participation rates
% of primary teachers with required qualifications	% of GDP spent by level of education
Number of tertiary students per capita	Population at various age groups
Cumulative tertiary graduates per capita	Quality of education and standardized testing results
Percentage of male grade 1 net intake	Instruction time and length of school year
Percentage of female grade 1 net intake	Educational participation quality and results
	Ratio of student population at each level of completion
	Mathematics, reading, writing, and basic science

Structural Capital

Market Capital

Original Indicators	*Proposed Indicators*
High-technology exports as a percentage of GDP	Openness to different cultures
Number of patents granted by USPTO per capita	Number of foreign spoken languages
Number of meetings hosted per capita	Volume of tourist traffic
	Subjective measures of honesty and trust in business dealings
	Ease of launching new businesses
	International awards and recognitions
	Immigrant inflow and outflow
	Export of magazine, books, and periodicals
	World expositions and conventions hosted
	Professional Olympic athlete participations
	Students and scholarships in foreign schools

Organizational Capital

Process Capital

Original Indicators	*Proposed Indicators*
Telephone mainlines per capita	Computer literacy rates
Personal computers per capita	Digital storage per capita
Internet hosts per capita	Volumes of books in libraries per capita
Mobile phones per capita	Transportation statistics such as paved roads per capita
Radio receivers per capita	Availability and extent of software usage
Television sets per capita	Entrepreneurship and number of venture start-ups
Newspaper circulation per capita	Venture capital funding

Renewal and Development Capital

Original Indicators	*Proposed Indicators*
Books and periodicals imports	Number of graduate students studying abroad who return
Total R&D expenditures	Ratio of patent applications to granted patents
Number of ministry employees in R&D per capita	Number of applications for registered trade marks
Number of university employees in R&D	Intellectual aptitude of the younger population
Tertiary expenditure as % of public education funding	

This following transformations were made to further adapt the model to the context of socio-economic development: market value was replaced with national wealth, financial capital was replaced with financial wealth, customer capital was replaced with market capital, and, innovation capital was replaced with renewal capital.

Three are many similarities between the indicators of this model shown in Table 3 and the indicators used in developmental analysis by organizations such as World Bank and OECD. Indicators that have been validated, refined and applied with success in multiple cases offer reliable metrics that can be applied in other similar contexts. In contrast, indicators that have seen limited empirical validation with mixed findings need to be tested and analyzed further to develop confidence in their reliability and validity. The key goal is to develop a parsimonious set of indicators to explain and predict how specific policy directives affect achievement of specific socio-economic and human development objectives.

Based on the analyses of collected data, Bontis (2002) highlights the importance of human capital as the "pre-eminent antecedent for the intellectual wealth of a nation." The significant role of the nation's citizens in codifying and internalizing the knowledge and applying it in course of various structural, institutional, and organizational activities, processes, and procedures needs further understanding.

Summary: This section reviewed one national knowledge assets measurement model relevant to the developmental focus and discussed its application for one world region. There are many similarities between this measurement model and the developmental assessment models used by major development organizations. This is not unexpected given that the objective of the adapted model based on Skandia's framework is same as that of developmental organizations, i.e., assessment of national socioeconomic performance based upon both tangibles and intangibles. There is need for an overall methodology for development and implementation of the process for applying knowledge metrics across public sector organizations. The next section develops such a methodology with focus on performance outcomes.

Section 5. Building Public Sector Capacity for Measuring Knowledge Assets

A review of knowledge assets measurement models in practice, research, and policy development in prior sections suggested various important areas for improvement. We find that most extant models primarily focus on inputs and structural variables with lesser attention to process, outputs, and outcomes. Expected performance outcomes are key determinants of investment decisions for public sector projects. In addition, despite the abundance of measurement models, there is dire need for connecting *measurement* of knowledge assets to their *management*. The raison d'être of the measurement process is to provide for better management of knowledge assets. Application of any knowledge measurement methodology requires understanding of the causal links between inputs-processes-outputs-outcomes as a pre-requisite. Understanding how performance metrics guide specific actions and behaviors to yield desirable performance outcomes is the quintessential foundation that underlies successful development and implementation of measurement models.

In this section we develop the foundation for linking inputs to performance outcomes. On this foundation, we develop the overarching measurement and management methodology for linking national strategic vision with specific core competencies and the critical success factors that influence performance outcomes. For the implementation of this methodology, we develop an adaptation of the Balanced Scorecard model to depict the causal links between specific policy directives and expected performance outcomes.

How Knowledge Asset Metrics Guide Knowledge-Based Performance

In prior sections, we discussed how social capital and human capital play a key role in deriving expected performance outcomes from structural capital. Given this backdrop, we envision a national knowledge sharing culture that derives benefits for stakeholders in terms of learning, innovation, communication, coordination, and collaboration with the help of structural assets such as ICT systems. The primary focus of this vision treats people – as individuals and collectives – as the central focus of most processes and activities that leverage desirable outcomes from various aspects of intellectual capital.

Before the measurement models are applied, four important issues need to be addressed.

- ***What is being measured?*** Overall, the focus is on tracking the progress of the nation toward the realization of the vision of the knowledge society of which knowledge economy is a part. When the model is implemented at the organizational or institutional level, the specific criteria and causal links are defined at that level in congruence with the national vision.

- ***Why it is being measured?*** Different public sector organizations may have disparate needs in terms of how the measurement and management would facilitate their specific goals. Some may need the measurement model as a diagnostic for assessment of progress and for benchmarking while others may need it as a tool for building advocacy. Some may need it as a means for prioritizing investment allocations and others may need it for mobilizing political support for remedial action. Diverse needs, when understood in the relationship to the strategic vision and desired performance outcomes, would still address common and shared goals at higher levels.

    - ***How it is being measured?*** In many cases more than one model or set of indicators may seem appropriate for measuring knowledge assets. In other cases, there may be need for adapting existing measures while in some cases measures need to be devised from scratch. Despite these differences, the process should be based on the awareness that the primary purpose of the measures is informing and communicating the relevant stakeholders for realizing behaviors or actions that yield desired outcomes.

    - ***When it is being measured?*** There are two aspects of this issue: one related to the maturity level of the KM project and the other related to the specific causal loop of inputs-processes-outputs-outcomes. Different stages of maturity of the KM project may have different expectations about performance outcomes. At pre-planning phase issues such as strategy development and risk analysis may be relevant whereas the start-up phase may need greater focus on building championship and support for the project. The pilot phase may need to focus more on benchmarking and developing 'good practices' while the growth phase may require institutionalization of those practices and their wide spread use.

The causal loop of inputs-processes-outputs-outcomes has been mentioned in prior discussions. Understanding the causal 'loop' and what various KM measures represent is necessary for developing effective metrics for knowledge assets and management of their 'stocks' and 'flows.'

Measures for Knowledge Inputs-Processes-Outputs-Outcomes

A major limitation of many important measures and indictors used in existing developmental models is their over-reliance on inputs-based measures. Fortunately, we are observing a growing awareness that investments in input resources are not reliable proxies for actual performance outcomes resulting from those investments. For instance, findings from prior macro-economic studies that suggested increased ICT

investments correlate with higher economic growth are increasingly suspect given findings from latest research studies that suggest an inverse relationship between ICT investments and business performance for best performing firms (Malhotra, 2004; Malhotra and Galletta, in press; Carr, 2003). Based upon related empirical studies and theory development that has focused on understanding the role of human behavioral and sociological issues in determining effectiveness of structural knowledge assets (ICT, information, and knowledge resources) (Malhotra 2004, 2001, 2000a, 2002a, 2002b, 2000d, 1999, 1998a, 1998b, 2002c; Malhotra and Galletta 2003, 1999), we believe that the causal linkage suggested in prior research between structural investments and performance outcomes are questionable in the knowledge economy. We also suggest that greater appreciation of sociological and behavioral aspects of social capital and human capital is necessary, an observation that is shared by findings from other studies related to socio-economic development (OECD 1996a, 1996b, 1999, 2001a, 2001d).

Important questions that need to be asked include: Are the knowledge resources being used? Are the resources being utilized in the expected manner? Is effective utilization of resources resulting in expected outputs? Do these outputs represent meaningful proxies for value-added performance outcomes? Such an iterative 'double-loop learning' process would ensure that the knowledge policies, knowledge frameworks, and measurement models are adapted and modified as needed for achieving intended developmental goals and objectives. The specific indicators representing KM inputs, processes, outputs, and outcomes that are implicit in above measurement related questions are clarified below.

Measures of KM Inputs Structural or financial investments for developmental purposes are considered as *inputs*. They are treated as inputs as they represent the raw material for getting the specific structural capital and process capital in place so that employees, customers, suppliers, or other stakeholders *may* utilize them. Compliance-based procedures or incentives may be used to persuade these 'users', however effectiveness of such 'manipulations' is often overrated as evident from insights based upon human behavior studies (Kelman 1958; Kelman 1980; Malhotra 1998b; Malhotra 1999; Malhotra 2000a; Malhotra 2001; Malhotra 2002b; Malhotra and Galletta 1999; Malhotra and Galletta 2003; Malhotra and Galletta, in press). In existing measurement models, 'structural capital' investments in associations, public sector developmental initiatives, small business development programs; 'human capital' investments in continuing educational programs, schools, professional and vocational certifications, training and development programs; and 'process capital' investments in hardware, software, computers, Internet, telephones and televisions represent KM inputs. These may also include other ICT-based knowledge infrastructure or derivatives such as best practices directories, lessons learned databases, communities of practice, expert directories, portals, collaborative systems, expertise yellow pages, and e-learning systems[4].

Such knowledge-based assets have two interesting characteristics as inputs and they need to be distinguished from processes, outputs, and outcomes. First, they often derive their existence as result of KM *processes*. In other words, they need to be appropriated and used for getting them to a stage where they represent value-added inputs for value-added use. Second, as they are used more and more effectively, they morph into value-added *inputs* for the users and also represent value-added *outputs*. For instance, a public sector organization could deploy an ICT-based virtual meeting capability to develop a community of practice (CoP) of small business entrepreneurs. The ICT-based capability or the digital 'shell' for the CoP does not represent value-added by itself. For it to 'accumulate' value, it needs to: a) be used for holding community meetings and sharing of knowledge; b) build up a critical mass of participants who can relate to the overarching developmental vision; c) develop a critical mass of questions, answers, and other knowledge artifacts to result in meaningful 'gain' and 'exchange' of knowledge; and, d) rely upon investments of time, effort, motivation, commitment and altruism of various stakeholders for its ongoing sustenance. If the expected socio-economic and human development related benefits were indeed realized (in terms such as enhancement of participants work life, money and time saved from knowledge used and knowledge gained, or general well being of the participants), these would

represent value-added *performance outcomes*.

Measures of KM Processes KM process measures track the utilization of the specific financial, structural capital and human capital inputs. Process related indicators give an indirect indication of knowledge flows based upon effective utilization of resources. They can also highlight resources that are most popular and identify potential problems in use and usability that might limit participation. Process related indicators about 'structural capital' investments would include items such as the quantity and quality of utilization by the expected users, effectiveness of utilization, and, procedures in place to improve user participation and resource utilization. Process related indicators about 'human capital' investments would include items such as the volume of enrollment by expected community groups, quality of contributions made by enrolled users, and procedures in place to increase participation and value added for relevant stakeholders.

Measures of KM Outputs Effective utilization of the financial, structural, and human capital is expected to result in tangible or intangible outputs. KM output measures track direct process output for the targeted users and other stakeholders. They provide evidence of the specific outputs that the users derive from participation in, and utilization of, various intellectual capital assets. Output measures for 'structural capital' may include indicators such as learning acquired, knowledge gained, skills developed, knowledge resources acquired, business plans written, start-up funding obtained, and, relationships developed based upon participation in associations, public sector developmental initiatives, and, small business development programs. Output measures for 'human capital' may include indicators such as certifications or credentials earned, value-added skills developed, knowledge gained, self-development achieved, and, earning potential improved from enrollment in continuing educational programs, schools, professional and vocational certifications. Intangible outputs would often be related to qualitative judgments and perceptions of users about the value derived from their subjective 'experiences.' Quantitative metrics such as number of courses taken, number of business plans written, number of clients contacted, may represent more tangible outputs.

Measures of KM Performance Outcomes These are the measures that determine the impact of KM inputs, processes, and outputs and help determine the weak links in the inputs-processes-outputs-performance loop. They help assess the overall impact of knowledge assets on the effectiveness of policy implementation. They also track if the investments in inputs and processes are indeed yielding outputs that are perceived as 'valuable' in terms of socio-economic and human development. Performance measures for 'structural capital' may include indicators such as small businesses launched, new ventures developed, revenue sources generated, new jobs created, and quality of jobs improved. Performance measures for 'human capital' may include indicators such as quality of life improvements, gains in income, gains in quality of jobs, market value of skills, and, potential for future professional progress. Additional indictors may include costs saved, incomes generated, and time saved other measures of value-added at micro- and macro- levels.

Different combinations of inputs, outputs, and processes may result in identical performance outcomes. Also, depending upon the stakeholders, not only different indicators may have different connotations but may be perceived differently. As apparent, development of valid measures is not a perfect science and requires insightful judgments in modeling as well as applying the measures. The challenges involved in exact measurement of complex constructs can be appreciated from the sign that hung in Einstein's office at Princeton: "Not everything that counts can be counted, and not everything that can be counted counts." Similarly the challenges involved in exact computational models of causality are captured in another quote attributed to Einstein: "As far as the laws of mathematics refer to reality, they are not certain, and as far as they are certain, they do not refer to reality."[5] (A more precise technical interpretation is available in the Notes at the end.)

There is need for connecting *measurement* of knowledge assets to their *management* by defining the causal links between inputs-processes-outputs-outcomes. The subsequent discussion focus is on developing an overall methodology that can guide the development and implementation of knowledge metrics across public sector organizations.

A Methodology for Measuring National Knowledge Assets

The underlying methodology was originally conceptualized as a 'guide for measuring the value of KM investments' (Hanley and Malafsky, 2002) and applied by the U.S. Department of Navy Chief Information Officer (2001) for translating its Knowledge Centric Organization (KCO) into an 'how to' operational action blueprint. The modified version developed for the current study: a) advances a more complete perspective of knowledge assets in terms of human capital, social capital, and intellectual capital; b) adapts the generic template to match the concerns and needs of the public sector and national policy; and, c) focuses on holistic development for socio-economic growth and human development.

To recapitulate, the methodology for measuring national knowledge assets proposed for this study[6]:

- Advances a more complete perspective of knowledge assets in terms of human capital, social capital, and intellectual capital;
- Adapts the generic template to match the concerns and needs of the public sector and national policy; and,
- Focuses on holistic development for socio-economic growth and human development.

The process consists of four main phases. It is iterative and builds upon lessons learned in fine-tuning the strategic vision, goals, and tactics as well as the measurement models and tools used for charting progress. This framework may be adapted, expanded, and enhanced with inputs from other measurement models and conceptual and theoretical frameworks discussed in this paper.[7]

Developing a vision of the knowledge-based national economy

The vision of the nation's future as a knowledge-based economy is identified through brainstorming sessions and interviews with national leaders and domain experts in areas relevant to national growth and performance. A mix of individuals and entities representing traditional and new thinking is recommended for connecting the past and current trajectory of socio-economic development with the planned trajectory of future progress. Specific articulation of a vision could be, for instance, in terms such as building a highly competitive, developed, modern, democratic and pluralistic nation attractive to world community, investors, and citizens. A review of existing research and national policy initiatives reveals that many of the world's nations have already embarked on this phase. The national and regional knowledge assessment models discussed in the prior sections and included in the bibliography are representative examples. In most such cases, active involvement and support of senior national and regional leaders provides some evidence of commitment in this phase.

Identifying core competencies needed for achieving the vision

Based upon brainstorming and critical reflection about the nation's vision, an agenda is defined to identify, develop, and enhance specific core competencies. These competencies are expected to contribute to specific socio-economic, cultural, and human aspects of national development. Such competencies would address specific national and regional goals related to development of intellectual capital, human capital, and social capital. During this phase, collaborative interaction between the senior leaders of government, developmental institutions, public sector institutions, industry, research sector, and academia is recommended. Key stakeholders as well as their critical concerns are identified that are related to development of specific competencies. These competencies are mapped into 'clusters' along each of the

dimensions of the measurement model. For instance, broader national goals deemed relevant for future growth may include enhancement of quality of life of citizens, and, improving national standing among developed nations. The former goal may depend upon developing competencies in terms of structural interventions such as enabling culture and regulations. The latter goal may depend upon building knowledge-based industries that can help spur economic growth.

Identifying key success factors for growing core competencies

The key competencies necessary for the nation's current and future performance may be clustered along the five components of the Skandia Navigator model discussed in a previous section: financial capital, market capital, process capital, human capital, and, renewal and development capital. Alternatively, those competencies may be mapped in terms of the Balanced Scorecard categories: knowledge management for learning and growth; relationship management for stakeholder satisfaction; internal improvement of business processes; and, net value creation through budget and cost management. Depending upon whichever measurement model is used, relevant competencies, success factors, and measures of inputs, processes, outputs, and outcomes need to be identified. Specific elements of the two models may be used in conjunction if needed.

The object of measurement models is not only assessment but also tracking the progress towards achievement of specific competencies. Specific socio-economic, human, cultural, and political development agendas and goals are then defined with focus on goals of the public sector institutions along with critical success factors relevant to building related competencies. An example of such success factors may include formal and informal relationships between the public sector, private sector, and structural institutions that need to be in place for achieving the charted goals.

Identifying key indicators for inputs, processes, outputs, and outcomes

The focus of this phase is on specific indicators needed for measuring the progress towards growth of specific competencies and the key success factors needed for supporting such growth. These indicators are derived from analysis of historical socio-economic growth data and projections about the future. A key challenge lies in identifying the indicators and relating them to inputs, processes, outputs, and outcomes. The input indicators that often measure investment in specific resource inputs may not represent valid proxies for outcomes. Measure of processes track what happens to the inputs or what is done with the inputs. Measures of outputs track results achieved from processing of inputs. The outcome measures determine the value creation that is attributed to the specific outputs. For instance, outcomes would relate to achievement of specific socio-economic and human development objectives derived from the national vision.

Subsequent discussion focuses on the implementation of this methodology with the aid of the Balanced Scorecard measurement model. This model is relevant to the proposed methodology given its popularity for linking the vision and strategy to human actions and performance outcomes.

A Balanced Scorecard Approach for Implementing the Methodology

This section develops a Balanced Scorecard model for measuring and managing knowledge assets for the public sector with focus on socio-economic development. Originally developed by Robert Kaplan and David Norton, the Balanced Scorecard (BSC) presents a holistic view of an organization's current state of health by monitoring its activities related to both tangible and intangible value creation. In contrast, most 'balance sheet' oriented models are restricted in their capability for linking people and performance. BSC can also help depict the causal links between practices and performance outcomes. In use by hundreds of organizations, this measurement model may be used in conjunction with other measurement models

discussed in the earlier sections. For instance, the U.S. Department of Navy uses BSC in combination with several other metrics – each set of metrics is related to specific projects with relevant performance outcomes. The outcomes are then used for delineating the various combinations of outputs, processes, and inputs for which the most appropriate measures and indictors are then chosen. The BSC helps ensure that the focus of metrics for specific initiatives does not overly concentrate on any single component of knowledge assets to the detriment of the overall effectiveness. A set of key performance measures is defined for each of the four areas of the Balanced Scorecard and used for each of the major initiatives related to assessment and development of knowledge assets.

Figure 2 shows the proposed Balanced Score Card model developed for national knowledge assets management and measurement. As evident, it is not only a model for knowledge assets measurement but is also a model for knowledge assets management. The methodology for starting with the national vision and determining the competencies along with success factors and relevant indicators for inputs-processes-outputs-outcomes needs to be mapped on the four related perspectives of the scorecard.

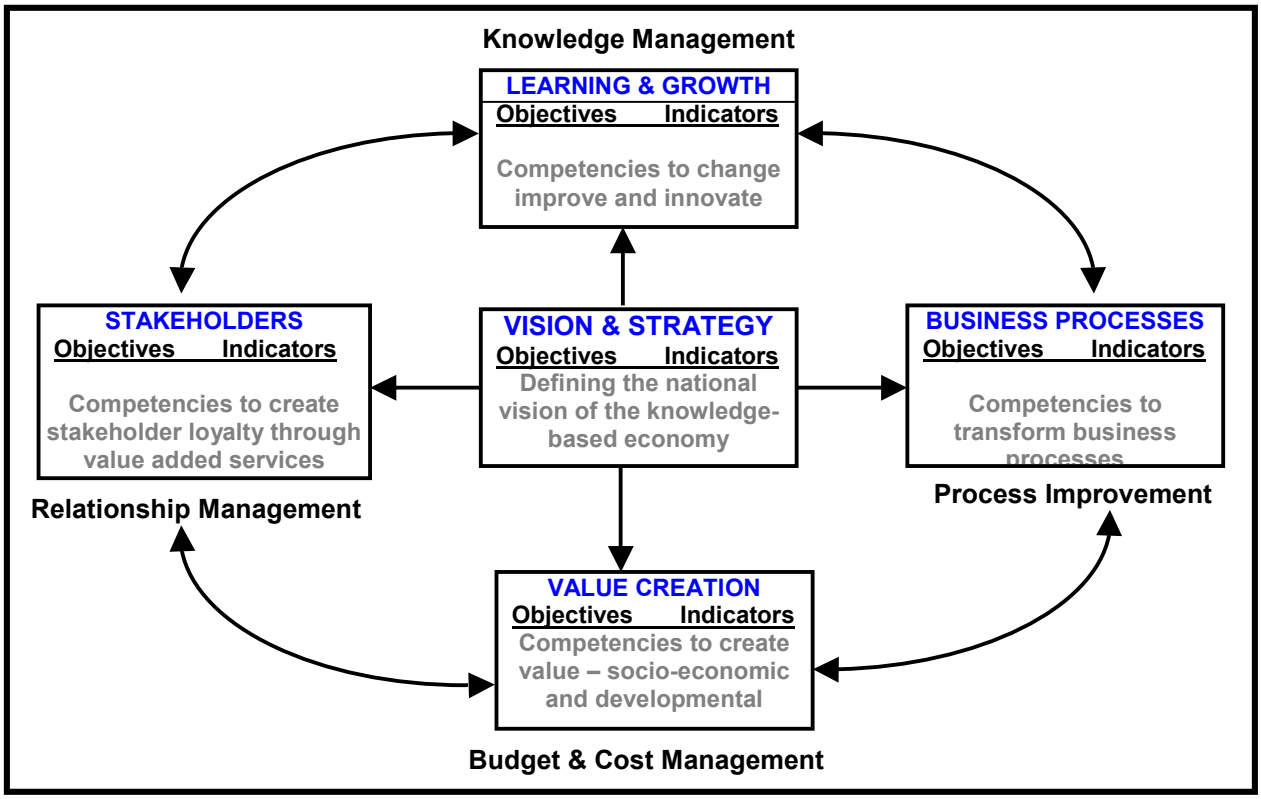


Figure 2. Balanced Score Card for Knowledge Assets Measurement and Management

(Based upon Malhotra, 2000b, 2003a, 2003b, 2004)

The BSC is more than a collection of measurement indicators as all the measures are linked through a chain of cause-and-effect that culminates into strategic success. The cause-and-effect hypothesis is fundamental to understanding the metrics that the balanced scorecard prescribes and how they relate to strategic success. Therefore, the policy analysts need to continuously assess if the chosen policies are correctly implemented (as determined by specific indicators) and then ensure that the assumptions made about cause and effect relationships are evident in practice. If the specific value-added performance

outcomes are not achieved, the causal links need to be reassessed to ensure that the constructs as well as their relationships are valid.

The process of developing the BSC starts with the vision of the national knowledge economy that is interpreted through the four perspectives: learning and growth, business processes, stakeholder satisfaction, and value creation in terms of tangible financial results or expected intangible outcomes. The vision is translated into competencies relevant to each of the four perspectives along with an assessment of critical success factors and specific indicators that represent the inputs, processes, outputs, and outcomes for each of the four perspectives. The four perspectives of the BSC as related to development and measurement of knowledge assets for the public sector are described below (Balanced Scorecard Insitute, 2002).

i) Learning and growth: BSC recognizes that innovation by creative citizens, presence of a learning and knowledge sharing culture, and formal and informal learning opportunities underpin the success of the knowledge vision and strategy. Learning and growth are fostered through knowledge management activities and initiatives such as strategic recruiting, hiring, training, team development, document management, collaborative communication systems, knowledge and skills audits of employees, knowledge base developments, and fostering of communities of interest within the organization

ii) Business processes: This perspective is achieved through strategic business process improvement activities that may range from moderate and localized changes to wide-scale changes in business processes, redesign of workflows to eliminate paperwork and achieve process efficiencies, and automation of routine transactions. Deployment of the balanced scorecard measurement system is itself one of these processes. It is anticipated that enlightened, skilled, and creative citizens would continuously improve the processes by re-assessing the underlying assumptions.

iii) Stakeholder satisfaction: This perspective is listed in the original BSC model as the customer perspective. Given that in one way or another all public sector stakeholders need the same care and relationship development generally reserved for customers, this perspective has been redefined as stakeholder satisfaction. For the governmental and public sector agencies, this is all the more relevant as they often need to negotiate implementation of specific policies by balancing diverse interests. The public sector agencies need to work closely with stakeholders and devise means for seeking feedback from them and continuously improving the stakeholder service processes. In addition, improvement of business processes by creative and innovative employees is expected to result in improved value-added outcomes.

iv) Value creation: This perspective is listed in the original BSC model as financial management and had its original focus on initiatives such as Activity-Based Costing (ABC), Functional Economic Analysis (FEA), Earned-Value Management (EVM) and other similar practices. The objective of such activities is to help policy analysts in tracking projects more closely and making improved cost and overhead estimates. With increasing focus on value creation expected from investments in public sector projects, this perspective is expanded to focus on value creation in both tangible and intangible forms.

In the above figure, the four BSC perspectives: learning and growth, business processes, stakeholder satisfaction, and value creation are executed through the following strategic management activities respectively: knowledge management, business process improvement, stakeholder relationship management, and budget and cost management.

Summary: This section developed a methodology for linking inputs to performance outcomes in knowledge assets measurement and management for public administration and development. This foundation was then used for developing the overarching measurement and management methodology for linking national strategic vision with specific core competencies and the critical success factors that

influence performance outcomes. An adaptation of the Balanced Scorecard model was developed to depict the causal links between specific policy directives and expected performance outcomes for the implementation of this methodology.

Section 6. Conclusions and Recommendations

Review of research and policy literatures on knowledge assets and intellectual capital indicates growing interest in knowledge economies and knowledge societies that can promote holistic social, cultural, economic development and well being of citizens. This study reviewed the concepts of knowledge capital and intellectual assets; compared and contrasted most popular knowledge assets measurement and management models and methodologies; critiqued the current models and indicators in use by developmental organizations; and proposed an actionable blue-print – containing models and methodologies – for developing public sector capacities in management and measurement of knowledge assets. We also made several recommendations related to the process, the content, and the substance of national knowledge assets measurement and its context-specific applications for the public sector. Much remains in terms of ensuring not only *how* we conduct measurement, but in developing clearer understanding of *what* we are measuring. The following discussion summarizes and recapitulates the recommendations made in previous sections and also provides directions for future research and development for further improvements in the measurement models.

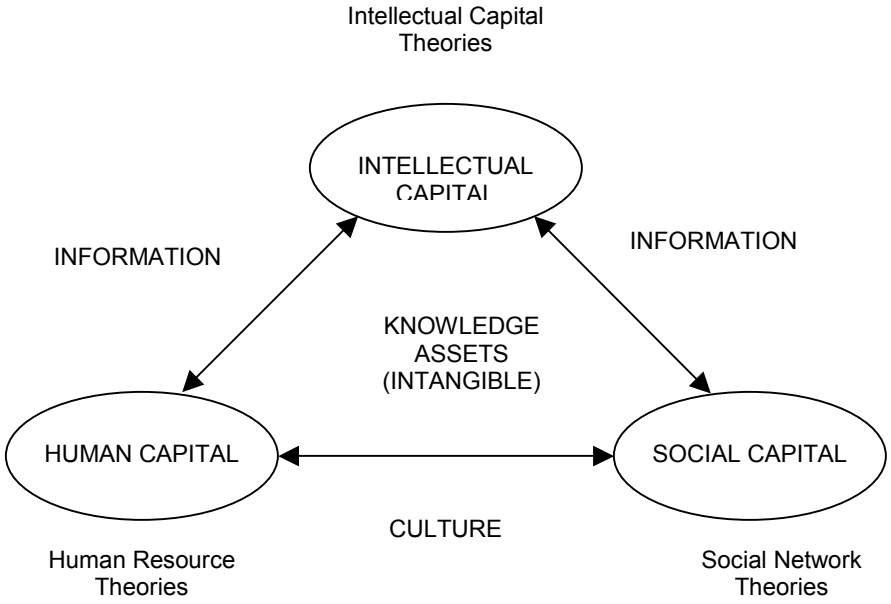
The key observations and recommendations based upon our review, analysis, and development of measurement methodology and frameworks for national assessment of knowledge assets are listed below. Many of these observations are listed in the form of questions as they represent critical 'thinking points' that can help define the contours and trajectory of the emerging knowledge economies. These questions define key issues that need to be further developed in terms of specific research agendas and policy applications.

a) Significant progress has been achieved in terms of development of measurement models of knowledge assets and intellectual capital for analysis at the firm level. There has been some progress in developing similar models for assessment of national knowledge assets and for enabling public sector capacity for measuring knowledge assets. Drawing upon a comprehensive review of the research and practice literatures as well as national policy documents, this study has attempted to fill this void.

b) Most existing models for measuring knowledge assets suffer from a critical 'disconnect.' Their reliance upon the inputs as valid proxies of performance outcomes raises a very critical issue: if they indeed measure what they attempt to measure. As discussed before, investments in public sector projects cannot be considered proxies for performance outcomes. Similarly, investments in developing structural artifacts and processes for 'getting things done' are not valid proxies for 'things that need to be done.' Also, what is actually done or delivered has to justify as value creation based upon prior expectations to conclude that performance outcomes have indeed been achieved. This study has proposed a model for linking inputs-processes-outputs-outcomes for measuring national knowledge assets and enabling public sector competencies for such measurement. Future research and development is needed for further improving the predictive validity of the measurement models and related indices and indicators.

c) While large number of empirical studies have been conducted around the world on intellectual capital, most of these studies have followed the accounting and economic perspectives. These disciplines share common criteria about evaluation of 'assets' and 'capital' even though conflicting national and regional accounting standards make cross-national comparison a

challenge. There has been growing recognition about developing complementary perspectives from disciplines such as sociology and psychology that can provide richer assessment of social and behavioral issues. An encouraging development is the recent developmental studies by organizations such as the OECD that share the concern about better indices and indicators related to human capital and social capital. Sociological and behavioral issues such as social influence, persuasion, self-determination, commitment, and, intrinsic motivation are directly relevant to the content and quality of performance outcomes wherever human agents are involved. Better understanding of such 'intangibles' is needed to enrich and refine the constructs of human capital and social capital. Information and knowledge are the raw material in work and life activities and in knowledge processes that depend upon communication, collaboration, and coordination. Ability and willingness are both ever more critical human traits for this world where information and knowledge are increasing exponentially and fundamentally transforming existing paradigms of work and work life. As depicted in **Figure 3**, Shared understanding of sociological, behavioral, and intellectual capital theories is needed for addressing theoretical and pragmatic concerns at their intersection.



(Based upon Malhotra, 2003c)

Figure 3. Needed Inter-disciplinary Understanding of Knowledge Assets

d) "What is the knowledge economy?" This question still begets an answer whether the focus is on "knowledge society" or "knowledge economy." Given that economic well-being is an important part of both constructs, it is yet to be understood what indeed is "knowledge economy?" While most existing measurement models define it in terms of 'residuals', more recent frameworks have tried to focus on the ICT investments based on the premise that they represent 'stores' of knowledge. Given fundamental problems implicit in such assumptions, the scope and scale of 'knowledge economy' is yet to be defined. A challenging problem is implicit in existing dichotomy between knowledge economies and industrial / agricultural economies. Does theory,

policy, and practice define that knowledge economies are based on information goods only? Given that in most cases, the information and knowledge is intrinsically intertwined with the tangibles, can we really distinguish between the two? Does it make sense from a theoretical or policy perspective to consider knowledge as a separate entity as it always exists in *something* or *someone*? Are economies that intensively apply knowledge in production of industrial goods industrial economies or knowledge economies? Is there any homogeneous knowledge economy for countries characterized by extreme disparities of knowledge content of various work activities and work processes? Future research needs to better define the theoretical foundations for the knowledge economy and knowledge society. Theory guides measurement, and in case of inadequate or inconsistent theory, measurement as well as management of knowledge assets may continue to suffer.

e) While significant development of existing measurement frameworks and methodologies has occurred in the past years, fundamental theoretical concerns loom large. For instance, in absence of a generally accepted theory of knowledge, how much confidence can we place in measurement models based on assumptions about the linear logic and incremental change that characterize 'industrial thinking.' Growth of multi-disciplinary and inter-disciplinary theoretical foundations that can integrate the concerns raised in this study is recommended for analysis of complex constructs that defy the bounded logic of specific disciplines. Prior stream of research that has attempted to develop the sociological and behavioral understanding for linking information and knowledge to behaviors, actions, and performance outcomes seems relevant in this regard (See for instance, Malhotra 2004, 2001, 2000a, 2002a, 2002b, 2000d, 1999, 1998a, 1998b, 2002c; Malhotra and Galletta 2003, 1999, in press). As the emphasis of the knowledge society shifts to beliefs, behaviors, and actions that are more directly related to performance outcomes, finer understanding of the 'inner workings' of the knowledge economy is required. The sociological, organizational, and behavioral literatures have developed advanced understanding of these issues. However, many other disciplines have failed to keep up with advances in these theories.

f) Most existing measurement and performance models are founded on the premise of 'compliant' humans based on their command-and-control logic that is characteristic of 'industrial thinking.' (Kelman 1958; Kelman 1980; Malhotra 1998b; Malhotra 1999; Malhotra 2000a; Malhotra 2001; Malhotra 2002b; Malhotra and Galletta 1999; Malhotra and Galletta 2003; Malhotra and Galletta, in press). A world depending upon pro-active knowledge use, sharing, creation, and renewal – in contrast to the world of mechanized assembly lines – cannot depend upon continuous surveillance and control mechanisms that are good enough to see what can be seen. The cerebral world of thoughts and ideas coupled with the knowledge societies interconnected with invisible bit streams flowing through the ether present a surreal picture for those accustomed to 'industrial thinking.' How do you manage what you cannot 'see'? How do you control what is virtually uncontrollable? These questions are not only applicable to the nature of the *goods* and *services* that constitute value in the global knowledge society, but also to the inter-connected cerebral knowledge *processes* that appropriate, use, create, transfer, copy, exchange, and derive value from them. In the global knowledge society with inter-connected knowledge economies, how does one demarcate the boundaries for knowledge assets belonging to nations, firms, and individuals? How does one determine property and ownership rights in a world that is dependent upon knowledge sharing and knowledge transfer and is based on the premise that 'information should be free'?

g) The problems of determining 'average' indices of knowledge assets for economies with large populations and extreme heterogeneities were mentioned earlier. Wouldn't it be more appropriate to distinguish between the high performance and low performing sectors of such economies? For instance, computing an index that is a catchall for highly efficient and highly inefficient work

processes and activities across multiple economic sectors provides an average that doesn't tell *anything* about *anything*? Do highly productive and highly unproductive sectors of agricultural economy add up to give an overall moderate-performing agricultural economy? Can knowledge-based economies exist in isolation from industrial and agricultural economies? Given that most humans would still need food to survive in the foreseeable future, does coming of the knowledge economy diminish the value of the agricultural economy? Given that most humans would live in abodes made of industrial products and work in offices with devices derived from the largesse of the industrial economy, does coming of the knowledge economy diminish the value of the industrial economy? What would happen if all nations advance knowledge based economies at the detriment of agricultural and industrial economies?

h) Is knowledge economy intrinsically more value adding than agricultural or industrial economy? Last week witnessed the longest and most severe blackout in the history of the most developed country of the world. This energy-based shortage brought 20% of the country of 300 million or so to a standstill and evaporated approximately a billion dollar in a day from the national economy. Doesn't this highlight the intertwined nature of the knowledge economy with 'energy-based' economy? Can the knowledge economy exist regardless of 'energy-based' economy and agricultural economy?

The primary focus of this research study was on developing measurement models for measuring national knowledge assets and for facilitating development of public sector capacities and competencies for such measurement. This study has achieved these objectives through developing context-specific methodology and measurement models for the above purposes. The above outcomes resulted from an understanding of strengths and limitations of the extant models through a critical analysis and comparative review. In addition to the above objectives, an additional important objective was to identify issues of theoretical, policy, and pragmatic concerns within which the measurement methodology, models, and measures are embedded. Review of existing theory, research, and practices has raised several fundamental questions that question the very premises underlying the concepts of knowledge, knowledge economy, knowledge society, knowledge assets, knowledge measurement, and knowledge management. It is hoped that future theory development supported by empirical research and pragmatic applications will chart the future progress of the national knowledge economies.

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Notes

[1] Although the more technical discussions on principles of measurement and psychometrics are beyond the scope of the audience of this paper, however given their critical importance, some very 'basic' issues that are critically relevant to efficacy of existing measurement models must be addressed.

[2] The inputs-processes-outputs-outcomes loop that relates measurement and management of knowledge assets is explained in detail in Section 5. In terms of socioeconomic causality, inputs refer to 'antecedents' and 'outcomes' refers to consequents.

[3] Variance is the range of difference between the maximum and minimum – for any given quantitative or qualitative attribute. The more extreme the differences, the more the measures tend to cancel out extreme 'negatives' and extreme 'positives' and tending to characterize everyone in the 'moderate' range. Also, countries with larger populations representing extreme 'negatives' would keep smaller 'very high positives' – that may be greatest contributors to national performance – outside the radar of policy analysts. It is a matter of concern that despite the developmental policies in place for the past few decades, the variances within the countries are in fact increasing for both the most developed countries as well as less developed nations.

[4] The *Metric Guide for Knowledge Management Initiatives* (United States of America Department of the Navy Chief Information Officer, 2001) defines a common action plan, performance blueprint as well as project-specific indicators for program and process management, program execution and operations, and for personnel and training issues. More specific input-process-output-outcome indicators related to ICT based process capital – such as best practices directories, lessons learned databases, communities of practice, expert directories, portals, collaborative systems, expertise yellow pages, and e-learning systems – are also available in the guide.

[5] In more precise terms (Churchill and Iacobucci 2001, p. 130-135), "We can never prove that X is a cause of Y. Rather, we always infer but never prove that a relationship exists. The inference is typically based on some observed data that should meet three conditions: concomitant variation, time order of occurrence of variables, and elimination of other possible causal factors. Evidence of concomitant variation refers to the extent to which X and Y occur together or vary together in the way predicted by the hypothesis. If they do vary as found from analysis of observed data, we can only say that the association makes the hypothesis more tenable, it does not prove it. Time order of variables implies: "One event cannot be a "cause" of another if it occurs after the other event. The occurrence of a causal factor may precede or may be simultaneous with the occurrence of an event; by definition, an effect cannot be produced by an event that occurs only after the effect has taken place." The elimination of other possible causal factors implies "when you have eliminated the impossible, whatever remains, however improbable, must be the truth," this type of evidence of causality focuses on the elimination of possible explanations other than the one being studied. This may mean physically holding other factors constant, or it may mean "adjusting" the results to remove the effects of factors that do vary."

[6] The underlying methodology was originally conceptualized as a 'guide for measuring the value of KM investments' (Hanley and Malafsky, 2002) and applied by the U.S. Department of Navy Chief Information Officer (2001) for translating its Knowledge Centric Organization (KCO) into an 'how to' operational action blueprint. The modified version developed for the current study: a) advances a more complete perspective of knowledge assets in terms of human capital, social capital, and intellectual capital; b) adapts the generic template to match the concerns and needs of the public sector and national policy; and, c) focuses on holistic development for socio-economic growth and human development.

[7] A critical weakness of most resource investments is that over-emphasis on inputs happens to constrain the attention on processes, outputs, and outcomes. This is particularly observable in investments related to structural and process capital (such as IC). It is therefore important that policy executives treat the strategic vision as the ultimate driver of inputs. The prevailing disconnect between knowledge asset inputs and knowledge performance outcomes, and how a strategy-pull model can be more effective for achieving these outcomes, are the subject of a forthcoming article by the author (Malhotra, 2004).