

S&T Higher Education Quality Indicators for Innovation Driven Economic Growth

A presentation by

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**Many thanks to the organizers
for kindly sponsoring my
participation in this meeting.**

**I am honored to be given an
opportunity to make this
presentation to you.**

**Please note,
as the title says,
in my presentation,
I am concentrating on
“Science and Technology
Higher Education
Institutions”**

Outline of Presentation

Part 1. Characteristics of New Economic World

Part 2. Technology Addition by S&T Work Force

Part 3. Short-comings of S&T Higher Education

Part 4. Reform Initiatives in Various Countries

Part 5. S&T Higher Education Quality Indicators

**Part-1 of the Paper
provides a contextual
review of the New World
Order that we live in:**

**The Characteristics of New
Economies of the World**

The New Economic World (1)

- **Human life — at home, work, and play — are intricately intertwined with technologies (the human-made, intelligence-based, help-mates).**
- **By making, improving, and using technologies, human societies have evolved from primitive life-style to “science and technology” intensive living.**
- **Curiosity; Imagination; Creativity; Competition —traits of human beings—have produced amazing inventions (science) & innovations (technology).**
- **Technological innovations have contributed to enormous productivity gain in economic activities and enabled enterprises to be highly competitive.**

The New Economic World (2)

- **Unprecedented advancements in the production, transportation, communication, and transaction technologies have contributed to “globalization.”**
- **Increasing globalization reflects various claims:**
 - Death of Distance; Shrinking of Time;**
 - Demise of Isolation; Power of Connectivity.**
- **ICT and Internet changed decision environment:**
 - Dizzy Pace of Change; Messy Type of Relations;**
 - Fuzzy State of Futures; Shaky Nature of Loyalty.**
- **Paradigm shift in the era of globalization:**
 - A large proportion of the new-world’s economic production is now “weightless — intellectual”**

The New Economic World (3)

- **The gap between rich and poor people of the world is widening; and middle class is enlarging — both nationally and internationally.**
- **Exploding new information and communication technologies (cell-phones and satellite-TV) have opened the eyes and ears of the vast majority.**
- **Growing middle class population want — and they want right away — what they can see the affluent people (near and far) are enjoying.**
- **But, since no country can produce everything, each country has to import something from other countries. Thus, international trade is a necessity.**

The New Economic World (4)

- **Contextual Characteristics of the new world:**
 - **Intellectual capital intensive economic activities**
 - **Homogeneous demand of goods and services**
 - **Economic interdependence through open trade**
- **Sustainable economic growth requires every country to engage in international trade.**
- **International competitiveness and value of exports depend on the “**technology content.**”**
- **For economic prosperity in the globalized era, “**technological innovation capacity building**” is a crucial requirement for developing countries.**

The New Economic World (5)

- In new economies: **technology** is human-made, intelligence-based, application-centric, help-mate.
- Technology is a **capital good**, used by firms as a transformation mechanism for goods production and as a platform for services provision.
- Technology is also used for **productivity gain** through value addition or cost reduction or both.
- The **systemic-components** of technology are:
 - Object-embodied physical facilities → tools or **Technoware**
 - Person-embodied human abilities → talents or **Humanware**
 - Record-embodied facts and figures → specs or **Inforware**
 - Organization-embodied work flows → steps or **Orgaware**

**Part-2 of the Paper
establishes the emerged
importance of national
higher education systems:**

**S&T Work Force for
Technology Content Addition**

Crucial Role of S&T Work Force (1)

- **UNESCO and OECD studied new requirements of Science and Technology (S&T) Work Force for Competitiveness at International and EU Levels.**
- **National Committees in many Asian and African countries have looked into the new requirements of S&T Work Force for Economic Development.**
- **OECD, WEF, World Bank, INSEAD, and US — Competitiveness Council; Science Foundation; National Academies; and American Management Association — have prepared thorough study-based reports on “Innovation and Competition.”**

Crucial Role of S&T Work Force (2)

- **Significant issues documented in the studies:**
 - **New “conceptual” age from information age**
 - **Knowledge management and learning society**
 - **Ability to learn and acquire knowledge capital**
 - **Talented S&T Work Force—the creative people**
 - **Protection of Intellectual Property—Patents**
 - **R&D Funding for Technological Innovation**
- **Convergence of recognition: education systems “producing knowledge and talent” for economies.**
- **With the increased demand for “transparency and accountability of academia” the “quality” of education and training has come to the forefront.**

Crucial Role of S&T Work Force (3)

- **Over the last 3-5 years, Scientists, Engineers, Development Planners, University Presidents and Enterprise Executives have collectively come to the following conclusions on economic growth:**
 - **Innovation is the new economic engine**
 - **R&D investment is essential for innovation**
 - **Knowledge is the most important resource**
 - **Talented S&T work-force is the bottleneck**
- **S&T Higher Education Systems produce the “knowledge” resource and “talent” for global level competition by focusing on “technology content” addition in goods produced and services provided.**

Crucial Role of S&T Work Force (4)

- **Technology Value Chain for Economic Growth:**
 - **Discovery and Invention (Knowledge);**
 - **Development of Ideas to Actionable Intelligences (Conceptual Frameworks);**
 - **Transformation of New Intelligences to Technologies (Technoware, Humanware, Inforware, and Orgaware); and**
 - **Utilization of Technological Innovation for Goods and Services (Value Generation).**
- **Education and Training Institutions provide the resources (capital goods) for “technological innovation” driven international competition.**
- **Education Quality is the basis for Competition.**

**Part-3 of the Paper
discusses the common
short-comings in many
developing countries:**

**Problems with S&T Higher
Education**

Some of the Short-comings (1)

- **In order for an S&T Higher Education System to contribute to the economic development process, it should be performing the following functions:**
 - **production of qualified human resources (talent)**
 - **training science and technology researchers**
 - **producing new science and technology knowledge**
 - **co-innovating with industrial and public R&D units**
- **Historically knowledge grew within: disciplines; institutions; activities; and organizations.**
- **Nowadays, most new knowledge for technology innovation is produced through fusion of “partial” and “dispersed” knowledge available in explicit and tacit forms through networking and retreat.**

Some of the Short-comings (2)

- **In order to increase access to National Higher Education System many institutions going online:**
 - **capacity is limited by growth in ICT and Internet**
 - **growth is generally in the “non S&T” study areas**
 - **effective knowledge networking very much limited**
 - **no face-to-face interaction for knowledge fusion**
 - **business market is covered by foreign universities**
- **Under the pressure for increasing outputs, most universities are going for standardized curricula and standardized testing systems resulting in:**
 - **Factory like operation, producing students who prepare for tests and forget everything soon after;**
 - **Instead of open-ended questions for creativity, multiple choice questions make mockery of reality.**

Some of the Short-comings (3)

- **Universities aspire to be centers of excellence without any concern for relevance to economy:**
 - **go for excellence in every area with limited funds**
 - **much emphasis on science and little on technologies**
 - **counting paper publications for faculty promotion**
 - **faculty and students take easy path for dissertations**
- **Academia-Industry “relationship” goal exists on paper, as SME research problems are beneath the dignity of prestigious PhD degree holding faculty.**
- **Even though “goods and services” innovation problems require — economic; cultural; social; and technological considerations — tertiary degree programs are still not adopting systems approach.**

**Part-4 of the Paper
deals with some reforms
currently underway in
different countries:**

**Reform Initiatives in S&T
Higher Education**

Reform Initiatives Underway (1)

- Now let's review a number of major "education reforms" currently underway in various countries.
- Since each of the developing countries has to compete for trade with the developed country economies, it is prudent to be forewarned with their education reform plans for competition.
- Therefore, before identifying the set of desired S&T Higher Education Quality indicators, in this part of the presentation, we list the most relevant initiatives underway in some selected countries.

Reform Initiatives Underway (2)

- **Education Reform in Australia includes:**
 - **Greater alignment of PhD level education with national innovation agenda.**
 - **Target setting for high level S&T degrees**
- **Education Reform in India includes:**
 - **ICT to be made more accessible to teachers, students and administration for learning, training, research, administration, monitoring, etc.**
- **Education Reform in Japan includes:**
 - **Producing quality papers and patents in emerging high-technology categories.**

Reform Initiatives Underway (3)

- **Education Reform in Singapore includes:**
 - **Promoting economic growth by a Council for Research, Innovation and Enterprise.**
 - **NUS excellence and linkage with industry.**
- **Education Reform in UK includes:**
 - **New Department of Innovation, Universities and Skills (DIUS) to promote world-class research and scholarship to create innovation.**
- **Education Reform in USA includes:**
 - **Funding R&D for innovation; integrating education of scientists and engineers with national security considerations.**

Reform Initiatives Underway (4)

European Union (EU) and OECD Member Countries (the rich and developed nations) are all focusing on the items listed in the previous slides to make their S&T Education System the best in the World.

Summary of what the Competitors are Doing

- **Technological innovation for competition.**
- **Targeted High-Tech Goods-Services export.**
- **R&D funding for new knowledge creation.**
- **Development of highly talented work-force.**
- **Creativity fostering educational system.**
- **Center of relevance as well as excellence.**

**Part-5 of the Paper
lists a set of indicators for
assessing quality of a
higher education institute:**

**S&T Higher Education
Quality Indicators**

List of Quality Indicators (1)

➤ Conventional Measures:

- Graduates at Masters, Doctoral and Post-Doctoral Levels
- Peer Reviewed Journal Publications and Citation Counts
- Patent Registrations and Commercialization Endeavors

➤ Relevance Measures:

- Proportion of Real World Innovation Related Problem Solving
- Adoption of Systems Approach in Project and Research Work
- Contemporary Subjects: Nanotechnology; Biotechnology; etc

List of Quality Indicators (2)

➤ Excellence Measures:

- Learning to Learn Philosophy Absorption by Students
- Use of Concepts Fusion for New Knowledge Creation

➤ Effectiveness Measures:

- Culture Development for Self-reliance Goal Adoption
- Creativity Facilitation Services of Faculty and Staff

➤ Efficiency Measures:

- Passion for Serious Research using Internet and Retreat
- Project Work for Collaboration based Internship in Firms

**Thank You Very Much
for Your Kind Attention**