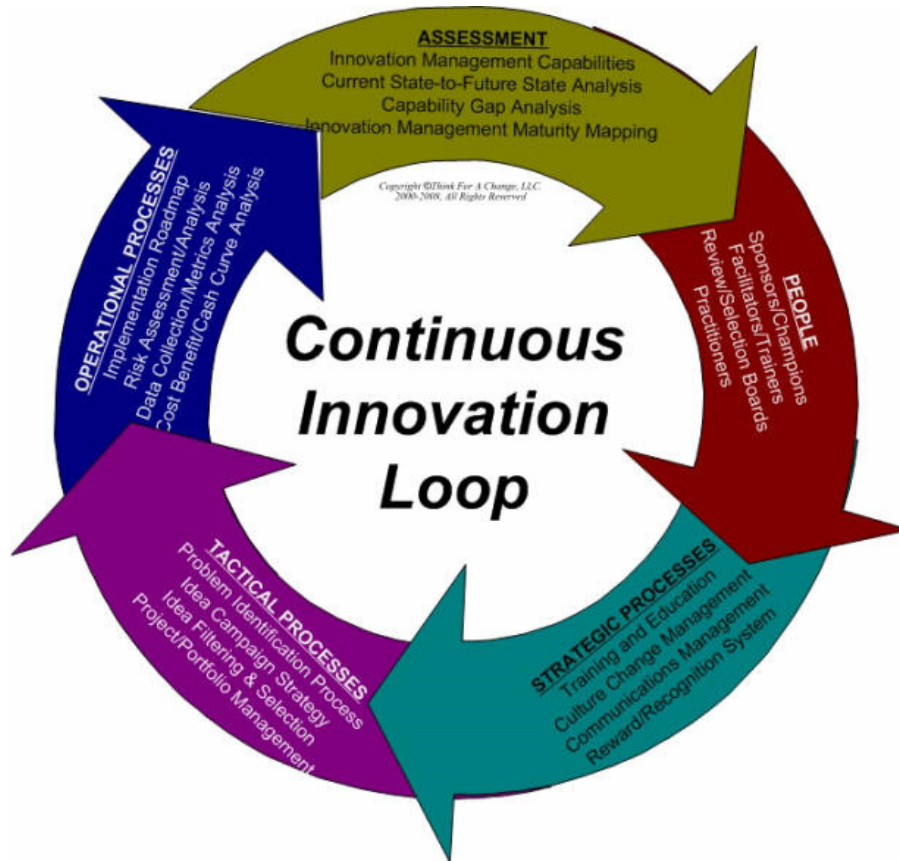


JAMAICA'S INNOVATION INFRASTRUCTURE: A COMPARATIVE ANALYSIS
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Innovation is the conversion of knowledge and ideas into tangible or intangible products, processes and services which may be for commercial use, or for the public good. Ideas drive information and improve the technology of production (Jones, 2002). A country whose citizens convert ideas into scientific and technological production is therefore expected to experience a high level of economic progress. If ideas drive innovation then the right environment must be established to generate and nurture these ideas and support their subsequent conversion into tangible or intangible benefits to society.

Developed countries such as the United States, Norway and Japan have harnessed ideas throughout the years to build their economies. Natural resources have been used for centuries through successive waves of intellectual and practical innovation (Shapiro & Hassett, 2005). However, while developed countries enjoy a relatively high level of innovation and economic development, developing countries are lagging behind.

In recent years the government of Jamaica has been focused on catalyzing and improving innovation in the country. Among the initiatives to boost innovation are: increased expenditure on Research & Development (R&D) from 0.1 per cent of GDP to 0.3 representing a 57 per cent from 2001 to 2004 (Science & Technology Indicator's Report, 2005) and the National Medal for Science and Technology (awarded by the Prime Minister). Other initiatives include: establishment and capitalization of two funds¹ to support S&T activities; promotion of entrepreneurship through small business development; the National Innovation Awards for Science and Technology; the National Quality Awards Programme and expansion of the Information and Communications Technology infrastructure

In addition, there are a number of public organizations such as the National Commission on Science and Technology (NCST), the Scientific Research Council (SRC) and the R&D departments of some ministries that are involved in R&D and S&T activities that seek to promote innovation and popularize S&T. R&D also occurs within the main tertiary institutions such as the University of the West Indies, the University of Technology, Northern Caribbean University and the College of Agriculture, Science and Education. While the level and type of R&D activity has been important there is still a huge gap between R&D and inventions, especially in meeting the needs of the local private sector. R&D in the private sector is relatively weak with few firms having the confidence to carry out significant research.

Jamaica has also made strides in educating the public on intellectual property rights and improving the intellectual property system. The government is now offering considerable support in the development of small businesses which is in line with global policies on entrepreneurship. Tax exemptions have also been granted on the purchase of R&D equipment and a Science and Technology Policy has been submitted to parliament that emphasizes the critical role of R&D, science education and popularization.

With all of these developments, how does Jamaica's innovation infrastructure compare with that of Small Island Developing States (SIDS) and developed countries? This is a pertinent question in light of the expressed intention of policy makers to take Jamaica to first world status in 20 years time.

¹ The National Energy Fund is a facility under the PetroCaribe Agreement, while the Universal Service Fund is financed through a levy on incoming international calls.

This paper seeks to answer this question by comparing aspects of the innovation infrastructure in Jamaica with those of Singapore and Norway. In particular, five quantitative indicators are compared: adult literacy; expenditure on education; percentage of tertiary graduates; expenditure on R&D and number of patents filed. The paper contends that innovation is a prerequisite to boost competitiveness, commercialize technology and spur sustained development. The selection of the countries was based on two main reasons, first, Singapore, like Jamaica, is a SIDS and second, Norway being a developed country, could provide some benchmarks for Jamaica's innovation.

Accepting that innovation drives economic development, the paper explores the nature of the relationship between the type of innovative activities and the economic status of the selected countries. Barriers to innovation in Jamaica are also identified and recommendations made to overcome these.

Socio-economic Overview of the Selected Countries

Jamaica

Jamaica currently has a population of 2.6 million. The economy is heavily dependent on services, which now account for 71 per cent of GDP (Economic and Social Survey, 2005). The country relies heavily on foreign exchange from remittances, tourism, and bauxite/alumina. Among the current problems being faced by the economy are high interest rates, increased foreign competition, exchange rate instability, a sizable merchandise trade deficit, and high debt to GDP ratio. The average growth of GDP for the past five years (2000-2005) is 1.4 per cent (Table 1).

Jamaica ranked 60 on the Global Competitive Index Ranking, 2005, three places up from 2004. Singapore and Norway ranked 5 and 12 respectively. Countries with high rankings show that good institutions and competent macroeconomic management, coupled with world-class educational attainment and a focus on technology and innovation, are a successful strategy for boosting global competitiveness.

Norway

Norway, regarded as a developed country, had a population of 4.6 million in 2005. The country is richly endowed with natural resources - petroleum, hydropower, fish, forests, and minerals - and is highly dependent on its oil production and international oil prices, with oil and gas accounting for one-third of exports (CIA Fact Book, 2005). The average GDP growth rate in 2005 was 3.9 per cent which is over two and a half times higher than Jamaica's GDP growth and the per capita GDP was US\$ 42,300.

Singapore

Singapore has a population of 4.5 million people as of 2005. The country has a successful free-market economy, enjoys a remarkably open and corruption-free environment, stable prices, and a per capita GDP equal to that of the four largest West European countries (CIA World Fact Book, 2005). The economy depends heavily on exports, particularly in electronics and manufacturing. Singapore has little natural resources. The real GDP growth rate in 2005 was 6.4 per cent (4.5 times Jamaica's GDP growth) and Singapore enjoys a per capita GDP of US\$ 28,100. It is seen as one of the most efficient business centres of the world.

Table 1. Selected Socio-economic indicators in Jamaica, Norway and Singapore.

Country	Population (million)	Real GDP growth rate (%)	Per capita GDP (US\$)	Unemployment rate (%)	HDI ² Rank	³ Global Competitive Index Rank
Jamaica	2.6	1.4	4,400	11.5	98	60
Norway	4.6	3.9	42,300	4.6	1	12
Singapore	4.5	6.4	28,100	2.5	25	5

Sources: Economic and Social Survey, 2005, CIA World Fact Book, 2005, Global Competitiveness Report, 2006, Human Development Report, 2005., Singapore Department of Statistics

As seen in Table 1 there is a wide disparity between the Jamaican economy and the economies of Norway and Singapore. Singapore, a developing country, ranked 25 out of a total of 177 countries listed in the Human Development Index, 2005 while Norway, a developed country had the highest rank in the world. Jamaica ranked 98 behind other CSM countries such as Barbados (30) and Trinidad and Tobago (57).

Comparative analysis of innovation in the countries

Education

Quality education is important in creating and driving the knowledge economy. Countries with high levels of education enjoy higher levels of innovation and economic growth than countries with lower levels of education. Today's economy is knowledge based so workers not only must have higher levels of education, but the ability to adapt, learn and master new skills quickly and efficiently.

Table 2: Key Educational Variables – Norway, Singapore and Jamaica.

Country	Adult Literacy ⁴ (%)	Public Expenditure in Education (% of GDP)	Tertiary education (% of population)
Norway	100	7.6	40
Singapore	93.0	3.5	25
Jamaica	88.0	6.1	8.3

Source: Human Development Report, 2005, Education Fact Sheet, 2005, Ministry of Education Singapore, Population Census, Jamaica 200, OECD Tertiary Review, Norway, 2006.

Table 2 shows that Norway enjoys 100 per cent adult literacy while the figure for Singapore stood at 93 per cent in 2004. However, Jamaica's adult literacy lags behind these two countries at 88 per cent. The percentage of a country's population with tertiary level education is also linked to the type and quality of innovation. The percentage of the population with tertiary education in Singapore and Norway was three and five times the figure for Jamaica. This is a significant gap that needs to be addressed if Jamaica is to achieve developed status.

² Human Development Index, 2005. The Index measures countries progress in life expectancy, educational attainment and adjusted real income. Total number of countries in HDI, 177.

³ The Global Competitive Index, 2006 ranks, countries based on criteria such as institutions, infrastructure, higher education, market efficiency, technological readiness and innovation. Total number of countries, 125.

⁴ Adult literacy is based on literate persons over 15 years old.

The table also shows that in 2005 public expenditure on education was 7.6 per cent and 3.5 percent of GDP in Norway and Singapore respectively while public expenditure on education in Jamaica was 6.1 per cent of GDP. Comparison with the selected countries shows that Jamaica spends almost twice as much on education than Singapore but less than Norway. Conventional wisdom suggests that the amount of expenditure by a country on education should be proportional to the economic development it experiences. Hence, one might expect that Jamaica and Norway should experience greater economic progress than Singapore.

However, there are other factors that must be considered; among them are the quality and type of education and the amount of expenditure on tertiary education as part of the education expenditure. According to the Human Development Report, 2005 Singapore and Norway spends 30 percent and 27.5 percent of the education budget on tertiary education respectively while the Economic and Social Survey Jamaica, 2005 reported a 19 per cent expenditure on tertiary education.

While innovation is not confined to persons with tertiary education the thrust towards a global knowledge economy requires a high degree of education to remain competitive. The type and quality of university education is also important in spurring innovation. For instance, universities in Singapore and Norway have a high research component as part of science courses which prepare students to think innovatively. On the other hand, tertiary institutions in Jamaica and the Caribbean tend to be less R&D focused. Graduates are therefore not adequately equipped to deliver high impact innovations necessary for significant economic development

Research and Development

A crucial element of any country's innovation system is R&D. In fact, economists agree that countries with high levels of R&D usually enjoy high levels of innovation and thus, significant economic growth. Table 3 compares R&D expenditure among the selected countries. The comparison shows that R&D expenditure in Singapore and Norway exceeds that of Jamaica by six and seven times respectively. Furthermore, these two countries have aligned R&D to their social and economic needs. Although Jamaica has recognized the importance of innovation, the level of investment in R&D by the public and private sectors has been inadequate.

Table 3 also shows that Singapore and Norway boasts over 4,000 researchers in R&D per million people. Although statistics on the number of researchers in R&D are not available for Jamaica it is known to be significantly less than the two other countries.

Table 3: Expenditure on R&D and Researchers in R&D

Country	R&D Expenditure /% GDP	Number of researchers in R&D/per million persons
Jamaica	0.3	-
Norway	1.8	4,587
Singapore	2.15	4,745
World	1.7	894
Developed Countries	2.3	3273
Latin America and the Caribbean	0.6	261

Source: World Development Report, 2006, S&T Indicators Report, 2005, UNESCO Science Report, 2005

While the bulk of expenditure on R&D is attributed to the government in Jamaica, Singapore and Norway have successfully forged public and private sector partnerships to boost R&D activities. Nevertheless, the governments of the two countries continue to spend significantly on R&D. For example, Singapore has embarked on creating an international R&D hub (which is estimated to cost US\$8.5 billion) for researchers in biomedical sciences, information technology and media which have lured top scientists from across the world (Tan & Phang, 2005).

In addition to the comparatively low expenditure, the level and type of R&D activity is an important driver of economic growth. Jamaica's innovation over the years has been low impact unlike countries like Singapore and Norway which expend greater effort and money in high impact, high technology R&D activities. In these countries policies and government incentives help to create enabling environments for energetic R&D activities.

Intellectual Property Rights and Patents

Over the last generation, economists have established a series of findings that demonstrate the vital importance of strong intellectual property rights to catalyze sustained innovation, encourage technological transfer and promote economic development (Shapiro and Hasset, 2005). Norway and Singapore boast highly developed and efficient intellectual property rights systems where inventors/innovators can gain individual profits while the society experiences social and benefits.

One of the important aspects of intellectual property rights is a patent. A patent, as defined by the Patent Act (1857), is a grant by the State of a monopoly in the use of an invention to the inventor, thereby excluding others from making, using or selling the invention within the country of grant for a specified period of time. Patent information is considered to be one of the best and most reliable methods of quantifying innovation or science and technological output⁵. In addition, patents bridge the gap between science and the marketplace and encourage private sector investment in R&D and innovation because of the increased level of protection awarded to the invention/innovation. Individuals or firms will be reluctant to spend on R&D if it easy for others to pirate their inventions.

Although patents indicate innovation activity not all inventions are patented. Companies may choose alternative methods of intellectual property protection such as trade secrecy or marketing techniques. Many informal inventions in Jamaica go unnoticed because they are not patented.

In 2004 resident patent filings per million people in Norway were 335 and 147 for Singapore (World Intellectual Property Office, Patents Report, 2006). On the other hand, patent filings for Jamaica over the five year period (2000-2005) stood at 23 per million people (Economic and Social Survey Report, 2005). A patent in Singapore and Norway initially lasts for 20 years while in Jamaica it is fourteen years with the option to renew. This is significant because the longer duration of patents favours innovation. Norway and Singapore have both signed on to the Patent Cooperation Treaty (PCT)⁶ and has filed significant patent applications. Jamaica is still not a member of the PCT.

High impact innovations, therefore, originate in Singapore and Norway where commitments to R&D are strong, there is political and macroeconomic stability, barriers to starting new businesses are relatively low and intellectual property rights are adhered to.

⁵ Science and technological output includes new processes and products.

⁶ The Patent Cooperation Treaty (PCT) came into force in 1970 and represents an international system for filing patents. This means that patents filed under the PCT are protected within member countries. Currently 126 countries are members.

Barriers to Innovation in Jamaica

The research has shown that in spite of the various initiatives to boost innovation, Jamaica lags far behind both Norway and Singapore when variables for education, R&D and Intellectual Property Rights are examined. This largely reflects the fact that there are a number of barriers stifling the creative potential of Jamaicans. Some of these barriers relate to the need for a science, technology and innovation (STI) culture, science education and R&D financing.

Culture

While the Jamaican culture has achieved global prominence through our music, dance and athletic abilities and these areas epitomize creative talent, we have yet to create diversity in innovation and engender a scientific culture. The country still suffers from low initiatives in scientific and technological effort and to a large extent the prevailing organizational model remains mechanistic. In a lot of public and private sector organizations enough is still not being done to encourage innovative thinking. Even at the tertiary level students do not sufficiently show new ways of thinking and are not adequately encouraged to do so. An element of secrecy and mistrust pervades the society where information is often kept rather than disseminated.

Science Education

There is still a lot to be done in improving the quality of science education, although the number of students being exposed to scientific knowledge is increasing. The current education system does not fully embrace innovative and adventurous thinking. Students should be taught the practical use of science from the early childhood years and continue throughout their school life.

Most students at the secondary level opt for business and social subjects rather than core science subjects. Exposure of students to practical scientific solutions to everyday problems must be an integral component of the education system. Equipped with highly trained science teachers, a paradigm shift should be cultivated in educational institutions which encourages new ways of thinking.

The R&D intensity in tertiary institutions is still inadequate although some improvement has been made. The UWI for instance is still lagging behind in creating and spearheading practical research to provide business solutions to promote and stimulate economic development for Jamaica and the Caribbean region. The University of Technology has also not been able to generate the impact on science and technology as envisioned.

Funding for R&D

The government still bears the weight of R&D funding in Jamaica although some tertiary institutions manage to obtain grants from different sources to complement their research funding. However, funding is difficult to obtain for research given the high risk involved. It is difficult to carry out high impact and intensive R&D which leads to innovation without adequate funding.

Private funding for R&D is weak, typified by the low level of R&D activities in the private sector. The Jamaican private sector must play a leading role in stimulating R&D and no longer depend on heavy government subsidies to drive innovation.

Recommendations

In order to address these barriers the following recommendations are being made:

1. Jamaica must create a scientific and technological culture where technology is not only consumed but created. Scientific and adventurous thinking must be encouraged in homes, communities, schools, work places and even in churches. Public and private sector agencies must encourage creative thinking, readily adapt to change and support and award creative talent to boost innovation. The country should also be tolerant and open to diversity and actually create the right environment to attract and retain creative talent.
2. Intensive R&D in sync with societal and industry needs must be a critical component of the curricula. There should be strong links among research bodies, tertiary institutions and industry to stimulate innovation and boost economic development.
3. Government funding for R&D, should be increased to at least 1 per cent of GDP, the average for developing countries, (Table 1) in the medium term and eventually be increased to at least 2 per cent in the long term to be on par with developed countries.
4. Forging strong, sustainable public-private sector partnerships is essential for stimulating and maintaining R&D. In addition, the continued emphasis on stimulating the growth of SMMEs and entrepreneurship should continue as these enterprises, if given the support, usually executes significant R&D.

Conclusion

The high levels of innovation within Norway and Singapore have had significant impacts on their social and economic development. Although significant strides have been made, Jamaica's current innovation environment is still inadequate to catalyze and support sustained innovations in order for the country to be competitive and achieve first world status. The Caribbean Single Market (CSM), of which Jamaica is a member, requires openness, new skills, innovation and transfer of technology which will allow countries within the CSM to successfully compete globally and enjoy high standards of living.

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