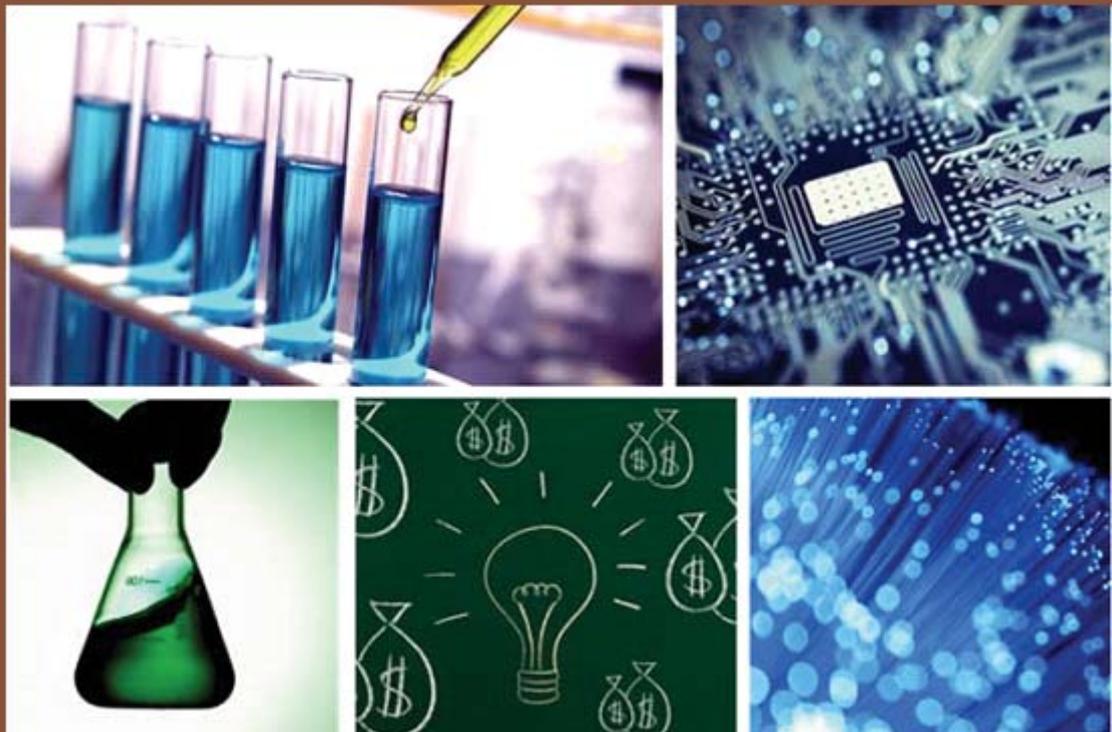


## Fostering Innovation to Fast-forward Growth in Sri Lanka



Anushka Wijesinha  
Nethmini Perera

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**Fostering Innovation to Fast-forward  
Growth in Sri Lanka**

**Anushka Wijesinha  
Nethmini Perera**

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**INSTITUTE OF POLICY STUDIES OF SRI LANKA**

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Institute of Policy Studies of Sri Lanka  
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## **Executive Summary**

*"Innovative entrepreneurs, with their new products, new processes, new markets, and novel approaches to putting inventions to effective use, are key to an economy's long-term growth"*

***Dr. William J. Baumol***

*Harold Price Professor of Entrepreneurship, Berkley Center for Entrepreneurship and Innovation, New York University;*

*Senior Economist and Professor Emeritus, Princeton University, USA*

With technological transformations continuing at a rapid pace, and the emergence of a globalised market-place, all countries are under pressure to become more innovative. Emerging economies, in particular, have been able to 'leapfrog' through stages of development by embracing and fostering innovation. For Sri Lanka too, adopting existing technologies and best practices, while of course gradually developing new ones, is now a critical policy priority in order for the economy to move up the value chain and the country to move up the development ladder.

This is envisaged in the country's current development paradigm as well. The Sri Lanka: Emerging Wonder of Asia document states that, "Sri Lanka's successful integration with the global economy and its sustained success in international competition will depend increasingly on effective combinations of science, technology and innovation" (p.126).

Yet, much needs to be done. A country's high-tech exports are a significant measure of a country's ability to innovate and commercialize scientific findings effectively. In Sri Lanka, the share of high-tech exports out of the total manufactured exports was just 2.2 per cent in 2001 and has fallen further to 1 per cent by 2010. While Sri Lanka recorded an average 1.8 per cent of high-tech exports share each year in the last decade, Korea recorded 75 per cent, Thailand 27 per cent, and Singapore and Malaysia over 50 per cent.

This is a direct symptom of Sri Lanka's weak innovation inputs - for example, a very low level of national R&D investment as a proportion of GDP, a key determinant of innovation in a country. As a percentage of GDP, Sri Lanka's Gross Expenditure on R&D (GERD) was just 0.21 per cent in 2004, 0.17 per cent in 2006, and 0.11 per cent in 2008. Meanwhile, the expenditure on R&D by the private sector, out of total R&D expenditure, is remarkably low. Unlike in most developed countries where much of the R&D expenditure is by the private sector - over 65 per cent in most cases - in Sri Lanka it is a mere 18 per cent. The bulk of R&D expenditure in Sri Lanka is by the state sector (57 per cent). This has strong implications on the rate of commercialization of science and technology research.

Yet, innovation is distinct from just research and it doesn't autonomously result from it. The nexus of industry-research collaborations, appropriate financing options, and support for commercialization are vital drivers to move research to innovation. Unlike in most developed and emerging economies, universities and research labs in Sri Lanka have not substantially established linkages with industry. Very few noteworthy examples of industry-research linkages

exist in Sri Lanka today. The most prominent one is the Sri Lanka Nanotechnology Centre (SLINTEC) - a first-of-its-kind initiative that brings together leading private sector firms with leading Sri Lankan nanotechnology scientists. In its first full year of operations alone, SLINTEC was able to secure 5 international patents on nanotechnology products, including carbon nanotubes, nano fertiliser and nano rubber.

Meanwhile, building a qualified pool of individuals geared towards S&T and R&D will be critical to Sri Lanka's innovation ambitions. Education - especially science education at all levels - is important not only for increasing general science and technology literacy, but also to build up a critical mass of scientists, researchers and engineers. Yet, very few students are engaged in science and engineering courses at Sri Lankan universities. Compared to a distinct knowledge-led economy like Singapore, where the majority enrolment is in engineering sciences of nearly 30 per cent, in Sri Lanka the majority enrolment is in Arts of over 30 per cent. This is a direct reflection of the fact that only 10 per cent of all secondary schools in the country have the facilities to teach science stream at the A/L (Grades 12-13). This naturally restricts the number of students who are able to gain admission to science and engineering programmes in university. Eventually, this leads to the low numbers of qualified-professionals - Sri Lanka records only 237 researchers per million people, well below the developing country average of 374.

In conclusion, fostering a forward-looking innovation system, that supports knowledge-interaction among various parties, and commercialization, is critical, if Sri Lanka is to achieve faster growth. Sri Lanka's weak performance on innovation is a symptom of the low priority given to S&T and R&D investment over the past several years. This may be largely attributed to the distraction of fighting a war. In post-war Sri Lanka, reversing this will be a critical determinant of our competitiveness.

Innovations come from the entrepreneurs who make them happen and ultimately depend on a society's responsiveness and ability to transform research into higher exports, into things that add value to people's lives and to the economy. Encouraging these entrepreneurs with appropriate policy support for "techno-entrepreneurship" is important, for example, by setting a conducive business environment, better access to finance through venture capital, incentivizing commercialization of inventions, etc.

For successful innovation policy to kick-in, it will need the firm backing of top leaders, to lend credibility to the vision and facilitate the adoption of key measures for removing bureaucratic hurdles. It is time that Sri Lanka set up a powerful 'National Innovation Council' chaired by H.E. the President or Prime Minister which can drive the innovation policy agenda at a national, strategic-level.

## විධායක සාරාංශය

කඩිනම් වේගයකින් අඛණ්ඩව සිදු වෙන තාක්ෂණ විද්‍යාත්මක විපර්යාසය ගෝලීයකරණයට පාත්‍ර වූ වෙළඳපොළක් ඇති වීම සමඟ සියළු රටවල් ඉතා අධික නව්‍යතාවයක් ඇති රටවල් ලෙස වෙනස් විය යුතුව ඇත. ශ්‍රී ලංකාවද තමන්ගේ ආර්ථික වටිනාකම් දැමීමට ඉහළට ගමන් කිරීමටත් සංවර්ධන ඉණිමගෙහි රට ඉහළට ගෙන යාමටත් පවතින තාක්ෂණයල සහ යහපත් ක්‍රියාකාරකම් සම්ප කර ගැනීමෙන් නව තාක්ෂණ සහ ක්‍රියාකාරකම්ල ක්‍රම ක්‍රමයෙන් ඇති කර ගැනීම දැන් ප්‍රතිපත්ති ප්‍රමුඛතාවය බවට පත්ව ඇත.

මෙය රටේ පවතින සංවර්ධන ක්‍රියාවලියෙහිද සැලකිල්ලට ගනු ලැබ ඇත. ශ්‍රී ලංකාව ආසියාවේ ආශ්චර්යය යන ලේඛණය මෙසේ සඳහන් කරයි. ,ගෝලීය ආර්ථිකය සමඟ ශ්‍රී ලංකාවේ සාර්ථක සංකලනය සහ ජාත්‍යන්තර තරගකාරිත්වයේ එහි අඛණ්ඩ ජයග්‍රහණයන් විද්‍යාව තාක්ෂණය සහ නව්‍යතාව යන කරුණුවල ප්‍රතිඵලදායී සංයෝජනය මත වැඩියෙන් රඳා පවතියි., (පි.126)

නව්‍යතාවයට හා විද්‍යාත්මක සොයාගැනීම් ප්‍රතිඵලදායී ලෙස වාණිජකරණයට ලක් කිරීම සඳහා වූ රටක හැකියාව පෙන්නුම් කරන වැදගත් මනුෂ්‍ය වන්නේ එම රටෙහි උසස් තාක්ෂණික අපනයන්ය. ශ්‍රී ලංකාවේ උසස් තාක්ෂණ අපනයනවල කොටස 2001 වසරේදී සම්පූර්ණ නිෂ්පාදන අපනයනයෙන් 2.2% කි. නව ද එය 2010 වන විට 1%ක් ලෙස පහත වැටී ඇත. ඉකුත් දශකයේ එක් එක් වසරවල ශ්‍රී ලංකාව 1.8% උසස් තාක්ෂණික අපනයන කොටසක් පෙන්නුම් කරන විට කොරියාව 75%ක කොටසකුත් තායිලන්තය 27% ක කොටසකුත් සිංගප්පූරුව සහ මැලේසියාව 50% කට අධික කොටසක් පෙන්නුම් කර ඇත.

මෙය ශ්‍රී ලංකාවේ දුර්වල නව්‍යතා යෙදවුම්වල සෘජු ලක්ෂණයකි. උදාහරණයක් ලෙස දළ දේශීය නිෂ්පාදිතයේ සමානුපාතයක් වශයෙන් ආර්ථික පර්යේෂණ හා සංවර්ධනයට ඉතා අඩු මට්ටමක ආයෝජනයක් පවත්වා ගැනීම රටක නව්‍යතාව තීරණය කරන වැදගත් කරුණකි. දළ ජාතික නිෂ්පාදිතයේ අනුපාතයක් ලෙස පර්යේෂණ හා සංවර්ධනය සඳහා වූ ශ්‍රී ලංකාවේ දළ වැය 2004 වසරේදී 0.21%කි. 2006 වසරේදී 0.17කි. 2008 වසරේදී 0.11%කි. මේ අතර පර්යේෂණ හා සංවර්ධනය සඳහා වූ පුද්ගලික අංශයේ වැය එම විෂය සඳහා වූ මුළු වැයෙහි කැපී පෙනෙන ලෙස අඩුයි. පර්යේෂණය හා සංවර්ධනය සඳහා කරනු ලබන වියදම්වලින් වැඩි කොටසක් 65%ක් වැඩියෙන් පුද්ගලික අංශය දරණ සංවර්ධනයවූ බොහෝ රටවල් මෙන් නොව ශ්‍රී ලංකාවේ එය හුදෙක්ම 18% කි. ශ්‍රී ලංකාව රාජ්‍ය අංශයෙන් පර්යේෂණ හා සංවර්ධනය සඳහා කරනු ලබන මුළු වියදම 57% කි. විද්‍යා හා තාක්ෂණ පර්යේෂණය වාණිජකරණයට ලක් කිරීමේ ප්‍රතිශතය මත මෙයට ප්‍රබල බලපෑම් ඇත.

නව ද නව්‍යකරණය යනු හුදෙක්ම පර්යේෂණවලින් වෙනස් වන අතර පර්යේෂණයක ස්වයං ප්‍රතිඵලයක් වශයෙන් නොලැබේ. සංවර්ධනය වූ සහ සංවර්ධනය වෙමින් පවතින බොහෝ ආර්ථිකවල මෙන් නොව ශ්‍රී ලංකාවේ විශ්ව විද්‍යාල සහ පර්යේෂණ ආයතන බොහෝවිට කර්මාන්ත ක්ෂේත්‍රය අතර පවතින සම්බන්ධතාවයට සැලකිය යුතු උදාහරණ කීපයක් පමණකි. එයින් ඉතා වැදගත් ආයතනය වන්නේ ශ්‍රී ලංකා නැනෝ තාක්ෂණ ආයතනයයි. ්බ්‍රැහම්චන්ද්‍ර මෙසේ ප්‍රමුඛ පෙළේ පුද්ගලික අංශයේ ආයතන ශ්‍රී ලංකාවේ ප්‍රධාන නැනෝ තාක්ෂණික විද්‍යාඥයින් සමඟ සම්බන්ධ කරන එම ක්ෂේත්‍රයේ ශ්‍රී ලංකාවේ ප්‍රථම ආයතනයයි. එම ආයතනය මෙහෙයුම අරඹා මුල් වසර තුළදී පමණක් නැනෝ නළ නැනෝ පොහොර සහ නැනෝ රබර් ඇතුළු නැනෝ තාක්ෂණික නිෂ්පාදන 05ක් සඳහා ජාත්‍යන්තර ජේටන් බලපත්‍ර ලබා ගෙන ඇත.

නව ද විද්‍යා තාක්ෂණික සහ පර්යේෂණ සංවර්ධන කටයුතුවල නිරත පුද්ගලයන් සම්බන්ධ කරමින් සුදුසුකම්ලත් කණ්ඩායමක් ඇති කිරීම ශ්‍රී ලංකාවේ නව්‍යතා පරමාර්ථයන්ට අත්‍යවශ්‍යයි. අධ්‍යාපනය විශේෂයෙන් සියලු මට්ටම්වල විද්‍යා අධ්‍යාපනය සාමාන්‍ය විද්‍යා හා තාක්ෂණික දැනුම වැඩිදියුණු කිරීමට පමණක් නොව විද්‍යාඥයින් පර්යේෂකකරුවන් සහ ඉංජිනේරුවන් ඇතුළත් වැදගත් මිනිස් සම්පතක් ඇති කිරීමටත් වැදගත් ය. ශ්‍රී ලංකාවේ විශ්ව විද්‍යාලවල ඉතා සුළු ප්‍රමාණයක සිසුන් පමණක් විද්‍යා හා ඉංජිනේරු ශිල්ප අධ්‍යයනවල නියැලී සිටී. 30% ක් පමණ බහුතර සිසුන් පිරිසක් ඉංජිනේරු ශිල්ප පාඨමාලාවන් හදාරන සිංගප්පූරුව වැනි අනුපම දැනුම පෙරටු කරගත් ආර්ථිකයක් සමඟ සසඳන විට ශ්‍රී ලංකාවේ 30% ක බහුතර සිසුන් කලා ක්ෂේත්‍ර පාඨමාලා හදාරනු දක්නට ලැබේ. ශ්‍රී ලංකාවේ උසස්පෙළ පාසල් සියල්ලෙන්ම 10%ක පමණක් උසස්පෙළ පන්තිවල (12 - 13 ශ්‍රේණි) විද්‍යාව ඉගැන්වීමේ පහසුකම් සහිතව තිබීමේ සෘජු පරාවර්තනය ලෙස මෙය හැඳින්විය හැකිය. මෙය නිතරින්ම විශ්ව විද්‍යාලවල විද්‍යා හා ඉංජිනේරු ශිල්ප අධ්‍යයනය සඳහා වූ ප්‍රවේශයට සුදුසුකම් ලබන සිසුන්ගේ සංඛ්‍යාව සීමා කරයි. එහි ප්‍රතිඵලයක් වශයෙන් සුදුසුකම්ලත් වෘත්තිකයන්ගේ සංඛ්‍යාව අඩු වීමට හේතු සාධක වෙයි. ශ්‍රී ලංකාව මිලියනයක පිරිසකට පර්යේෂකයින් 237ක් පමණක් ඇති රටකි. මෙය සංවර්ධනය වෙමින් පවතින රටවල සාමාන්‍ය අගය වන 374ට වඩා අඩු ය.

අවසාන වශයෙන් ශ්‍රී ලංකාව වේගවත් වර්ධනයක් ලබා ගැනීමට නම් විවිධ පාර්ශව අතර වූ දැනුම් අන්ර් ක්‍රියාකාරීත්වයකටත් වාණිජකරණයටත් සහයෝගය ලබා දෙන ප්‍රගතිශීලී නව්‍යතා ක්‍රමයක් ඇති කර ගැනීම ඉතා වැදගත් ය. ශ්‍රී ලංකාවේ නව්‍යතා පසුබෑම ඉකුත් වසර කීපයක් තුළ විද්‍යා තාක්ෂණ හා පර්යේෂණ සංවර්ධන ක්ෂේත්‍රවල ආයෝජනය කිරීමේදී අඩු ප්‍රමුඛත්වයක් ලබා දීමේ ලක්ෂණයකි. පැවති යුද්ධය පිළිබඳව වැඩි අවධානයක් යොමු වීම ඊට හේතු විය. එහෙත් පශ්චාත් යුධ සමය ශ්‍රී ලංකාවේ මෙම තත්ත්වය නැවත සලකා බැලීම අපගේ තරගකාරීත්වය තීරණය කරන වැදගත් සාධකය වේ.

නව්‍යතාවය යනු එය ඇති කරන ව්‍යවසායකයකින් විසින් ඇති කරනු ලබයි. අවසානයේ එය ජනතාවගේ ජීවිතවලටත් ආර්ථිකයටත් වටිනාකමක් එකතු කරන භාණ්ඩ ලෙස එය පරිවර්තනය කිරීමේ හැකියාවෙන් රඳා පවතියි. ජාතික උපාය මාර්ගිත නව්‍යතා ප්‍රතිපත්ති න්‍යාය පත්‍රයක් ක්‍රියාත්මක කිරීමේ බලය ඇති ජාතික නව්‍යතා සභාවක් අතිගරු ජනාධිපතිතුමා හෝ අග්‍රාමාත්‍ය තුමාගේ ප්‍රධානත්වයෙන් ඇති කිරීමට කාලය එළඹී ඇත.

## நிறைவேற்றுச் சுருக்கம்

துரித வேகத்தில் தொடர்கின்ற தொழில் நுட்பவியல் உருமாற்றங்களோடும், பூளோகமயப்பட்ட சந்தையொன்றின் தோற்றத்தோடும், அனைத்து நாடுகளுமே அதிகூடிய புத்தாக்கம் கொண்டதாக மாறவேண்டிய அழுத்தத்தின் கீழ் காணப்படுகின்றன. புத்தாக்கத்தைக் கைக்கொள்வதனுடாகவும் அதனை ஏற்றுக் கொள்வதனுடாகவும் குறிப்பாக வளர்ந்து வரும் பொருளாதாரங்கள் அபிவிருத்தியின் பல கட்டங்களை அகர வேகத்தில் அடைந்துகொள்ள ஆற்றல் பெற்றுள்ளன. இலங்கைக்கும் கூட அதன் பொருளாதாரம் பெறுமானச் சங்கிலியில் மேல் நோக்கி நகர வேண்டுமெனின் மேலும் நாடு அபிவிருத்தி ஏணியில் மேலே செல்ல வேண்டுமெனின் நடைமுறையில் உள்ள தொழில்நுட்பங்களையும் சிறந்த நடைமுறைகளையும் கைக்கொள்வதும் புதியவைகளை படிப்படியாக உருவாக்கிக் கொள்வதும் தற்போது தவிர்க்க முடியாத கொள்கை முன்னுரிமையாக மாறியுள்ளது. இது நாட்டின் தற்போதைய அபிவிருத்திச் செயன்முறையிலும் கூட கருத்திற் கொள்ளப்பட்டுள்ளது. “இலங்கை ஆசியாவின் ஆச்சரியம்” என்னும் ஆவணம் பின்வருமாறு கூறுகின்றது: “பூகோளப் பொருளாதாரத்துடனான இலங்கையின் வெற்றிகரமான பிணைப்பும் சர்வதேசப் போட்டித்தன்மையில் அதன் நிலையான வெற்றியும் விஞ்ஞானம், தொழில் நுட்பம் மற்றும் புத்தாக்கம் என்பவற்றின் பயனுறுதிவாய்ந்த இணைப்பின் மீது கூடுதலாகத் தங்கியிருக்கும். (பக்கம்.126)

இன்னும் அதிக தேவைகள் நிறைவேற்றப்பட வேண்டியிருக்கின்றன. ஒரு நாட்டின் உயர் தொழில்நுட்பப் பொருட்களின் ஏற்றுமதிகள் தான் புத்தாக்கத்துக்கும் விஞ்ஞானக் கண்டு பிடிப்புக்களைப் பயனுறுதி வாய்ந்த வகையில் வர்த்தக மயப்படுத்துவதற்குமான அதன் ஆற்றலைக் காட்டுகின்ற முக்கிய அளவீடாகும். இலங்கையில் உயர் தொழில் நுட்பப் பொருட்களின் ஏற்றுமதிகளின் பங்கானது, 2001ல் மொத்த உற்பத்திப்பொருள் ஏற்றுமதியில் வெறும் 2.2 வீதமாகக் காணப்பட்டது. அத்தோடு அது 2010ம் ஆண்டாகும் போது 01 வீதமாக வீழ்ச்சி கண்டது. கடந்த தசாப்தத்தின் ஒவ்வொரு வருடத்திலும், இலங்கையானது 1.8 வீத உயர் தொழில் நுட்ப ஏற்றுமதிப் பங்கொன்றை மாத்திரம் பதிவு செய்யும் போது கொரியா 75 வீத பங்கையும், தாய்லாந்து 27 வீத பங்கையும், சிங்கப்பூர், மலேசியா ஆகிய நாடுகள் 50 வீதத்திற்கும் மேற்பட்ட பங்கையும்,பதிவு செய்துள்ளன.

இது இலங்கையின் பலவீனமான புத்தாக்க உள்ளீட்டுக்கான நேரடிக் குறிகாட்டியாகும். உதாரணமாக மொத்தத் தேசிய உற்பத்தியின் விகிதாசாரம் என்று பார்க்கும் போது தேசிய ஆய்வு மற்றும் அபிவிருத்திக்கு மிகக்குறைந்த மட்டத்திலான முதலீடே காணப்படுவதானது, ஒரு நாட்டின் புத்தாக்க மட்டத்தைத் தீர்மானிக்கின்ற முக்கிய காரணியாகத் திகழும். மொத்தத் தேசிய உற்பத்தியின் வீதம் என்றவகையில் ஆய்வு மற்றும் அபிவிருத்திக்கான இலங்கையின் மொத்தச் செலவினங்கள் 2004ம் ஆண்டில் வெறும் 0.21 வீதமாகும். 2006ம் ஆண்டில் இது 0.17 வீதமாகும். 2008ம் ஆண்டில் இது 0.11 வீதமாகும். அதேவேளை ஆய்வு மற்றும் அபிவிருத்திக்கான தனியார் துறையினரின் செலவினங்கள் அத்துறைக்கான மொத்தச் செலவினங்களோடு ஒப்பிடுகையில் கணிசமானளவு குறைவாகும். ஆய்வு மற்றும் அபிவிருத்திக்கான செலவினங்களில் அதிகமான பங்கை - 65 வீதத்தை விடவும் அதிகமாக - தனியார் துறையினர் மேற்கொள்ளும் அபிவிருத்தி அடைந்த அனேக நாடுகள் போலன்றி இலங்கையில் அது வெறும் 18 வீதமாகக் காணப்படுகிறது. இலங்கையில் அரசாங்கத்துறையினால் ஆய்வு மற்றும் அபிவிருத்திக்காக செய்யப்படும் மொத்தச் செலவினம் 57 வீதமாகும், விஞ்ஞான மற்றும், தொழில்நுட்ப ஆய்வை வர்த்தகமயப்படுத்துகை வீதத்தின் மீது இதற்கு பலமான தாக்க விளைவுகள் காணப்படுகின்றன.

அத்தோடு ,புத்தாக்கம் என்பது வெறும் ஆய்வு என்பதை விடவும் வித்தியாசமானது. மேலும் அது ஆய்வின் விளைவாகத் தானாகப் பெறப்படுவதுமில்லை. கைத்தொழில் ஆய்வுக் கூட்டிணைப்புக்களுக்கிடையிலான இடைத்தொடர்பு, உரிய நிதியிடல் வசதிகள் மற்றும் வர்த்தக மயப்படுத்தலுக்கான ஆதரவு என்பன ஆய்வை புத்தாக்கத்தை நோக்கி நகர்த்துவதற்கான முக்கிய காரணிகளாகும். அபிவிருத்தி அடைந்த மற்றும் அபிவிருத்தி அடைந்துவருகின்ற அனேக பொருளாதாரங்களில் போலன்றி, இலங்கையின் பல்கலைக் கழகங்களும் ஆய்வு கூடங்களும் பெரும்பாலும் கைத்தொழில் துறையுடன் தொடர்புகளைக் கொண்டிருப்பதில்லை. இன்று இலங்கையில் கைத் தொழில் மற்றும் ஆய்வுத்துறைகளுக்கிடையிலான தொடர்புக்கான குறிப்பிட்டுச் சொல்லத்தக்க ஒரு சில உதாரணங்களே காணப்படுகின்றன. அவற்றுள் மிக முக்கியமான நிறுவனம், இலங்கை நனோ தொழில் நுட்ப மத்திய நிலையமாகும் (எடுஐவேநுஊ). இது முன்னணி தனியார் துறை நிறுவனங்களை இலங்கையின் முன்னணி நனோ தொழில் நுட்ப விஞ்ஞானிகளுடன் இணைக்கும், இத்துறையிலான இலங்கையின் முதல் முன்னெடுப்பாகும். தனது ஆரம்ப வருட செயற்பாட்டில் மாத்திரம் இந்நிறுவனமானது காபன் நனோ குழாய்கள், நனோ பசளை மற்றும் நனோ ரப்பர் உள்ளிட்ட நனோ தொழில் நுட்ப உற்பத்திகளுக்கான 05 சர்வதேச உரிமைச் சான்றிதழ்களைப் பெற்றுக்கொண்டது.

அதேவேளை, விஞ்ஞானம், தொழில்நுட்பம் மற்றும் ஆய்வு, அபிவிருத்தி என்பவற்றில் ஈடுபாடு கொண்ட தனிநபர்களை இணைத்து தகுதி வாய்ந்த குழுவொன்றைக் கட்டியெழுப்புவது இலங்கையின் புத்தாக்க இலட்சியங்களுக்கு இன்றியமையாததாகும். கல்வி – விஷேடமாக எல்லா மட்டங்களிலுமான விஞ்ஞானக் கல்வி, பொதுவான விஞ்ஞான தொழில் தொழில்நுட்ப அறிவு மட்டத்தை அதிகரிக்கச் செய்வதற்கு மாத்திரமன்றி, விஞ்ஞானிகள், ஆய்வாளர்கள் மற்றும் பொறியியலாளர்கள் ஆகியோரை உள்ளடக்கிய முக்கிய மக்கள் திரளொன்றைக் கட்டியெழுப்புவதற்கும் இன்றியமையாததாகும். இருப்பினும் இலங்கையின் பல்கலைக் கழகங்களில் மிகக் குறைந்த எண்ணிக்கையிலான மாணவர்களே விஞ்ஞான மற்றும் பொறியியல் கற்கைகளைப் பயில்கின்றனர். சுமார் 30 வீதம் வரையான பெரும்பான்மையான மாணவர்கள் பொறியியல் மற்றும் விஞ்ஞானக் கற்கைகளைப் பயில்கின்ற சிங்கப்பூர் போன்ற தனித்துவம் மிக்க, அறிவை முதன்மைப் படுத்திய பொருளாதாரமொன்றுடன் ஒப்பிடுகையில் இலங்கையில் 30 வீதத்துக்கும் மேற்பட்ட பெரும்பாலான மாணவர்கள் கலைத்துறைக் கற்கைகளைப் பயில்வதனையே காண முடியும்.

இலங்கையின் அனைத்து உயர் தரப் பாடசாலைகளிலும் வெறும் 10 வீதமானவை மாத்திரமே உயர் தர (தரம் 12,13) வகுப்புகளுக்கு விஞ்ஞானத் துறையைக் கற்பிக்கும் வசதிகளைக் கொண்டிருப்பதன் நேரடிப் பெறுபேறே இதுவாகும். இது இயல்பாகவே பல்கலைக் கழகங்களில் விஞ்ஞான மற்றும் பொறியியல் கற்கைகளுக்கான அனுமதிக்குத் தகுதி பெறும் மாணவர்களின் எண்ணிக்கையை வரையறுக்கின்றது. விளைவாக தகுதிவாய்ந்த தொழில் வான்மையாளர்களின் எண்ணிக்கைக் குறைவுக்கு இது காரணமாக அமைகிறது. இலங்கை ஒரு மில்லியன் பேருக்கு 237 ஆய்வாளர்களை மாத்திரமே கொண்டிருக்கிறது. இது அபிவிருத்தி அடைந்து வரும் நாடுகளின் சராசரி எண்ணிக்கையான 374ஐ விட மிகவும் குறைந்ததாகும்.

நிறைவாக இலங்கையானது வேகமான வளர்ச்சியை அடைய வேண்டுமாயின், பல்வேறு தரப்பினருக்குமிடையிலான அறிவு ஊடாட்டத்துக்கும் வர்த்தகமயப்படுத்தலுக்கும் ஆதரவு வழங்குகின்ற முன்னோக்கிய புத்தாக்க முறைமையொன்றை வளர்த்தெடுப்பது இன்றியமையாததாகும். இலங்கையின் புத்தாக்கப் பின்னடைவானது, கடந்த பல வருடங்களாக விஞ்ஞானம், தொழில் நுட்பம் மற்றும் ஆய்வு, அபிவிருத்தித் துறைகளில் முதலீடு செய்வதில்

குறைந்தளவு முன்னுரிமை காட்டப்பட்டதன் குறிகாட்டியாகும். யுத்தத்தில் கூடுதலாகக் கவனம் குவிக்கப்பட்டமை அதற்குக் காரணமாக இருக்கலாம். என்றாலும், போருக்குப் பிந்திய இலங்கையில், இந்நிலைமையை மறு பரிசீலனை செய்வது எமது போட்டித்தன்மையைத் தீர்மானிக்கின்ற முக்கிய காரணியாக அமையும்.

புத்தாக்கங்களை அவற்றை ஆக்குகின்ற முயற்சியாளர்கள் வெளிக்கொணர்வர் இறுதியில் அவை சமூகத்தின் ஆதரவிலும், ஆய்வுகளை உயர் ஏற்றுமதிகளாக அதாவது மக்களின் வாழ்க்கைக்கும் பொருளாதாரத்துக்கும் பெறுமானம் சேர்க்கின்ற பொருட்களாக அவற்றை மாற்றும் இயலுமையிலும் தங்கியிருக்கின்றன. இந்த முயற்சியாளர்களை “ தொழில் நுற்ப முயற்சியாண்மை” க்கான உரிய கொள்கை ஒத்துழைப்புகளை வழங்கி ஊக்குவிப்பது மிக முக்கியமாகும். உதாரணமாக வியாபார நடவடிக்கைகளுக்கு சார்பான சூழல் ஒன்றை தோற்றுவித்தல் வியாபார மூலதனத்தினூடு நிதியீட்டத்திற்கான சிறந்த வழிமுறைகளை ஏற்படுத்துதல், கண்டுபிடிப்புகளை வர்த்தக மயப்படுத்துவதற்கான தூண்டுதல் ஊக்குவிப்புகளை வழங்குதல் முதலியன. ஒரு வெற்றிகரமான புத்தாக்கக் கொள்கையை அமுல்படுத்த வேண்டுமாயின் அதன் இலக்கு குறித்த நம்பகத்தன்மையை ஏற்படுத்தவும், பாரம்பரிய அதிகார ரீதியான தடைகளை களைவதற்கான பிரதான நடவடிக்கைகளைக் கைக்கொள்ளவும், உயர் மட்டத் தலைவர்களின் உறுதியான ஆதரவு தேவை. தேசிய உபாய மட்டத்தில் புத்தாக்கக் கொள்கை நிகழ்ச்சி நிரலை இயக்கும் ஆற்றல் கொண்ட பலம் மிக்க “தேசிய புத்தாக்க சபை”யொன்றை அதி மேதகு ஐனாதிபதி அல்லது பிரதமர் தலைமையில் உருவாக்குவதற்கான தருணம் இதுவாகும்.

## 1. Introduction

Innovation has been at the heart of the economic transformation of the world's leading economies. Countries have been able to position themselves as dynamic global players as a result of innovation and the enhanced competitiveness that it brings with it. Emerging economies, particularly, have been able to leapfrog by embracing and fostering innovation. South Korea's Hyundai and Kia manufacture the most fuel-efficient cars in the world today. Brazil's Embraer is one of the leading jet manufacturers and has partnerships with the market leaders, Boeing and Airbus. Taiwan's Acer and Asus are now two of the leading notebook manufacturers in the world. Innovation was at the heart of propelling these firms, and these countries, into the global spotlight.

With the end of the armed conflict, Sri Lanka too hopes to position itself as a dynamic global hub, with rapid and sustained economic growth. As stated in the 'Sri Lanka: Emerging Wonder of Asia' document,<sup>1</sup> "Sri Lanka's successful integration with the global economy and its sustained success in international competition will depend increasingly on effective combinations of science, technology and innovation" (p.126). This document rightly recognizes that "the country needs a research and innovation capacity capable of promoting dynamic economic development" (p.119). Positioning Sri Lanka as a "knowledge hub" is a clear policy objective of the current government, and is one of five "hubs" envisaged. In this context, creating supporting structures which ensure that goods and services produced in the country are globally competitive becomes essential. This depends mainly on enhancing the level of innovation of the Sri Lankan economy.

In the document "Sri Lanka: Emerging Wonder of Asia" the word "innovation" (and alternatively "innovations") features forty times, testament to the emphasis placed on innovation in the current government's economic thinking. Yet, on each occasion it refers to innovation in particular sectors and the "need" for promotion thereof. Taking a holistic approach, driving innovation at a national, strategic level, therefore, needs to become the new priority, and this is what this paper advocates.

Although technology has permeated many levels of the economy and society in the country, Sri Lanka has missed successive "waves" of transformative technology, partly due to the distraction of fighting a war. The UK, Europe and the USA advanced on the basis of the industrial revolution. South Korea, Taiwan, and other East Asian 'tiger' economies latched on to the ICT and electronics (semi-conductor) revolution. China, India and Cuba caught the bio-technology revolution. Sri Lanka also ranks poorly in the Global Innovation Index, at 82nd out of 115 economies ranked, but does show promise on several sub-indicators analyzed in the report (see Box 1.1 for more). The challenge for Sri Lanka now is to see which elements of these technology revolutions can still be adopted in the country to drive higher value exports and greater domestic value addition of our products, and improve the standard of living of the Sri Lankan people. Meanwhile, latching on to new and emerging technological revolutions like nanotechnology, which can be truly transformational, must also be looked at.

The overarching issue for all of this is the need to create a dynamic innovation culture in the country, and for this, having a holistic innovation policy is essential. While neither national governments nor private

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<sup>1</sup> Ministry of Finance and Planning (2010).

economic actors can fully predict what the next technology revolution would be or forecast how best to latch on to it, by creating a culture where innovation thrives and permeates through the economy, economic actors in the country would be nimble and agile in capitalizing on whatever new technologies emerge and use them to benefit national development and achieve faster economic progress. For this, having the right policy frameworks in place, is key.

Some initiatives in this regard have already been taken. Sri Lanka's cabinet of ministers adopted a Science and Technology Policy (STP) in June 2009. While this identifies the general Science and Technology (S&T) capability required for Sri Lanka, and highlights the broad areas of focus, it does not provide specific priorities. Moreover, innovation policy is much sharper than S&T policy. In fact, innovation may not necessarily be achieved through improved S&T capability alone, as will be discussed later in this paper.

A more recent initiative towards advancing this agenda has been by the Ministry of Technology and Research which published its Science, Technology and Innovation Strategy (2011-2015). This document takes a far more advanced approach, as well as provides concrete goals and proposes implementation plans. Yet, it remains the strategic plan of an individual line ministry. As this paper will argue, promoting innovation requires a much more holistic outlook through a national innovation policy that takes a "whole-of-government approach", gets the buy in of a wider array of stakeholders, as well as provides clear direction on what needs to be done for these stakeholders, including line ministries beyond just the Ministry of Technology and Research. It is this idea that this paper advocates.

The rest of this paper is organized as follows. Section 2 will look at the importance of innovation to economic growth, reviewing relevant literature. Section 3 attempts to dissect what innovation is and the elements in promoting it, while Section 4 discusses the importance of innovation policy, and Section 5 provides an overview of the status of innovation policy-making in Sri Lanka. Section 6 introduces the concept of national innovation system (NIS) and how it feeds in to effective innovation policy-making, while Section 7 reviews Sri Lanka's performance across selected elements of the NIS (with several sub-sections focusing on particular areas like R&D, human capital, incentives, and financing and commercial-

### **Box 1.1**

#### **Sri Lanka in Bottom Half of Global Innovation Index**

Sri Lanka was ranked 82nd out of 125 economies in the Global Innovation Index 2011 issued by INSEAD, an international business school. Sri Lanka stands behind India but ahead of other key south Asian countries. Out of the sub-indices measured, the country is placed at 96 in the innovation input sub-index, which evaluates the environment for innovations, while been placed far above at 65 in the innovation output sub-index, bringing it among the top twenty countries in terms of innovation efficiency. Within innovation inputs, institutions, human capital and research, market sophistication and business sophistication are found to be of relatively low order, while innovation infrastructure seems to be of a higher quality. Within the innovation outputs, Sri Lanka ranks low in science outputs such as patent applications, journal articles, new business density and hi-tech exports, while performing relatively well in creative outputs such as trade mark registrations, recreation and culture, and creative goods exports.

Source: Global Innovation Index 2011.

ization). Section 8 highlights the importance of international openness and cooperation to strengthen innovation, Section 9 discusses reversing the 'brain drain' and leveraging the diaspora, and finally, Section 10 provides a way forward and concludes.

## **2. What is Innovation and Why is it Important?**

The relationship between economic growth and technological development has been established in the literature.<sup>2</sup> Although not the only pillar of innovation, technological development is both part of the process of innovation as well as a result of it. Innovation involves much more than knowledge of the relevant science and technology. At least since Schumpeter (1911), economists have accepted a distinction between the formulation of a working idea for a product or process (an invention) and the application of that idea to the economy (an innovation).<sup>3</sup>

The literature stresses that innovation, i.e., the improvement of existing or the creation of entirely new products, processes, services, and business or organization models, drives long-run economic growth and quality-of-life improvements.<sup>4</sup> The U.S. Department of Commerce has estimated that technological innovation has been responsible for as much as 75 per cent of the growth in the American economy since World War II.<sup>5</sup> Innovation achieves this impact by enabling the productivity and competitiveness improvements that lie at the core of economic growth. For instance, the innovative use of information technology was responsible for two-thirds of total factor productivity increase in the U.S. between 1995 and 2002 and virtually all of the growth in labour productivity.<sup>6</sup>

Innovation also leads to job growth. As the Organization for Economic Cooperation and Development (OECD) noted in a review of studies on productivity and employment, "Technology both eliminates jobs and creates jobs. Generally it destroys lower-wage, lower-productivity jobs, while it creates jobs that are more productive, higher-skilled and better paid". For a country like Sri Lanka where wages in basic manufacturing are rising (and consequently, the advantage of low-cost labour in the country is declining), and aspirations and attitudes towards employment are evolving towards higher-earning jobs, creating jobs that encourage higher productivity and better skills and pay becomes increasingly important. The OECD (1994) report noted that, historically, the income generating effects of new technologies have proven more powerful than the labour-displacing effects: technological progress has been accompanied not only by higher output and productivity, but also by higher overall employment.<sup>7</sup>

Innovation has become a more central driver of growth and competitiveness. As modern technologies have brought the world ever closer together, global economic competition has become more intense than ever. Government officials in many countries are constantly searching for strategies to win in this global competition to achieve economic growth and prosperity for their people, and attract foreign investment and talent to their shores. As noted in Ezell and Atkinson (2010), in just the past decade a large number of countries have come to the realization that spurring innovation in the economy must be a central compo-

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<sup>2</sup> For example, Romer (1990), Grossman and Helpman (1991), Aghion and Howitt (1992), and Jones and Williams (1998).

<sup>3</sup> Schumpeter (1911).

<sup>4</sup> Ezell and Atkinson (2010).

<sup>5</sup> Ideas in Action with Jim Glassman, "Is America Suffering an Innovation Gap?", July 9, 2010, <http://www.itif.org/media/america-suffering-innovation-gap>.

<sup>6</sup> Atkinson and McKay (2007).

<sup>7</sup> OECD (1994).

ment of their economic development strategies.<sup>8</sup> For example, in 2009, the United Kingdom made a conscientious decision to "place innovation at the centre of the country's economic growth strategy". Three dozen other countries have now created national innovation agencies and implemented national innovation strategies designed specifically to link science, technology, and innovation with economic growth.<sup>9</sup> An analysis by Krammer (2009) of Eastern European countries found that both innovation-oriented and business friendly policies enhance national innovation and boosts competitiveness in international markets.<sup>10</sup> The study highlights the crucial role of universities and existing knowledge base complemented by R&D commitments from both public and private sources in driving innovation.

### **3. Innovation Policy and Key Elements in Promoting Innovation**

It is important to understand what constitutes innovation in the developing world. Generally, it does not mean something "new" in absolute terms but something new for the society under consideration. Innovation is usually instigated by a key actor - an entrepreneur who brings the project to fruition in designing the new product or process, looking for finance, and exploring markets. The entrepreneur interacts with different organizations within the so-called "innovation system", such as universities, public laboratories, banks, business chambers, and other enterprises. In addition, the environment in which innovation takes place is strongly influenced by broader factors such as the macroeconomic situation, the level of infrastructure development, and the quality of institutions and governance.

A key success factor is to integrate a vision for innovation in long-term development strategies. For example, China decided to become "the world's factory" while Malaysia aimed at becoming an "information society world leader". This vision allows a country to define priorities and implement them across ministries and throughout the economy with well-aligned policies and investments. This requires an explicit "government-wide approach".

Innovation policy is, therefore, fundamentally different from simply promoting ideas and projects from research to market, or - the reverse - identifying needs and calling upon research or the science base to satisfy them. This linear and mechanistic view of the innovation process is outdated; a holistic and biological approach is more appropriate.<sup>11</sup> Governments should see their role as creating a favourable climate in which innovative projects can flourish.

### **4. Government Policy Support for Innovation**

Aubert (2010) stresses that in the innovation arena, a government "has basically three functions - providing incentives and facilities to elicit or support innovative projects; removing bureaucratic, regulatory, competitive and other obstacles to innovation; and improving the knowledge base and its use in developing technical education and R&D structures" (p.8).<sup>12</sup>

As explained in Ezell and Atkinson (2010), innovation policy constitutes those elements of science, technology and economic policy that explicitly aim to promote the development, spread, and efficient use

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<sup>8</sup> Ezell and Atkinson (2010).

<sup>9</sup> Ezell (2009)

<sup>10</sup> Krammer (2009).

<sup>11</sup> Aubert (2010).

<sup>12</sup> *Ibid.*

of new products, processes, services, and business or organizational models. Innovation policy conscientiously and proactively anticipates and articulates the intersecting roles and relationships of policies in science and technology, research and development, education, workforce training, immigration, tax, trade, intellectual property, and digital infrastructure in creating economic and social welfare.<sup>13</sup> An innovation policy should not exhibit favouritism to domestic over foreign firms located in the country or vice-versa; all firms located in the country should be able to enjoy the benefits of the country's innovation policies. In contrast, industrial policy is designed to intervene in an economy to support, favour, or restructure specific business or sectors. Industrial policies often seek to pick specific national champion firms. This was a staple of Japanese and South Korean economic growth policy following World War II.

To clarify the differences between innovation policy and industrial policy, it is useful to envision a continuum of government-market engagement increasing from left to right from a "laissez faire" approach to "supporting factor conditions for innovation" to going further by "supporting key broad technologies/industries" to, at the most extreme, "picking specific technologies/firms", or in other words, picking

#### **Box 4.1 Innovation as Adaptation**

Innovation as a concept doesn't just mean the domestic development of cutting-edge scientific discoveries - say for example, Sri Lanka trying to develop a game-changing technology, but also the adaptation and use of existing innovations for productive use in the local context. This balance needs to be struck in Sri Lanka. While we continue to drive new innovation, for example, through innovative PPP (private-public partnership) mechanisms like the SLINTEC, we need to cooperate more closely with technology champions in the world - from the world's most innovative nation, the USA, or Europe's innovation and technology champion, Germany, to Eastern technology giants like Japan, China, South Korea and even India.

Many developing countries like Sri Lanka have a long way to go before they can start creating world-changing, cutting-edge technologies. But this does not mean that their development should not focus on creating an innovation culture. According to the report on 'Building Sri Lanka's Knowledge Economy' (published by the World Bank in 2008), large rewards from technology accrue to those that adopt new technologies, adapt them, and make them productive in the local context. A report on Indian innovation revealed that India achieved a five-fold growth in output by simply adopting existing information and technologies elsewhere. East Asian champions like Korea, Singapore and Malaysia also grew rapidly by adopting existing technologies by often 'looking East' towards early adopters like Japan. Of course, later they developed new and advanced capabilities and became global innovation hubs themselves.

So, an innovation culture for developing countries like Sri Lanka must be understood as the building of a technical culture and a system of incentives that support the adoption and subsequent adaptation of existing (often foreign) technologies.

Source: Wijesinha (2012), 'What is An Appropriate Path for Sri Lanka as an Emerging Economy?', paper presented at Symposium on E.F. Schumacher Centenary Birth Celebrations, Practical Action, Colombo April 2012.

<sup>13</sup> *Ibid.*

winners. As emphasized by Ezell and Atkinson (2010), government support and engagement is best placed at points 2 and 3 of this spectrum, supporting factor conditions and placing strategic bets to support potentially breakthrough technologies (e.g., nanotechnology, biotechnology, robotics, etc.) and industries (e.g., broadband telecoms, life sciences, clean energy, etc.), all the while enabling competitive markets. This appears to be the approach taken by the Sri Lankan state as well, for example, through the general promotion of nanotechnology through the National Nanotechnology Initiative (NNI) since 2006.

As Metcalfe (2000) argues, the science, technology, and innovation policies of developing economies should not be aimed primarily at reaching the frontiers of world science, technology and innovation. Rather, the central concern should be with "absorption and adaptation of established practice to suit local resource endowments and market prospects"<sup>14</sup> (p.13). This is an important consideration for Sri Lanka (see Box 4.1 for more).

## **5. Status of Policy Relating to Innovation in Sri Lanka**

So far, in Sri Lanka, innovation has been seen mainly through the lens of 'science and technology'. In 1998, Sri Lanka established a National Science and Technology Commission as a policy-making body with the responsibility of making recommendations to the Government on all aspects of scientific and technological development (Wickremasinghe, 2011). Prior to this, there was a Presidential Task Force on S&T Development which published its report in 1991. More recently, however, a Science and Technology Policy was adopted by the Cabinet of Ministers (May 2009) (see Box 5.1).

The latest government vision and policy document, "Sri Lanka: Emerging Wonder of Asia", is the main macro-level policy which refers to science, technology and innovation, and recognizes that a broad range of policy areas need to be considered. It states,

*"Adoption and application of advanced technologies by industries will be promoted. A legislative basis for growth of high-technology industry will be provided through means such as national banking regulations, low-interest loans, tax incentives, and duty-free import of selected capital goods. Support will be given for application of advanced technologies in industry including biotechnology and nanotechnology. High-tech industrial parks with requisite modern physical infrastructure facilities will be established" (p.70).*

Meanwhile, the Ministry of Technology and Research (reformulated from the previous Ministry of Science and Technology) has under its wing many science and research institutions engaged in R&D and technology development and transfer. Some of these are the Arthur C. Clark Institute for Modern Technologies (ACCIMT), the National Science Foundation (NSF), and the Industrial Technical Institute (ITI, formerly the CISIR). The ITI, in particular, supports the industry sector through scientific and industrial research and provision of training, consultancy, and technology transfer, design, fabrication, calibration, trouble-shooting, and quality assurance services.

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<sup>14</sup> Metcalfe (2000).

### Box 5.1

#### Sri Lanka's National Science and Technology Policy, 2009

Sri Lanka was a late-comer to the S&T game and introduced the STP only in 2009, although attempts to design and adopt a national STP date back to the 1960s. The STP is largely in line with the 10-year development plan put forward in the Mahinda Chintana document (2005). The 10 objectives of the National S&T Policy are:

1. Foster a science, technology and innovation culture that effectively reaches all citizens of the country.
2. Enhance science and technology capability for national development, make use of science and technology expertise in the national planning process, and strengthen governance and policy implementation mechanisms.
3. Build up, and progressively expand and improve the resource base of scientists and technologists necessary to respond to the developmental needs of the country.
4. Promote basic, applied and developmental research, particularly in areas of national importance and priority.
5. Develop, or acquire and adapt, scientific knowledge and technologies for transfer, to achieve progressive modernization of all sectors and to enhance the country's competitiveness in the world economy.
6. Ensure sustainable use of natural resources for development, while protecting the environment.
7. Document, research into the scientific basis of, and promote indigenous knowledge-based technologies.
8. Develop a culture of innovation and IP, and ensure the protection of IPRs.
9. Ensure quality standards of S&T institutions, products and services to achieve national and international recognition.
10. Promote the application of S&T for human welfare, disaster management, adaptation to climate change, law enforcement and defence, to ensure human and national security.

The National S&T Policy declares ambitious targets to increase investment for S&T up to 1.5 per cent of GDP by 2016. This value was just 0.17 per cent in 2006. The target is ambitious even when compared with the globally recommended value for developing countries of 1 per cent.

Source: Witharana, D. (2010).

## 6. Concept of the 'National Innovation System'

Frameworks aimed at supporting science, technology and innovation have evolved from so-called "linear" models of innovation into models based on the concept of the NIS. Linear models imply that there is a direct causal relation from initial impulse to final outcome, which is innovation; the initial impulse can be either of a "supply push" nature, that is, it originates from government initiatives to set up institutions and policies to encourage R&D, or of a "demand pull" nature, that is, the initial impulse comes from the demands and needs existing in the markets. Linear models of the "push" category tend to emphasize supply-side policies (e.g., investment in training, R&D, and national ICT infrastructures), while "pull" models imply demand-side policies (e.g., market stimulation, user training, or the establishment of uniform standards). In practice, national policies have often been volatile mixtures of technology push and demand pull models, reflected in swings of emphasis between interventionist and laissez-faire policies.

The concept of a NIS is not new to the world but is still new to developing countries like Sri Lanka. Work by Freeman (1995) and Lundvall (1992) were catalytic in promoting this concept. Metcalfe (1995) writes that the NIS is "a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies". UNCTAD (2011) notes that, "Although there are many definitions of an NIS, in simple terms this concept refers to the network of institutions in the public and private sectors whose activities and interaction initiate, import, modify and diffuse new technologies" (p. 13).<sup>15</sup>

In practice, this is the network of universities, research centres, think tanks, firms, business associations, and more generally, producers and users of knowledge in the country. Meanwhile, supportive government policies are important in fostering NIS, as emphasized by Edquist (2007), for example. Public policy does have a role to play in cultivating this network. Sri Lanka's recent example of providing tax breaks for private sector firms who utilize public research institutions for their R&D, is such an example.

According to Wickremasinghe (2006), the NIS concept is novel for Sri Lanka, where interaction among various actors and institutions involved in technological innovation remains weak. Wickremasinghe (2006) emphasizes the importance of paying attention to how the government policy framework, R&D activities, education system, culture, history, traditions, etc., play their roles in this network system.

Developing a robust innovation system in a country requires a robust network consisting of government institutions, regulators, research institutes, universities, enterprises, consulting firms and professional/business groups. It is not just creating the right environment for this network to operate but also proving the right government interventions to ensure that a productive nexus develops from this.

A key idea of the NIS perspective is that firms do not engage in innovation in isolation. Innovation depends on the existence of a variety of agents and institutions (much greater in scope than just technology providers and technology users) and on the effectiveness of the interactions between these agencies and institutions. The ability and propensity of an enterprise to innovate not only depends on its access to knowledge from research institutes or technology services centres, but also on many other factors, including access to finance; access to human resources; adequate basic physical infrastructure; firm-level capabilities<sup>16</sup> (design, operation, maintenance, managerial); inter-firm linkages and collaboration partnerships in R&D among academic and commercial entities; general business services; and demand conditions.

Policy needs to consider a broad range of matters:<sup>17</sup>

1. Increasing the supply of knowledge into the system by reinforcing education, particularly science education as well as building a deep pool of human capital in scientific research, engineering, managerial, etc. Supply-side policies should be complemented with demand incentives too.

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<sup>15</sup> UNCTAD (2011).

<sup>16</sup> Sri Lanka lacks a national institution to help improve firm-level capabilities. Although the National Institute of Business Administration (NIBM) was started with that objective, it has since lost that focus and currently engages almost entirely in running vocational programmes in business /management, IT and English, which are perhaps more lucrative.

<sup>17</sup> Adapted from UNCTAD (2011).

2. Promoting stronger linkages between the various players in the national innovation system, by, for example, supporting research networks, incentives for inter-firm collaboration, and facilitating linkages between public research institutions and private enterprises, and between national firms and foreign companies. Policies to encourage public-private partnerships, the development of technology clusters, and the promotion of technology parks are other examples of policies in this broad area.
3. Dealing with intellectual property rights may have an important role in facilitating transfer of technology from academia to the productive sector and from international to domestic markets.
4. Creating avenues for commercializing and financing innovation, for example, exploring the suitability of the venture capital model of some developed countries, as well as fiscal incentives to support innovation.

## 7. 'National Innovation System' – Reviewing Sri Lanka's Performance

While innovation policy discussions, and the NIS, point to a plethora of indicators and areas for consideration, this paper limits itself to discussing selected areas in assessing Sri Lanka's performance, owing mainly to data unavailability.

### 7.1 Research and Development

Sri Lanka displays a very low level of national R&D investment as a proportion of GDP - a characteristic that has not changed over time. As a percentage of GDP, Sri Lanka's Gross Expenditure on R&D (GERD) was 0.21 per cent in 2004, 0.17 per cent in 2006, and 0.11 per cent in 2008.<sup>18</sup> The number of R&D scientists has also decreased from 4,062 in 2004 and 4,520 in 2006, to 4,037 in 2008.<sup>19</sup> The Budget 2012 speech by H.E. President Mahinda Rajapaksa notes, "Our universities as well as research and technology institutes have around 4,000 researchers at present. This number should be increased to about 20,000 by the year 2020".

Public R&D institutions form the bulk of the NIS in Sri Lanka, along with universities. The National R&D Survey (2008) conducted by the NSF reveals that dedicated R&D institutions account for 29.4 per cent of the total R&D scientists in the country, while universities account for 61 per cent, and the private sector around 9.6 per cent.<sup>20</sup>

Creating mutual confidence and motivation between the public sector (public research institutions and universities) and the private sector is a need of the hour. Wickremesinghe (2011) writes, "R&D scientists (both in universities and research organizations) are distancing themselves from the industry. [...] Unfortunately, most of the industrialists are not fully aware of the potential and capabilities of the scientists at universities and (public) R&D organizations. Such a situation highlights the importance of networking R&D institutions..." (p.17).<sup>21</sup>

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<sup>18</sup> National Science Foundation (2008).

<sup>19</sup> *Ibid.*

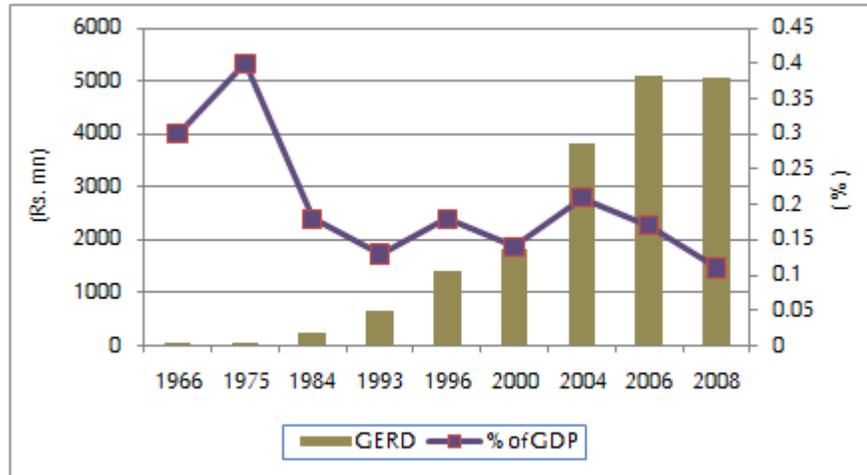
<sup>20</sup> *Ibid.*

<sup>21</sup> Wickremesinghe (2011).

### 7.1.1 Performance on Innovation Inputs

The gross expenditure on R&D has recorded a significant increase over time, particularly after 2000. During the four-year period between 1996 and 2000, the expenditure has marked a growth of 28 per cent, which has increased to 33 per cent between 2004 and 2008.

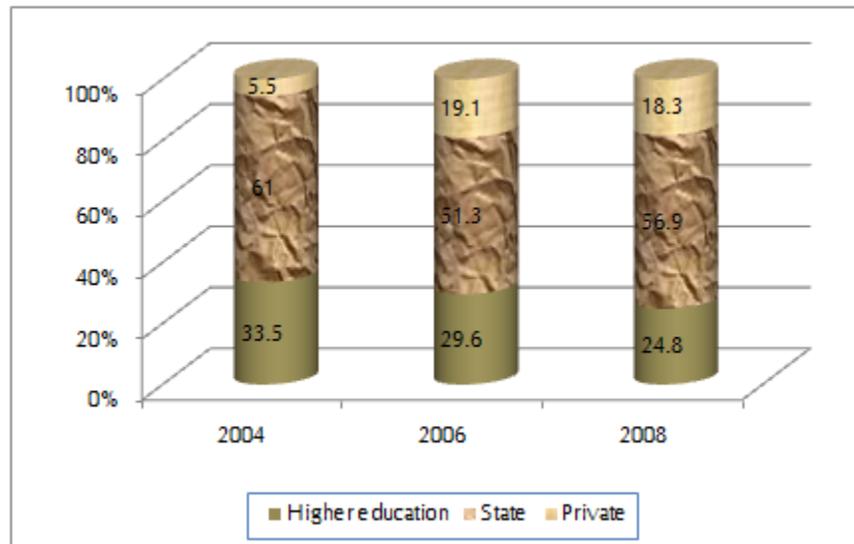
**Figure 7.1**  
**Gross Expenditure on R&D (1966 – 2008)**



Source: Science and Technology Policy Research Division, NSF.

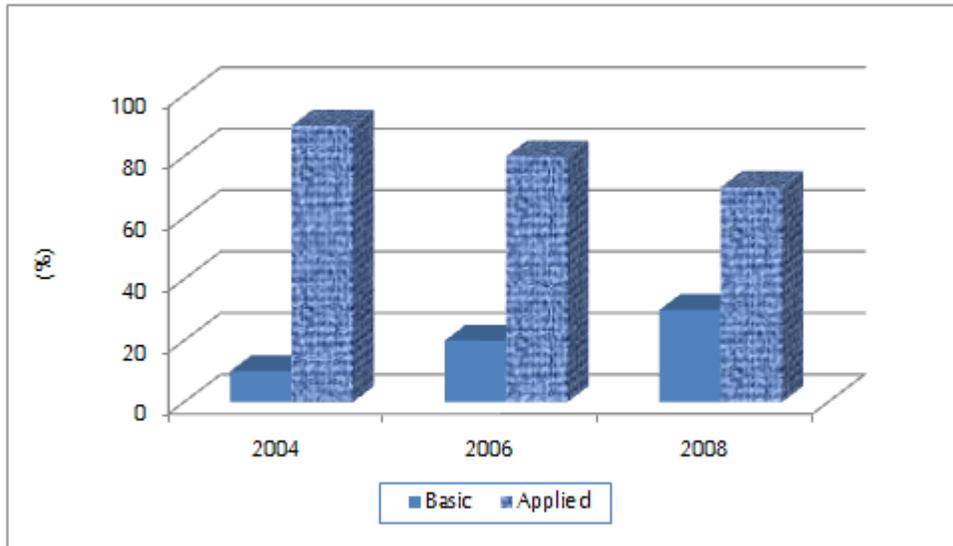
However, the investment on R&D does not seem to have improved proportionate to the growth of the national output. The R&D expenditure to GDP ratio has declined from 0.4 per cent in 1975 to 0.11 per cent in 2008, recording a diminishing trend over the years.

**Figure 7.2**  
**R&D Expenditure by Sector (2004-2008)**



Source: NSF, R&D Survey, 2008.

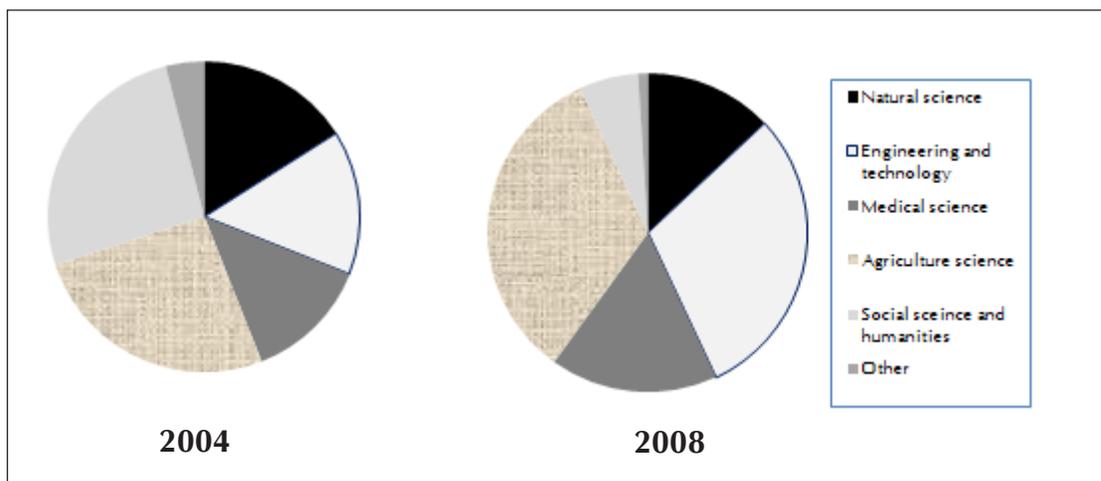
**Figure 7.3**  
**R&D Expenditure by Nature of Research Activities**



Source: NSF, R&D Survey, 2008.

Although the total allocation for R&D has risen over time, the composition by sector shows an interesting trend. The share by higher education and the state sectors have declined over time whereas the reverse has been recorded for the share of the private sector. Out of the total expenditure, the shares for applied research and basic research seem to have moved in opposite directions. The share of allocation for basic research has risen from around 10 per cent to 30 per cent between 2004 and 2008 while that for the applied research fallen from nearly 90 per cent to 70 per cent.

**Figure 7.4**  
**Gross Expenditure on R&D by Discipline**



Source: NSF, R&D Survey, 2008.

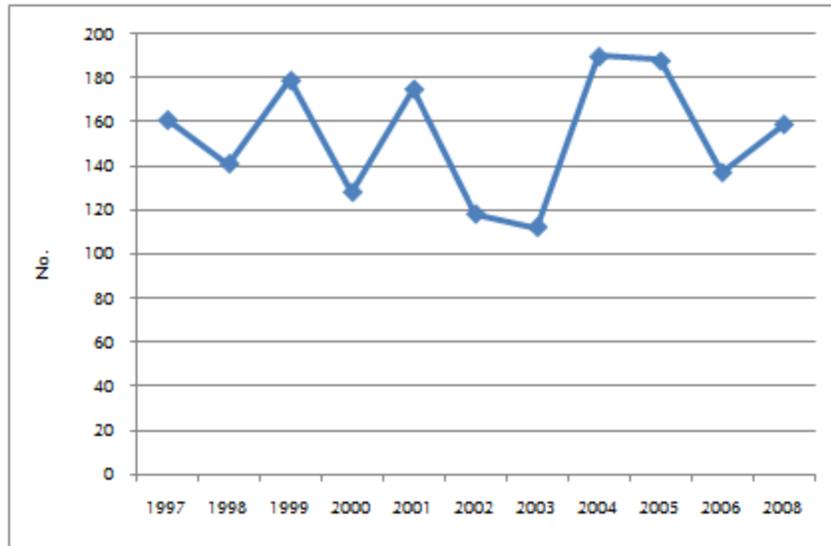
The composition of investment by discipline over the years shows a notable trend. The shares of investment in the fields of natural science and social science have declined, where the latter has marked a significant fall from around 26 per cent to 6 per cent between 2004 and 2008. The remaining three fields have improved where the share of expenditure in engineering and technology has doubled.

Meanwhile, the expenditure on R&D by the private sector, out of total R&D expenditure, is low. As Figure 7.2 demonstrates, unlike in most developed countries where much of the R&D expenditure is by the private sector (over 65 per cent in most cases), in Sri Lanka it is a mere 18 per cent. The bulk of R&D expenditure in Sri Lanka is by the state sector (57 per cent). This has strong implications on the rate of commercialization of science and technology research.

### 7.1.2 Performance on Innovation Outputs

The registration of patents in the country has fluctuated over time, resulting in the figures in 1997 and 2008 to be nearly the same. During the eleven years considered, the highest number of patents has been recorded at 190 in 2004, while the lowest has been 112 in 2003.

**Figure 7.5**  
**Number of Patents Registered in Sri Lanka (1997 -2008)**



Source: NSF, R&D Survey, 2008.

A significant feature of the trend is that before 2002 the majority of patents have been registered by non-resident scientists while the pattern has reversed since then. This could be an indication of improved conditions within the country for the scientists to carry out research, but more analysis is required before drawing any conclusions.

**Table 7.1**  
**Publication Trends in Science Citation Index (SCI) Journals**  
**by Sri Lankan Scientists**

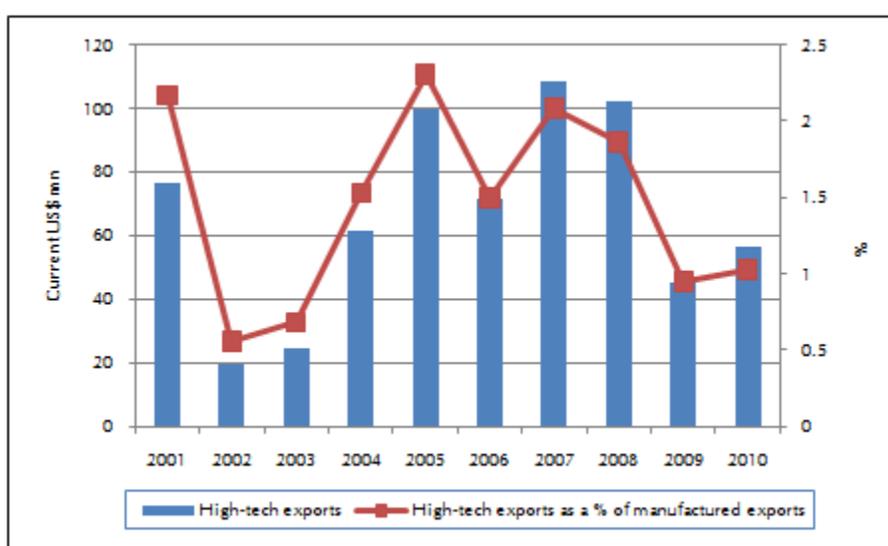
Year	No. of Publications
2004	231
2005	239
2006	233
2007	269
2008	303

Source: NSF, *R&D Survey*, 2008.

Dissemination of research carried out by the Sri Lankan scientists through publishing in journals has been gradually rising where in 2004 the number of scientists per publication has been around 11, which has dropped nearly by half to around 6 by 2008.

A country's high-tech exports are another significant output measure of a country's ability to innovate and commercialize their findings effectively. In Sri Lanka, the value of high-tech exports have fluctuated over the years where it has increased from 2002 but drastically declined after 2008, recording an over two-fold drop from US\$ 102 mn in 2008 to US\$ 45 mn in 2009, yet managing to improve by 25 per cent in 2010 (see Figure 7.5). The share of high-tech exports out of the total manufactured exports has followed the same trend, recording 2.2 per cent in 2001 and falling to 1 per cent by 2010. The highest high-tech exports in recent years were recorded in 2007 at US\$ 108.6 mn while the highest share has been recorded at 2.3 per cent in 2005. While Sri Lanka recorded an average 1.8 per cent of high-tech exports share each year in

**Figure 7.6**  
**Performance of High Technology Exports from Sri Lanka (2001-2010)**



Note: Products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery.

Source: World Bank Database, <http://data.worldbank.org/>.

the last decade, Korea recorded 75 per cent, Thailand 27 per cent, and Singapore and Malaysia over 50 per cent.<sup>22</sup>

## **7.2 Moving from Research to Innovation - Industry Linkages, Financing, and Commercialization**

As articulated earlier, innovation is distinct from just research and it doesn't autonomously result from it. The nexus of industry-research collaborations, appropriate financing options, and support for commercialization are vital drivers to move research to innovation.

### **7.2.1 Industry-Research Linkages**

Unlike in most developed countries, many universities in developing countries like Sri Lanka have not established sufficiently strong linkages with industry. Such collaborative efforts have become quite pronounced in the developed world, providing benefits to both parties. Industry obtains access to university laboratories, talents research scientists and a pool of potential recruits. Universities receive industry's financial support, necessary to conduct their work and expand their resources, and they also receive feedback from industry to adapt research to the needs of the economy.

The Five Year Strategy of the Ministry of Technology and Research observes that, "at present very few knowledge intensive companies and very little R&D that is required for innovation, is taking place in the private sector. On the other hand, most of the R&D undertaken by Sri Lankan scientists end up as mere publications in scientific journals with very few research outputs yielding a commercial product or a process. As such, the contribution of R&D to the growth of our GDP at present is negligible" (p. 31).

Currently, in Sri Lanka very few examples of significant industry-research linkages exist. The most prominent one is the Sri Lanka Nanotechnology Centre (SLINTEC), which is a first-of-its-kind initiative bringing together leading private sector firms together with leading Sri Lankan nanotechnology scientists.

SLINTEC, established in 2008 as a private Company is a Rs. 420 Million venture with the shareholding of the Company owned by GOSL (50 per cent) and five Private Sector Founder Promoters (50 per cent collectively). The Government of Sri Lanka shares are held through its nominee, NSF, and the five private sector "founder promoters" are: Brandix Lanka Ltd., Dialog Axiata PLC, Hayleys PLC, Loadstar (Pvt.) Ltd., and MAS Capital (Pvt) Ltd. In its first full year of operations alone, SLINTEC was able to secure five international patents on nanotechnology products, including carbon nanotubes, nano fertiliser and nano rubber. This is impressive when compared with Sri Lanka's historic average of 1.8 total international patents per year.<sup>23</sup>

More recently, a leading private enterprise Laugfs Holdings Limited set up a joint venture with SLINTEC to set up the country's first plant to produce titanium oxide from mineral sand. The new venture would allow value to be added to mineral sands, which have so far been exported from the country in raw bulk form. The setting up of the plant will allow production of titanium dioxide from ilmenite obtained from mineral sands extracted from Sri Lanka's Pulmoddai region. SLINTEC is also spurring international collaborations.

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<sup>22</sup> Ministry of Technology and Research (2010).

<sup>23</sup> *Ibid.*

One of the most noteworthy recent examples of success in research-to-market technology development is the development of nanotechnology-based plant nutrition solutions by the SLINTEC. In a first of its kind for Sri Lankan science, the scientific journal publication on the slow-release fertilizer which was developed by SLINTEC scientists together with Hayleys Agro as the private sector partner, had been picked up by a foreign entity which offered to buy the patent and commercialize the product. The firm, Nagarjuna Fertilisers and Chemicals Ltd. of India, purchased the required patents from, and signed a strategic technology development partnership with, SLINTEC in a deal worth US\$ 3 million.

Similar industry-research partnerships in areas aside from nanotechnology need to be cultivated, drawing encouragement from SLINTEC's successes. There are some limited examples of this, for example, in the ceramics industry (see Box 7.1) and in the mobile communications industry (see Box 7.2). Sri Lanka can learn from other country experiences as well. For example, Taiwan Province of China has used R&D

### **Box 7.1**

#### **Ceramics Council Attempts Research-Industry Collaboration**

During 'The Competitiveness Programme' funded by the USAID, the ceramics industry cluster (Ceramics Council) established the Center of Technical Excellence in Ceramics (CENTEC) through a partnership among Sri Lankan ceramic manufacturers, suppliers, the government and universities. CENTEC, opened in 2007, was aimed primarily to be a lab which will investigate ways in which the industry can cut costs, improve production efficiencies and enhance quality of ceramics products.

The centre, modelled as a Private-Public Partnership (PPP), was funded by several ceramics industry firms through both cash contributions as well as donations of equipment. Additionally, the USAID funded a few pieces of expensive testing equipment. The centre was set up as a limited liability company with a Board of Directors (comprising mostly of the heads of the ceramics industry firms), was housed as a small unit within the government Industrial Technology Institute (ITI) premises, and had links to the universities of Moratuwa and Peradeniya in Sri Lanka and Alfred University in the USA.

Although initially hailed as a model for industry-research collaboration that other sectors could emulate, there does not appear to have been a significant contribution of the centre to enhancing performance in the ceramic industry. However, this cannot be conclusively judged as no evaluation has been conducted. The critical constraint to its operations is the lack of a full-time centre manager. The centre has found it difficult to attract and retain a dynamic centre manager due to the limited scope of the centre's work. Moreover, the staff of the centre (mostly ITI technicians on secondment) had not sought to actively engage with the industries, seek projects, offer testing services, etc., and rather waited for them to approach the centre.

Although the performance has been lacklustre so far, the ceramics companies had been satisfied with the few testing projects that had been undertaken by the centre in the past. It appears that the ceramics industrialists recognize the importance of the establishment, and discussions are underway to restructure and revive it again. As part of the restructuring process, appointment of a second tier of directors is being mooted, which will comprise of the most senior technical officers of each firm. This aims to ensure that each firm takes a greater interest in the centre, and engage it in research and testing.

Source: Author's interview with former President of Ceramics Council and current Board Director of the CENTEC, and Lanka Business Online (LBO), 'Lab Edge - Sri Lanka opens ceramics R&D lab to enhance competitiveness', 5th April 2007 <http://www.lankabusinessonline.com/fullstory.php?nid=1326052179> [accessed on June 13th 2012]. NSF, *R&D Survey*, 2008.

### Box 7.2

#### Telco Giant Dialog Axiata Partners Moratuwa University for Research Lab

The first ever research lab for Telecommunication Technologies Research was opened at the Moratuwa University, which is acclaimed to be one of the best in Sri Lanka for Engineering and Telecommunication Programs. The first of its kind in Sri Lanka, the laboratory, which specializes in Applied Mobile Telecommunication Technologies Research, was set up as a part of Dialog's social investment towards uplifting and facilitating research & development and higher learning in Sri Lanka.

Applied research projects and product development initiatives, that are beneficial to the industry, and are academically challenging are undertaken by the laboratory, whilst providing for technology transfer with similar research bodies. New ideas in wireless communication, which encompass the spheres of designing, prototyping, testing, and training, are explored, with the objective of developing new products and services that will serve the purpose of taking Sri Lanka to the forefront of mobile technologies, thereby ensuring Sri Lanka's place in the challenging and evolving world of mobile technology.

Two creations of the laboratory - a remotely activated GSM alarm device and a learning management system - are being used in two Dialog-supported national initiatives namely, the Disaster and Emergency Warning Network (DEWN) and the Digital Bridge respectively.

Note: "The Dialog-University of Moratuwa Moratuwa Mobile Communications Research laboratory is a realization of the University's dream to actively interact with the private sector for mutual benefit, through the development of relevant and innovative technologies" - Prof. Dileeka Dias, Director, Dialog-University of Moratuwa Lab.

Source: Dialog Axiata website, available at <http://www.dialog.lk/about/responsibility/outreach-cr/research-lab/>

consortia to foster cooperation between laboratories in the government-funded Industrial Technology Research Institute and local private enterprises. This joint effort has resulted in technology transfer and innovative processes and products.

### 7.2.2 Commercialization

Commercialization is the final stage of a process of innovation (see Figure 7) where a product has come from a research and development stage to a market-ready product. This is the most challenging part of technology-based innovation. Support for commercialization (in terms of product development, patent applications, and finance for business spin-offs), essentially the pinnacle of an innovative process, is lacking in Sri Lanka.

According to the Sri Lanka Inventors Commission (SLIC), several inventors in the country have been able to commercialize their inventions, noting that at present there are fourteen commercialized inventors in the category of Rs. 1 million capital or less, six with Rs. 1-5 million, two between Rs. 5-10 million, and five with a capital of over Rs. 10 million.<sup>24</sup> In Sri Lanka, independent inventors have limited options to build and refine prototypes in preparing for commercialization. University facilities are already resource-constrained and may not be able to offer free or concessionary-rate services to build prototypes, while private firms are unlikely to provide these services unless the technology can be ex-ante acquired from the inventor and owned.

<sup>24</sup> 'Creation of Sri Lanka Inventors Business Chamber to boost inventions mooted', Sunday Times, 15th April 2012, available at <http://www.sundaytimes.lk/120415/BusinessTimes/bt018.html> [accessed on 10th May 2012].

A recent example of efforts to support commercialization through "techno-entrepreneurship" by the government is the unique 'Technology Marketplace' hosted by the Ministry of Technology and Research held in late 2011. The initiative, hailed as a success for a first-time event, brought together all of the government research institutions together with interested private sector parties, to see if productive partnerships to commercialize research can be forged.<sup>25</sup>

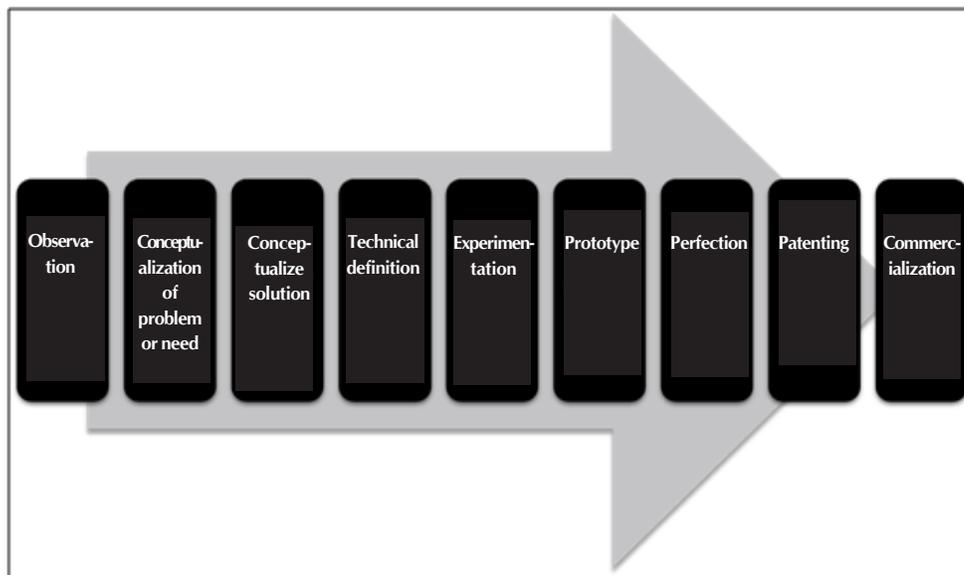
### 7.2.3 Financing

Financing innovations is a key challenge in Sri Lanka. This challenge is particularly true for small and medium enterprises (SMEs) in the country. In an environment where general access to finance for SMEs is a severe constraint,<sup>26</sup> finding finance for innovations maybe tricky, as banks are already risk-averse when it comes to SME lending.

While some efforts are being made, for example by the Sri Lanka Inventors Commission (for example, in allocating funds to support patent applications and inventions labs for proto type building) as well as the National Science Foundation (particularly in funding start-ups, see Box 7.3), this needs scaling up and made accessible to more individuals and institutions.

Venture Capital (VC) is an important financing source for tech start-ups globally, and was a critical success factor in creating the booming IT industry in 'Silicon Valley', California. Previous attempts at VC showed mixed results, with some trail-blazing firms emerging as a result of it, but also a sudden decline in VC-led activity (see Box 7.4 for more). Currently, VC activity in Sri Lanka is very tempered and the government

**Figure 7.7**  
**The Process of Innovation**



Source: Sri Lanka Inventors Commission Strategic Plan (2012-2014).

<sup>25</sup> "Technology Marketplace hailed as great success", Daily Financial Times Online, 26th October 2011, available at <http://www.ft.lk/2011/10/26/%E2%80%98technology-marketplace%E2%80%99-hailed-as-a-great-success/> [accessed on 20th April 2012].

<sup>26</sup> Wijesinha (2010), 'Post-Conflict, Sri Lanka's Enterprises Struggle to Grow', 'In Asia', The Asia Foundation Blog available at <http://asiafoundation.org/in-asia/2010/10/13/post-conflict-sri-lankas-enterprises-struggle-to-grow/>.

### Box 7.3

#### National Science Foundation Launches Grant Scheme Supporting Tech Start-ups

The National Science Foundation (NSF) has recently called for applications for a new technology grant scheme called "Support for Start-up Businesses Based on Novel Technologies". It states as its rationale, "having considered the fact that many research and experimental development projects are confined to laboratories without progressing into commercial applications and also with a view to develop an entrepreneurial culture among researchers/scientists/engineers in the research institutes and universities...". The scheme aims to provide an opportunity for start-up companies or spin-offs using university/institute-based new technologies. This grant programme rightly identifies that entrepreneurs often find it difficult to obtain necessary seed funding in financial markets given the financial risks involved in establishing technology-based start-up companies or corporate spin-offs stemming from novel technology research and development.

The objectives stated by the NSF for this grant scheme are:

- Convert University and research institute research outputs into marketable products/services.
- Encourage scientists, researchers, and engineers to become successful entrepreneurs.
- Encourage establishment of new technology-based firms by state and non-state organizations and individuals.
- Promote technology transfer and commercialization of new technologies.

Source: National Science Foundation website [www.nsf.lk](http://www.nsf.lk) [accessed on 29th May 2012].

would need to revisit the past experience and see how best to stimulate the VC industry in Sri Lanka once more, with a particular focus on aiding innovation.

## 7.3 Talent Pool for Innovation - Investing in S&T Education

### 7.3.1 Supplying the Relevant Talent Pool

Building a qualified pool of individuals geared towards S&T and R&D will be critical to Sri Lanka's innovation ambitions. Education - especially science education at all levels - is important not only for increasing general science and technology literacy, but also to build up a critical mass of scientists, researchers and engineers. While these are indicated as priorities for Sri Lanka by the Government, under the Knowledge Hub initiative put forwarded in the Mahinda Chintana: Vision for the Future, several supply-side bottlenecks need to be addressed, and have been emphasized in IPS (2011) as well. Although in the higher education section of 'Sri Lanka: Emerging Wonder of Asia' document it states that, "...higher education policy will focus on [...] (c) fostering a culture of research and innovation...", it is clear that this will be a major challenge by virtue of the fact that very few students are engaged in science and engineering courses at Sri Lankan universities.<sup>27</sup> Compared to a distinct knowledge-led economy like Singapore, where the majority enrolment is in engineering sciences of nearly 30 per cent, in Sri Lanka the majority enrolment is in Arts of over 30 per cent (see Figure 7.8).

Yet, this cannot be only attributed to A/L graduates preferring arts and humanities streams over science and engineering, it is, more critically, a reflection of the limited number of schools that offer science stream classes at A/Ls, thus constraining those interested from undertaking it. Only 10 per cent of all secondary

<sup>27</sup> This is of course, aside from the broader challenge of expanding tertiary education in Sri Lanka, where at present of more than 1000,000 deserving students only around 15 per cent who gain the necessary A/L qualification are able to enter into University (Source: IPS, 2011).

#### Box 7.4

##### Previous Efforts at Venture Capital in Sri Lanka and the "Banker's Trap"

The VC industry in Sri Lanka emerged in the early 1990s, resulting from a government decision to provide fiscal incentives for VC funds (tax deductibility for investment in approved VC funds and a 10-year tax holiday for VC profits). Prior to 1990, no VC firms existed in Sri Lanka. However, by 1992 there were seven.

The two development banks at that time, National Development Bank (NDB) and Development Finance Corporation of Ceylon (DFCC), one state bank, People's Bank, one private bank, Commercial Bank, two investment banks, DCIC and Asia Capital, and one finance company jointly with another private bank, Central Finance/Hatton National Bank (HNB) floated VC subsidiaries, launching 7 VC funds. By the end of 1992, all seven funds were qualified and in the years 1993-1996 they made 76 investments, an average of just over three investments per year, per fund. The average in 1997-1999 dropped dramatically to less than one investment per year per fund. This drop reflects that the funds had invested much of their capital by 1997. The per-investment average (for the decade) was about LKR 10 million.

The total funds base of all seven VC companies was around LKR 1.5 billion. All seven VC companies collectively invested LKR 1 billion in 101 projects during the 9 years from 1991 to 1999. A study funded by USAID and conducted by an American expert John Burr revealed that the performance of only 1 out of the 101 investments truly qualified as a 'successful VC investment' in terms of a return equal to a significant multiple of the value of the original investment.

The successful VC investment was Millennium Information Technologies (MIT). The VC fund PVIC was the only company to invest in MIT when it first bid for the computerization contract at the Colombo Stock Exchange and required to expand. PVIC invested LKR 7.5 million in 1996. In 1999, PVIC sold its stake to a foreign fund for LKR 43 million, a 573 per cent return on investment. Subsequently, MIT sold out to the London Stock Exchange for US\$ 30 million.

The defining feature of all these VC companies, as clear from the list of VCs given above, was that they were all subsidiaries of banks. The Boards of Directors of these companies were filled largely by veteran bankers. Moreover, even much of the senior management positions of the VC funds were taken up by bankers seconded from the parent companies. An important feature of banking is 'downside protection'. Bankers are, by training, keen to minimize the overall risk of an investment portfolio by diversifying across the different variables such as the sector, stage of growth, and size of investment. This was in line with the standard investment theory of hedging against the downside risks of an investment portfolio by investing in assets whose movements are negatively correlated with each other.

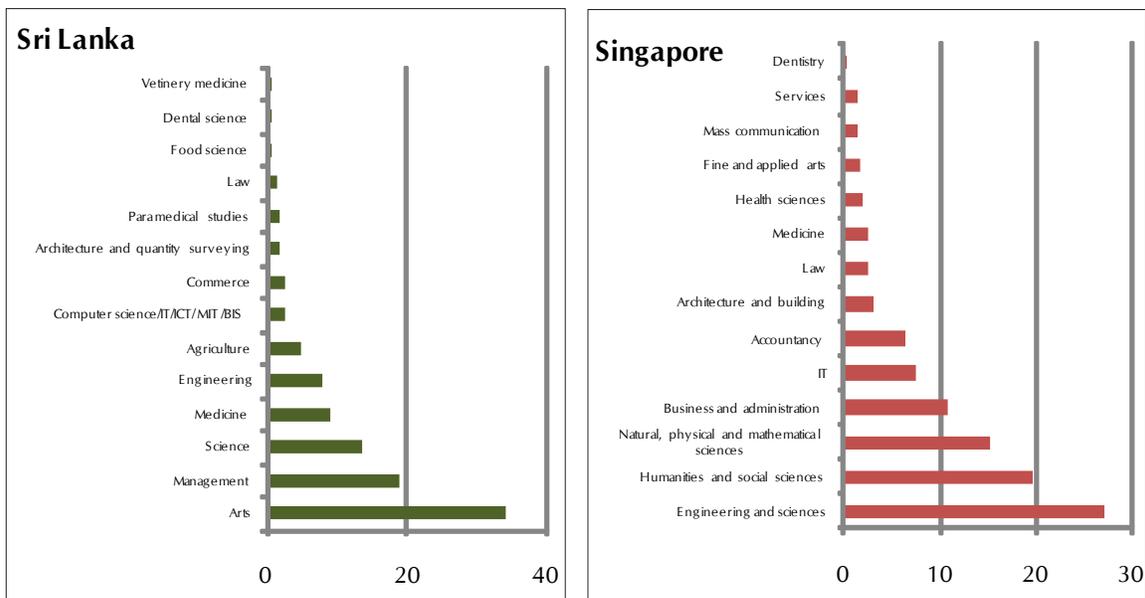
Essentially, the funds were managed by bankers with a banker's mindset rather than by venture capitalists with a venture capital/risk capital mindset. In deciding on the investments, they chose 'moderate risk, moderate return' projects, with a heavy focus on 'downside protection' as highlighted earlier. As the VC companies rarely had industry experts, enterprise experts, and those with strategic business development expertise, these funds did not really pick 'winning firms', i.e., firms with high intellectual capital and extremely strong upside potential if the right guidance and hand-holding was provided. Furthermore, as the VC companies employed predominantly bankers, the firms that received the investments received little or no management, operational, and strategic input from the VC Company. By the early 2000s, many of the companies invested in by the VC funds had either returned only modest returns or had under-performed completely, and consequently, many of these VC funds themselves failed.

Source: Wijesinha (2011), 'Introducing Venture Capital for Traditional and Small Enterprises in Sri Lanka', Briefing Paper, Policy Strategy Committee, Ministry of Traditional Industries and Small Enterprise Development, April 2011.

schools in the country have science stream at the A/L (Grades 12-13).<sup>28</sup> This naturally restricts the number of students who are able to gain admission to science and engineering programmes in university. Moreover, there are significant spatial disparities as well. As noted in IPS (2011), even schools that do offer science education are not rationally located, with the majority located in the Western Province. The School Census (2008) of the Department of Census and Statistics reveals that there was one school with A/L science stream for every 400 km<sup>2</sup> in Mullativu and Vavuniya and for every 200 km<sup>2</sup> in Mannar, while there was one for every 10 km<sup>2</sup> in Colombo, 25 km<sup>2</sup> in Gampaha and 45 km<sup>2</sup> in Kandy. It also revealed that 80 per cent of schools in Killinochchi did not have science labs, while only 11 per cent of schools in Colombo and 10 per cent of schools in Gampaha suffered the same problem. These issues become especially pertinent in Sri Lanka post-war context where inclusive growth and equity in economic opportunities need to be central concerns.

At the qualified-professional end of the spectrum, too, Sri Lanka fares poorly but has been showing improvement. Sri Lanka records only 237 researchers per million people, well below the developing country average of 374.<sup>29</sup> However, the total number of S&T personnel has increased from around 27,000 in 2004 to around 44,000 in 2008, recording over 60 per cent increase (see Figure 7.9). This stems mainly from the expansion in the state sector, recording over two-fold increase, with the higher education and private sectors expanding only marginally. However, the number of scientists has marked a declining trend over time, where the number between 2004 and 2008 records a significant fall by around 700. Scientists in the state and private sectors have improved in numbers while in the higher education sector it has dropped considerably. Comparison of 2006 and 2008 status, nevertheless indicates that all three sectors are improving in terms of the strength of scientists.

**Figure 7.8**  
**Tertiary Education Enrolment by Subject Area - Sri Lanka vs Singapore**

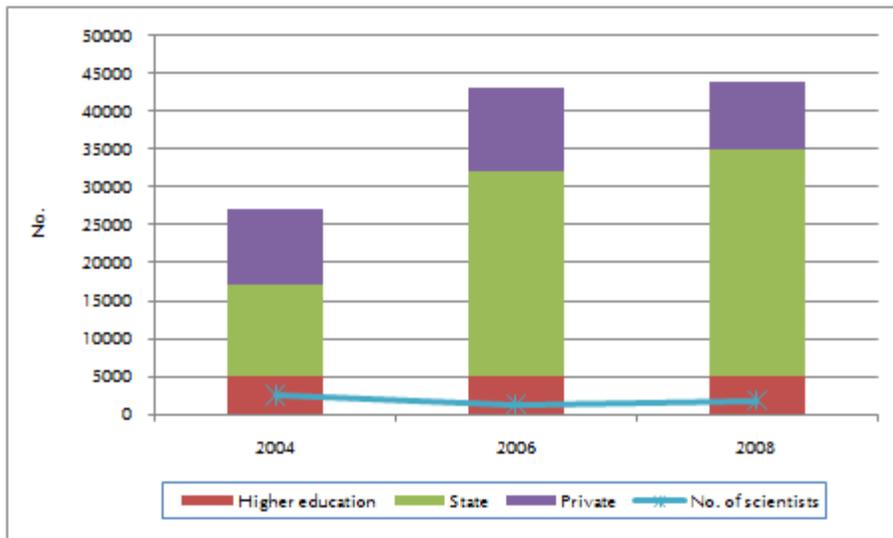


Source: Arunatilake, N. (2011), "Making Everyone Work for Growth: Creating a Winning Workforce", Presentation at IPS National Conference, October 2011.

<sup>28</sup> IPS (2011).

<sup>29</sup> World Bank (2008).

**Figure 7.9**  
**Science and Technology Personnel\* by Sector (1966 - 2008)**



Note: \* S&T personnel include all scientists, technicians, supporting staff involved in S&T research, service and management activities.

Source: NSF, R&D Survey, 2008.

According to Gamage (2008), Sri Lanka produced just 2.5 PhDs per year on average during 1991-2000 in 7 universities. Meanwhile, qualification levels of universities faculties remain poor, with 23 per cent of Humanities and Social Science teachers having only a Bachelors degree and 33 per cent having a Masters degree from the same university.<sup>30</sup>

### 7.3.2 Human Resources in Science and Technology<sup>31</sup>

The demand and supply of highly skilled personnel, although often studied separately is essentially one concept that indicates a country's readiness to adopt technologies and later innovate. The OCED (1995), in its 'Canberra Manual', conceptualized this readiness indicator and referred to it as Human Resources for Science and Technology (HRST).

The Manual defined HRST in terms of both educational attainment and occupations. Accordingly, HRST was defined as persons with tertiary level education and persons working as Specialized Managers, General Managers, Professionals and Associate Professions, as ordered in the International Standard Classification of Occupations 1988, regardless of their educational attainment.

During 2009/2010 Sri Lanka's labour force counted 1.6 million HRST personnel. Out of the total HRST count only 219 thousand were qualified to be categorized as HRSTCore (HRSTC) - both educationally and occupationally qualified. 129 thousand out of the remaining HRST personnel were only educationally qualified (HRSTE) and 1,219 thousand were qualified by occupation (HRSTO).

<sup>30</sup> Gamage (2008).

<sup>29</sup> This section draws from a draft paper titled 'Human Resources for a Knowledge Economy - Placing Sri Lanka Among Global Benchmarks' prepared by Harshanee Jayasekera for the Sri Lanka Economics Research Conference 2012.

**Table 7.2**  
**Sri Lanka's S&T Human Resources by Category (2009/10)**

Category	Number of Persons
HRSTE	129,057
HRSTC	218,629
HRSTO	1,218,973
HRST	1,566,658

Source: Authors' calculations based on DCS (2009/2010), *Labour Force Surveys*.

Ideally, a major part of the count of HRST should consist of those both educationally and occupationally qualified to be in science and technology work, where the demand for highly skilled persons is met with adequately qualified supply. But, in the case of Sri Lanka, majority of the HRST pool were only qualified by occupation. This suggests that either the demand for highly skilled persons for S&T occupations are unmet or that it is relatively easy to find employment in S&T occupations despite not having ideal qualifications. A closer look at those HRST personnel only qualified by education (HRSTE) indicates that only 63 per cent of the sub category was employed in S&T occupations. Of the remaining HRSTE, 84,516 were not employed at all and the rest were employed in jobs for which they are overqualified. The category of HRSTE not working in occupations suited to their educational attainment suggests that better matching is necessary between work and school. It is also plausible, given the trends observed in Sri Lanka, that a higher number of tertiary qualified persons are 'queuing' for government employment. At the same time, because tertiary education is almost entirely provided by state universities and majority of students graduate in fields of Arts or Humanities, the limited relevance of education to S&T occupations could also be a reason for the number of HRSTE being employed in non-S&T occupations or not being employed at all.<sup>32</sup>

Out of the HRSTC, the highest count was 'General Managers' followed by 'Teaching Professionals' and 'Associate Teaching Professionals'. Despite ideal qualifications, the likelihood of 'Teaching Professionals' and 'Associate Teaching Professionals' (except 'University Teaching Professionals') contributing to an innovation-driven economy is small. However, 'General Managers' could, in theory, actively contribute towards an innovation driven knowledge economy, as they would be taking important decisions regarding new technologies and knowledge importation and adaptation.

Comparing Sri Lanka's performance viz. other countries and regions (where information is available) questions the quality of the domestic labour force, where HRST is overrepresented by people only qualified by their occupation (78 percent of total HRST and 85 percent of total HRSTO). The European Union had just over 30 per cent working with less than tertiary education (Tomas, 2008) and India had 65 per cent of its HRSTO working with less than ideal qualifications (The Levin Institute, 2009). Even in terms of educational attainment, the S&T focus of tertiary education is a critical constraint that holds Sri Lanka back when competing with comparable countries, as highlighted earlier.

<sup>32</sup> This observation is based on the data obtained by the University Grants Commission of Sri Lanka.

According to globally benchmarked indicators, too, Sri Lanka's performance shows the need for significant improvement. The Global Innovation Index (GII),<sup>33</sup> in its latest (2012) report, ranks Sri Lanka 94th among 141 countries in the overall index and 115th in the 'innovation inputs' sub-index. Sri Lanka's position on almost all talent-related indices of the GII is far below India's, China's and Brazil's. Meanwhile, the Global Talent Index (GTI),<sup>34</sup> which measures the competitiveness of a country's talent pool, ranks Sri Lanka 59th among 60 countries in 2011, and places the country last on the sub-ranking of 'quality of university education'.

### **7.3.3 Simultaneously Addressing Demand Issues**

The improvement of higher education will not be fully effective at stimulating innovation unless it is also accompanied by an expansion of opportunities for graduates to apply their skills and talents. With a significant amount of R&D activity occurring in the private sector, business enterprise serves as a primary source of demand for S&T specialists. By providing employment opportunities and career paths for scientists and technologists, enterprises encourage students to enroll in scientific and technological fields. As more students graduate with relevant skills and motivation, this growing pool of human capital will, in turn, attract more enterprises to the region, thus creating a virtuous, self-reinforcing circle of technological capacity development and R&D activity. Government could review whether firms, particularly SMEs, face negative or positive incentives when hiring the university graduates. Possible positive incentives could include tax breaks or financial aid, to support internships or offset the initial cost of hiring and training new employees. Enterprises could also be encouraged to employ students as interns or part-time researchers, laying the foundation for later employment.

## **7.4 Incentives for Innovation**

Incentives for innovation in Sri Lanka are mainly in the form of tax concessions and tax breaks for R&D, and this too particularly through the most recent Government budget proposals (Budget 2012) announced in November 2011. In Budget 2012, the following tax incentives were announced:

- Reduction of income tax on research income from 24 per cent to 16 per cent.
- Reduction in personal income tax of all those engaged in research and technology from 24 per cent to 16 per cent.
- Reduction in income tax on all institutions engaged in research and technology to 20 per cent and such institutions are exempt from Value Added Tax (VAT).
- Triple deduction in relation to research and development expenditure undertaken by enterprises through Government institutions, to promote private institutions to use Government research facilities.
- Government institutions to extend research facilities to SMEs at a nominal fee
- Allocation of 50 per cent of research related income earned by Government institutions by carrying out research for the private sector to be shared among such researchers as a promotional allowance.
- Allocating Rs. 300 million to the National Research Council to encourage special research that would facilitate economic development.

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<sup>33</sup> Published by INSEAD Business School and World Intellectual Property Organization (WIPO).

<sup>34</sup> Published by Heidrick and Struggles, a global consultancy firm.

These measures have been commended by private sector groups.<sup>35</sup> However, interviews with leading industrialists revealed that several key challenges may constrain the aforementioned incentives: (1) the small number of suitable Government research institutions capable of catering to industry needs (the ITI was the only one mentioned by those interviewed); and (2) the limited capacity in, and low-industry orientation of, Government research facilities. However, this is a vicious cycle and needs to be broken. Government research institutions cannot develop greater industry-orientation without kick-starting this process. Meanwhile, Sri Lanka's private sector needs to be given confidence in the abilities of Government research institutions, and for this their financial and human resource capacities need to be expanded.

Budget 2011 too had announced the granting of a research allowance to university staff and researchers to incentivize them to conduct more research. However, the scheme has only been in place for less than a year, and it is unclear as to the impact this incentive has had in terms of spurring more research among university academics. Moreover, the budget proposal did not specify which areas of research this would be applicable to, and it is likely that it is not a focused measure meant just for science and technology research. Additionally, the element of innovation has not come in, where commercializing research is incentivized through this allowance.

## **8. Importance of International Openness and International Cooperation for Innovation**

Much of the literature on innovation points to the importance of 'international openness' as an important element in spurring innovation. The literature emphasizes that domestic innovation cannot be achieved without greater openness to international trade and investment and greater access to international markets (for instance UNCTAD, 2011).<sup>36</sup> Technology transfer through heightened trade and investment linkages is a key way in which the level of domestic innovation gets upgraded. Sri Lanka has not moved fast enough on international trade and investment treaties. It is yet to agree on a CEPA with India, and no ambitious treaties with other nations are in the pipeline (except for some ongoing discussions on the US-SL TIFA). Sri Lanka needs to consider moving more aggressively on technology partnership agreements at least (like between India and the US for example, see Box 8.1), in its thrust to become a knowledge hub, and for this looking both East as well as West will be necessary.

As Sri Lanka's innovation capacity is at a nascent stage, it will be important to develop linkages with the technology and innovation leaders of the global economy. In the midst of the antagonism stemming from the issues surrounding the end to the armed conflict, Sri Lanka must find a strategic balance with the West, particularly innovation leaders like the US. Despite its current economic troubles, strength of the US economy lies in its capacity to invent and innovate. These inventions are converted into commercial or military products at a rate much faster than in other countries. Many social factors and flexibility in economic policies contribute to this innovative dynamism. America's Gross Domestic Expenditure on Research and Development is the second highest in the world (next to Japan) and has consistently been higher than the OECD and EU average. It accounts for a significant 43 per cent of all pharmaceutical

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<sup>35</sup> "National Chamber commends the 2012 Budget proposals", The Island Online, November 22, 2011 [http://www.island.lk/index.php?page\\_cat=article-details&page=article-details&code\\_title=39577](http://www.island.lk/index.php?page_cat=article-details&page=article-details&code_title=39577) [accessed on 1 May 2012].

<sup>36</sup> UNCTAD (2011).

patents, half of all medical patents and almost 20 per cent of all environmental patents. It publishes nearly 280,000 scientific articles each year, the highest in the world.

Meanwhile, Europe has its own leaders, especially Germany. Products with the insignia "Made in Germany" still command an unrivalled global position, re-known for their high quality and cutting-edge technology. In 2008, Germany spent around 2.6 per cent of its GDP on R&D, well above the EU average of 1.9 per cent. In 2009, firms based in Germany registered the 3rd highest number of patents in the world. In an analysis of the world's leading innovation hubs, five German cities featured in the top 15 - Frankfurt, Hamburg, Berlin, Stuttgart, and Munich. The country boasts over 750 publicly-funded research institutions, the highest in Europe. Yet, it is the German private sector that leads the way in R&D. Of the 62 billion Euros spent on R&D in 2009, more than two thirds was by the private sector. Germany's leadership in innovation and its sustained focus on developing a highly skilled workforce is what will help it adapt its economy well to the changing tides.

Closer to home, the Asian innovation leaders are China and India, but China is the clear front runner. While the economic relationships between Sri Lanka and China appear strong at the moment, much of the partnerships are related to infrastructure (ports, airports, railways, and roads). Sri Lanka can capitalize on the friendly economic ties on another, possibly equally important front, technology and knowledge transfer for innovation. China has 708 researchers per million people compared to 119 in India. By 2009, China had over 16,000 PhDs in science and engineering, while India had around 6,400. In 2007, the Chinese filed 245,000 patents compared to 35,000 in India. China is set to overtake Japan as the second largest spender on R&D after the US in the next two years.

But simply opening to freer trade and investment flows will not be sufficient to develop technology. For a country like Sri Lanka which is at the relatively lower-end of the technology ladder, without government support to building innovative capacity, could find itself languishing at the low-technology product spectrum, and lose competitiveness over time.

UNCTAD (2011) asserts that, "it is very difficult for countries trapped in a development pattern characterized by low-technology, low-skill, and low-learning specialization to change course without a concerted

#### **Box 8.1**

##### **India Partners with USA for R&D Center**

The agreement to initiate a Joint Clean Energy R&D Center in India was one major outcome of US President Barack Obama's visit to India in 2010. India and USA pledged to make an effort to promote clean energies through the initiation of this Joint Clean Energy R&D Center. The Joint R&D Center will focus mainly on solar energy, energy efficiency, bio-fuels, clean coal technology and an integrated gasification combined cycle project that turns coal into synthesis gas. Apart from its contribution to sustainable economic development, the joint venture is also projected to contribute to the Indian economy by creating a number of new jobs in India.

Source: Environmental News Services (ENS)(2010) "India and America Are Indispensable Partners", 8th November 2010. Available at <http://www.ens-newswire.com/ens/nov2010/2010-11-08-02.html> [accessed on 19th May 2012].

shift in a large number of interacting markets and institutions" (p. 17). Foreign technology transfer, either through trade, FDI, or through other channels such as international partnerships or contributions from the Diaspora, can play a useful role.

## **9. Reversing 'Brain Drain' and Leveraging the Diaspora to Strengthen Innovation Capacity**

'Brain drain' was first used to describe the outflow of scientists and technologists to the United States and Canada in the 1950s and early 1960s. Now it is used more generally to imply the outflow of technologically, professionally and academically qualified persons towards the developed countries and to other fast-developing countries (Giannoccolo, 2004). Davenport (2004) notes that 'brain drains' between home and host nations are perhaps the most widely recognized demography of scientific and technical human capital diffusion trends.

The problem of scarcity of human capital for innovation is exacerbated in many developing countries by serious problems of 'brain drain' (UNCTAD, 2011). By some estimates, up to one third of R&D professionals from the developing world reside and work in OECD countries. With decades of conflict, security and political uncertainty, and the resultant slow economic growth, Sri Lanka has faced significant 'brain drain' over the past couple of decades. Consequently, academic and research institutions in the country have not sufficiently expanded to absorb graduates in science and technology, and sufficient employment opportunities in commercial sectors have been slow to emerge. The conditions of work are less attractive in Sri Lanka than in developed countries, and professional opportunities are more enticing, funding is more forthcoming, and there is a consequent lack of a critical mass of researchers required to create active research communities.

Particularly concerning the 'brain drain' of the Sri Lankan scientific community, a study by Anas and Wickremasinghe (2010) provides revealing insights. The study used a database of 220 expatriate scientists and technologists available in the expatriate scientists' database of the Science and Technology Management Information System of the NSF. The study revealed that the most commonly cited reason by the expatriate scientists for leaving Sri Lanka was to gain further qualifications and/or develop skills (71.3 per cent), followed by better career advancement opportunities (59.4 per cent agreed). The study further revealed that expatriate scientists were also concerned about the issues such as lack of intellectual leadership, suitable role models, recognition and incentive schemes, and excessive bureaucracy. However, on the question of returning to Sri Lanka, the study was equally revealing. An overwhelming majority (96 per cent) of the scientific community surveyed noted that, if their needs are adequately met they would be willing to return to Sri Lanka. Of them, nearly half would consider prefer to work permanently in Sri Lanka. Better working environment or working conditions as well as adequate salaries and benefits were the main needs they would consider for returning. The study quotes a qualitative interview with a "senior manager of a well-established private company" who had observed, "I acknowledge the fact that many private sector industries in Sri Lanka have overlooked the issue of creating job opportunities for science graduates and there is a very weak university-industry institute partnership. Since we offer better salaries to them than the government sector, making use of them towards a knowledge-based economy should help reduce the brain drain of the country".

While providing a dynamic environment for graduates to engage in innovative activities and thereby stem the brain drain, it is also important to encourage expatriate scientists to return to their native country. Returning expatriates bring with them much-needed tacit knowledge about new scientific methods, equipment and promising areas of enquiry, as well as collaborative networks that they have built which can help in national innovation efforts in their country of origin (Turpin *et al.*, 2007).

Several countries have useful schemes aimed at this. For example, India's Council for Scientific and Industrial Research provides temporary employment to highly qualified Indian scientists and technologists returning from abroad as a means of eliminating the uncertainty and economic problems faced by potential returnees from abroad (Krishna and Khadria, 1997). Establishment of 'science parks' could also be useful to provide a dynamic environment for expatriate scientists to return for regular periods and conduct collaborative research with local partners, and teach or undertake specific projects at 'home' (Turpin *et al.*, 2007). Such science parks are currently established in India, China, Korea, and Thailand, among other countries. The 'Sri Lanka Emerging Wonder of Asia' document states that such projects will be initiated in Sri Lanka too, noting that "Two science parks will be established in the Southern and North-Western provinces with a view to facilitating high tech industries to operate in a dynamic environment that enables them to nurture ideas, innovate and develop. Science parks will contain fully equipped laboratories and office spaces, innovation centres to bridge designers and industries and convenient amenities for both local and overseas companies alike" (p.122).

## **10. Way Forward for Sri Lanka**

With technological transformations continuing at a rapid pace, and the emergence of a globalised marketplace, all countries are under pressure to become more innovative. For Sri Lanka too, adopting existing technologies and best practices, while of course gradually developing new ones, is the quickest way for its products to move up the value chain and its economy as a whole to move up the development ladder. If Sri Lanka is truly aspiring to be a Knowledge Hub, it needs to take the creation of an innovation culture and an innovation system more seriously. Fostering a forward-looking innovation system, that supports knowledge-interaction among various parties, and commercialization, is critical. In Sri Lanka, the general underdevelopment of the individual components of the innovation system, as well as the nexus between them, is a symptom of the low priority given to S&T and R&D investment over the past several years. This may be largely attributed to the distraction of fighting a war. In post-war Sri Lanka, reversing this it will be a key determinant of our competitiveness in the coming decades.

This paper stresses weaknesses on several fronts, which highlight the need for holistic policy action. Greater investment in R&D is a must, but prioritizing the fields to which the funding should be directed should be carefully planned. The R&D undertaken, without limiting to publications, should be taken forward to research outputs with a commercial value so that there will be a contribution to the growth of the national production. Instead of the present state where the bulk of R&D expenditure is by the state, creation of an enabling environment for greater private sector involvement is essential if to better commercialize science and technology research. In moving from research to innovation, improving industry-research association is key to adapt research to the needs of the economy. Focus on generating means to finance innovation, scaling it up as well as making it accessible to more people/institutions should be made. Expanding and deepening the talent pool is another area calling for urgent attention. Creation of

more space in the science stream in the education sector is essential. On the other hand, attracting of enterprises, both local and foreign, that will demand for the knowledge and skills of the scientists also need to be addressed. Although Sri Lanka is in an advanced position in terms of incentivizing innovation by way of tax concessions, if it is to ensure full utilization of these, upgrading the research capacity of our state institutes will have to be seriously looked into, particularly in the areas such as industrial research which had direct contribution towards the growth of GDP.

A key point made in this paper is that innovation is beyond just research. Innovations come from the entrepreneurs who make them happen and ultimately depend on a society's responsiveness and ability to transform research into something that adds value to people's lives, to the economy. Encouraging these entrepreneurs with appropriate policy support for "techno-entrepreneurship" is important, for example, by setting a conducive business environment, better access to capital through venture capital, incentivizing commercialization of inventions, etc.

For a successful innovation policy to kick-in, it will need the firm backing of top leaders, such as H.E. the President or the Prime Minister. It gives credibility to the vision and facilitates the adoption of key measures for removing bureaucratic hurdles. It is also important to have efficient mechanisms that facilitate cross-departmental cooperation, as by its very nature, innovation policy concerns parts of government that usually work independently. Therefore, this paper calls for a powerful National Innovation Council chaired by H.E. the President or Prime Minister which can drive the innovation policy agenda at a national, strategic-level.

Sri Lanka could consider incorporating the term 'innovation' in the official name of the relevant ministry mandated to overlook this area, as it would further demonstrate the government's commitment to the concept and recognition of its importance. Several countries already have this. For example, the Ministry of Economic Development and Innovation in Canada, the Ministry of Economy, Innovation and Development in Portugal, the Ministry of Science, Technology and Innovation in Malaysia, the Ministry of Science, Technology and Innovation in Denmark, the Ministry for Innovation and Technology in Austria, the Ministry of Economic Affairs, Agriculture and Innovation in the Netherlands, the Ministry of Science and Innovation in New Zealand, and the Ministry for Innovation, Science, Research and Technology in the state of North Rhine-Westphalia, Germany.

Meanwhile, rewarding and recognizing innovations is important. In an environment where there are award schemes for nearly everything in Sri Lanka, it is high time that a Presidential National Innovation Awards scheme is introduced to promote and recognize successful innovations, particularly those that have resulted from industry-research collaborations. This should go beyond the currently operational Presidential Awards for Inventors that takes a much narrower focus.

While much of the literature on the importance of innovation to economic development focuses almost exclusively on its impact on building more productive and competitive firms and products, Sri Lanka needs to look at the innovation imperative more holistically - on how it matters to society as a whole. Innovations would be important not just for firm-level progress but also social development. Innovations can

lead to better ways of delivering public health care, safer and more efficient public transport, better disaster warning systems, etc.

In summary, Sri Lanka needs to take a holistic approach to innovation if it is to succeed in building a competitive economy capable of growing at a sustained, fast rate. Sri Lanka's competitor countries are moving forward at a rapid pace, and making innovation policy a key priority in the coming decades will determine how the country places itself in a rapidly changing global economic environment and delivers high growth and increased prosperity for its people.

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