Planning processes, policies and initiatives in ICTD education at institutions of higher learning in Asia and the Pacific:
Sri Lanka Country Paper

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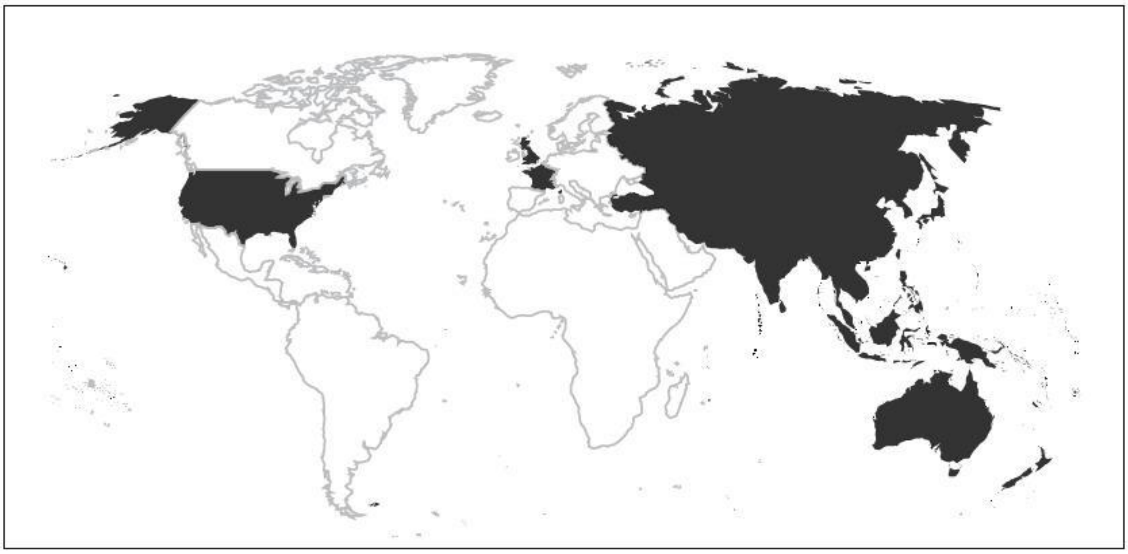

The shaded areas of the map indicate ESCAP members and associate members.

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Abbreviations and Acronyms

APCICT	Asian and Pacific Training Centre for Information and Communication Technology (United Nations)
CS	Computer Science
CS&E	Computer Science and Engineering
ESCAP	Economic and Social Commission for Asia and the Pacific (United Nations)
Gbps	GigaBits per Second
ICT	Information and Communications Technology
ICTA	Information and Communication Technology Agency (Sri Lanka)
ICTD	Information and Communications Technology for Development
IHL	Institution of Higher Learning
ISP	Internet Service Provider
IT	Information Technology
ITU	International Telecommunication Union
LAN	Local Area Network
LEARN	Lanka Education and Research Network
LMS	Learning Management System
MB	MegaBits
Mbps	MegaBits per Second
OER	Open Educational Resource
SARUA	South African Regional Universities Association
SDG	Sustainable Development Goal
SMS	Student Management System
STEM	Science, Technology, Engineering and Mathematics
TEIN	Trans-Eurasia Information Network
UNESCO	United Nations Educational, Scientific and Cultural Organization
UoM	University of Moratuwa
WAN	Wide Area Network

1. Introduction

This paper aims to provide a national-level gender-sensitive analysis of information and communications technology for development (ICTD) education in institutions of higher learning (IHLs) in Sri Lanka. The study analyses the planning processes, policies and initiatives in IHLs to prepare future ICTD leaders in the country. It includes an examination of information and communications technology (ICT) connectivity issues, and exploration of the partnerships between IHLs, policymakers, regulators and the private sector.

ICT holds the promise of improving the lives of people, and of disadvantaged people in particular. IHLs in developing countries, especially the public institutions, are continually reminded that they should prepare future leaders with the advanced knowledge and skills needed for the next stage of development in their countries, with the specific aim to achieve the Sustainable Development Goals (SDG).

The need for an orientation towards ICTD in academic curricula, whether in ICT or other disciplines, is recognized by the United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (APCICT) in its Turning Today's Youth into Tomorrow's Leaders' Programme, as pointed out in the following:[1]

> Recent research has indicated that universities and other higher-learning institutions in the region responsible for training the next generation of leaders lack adequate coverage of ICTD in their curricula. Programmes and courses that are best suited to provide training and impart knowledge about the use of ICT for socioeconomic development either do not cover ICTD or [do not] address it in a manner that sufficiently identifies the potential of ICTD.

Does Sri Lanka have plans, policies and initiatives necessary to build tomorrow's ICT leaders with sensitivity to ICTD issues, at the national, institutional and programme levels? This country study attempts to answer this question through desk research, and a case study of a selected academic institution, which includes an in-depth study of its ICT programme. In Sri Lanka, the Department of Computer Science and Engineering at the University of Moratuwa (UoM) has been selected for the case study.[2]

An ICTD leader must be able to leverage the potential of ICT for development purposes. For the most part, this requires ICT competencies, although in some cases, business, public policy or domain expertise may suffice. The ICTD practice also requires working in remote, peripheral locations and with vulnerable people. ICT connectivity is likely to be problematic in such areas and for such people. IHLs that prepare ICT or ICTD leaders will be hindered if they lack good ICT connectivity and awareness on the conditions and requirements to implement ICTD initiatives. Therefore, it is necessary to examine the state of ICT connectivity at national, institutional and programme levels. It is hoped that the findings will then feed into the process of policymaking and programming at the IHLs, as well as at the national level, to encourage students and researchers to develop, implement and innovate ICTD initiatives for inclusive and sustainable development.

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[1] APCICT, "Turning Today's Youth into Tomorrow's Leaders Programme". Available from http://www.unapcict.org/partners/aboutus/programmes/advisory/future-ict-leaders-programme.

[2] The Department of Computer Science and Engineering is part of the Faculty of Engineering at UoM. For more information see http://www.mrt.ac.lk/.

Additionally, gender-sensitive analysis is important because the low participation of women in computing is a worldwide phenomenon. For women to become ICTD leaders, IHLs should have a sufficient number of female graduates in ICT to start with, and encourage their active participation in ICTD initiatives.

The study begins by defining ICTD in the context of this study.

1.1 Definitions of ICTD

There is no standard definition of ICTD, but three commonly-referenced sources—APCICT, Heeks and the World Bank[3]—provide sufficient guidance for compiling a definition. APCICT introduces ICTD broadly as the use of ICT to achieve socioeconomic development goals. Heeks who is reputed to have coined the term ICTD, uses ICT in the context of addressing pressing problems of the poor in developing countries. The 2012 World Bank Group Strategy includes the use of ICT to reduce poverty, increase productivity, boost economic growth, and improve accountability and governance. The following definition captures ICTD attributes highlighted in all three sources:

> ICTD is the use of ICT for inclusive and sustainable socioeconomic development.

Preliminary discussion with ICT educators at IHLs reveals that "ICTD" and "inclusive and sustainable socioeconomic development" are difficult concepts for educators and students to grasp, and it is necessary to elaborate on these concepts. Issue 1 of the APCICT Primer Series on ICTD for Youth[4] provides a set of case studies on ICT applications in different sectors and cross-cutting issues, including agriculture, climate change, cultural preservation, education, health, governance, poverty reduction, and the empowerment of marginalized groups. Based on these case studies, the following definition has been found to be useful in explaining ICTD to ICT faculty, students and alumni:

> ICTD is the use of ICT to address problems of a public interest nature that may not be addressed by the private sector without subsidies or other inducements. Examples include ICT applications that bring quality education to marginalized communities, the dissemination of agricultural information to rural communities, and the analysis of big data to better understand and manage public health issues, such as the spread of diseases.

[3] APCICT, *Primer Series on ICTD for Youth – Issue 1: An Introduction to ICT for Development* (Incheon, 2013). Available from http://www.unapcict.org/pr; Richard Heeks, "The ICTD 2.0 Manifesto: Where Next for ICTs and International Development?" Development Informatics Working Paper, No. 42 (Manchester: University of Manchester Global Development Institute, 2009). Available from http://www.gdi.manchester.ac.uk/research/publications/other-working-papers/di/di-wp42/; and World Bank, *ICT for Greater Development Impact: World Bank Group Strategy for Information and Communication Technology, 2012-2015* (Washington D.C.: World Bank, 2012). Available from https://siteresources.worldbank.org/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/Resources/WBG_ICT_Strategy-2012.pdf.

[4] APCICT, *Primer Series on ICTD for Youth – Issue 1: An Introduction to ICT for Development* (Incheon, 2013). Available from http://www.unapcict.org/pr.

1.2 ICT/ICTD in Higher Learning

Higher education policies and initiatives in a country are generally determined and implemented at three levels:

1. The Ministry of Education or Ministry of Higher Education;
2. The agency that liaises between IHLs and the ministry (e.g., a University Grants Commission); and
3. The accreditation authority

Typically, national policies are set by the Ministry of Education. The formulation and implementation of national and sector-specific polices are carried out by the relevant agencies. A separate accreditation agency may be given the responsibility to maintain standards.

IHLs generally operate with greater autonomy than other educational institutions offering primary, secondary, technical and vocational education.[5] This may be because IHLs are at the top of the credentialing hierarchy in a country, and are therefore expected to self-regulate through peer review and related mechanisms. As a result, IHLs usually formulate and implement policies on their own within the broad guidelines set by the relevant ministry or the responsible agency.

As ICT policies are equally relevant to the objectives of this study, the policies for both higher education and ICT in Sri Lanka are examined.

1.3 ICT Connectivity

If IHLs are to produce future ICT or ICTD leaders, they need data and information on ICT connectivity and usage in teaching and learning processes, and related administration, for decision-making. While country data on general ICT connectivity are available from the International Telecommunication Union (ITU), there are no international surveys conducted on ICT issues in IHLs.

A study by the United Nations Educational, Scientific and Cultural Organization (UNESCO) identifies four critical issues related to the use of ICT in higher education as follows:[6]

1. Better access at lower costs
2. Access through mobile technology
3. Cloud computing
4. Open resources or digital content

However, country-level analyses are missing in the UNESCO study. Similarly, an Asian Development Bank study[7] discusses ICT strategies for universities, but national-level data are

[5] Arthur L. Stinchcombe, *Information and Organizations* (Berkeley: University of California Press, 1990).
[6] UNESCO, *ICTs for Higher Education: Case Studies from Asia and the Pacific* (Bangkok, 2011). Available from http://unesdoc.unesco.org/images/0021/002141/214143E.pdf.
[7] Jouko Sarvi and Hitendra Pillay, *Integrated Information and Communication Technology Strategies for Competitive Higher Education in Asia and the Pacific* (Mandaluyong City: Asian Development Bank, 2015). Available from https://www.adb.org/publications/integrated-ict-strategies-competitive-higher-education.

not provided in the report. Based on a literature review, only reports from the South African Regional Universities Association (SARUA) have been found to provide details on ICT connectivity at an institutional level. The 2006 SARUA study on ICT connectivity at IHLs reports on results from 54 institutions in 27 African countries.[8] SARUA summarizes the state of Internet connectivity at IHLs in Africa as too little, too expensive and poorly managed.

To provide an overview of ICT connectivity at IHLs in Sri Lanka, the study looks at the national ICT polices and initiatives, and the national-level indicators relevant to ICT connectivity. Since institutional-level data on ICT connectivity at IHLs are not available in Sri Lanka, the study examines in detail the ICT connectivity at UoM, a premier public IHL in the country with possibly the best connectivity in a public IHL in Sri Lanka.

1.4 Gender Issues in ICT Education

This report aims to integrate a gender perspective. The low participation of women in computer science and engineering programmes is a worldwide phenomenon.[9] Data on science, technology, engineering and mathematics (STEM) related fields are not available for Sri Lanka but data from a survey of seven countries conducted on women in STEM[10] can be used as a guide.

From the survey, the participation of women in STEM degree programmes from Cambodia, Republic of Korea and United States of America (USA), is estimated at 11 per cent, 19.5 per cent and 20 per cent, respectively.[11] It may be inferred that women's participation in computer science is also in these ranges. The reason for the low participation of women in STEM and computer science across the world is not understood too well. Social conditioning is thought to play a large role.[12] When women's participation in ICT education is small, their participation in ICTD may be assumed to be miniscule. Yet, women could be more enthusiastic about development-oriented applications than men. For instance, it is found that women entrepreneurs are more socially committed, irrespective of their businesses in developed or developing economies. Women are 1.17 times more likely than men to create social ventures rather than economic ventures, and 1.23 times more likely to pursue environmental ventures than economic ventures.[13]

The present study will focus specifically on women's participation in ICT programmes in Sri Lankan IHLs.

[8] SARUA, "African Tertiary Institutions Connectivity Survey Report", 2006.
[9] Wachira Kigotho, "Women enrol in sciences but not STEM", *University World News*, 20 February 2015. Available from http://www.universityworldnews.com/article.php?story=20150218131443779; and UNESCO, *A Complex Formula: Girls and Women in Science, Technology, Engineering and Mathematics in Asia* (Bangkok, 2015). Available from http://unesdoc.unesco.org/images/0023/002315/231519e.pdf.
[10] National Science Foundation, "Women, Minorities and Persons with Disabilities in Science and Engineering". Available from https://www.nsf.gov/statistics/2015/nsf15311/digest/theme2.cfm.
[11] Ibid.
[12] Eric S. Roberts, Marina Kassianidou and Lilly Irani, "Encouraging Women in Computer Science", Department of Computer Science, Stanford University (no date). Available from http://www-cs.stanford.edu/people/eroberts/papers/SIGCSE-Inroads/EncouragingWomenInCS.pdf.
[13] APCICT, *Women and ICT Frontier Initiative: Enabling Role of ICT for Women Entrepreneurs (Core Content, Module 2)* (Incheon, 2016). Available from http://www.unapcict.org/wifi.

2. Methodology

This country report is part of a five-country study of ICTD education at IHLs in Asia and the Pacific. The other countries that the study cover include Cambodia, India, Republic of Korea and Thailand. These countries have been selected based on the following criteria: (1) there must be at least one country from each of the major sub-regions—South Asia, South-East Asia and East Asia; and (2) there must be at least one country from each of the World Bank Lending Groups–high income, upper-middle income, lower-middle income and low income.

The focus of the country study is on "building ICTD leaders with higher skills", and emphasis is placed on analysing the academic programmes that provide graduates with advanced skills in ICT at the bachelor's level, with some information collected on master's and doctoral degree programmes. Given the paucity of data on ICT and ICTD education at IHLs in general, the focus is on uncovering as many good practices as possible from a well-established ICT degree programme in one selected institution in each country, as identified by the Times Higher Education Ranking Survey[14] or by local recognition. The five selected ICT degree programmes are the top programmes from each of the five surveyed countries. Together, they offer a set of observations on good practices that may be used as reference points, and a basis for ICT and education policymakers to enhance the quality and relevance of policies and programmes in the coming years.

Sri Lanka universities are not ranked by the Times survey, hence UoM has been selected based on the entry criteria used by the University Grants Commission of Sri Lanka. Of all the public universities with computer science or engineering programmes, UoM requires the highest academic scores from applicants.

This report is based on data and information collected from desk research, a questionnaire survey to better understand UoM and its academic programmes, and interviews with three ICTD leaders in the country, who are also UoM alumni. Data for the UoM case study was collected by Ms. Vishaka Nanayakkara, a faculty member in the Department of Computer Science and Engineering at UoM.

In this study, the national-level data on ICT connectivity at IHLs are limited to: (1) ICT policies, frameworks and initiatives; (2) ICT connectivity in general; (3) the national research and education networks; (4) open educational resources (OERs) in the country; and (5) the situation and experience in the selected institution and ICT programme.

Related to ICTD education, information on national and institutional policies and initiatives, and general programme characteristics such as data on student enrolment, student-teacher ratios, uses of ICT in education, and innovations in ICT and ICTD education, have been documented.

Data on the percentage of women among the student body and the faculty have also been collected. Informants have been asked to report on any special initiatives to increase the participation of women, and provide country-specific reasons for low women's participation in ICT and ICTD. As a rule of thumb, participation is considered low if it is less than 33 per cent.

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[14] Times Higher Education, *The World University Rankings* (2016). Available from http://digital.timeshighereducation.com/THEREPRANKINGS2016/offline/download.pdf.

From an analysis of all the data and information, a set of challenges and opportunities to foster ICTD leaders in Sri Lanka is presented. It is hoped that the examples and experiences documented in this report will be used by ICT and education policymakers to strengthen the linkage between the ICT academic programmes, faculty and graduates, and the society at large.

3. ICT Connectivity

3.1 National Policies

In Sri Lanka, the election manifesto of the ruling party is considered the basic policy statement of the government. In the election held in August 2015, the ruling party's manifesto broadly commits to digitizing the economy, contains several proposals related to higher education, and promises to establish free Wi-Fi zones in universities. Furthermore, the government has promised to enable participatory governance through a citizen-centric government.

The Ministry of Telecommunication and Digital Infrastructure is responsible for policy on telecommunications and digital technologies. The Information and Communication Technology Agency (ICTA) of Sri Lanka is the apex ICT institution of the government under the Ministry of Telecommunication and Digital Infrastructure. According to Section 6 of the ICT Act No. 27 of 2003, as amended by Act No. 33 of 2008, an Inter-Ministerial Committee is mandated to advise the government in the formulation of the National Policy on ICT. This includes providing all information necessary for the formulation of the policy, in the areas of capacity building, citizen empowerment, digital infrastructure, digitizing government, industry development, legal framework, policy framework and security. The Telecommunications Regulatory Commission is under the President. The 2008 amendment to the Act explicitly added “the Minister in charge of the subject of Education and Higher Education, or Education or Higher Education, or his nominee or their nominees as the case may be” to the Inter-Ministerial Committee responsible for advising the Cabinet on ICT policy.

There is no national broadband policy in Sri Lanka. At the Sri Lanka National Broadband Forum held on 8 August 2016, an event that was co-hosted by the Ministry of Telecommunication and Digital Infrastructure, Telecommunications Regulatory Commission and Huawei Technologies, the Minister himself noted the absence of such a policy and the need for one.

Of the activities listed on the ICTA website since August 2015, most are concerned about supporting a start-up culture, culminating in the organization of Disrupt Asia,[15] Sri Lanka's first start-up conference held on 28 July 2016. The establishment of free Wi-Fi zones has also received a lot of attention. According to a statement by the Minister for Telecommunication and Digital Infrastructure on 4 August 2016, 255 free Wi-Fi zones have already been established and the number is to be increased to 400.[16]

[15] Disrupt Asia. Available from http://www.disruptasia.today/.
[16] Asian Mirror, "Free WiFi to be Provided at 400 Locations: Harin Fernando", 4 August 2016. Available from http://www.asianmirror.lk/news/item/18074-free-wifi-to-be-provided-at-400-locations-harin-fernando.

Central to the proposals related to higher education is the introduction of a smart card with a special ID that includes an Internet access package at a special price, a pay-back method for a laptop obtained on low-interest loans, and access to Wi-Fi zones in all libraries and reading rooms. The laptop programme for universities is currently underway (see section 3.5).

3.2 ICT Connectivity Indicators

Sri Lanka's Internet access indicators improved quite significantly from 2013 to 2015, according to ITU's ICT connectivity data:[17]

- Mobile broadband subscriptions increased from 13.0 per 100 inhabitants to 15.8 per 100 inhabitants.
- The proportion of households with a computer increased from 16.4 per cent to 24.2 per cent.
- The proportion of households with Internet increased from 12.7 per cent to 18.1 per cent.
- Individuals using the Internet increased from 21.9 per cent to 30.0 per cent.

However, fixed modes of access remained stagnant with fixed telephone subscriptions decreasing from 12.7 per 100 inhabitants to 12.0 per 100 inhabitants, and fixed broadband subscriptions showing only a small increase from 2.6 per 100 inhabitants to 3.1 per 100 inhabitants.

Table 1: ICT and related indicators in the five surveyed countries, 2015

	Cambodia	**India**	**Sri Lanka**	**Thailand**	**Republic of Korea**
GDP per capita, 2015 (current USD)	1,159	1,582	3,926	5,816	27,222
Fixed-telephone subscriptions per 100 inhabitants	1.6	2.0	12.0	7.9	58.1
Fixed (wired) broadband subscriptions per 100 inhabitants	0.5	1.3	3.1	9.2	40.2
Mobile cellular subscriptions per 100 inhabitants	133.0	78.8	112.8	125.8	118.5
Mobile broadband subscriptions per 100 inhabitants	42.8	9.4	15.8	75.3	109.7
Households with a computer (%)	16.0	20.0	24.2	29.5	77.1
Households with Internet access at home (%)	21.0	14.1	18.1	52.2	98.8

[17] ITU, "Statistics". Available from http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx.

Individuals using the Internet (%)	19.0	26.0	30.0	39.3	89.9

Sources: ITU, "Statistics". Available from http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx; and World Bank, "GDP per capita (current US$)". Available from http://data.worldbank.org/indicator/NY.GDP.PCAP.CD?page=3.

A comparison of 2015 ICT connectivity data across all five surveyed countries is of interest here. Values of all indicators increase from Cambodia to India, Sri Lanka, Thailand and Republic of Korea in that order, except for mobile cellular subscriptions, mobile broadband subscriptions and households with Internet access, which are comparatively higher in Cambodia, even though it has the lowest GDP per capita among all the surveyed countries.

3.3 National Research and Education Networks

The Lanka Education and Research Network (LEARN),[18] was established in 1989 as a meagre dial-up service connecting three universities. Today, the network serves as the default Internet service provider (ISP) for all public universities, with each university purchasing its requirements. The LEARN is financially supported by the Ministry of Higher Education, but it is administered as an independent inter-university programme. It is considered a national network facility, co-purchased by universities in the network consortium.

At present, LEARN's international connectivity includes a 1.65 Gbps link to the commercial ISPs and a 45 Mbps link to the academic/research Internet through the Trans-Eurasia Information Network (TEIN). TEIN provides a dedicated high-capacity Internet connectivity for research and education communities across the Asia-Pacific—it currently interconnects universities and research centres in 20 countries. LEARN's reliance on private providers is much larger at 1.65 GBps than its reliance on international public network providers such as TEIN.

LEARN provides each university with a maximum 750 Mbps bandwidth for Internet access, and up to 1,000 Mbps for the Wide Area Network (WAN) connecting the public universities. Some universities purchase the maximum allotment while others use less. For example, in 2016, the University of Visual and Performing Arts purchased only 40 Mbps for Internet and 100 Mbps for the WAN.

With better and cheaper modes of access being offered by private service providers, universities have started to complement LEARN network facilities with private provision. However, LEARN remains a central part of the ICT infrastructure of universities in the country.

3.4 Open Educational Resources

The National Science Foundation, funded by the Government of Sri Lanka, implemented the National Digitization Project to digitize local Science and Technology literature, create open access databases, as well as train library staff to use databases.[19] Together with the National

[18] The Lanka Education and Research Network was formerly the Lanka Experimental Academic and Research Network.

[19] Mashroofa Mohamed Majeed and Seneviratne Wathmanel, "Open Access Initiatives and Institutional Repositories: Sri Lankan Scenario," Annals of Library and Information Studies 63 (2016). Available from:

Science and Technology Commission, the National Science Foundation also formulated a policy template on open access for IHLs in Sri Lanka, helping open access initiatives to be introduced in most IHLs in Sri Lanka.[19] One example of such initiatives is the provision of Open Educational Resources (OER), and the Department of Mathematics and Computer Science at the Open University of Sri Lanka provides online open access to the course resource, *ICT Skills,* as well as associated multimedia resources files.[20]

3.5 Connectivity at Institutional and Programme Levels

The LEARN network is the default ISP for public universities. LEARN connects the universities to each other within WAN, but it does not offer any digital learning materials, repositories or advanced data applications.

The case-study university, UoM, accesses the Internet exclusively through the LEARN network. It provides Wi-Fi coverage across the campus using the Local Area Network (LAN) linked to LEARN. There is a system to cache downloads from the Internet for the purpose of economizing the bandwidth used for Internet access. It has been suggested that universities in developing countries should use their LANs creatively with institutional knowledge repositories and cached content to make up for bandwidth limitations.[21]

The academic staff at UoM's Department of Computer Science and Engineering receives a prioritized access to LAN, WAN and the Internet. The university also pays the monthly subscription for a 4G data bundle for the department. This provision is used by the department to purchase mobile broadband access from the one of five telecom operators in the country. The academic staff optimizes their connectivity using a combination of the campus network and the private network of their choice to access their e-mail and learning management systems (LMS), and conduct video conferencing and other tasks. When asked about the quality of access, the faculty coordinator gave a 9 out of 10 rating.

Student labs are connected to one or more LANs, which are connected to the WAN and Internet through fibre optic and/or copper wire networks. The Information Technology (IT) Service Department in the university has led the development of a student management systems (SMS) and LMS using free and open software. Online library services are also available.

The bandwidth available to this premier university in Sri Lanka is at 1 Mbps per 1,000 users,[22] which is about one hundredth of the benchmark of 100 Mbps per 1,000 users that is recommended by the State Education Directors Association for school systems in the USA for 2017-2018.[23] However, according to one of the faculty members, the bandwidth seems

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[20] "ICT Skills," 2013, accessed February 28, 2017, available from: http://www.ou.ac.lk/home/index.php/computer-science.

[21] Jouko Sarvi and Hitendra Pillay, *Integrated Information and Communication Technology Strategies for Competitive Higher Education in Asia and the Pacific* (Mandaluyong City: Asian Development Bank, 2015). Available from https://www.adb.org/publications/integrated-ict-strategies-competitive-higher-education.

[22] At UoM, LEARN bandwidth available is 750 Mbps, and the total number of users is 8,062 (7,687 undergraduates, 317 faculty members and 58 administrative staff).

[23] Christine Fox and others, *The Broadband Imperative: Recommendations to Address K-12 Education Infrastructure Needs* (Washington, D.C., State Educational Technology Directors Association, 2012). Available from http://www.setda.org/wp-content/uploads/2013/09/SETDA_BroadbandImperative_May20Final.pdf.

adequate for current levels of use. As more faculties and departments start using LAN-based applications and access to the Internet, the network can be upgraded as needed.

The entire university is Wi-Fi connected. Peak usage is during the daytime. The Wi-Fi system is password protected and both students and faculty members have access to it. However, according to anecdotes from students and faculty members, some students prefer using their dongles during peak hours due to slow download speeds. UoM has negotiated a package for Internet connectivity for faculty members whereby an individual member receives a monthly 4GB data package that is paid by the university. This package is often used by faculty members during peak hours. This points to the need for quality of service[24] data that goes beyond number of users and theoretically available broadband capacity.

Students gain access to the campus network through computer labs or their own mobile handsets, tablets or laptops. UoM maintains a satisfactory level of access to devices by students for coursework-related needs with a student-computer ratio of about two to one. There are multiple labs where students have access to the Internet. The university provides a computer lab for each level (or year) of study. The labs are equipped as follows for each level of year of study:

- Year 1 – 100 desktop computers
- Year 2 – 70 desktop computers
- Year 3 – 50 desktop computers[25]
- Year 4 – for project work each group is given a laptop if needed

The number of computers that are provided decrease by the level of study because, although students use labs during formal class time, students' laptop ownership is nearly 100 per cent by Level 2 (or Year 2).[26]

3.6 Integration of ICT in Education

For university graduates to become savvy users of ICT for development, they have to be users of ICTs in their own education. The extent of SMS and LMS available in a campus, and the use of those services in teaching and learning, are indicative of the exposure and experience received by students in using ICTs.[27]

All faculty members are given a laptop by the university together with a broadband connection with reasonable data access. They extensively use ICT for instruction. Furthermore, the Moodle-based LMS at UoM is used for content delivery and assignment submission. Moreover, student registration is done through the SMS. The Department of

[24] Shazna Zuhle, "TRAI's QoS measure - Perception Survey, LIRNEasia, 17 February 2015. Available from http://lirneasia.net/2015/02/trais-qos-measure-perception-survey/.

[25] The computer lab for final year students was recently refurbished and PCs were replaced with laptops.

[26] From the second semester onwards students use these computers for all their learning-related requirements. In a trial conducted a few years ago, final year students were given a laptop at the beginning of the final year, which they had to return when they graduate. If they lose the laptop, they will be charged a fine three times the price of the laptop. However, over time, the university found that final year students prefer to buy their own laptops. Therefore, now the laptops are given to second or third year students who do not own a laptop.

[27] In order to increase the integration of ICT into the academic programmes, UoM recruited a webmaster who is responsible for the campus website and other web-based applications.

Computer Science and Engineering expects students to use ICT extensively in the learning process.

All faculty members at UoM are required to post their syllabi on the LMS, but using any additional features is optional. The faculty member interviewed for this study uses LMS extensively in her teaching. About 70 per cent of the materials in the curriculum that are not found in text books, are posted on the LMS. The faculty member interviewed uses the file management, storage, retrieval, and communication and collaboration functions of the LMS. According to her estimate, LMS is fully used by only 50 per cent of the 20 faculty members at the Department of Computer Science and Engineering. Further, she estimates that only 10 per cent of the other 400 faculty members at UoM use the LMS fully. The faculty member also uses various applications available on the Internet, including online journals, bibliographic/data/audio/video repositories, online book stores and other knowledge sources, as well as collaboration platforms and discussion forums for academic collaboration.

4. ICTD Planning, Policies and Initiatives

4.1 National Level

The higher education system consists of institutions comprising of a ministry, a regulatory agency and an accreditation body. Under the new government that came into power in August 2015, the ministry is called the Ministry of Higher Education and Highways. The objectives of the higher education policy of the ministry emphasize academic quality, access and contribution to national development. A distinct technology and development-related goal at the national level is to change the composition of graduates produced by public IHLs, by decreasing enrolments in humanities and social sciences, and by adding new Bachelor of Technology programmes, including Bachelor of ICT programmes.

Currently, universities produce about 20,000 graduates per year. This new initiative is expected to add about 2,000 Bachelor of Technology graduates to the number. Whether these Bachelor of Technology graduates will be better equipped with practical knowledge relevant to development, than graduates from traditional Bachelor of Science programmes in ICT, is yet to be seen.

There is an inclusive element in this intervention. Schools in rural areas channel students into humanities and social sciences programmes because of the lack of facilities for science education. More support is now given to technology education and it is expected that students from rural areas will find technology subjects more accessible and attractive than pure science subjects.

4.2 Institutional Level

The Department of Computer Science and Engineering in the Faculty of Engineering at UoM is the selected case study. Although this university is not included in international ranking surveys such as the Times Higher Education World University Rankings, it is locally considered the leader in building advanced ICT skills in the country.

The UoM is a public institution established in 1978. Policies and planning regarding academic programmes are made and implemented by the university council and implemented by departments. The stated mission[28] of the university points to an institution dedicated to improving its rankings in the international arena. Unlike the Indian institutes of technology, UoM has no obligation to play a leadership role in public sector engineering education in the country.

The developmental role of the university is most visible in building partnerships with the industry. For example, external collaboration with other universities and industry is an action item in the university's corporate plan. The general environment in the university is considered conducive to new ideas, but the stories from ICTD entrepreneurs who are current students or alumni of UoM point to possible improvements, as described in section 4.6.

4.3 Programme Level

The university's academic programmes consist of undergraduate programmes conducted through the faculties of engineering, architecture and IT. About 50 postgraduate courses are part-time and fee levying, in addition to a few continuous development programmes.[29] The Faculty of Engineering established the Department of Computer Science and Engineering in 1985, and the Faculty of IT was established in 2001. The case study programme selected is the Department of Computer Science and Engineering. The Faculty of IT and its purpose are discussed in detail in section 4.5.

4.4 Programme Description

The Computer Science and Engineering Programme enrols 500 students and bears a student-teacher ratio higher than those of parallel programmes in India, Thailand and the Republic of Korea, but lower than that in Cambodia (see Table 2).

Table 2: Student enrolment and full-time faculty headcount across five surveyed countries

	Cambodia	**Sri Lanka**	**India**	**Thailand**	**Republic of Korea**
	CS (Yr. 2-4)	**CS&E**	**CS&E**	**CS&E**	**CS&E**
No. of students	2000	500	400	304	400
% Female	~7-8%	20%	15%	-	~30%
No. of faculty members	45	20*	30	36	32
% Female	4%	35%	10%	28%	3%
Student-teacher ratio	44	25	13	9	13

[28] University of Moratuwa, "QS Seminar on University Rankings, Ratings & Branding Strategies". Available from https://www.mrt.ac.lk/web/news/qs-seminar-university-rankings-ratings-branding-strategies.
[29] University of Moratuwa, "Facts and Stats about UoM". Available from https://www.mrt.ac.lk/web/facts-and-stats-about-uom.

No. of master's degree students	60	200	50	200	~140
No. of doctoral degree students	-	2-3[#]	50	36	~100

Notes: CS = Computer Science; and CS&E = Computer Science and Engineering.
* 28 if visiting faculty members and those on study leave are included.
[#] None graduated yet.
Sources: Desk research and interviews, July-August 2016.

The student-teacher ratios need to be contextualized using the number of master's degrees offered by the same faculty, since master's students are not included in the ratio. The UoM programme offers 200 master's degrees, which is significantly higher than the parallel programmes in Cambodia and India.

4.4.1 Building Future ICTD Leaders

Students can be exposed to ICTD applications directly through the curriculum, or through co-curricular or extra-curricular activities. In this section, the computer science and engineering curricula will not be evaluated. Instead, the focus will be on the ICTD-related elements in the curricular, co-curricular or extra-curricular activities. The main objective is to present observations on possible good practices.

4.4.2 Curriculum

There are no identifiable ICTD courses as per this study's definition of ICTD (see section 1.1). There are no specific programmes on big data or mobile technologies either, but students receive the basics of computer science and engineering relevant to big data and mobile technologies through their coursework, and some receive experience through partnerships and joint initiatives with Dialog—a local telecom operator, Microsoft, Deakin University of Australia and LIRNEasia—an Asian think tank located in Colombo.

4.4.3 Student Projects

All undergraduates are required to complete a module project for one of the core subjects in the course. The purpose of the project is to utilize the theoretical principles and good practices taught in the class. In order to contribute to socioeconomic development and utilization of ICT in the country, the students are expected to identify an existing business need and provide an IT solution.

The projects carried out by student groups in the past few years have mostly been for companies and government entities. The majority of the projects focused on automating a business process or extending an existing system, thus improving overall efficiency. At the end of the project the clients are expected to use the system and certify that their requirements have been fulfilled.

Some notable systems developed through these projects include the inventory management system for government retail shops; information management systems for the National Blood Bank; and projects for a Divisional Secretariat, a government entity in a distant province, and for the Arthur C. Clarke Institute for Modern Technologies. Interestingly, quite a few projects focused on using IT for family businesses.

4.4.4 Extra-Curricular Activities

The department officially supports the participation of students in the following competitions:

- Sri Lanka Association of Software and Service Companies events[30]
- Google Summer of Code[31]
- Imagine Cup[32]
- NBQSA Awards[33]
- Local hackathons

These kinds of events are universally accepted as important by computer science and engineering educators for challenging and motivating students. UoM students were the runners-up in the Innovation category of the Microsoft Imagine Cup finals in 2016, held in Seattle, USA.[34]

4.4.5 Research Collaboration

Research collaboration with the following entities give students valuable exposure to mobile technology and big data-related problems:

- Dialog – UoM lab[35]
- Microsoft mobile technology lab[36]
- Deakin University – UoM collaboration[37] on data analytics
- LIRNEasia – UoM collaboration[38] on data analytics
- Massachusetts Institute of Technology (MIT) – UoM collaboration

Partnerships with Dialog and Microsoft concern mobile technology applications, while partnerships with Deakin University and LIRNEasia are focused on data analytics. Although the projects may not have direct developmental impact, exposure to these two areas of study will prepare students for ICTD applications, if they choose such a focus in their future careers.

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[30] Sri Lanka Association of Software and Service Companies, “Events”. Available from https://slasscom.lk/events.
[31] Google Summer of Code. Available from https://summerofcode.withgoogle.com/.
[32] Microsoft, "Imagine Cup". Available from https://compete.imagine.microsoft.com/en-us/category/0?skillLevel=0.
[33] National Best Quality ICT Awards - Sri Lanka. Available from http://www.nbqsa.org/.
[34] Microsoft, "Bit Masters". Available from https://compete.imagine.microsoft.com/en-us/team/79185; and Mizrin Mahisha, "Microsoft Imagine Cup 2016 - Innovation category - 2nd place goes to Bit Masters from Sri Lanka", *Windows Geek*, 29 July 2016. Available from http://english.windowsgeek.lk/microsoft-imagine-cup-2016-innovation-category-2nd-place-goes-bit-masters-sri-lanka/.
[35] Dialog-UoM Mobile Communications Research Laboratory. Available from http://www.ent.mrt.ac.lk/dialog/.
[36] Rajesh Jha, "Microsoft aquires Mobile Data Labs to advance intelligent productivity solutions for the mobile workforce", *Official Microsoft Blog*, 5 November 2015. Available from https://blogs.microsoft.com/blog/2015/11/05/microsoft-acquires-mobile-data-labs-to-advance-intelligent-productivity-solutions-for-the-mobile-workforce/#sm.000lad58s1e2bdifv7f13jlubbq6p.
[37] Deakin University, "Collaboration". Available from http://www.deakin.edu.au/collaboration.
[38] LIRNEasia, "Tag Archives: University of Moratuwa". Available from http://lirneasia.net/tag/university-of-moratuwa/.

The partnership with MIT has been possible through a professor at MIT who is an alumnus of UoM. He enabled UoM undergraduates to join an ICTD project conducted by MIT in Africa where they coached university students to complement their technical skills with business development skills.

The employability of UoM's IT graduates at graduation is 100 per cent, but the department does not have statistics on the number of graduates working in ICT-related fields and other fields. One of the study's informants estimates that almost all the graduates work in ICT professions.

4.5 Gender Issues

The purpose of the new Faculty of IT is to widen access to IT degrees. Entry to the Computer Science and Engineering Programme requires advanced mathematics, but qualifications in general science are sufficient for entry into the Faculty of IT's two undergraduate degree programmes—Bachelor of Science in IT, and Bachelor of Science in IT and Management.

Due to the relaxation of entry criteria, the Faculty of IT has opened doors to twice as many undergraduates as the Department of Computer Science and Engineering. The female student participation in the Faculty of IT was 50 percent, while it was 20 percent in the Computer Science and Engineering Programme. The percentage of female faculty members is also higher in the Faculty of IT at 60 per cent (see Table 3).

Table 3: A comparison of Computer Science and Engineering and IT degree programmes at UoM

	CS&E	IT
No. of students	500	1,050
% Female	20	50
No. of faculty members	20 (+ 8 on study leave)	35
% Female	35	60
Student-teacher ratio	25:1 (20:1)	30:1
No. of master's degree students	200	Not available
No. of doctoral degree students	2-3	Not available

Sources: Desk research and interviews, July-August 2016.

The advanced mathematics requirement seems to be a barrier for women's entry into the computer science and engineering programme. A more in-depth and systematic analysis is required to examine this deduction. This initiative at UoM is worth looking at as a possible good practice to increase women's participation in computer science.

There is no formal assessment on the employability of the above two types of graduates. Anecdotally, there are stories of IT graduates who have gone on to become top notch software developers, but a deeper analysis of the differences in course content and the relative success of IT graduates is warranted.

4.6 ICTD Alumni Perspectives

Those who graduate from UoM's ICT programmes are in high demand in the local software industry. Some graduates have gone on to develop ICT applications that touch the lives of a large number of people through employment in the non-profit sector or through entrepreneurship.

In this section, the cases of the following three alumni of UoM are highlighted to help gain insights and identify ways to strengthen the connection between academic studies and ICT applications for socioeconomic development:

- **Mr. Danaja Maldeniya**, Senior Researcher, LIRNEasia
  - Educational background – Computer Science and Engineering, UoM
- **Mr. Buddhika Jayawardana**, Entrepreneur, Siplo.lk
  - Educational background – Bachelor of Science in Integrated Computer Engineering, UoM
- **Mr. Dhanika Perera**, Co-founder, Bhasha Lanka (Pvt.) Ltd.
  - Educational background – Computer Science and Engineering, UoM

Danaja Maldeniya is a graduate of UoM's Department of Computer Science and Engineering. Danaja is currently a Senior Researcher in big data at LIRNEasia. His core research areas are human mobility and transport, in particular, urban development and transport-related research. In collaboration with Prof. Amal Kumarage at UoM, he carried out a study on understanding the effect of transport shocks, specifically to the opening of the E3 expressway[39] and how it has affected the people in that area. He also contributed his knowledge to a research project on understanding the spread of dengue through human mobility. This project was carried out with a group of final-year computer science students at UoM. Danaja has won numerous best presenter awards and has been accepted to the doctoral programme at the University of Michigan. Danaja says that an interest in ICTD is rare among graduates. He estimates that less than 10 per cent of the students pursue careers in ICTD.

He shares the following observations about attracting more students to ICTD:

- Students get into ICTD through personal experience—they should get a taste for ICTD work to stimulate their interest;
- In every batch, about 10-15 out of 100 will be interested in contributing to socioeconomic development;
- The university should encourage guest lectures on development topics;
- Internet access is extremely important because information is acquired through the Internet. Sometimes, if download speed is slow, students will not pursue studies that are bandwidth dependent (e.g., stream processing of Twitter).

[39] Wikipedia, "E03 expressway (Sri Lanka)". Available from https://en.wikipedia.org/wiki/E03_expressway_(Sri_Lanka).

Buddhika Jayawardana is a young innovator who is currently in his fourth year at UoM, studying for a Bachelor of Science in Integrated Computer Engineering. He co-founded a start-up, Siplo.lk,[40] with Asela Priyadarshana in May 2015. Siplo.lk is an online peer tutoring platform that has been recognized as a top five finalist at the Global Student Entrepreneurship Awards 2016.

Buddhika had a passion to start his own company, and before starting-up Siplo.lk he tried out several ideas that involved the use of Internet of Things technologies. Through his studies at UoM, he obtained sound theoretical knowledge, but he lacked marketing and business management skills, which made the start-up venture quite challenging. In this aspect he received guidance from Dr. Gamage, a faculty member, as the technical advisor for his start-up. Buddhika also received support from Mr. Kanishka Weeramuna as his mentor in business management, and from the UoM Entrepreneurship Club. His participation in the MIT-UoM project described earlier provided him with basic business and product development knowledge and experience.

For encouraging ICTD activities, Buddhika recommends:

“Having more real-life experience with product-based application development would be useful. Currently most large-scale projects are research oriented, and even when students do get the opportunity to do such projects, the time-span of four months is not enough to do a project of significant scope.”

Dhanika Perara co-founded Bhasha Lanka (Pvt.) Ltd.,[41] a Sri Lanka-based software development company dedicated to developing local language software solutions. It was founded in 2011 as a virtual company with no physical office. But today they have become a reputed company with a number of award-winning products and a growing client base.

The story of Bhasha began when Dhanika was at UoM’s Department of Computer Science and Engineering. He developed a mobile web browser for local language users for his third-year project, using a new technology to render complex scripts on mobile screens. It was awarded an mBillionth South Asian Award.[42]

His passion in this area of work came from his school days. As an indication, he developed a Sinhala-language biological encyclopedia for human anatomy while in school. He considers himself a multi-skilled person. He is a good developer, designer, speaker, leader, voice-over artist, localization professional and technical translator. According to him, if he had joined a company, he would have become a software engineer, but he would be limiting his talents to a certain area only.

Dhanika thinks many people find it difficult to become an entrepreneur because of the risk of failing. In his case, even before he graduated from the university, he was already working in the area and had products and links with the industry. So, he was fairly confident of success.

[40] See https://siplo.lk/.
[41] See http://www.bhasha.lk/.
[42] See http://mbillionth.in/.

At UoM, he was planning to work in a company, and even signed the contract a few months before he graduated. Since all the 100 students graduating from the Department of Computer Science and Engineering the same year as Dhanika made their decision to work in reputed companies, he decided to do the same, and work part-time at Bhasha. But he soon realized that he could not be an entrepreneur while being employed at another company.

Although engineers have become successful entrepreneurs in the new technology businesses, especially in Western countries, Dhanika does not see the same trend in Sri Lanka. Out of all the students that graduated the same year as Dhanika, only he himself became an entrepreneur. He thinks the cause is the absence of an entrepreneurial culture in Sri Lanka. According to Dhanika, everyone in Sri Lanka is looking for a job as soon as they get some educational qualifications, and many do not even think that there are other options. He also thinks that the society and traditional industries do not have a good image of young entrepreneurs. He believes that this misconception should be corrected. In his opinion, graduates should try to be job-makers, not just job-seekers.

5. Summary of Observations and Conclusion

Although there is no broadband policy in place, Sri Lanka's ICT policy is mandated by the ICT Act of 2003 and its amendment. Mobile broadband subscriptions and Internet usage have improved in recent time, while fixed broadband subscriptions have remained stagnant.

Funded by the Government of Sri Lanka, LEARN serves as the default ISP for all public universities, with each university purchasing its requirements. LEARN remains a central part of the ICT infrastructure of universities in Sri Lanka.

UoM's ICT connectivity includes both fixed and mobile broadband for its operation and service delivery. At the university, students have access to Wi-Fi connections, as well as computer labs that are equipped with either desktops or laptops connected to the Internet. Faculty members have used the Internet for instruction and communicating with students, especially via the Moodle-based LMS and SMS.

While there are no identifiable ICTD courses in UoM's Department of Computer Science and Engineering's curriculum, all undergraduate students are required to complete a project module by identifying an existing business challenge and develop solutions using ICT. This project module has provided students with good foundation knowledge, particularly in the automation of business processes and upgrading of existing systems to improve efficiency. Extra-curricular activities, such as students' participation in competitions, and research collaborations with Dialog, Deakin University, LIRNEasia, Microsoft and MIT, have also deepened students' knowledge and experiences. Such experiences should be encouraged to establish linkages between ICT knowledge and the practical application.

Some alumni have become successful ICT entrepreneurs after completing their university programmes. They have however highlighted the following recommendations for integrating ICTD in higher education:

- Internet connectivity is critical to tapping into the opportunities offered by ICT;

- Universities should encourage and facilitate exchanges of ideas through guest lecturers;
- There is a need for closer collaboration with the business and non-profit community to allow students greater exposure to real-life challenges and solutions; and
- Graduates should be encouraged to become ICT or ICTD entrepreneurs by supporting more systematic inter-disciplinary collaboration between faculties and departments, in particular between ICT and business.

Some lingering questions from this study include the ways to increase the enrolment of female students in computer science and IT, and whether the requirement for advanced mathematics is a barrier to women’s participation in these fields. Moreover, what are the ways in which universities can promote ICTD by and for women.