INTEGRATED INFORMATION AND COMMUNICATION TECHNOLOGY STRATEGIES FOR COMPETITIVE HIGHER EDUCATION IN ASIA AND THE PACIFIC

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ASIAN DEVELOPMENT BANK

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Abbreviations

ADB — Asian Development Bank

BYOD — bring your own device

HEI — higher education institution

ICT — information and communication technology

LAN — local area network

LMS — learning management system

MIT — Massachusetts Institute of Technology

MOOC — massive open online course

OCW — open courseware

PPP — public-private partnership

SUTD — Singapore University of Technology and Design

WAN — wide area network

Executive Summary

Developing countries in Asia and the Pacific are rapidly reaching middle income economic status. Their competitive advantage is shifting from labor-intensive industries and natural resource-based economies to knowledge-based economies that innovate and create new products and services. Early adoption of information and communication technology (ICT) can allow countries to leapfrog over the traditional development pathway into production of knowledge-based products and services. Since higher education institutions (HEIs) are considered a primary engine of economic growth, adoption of ICT is imperative for securing competitive advantage. ICT is thought to be one of the fastest growing industries and is frequently heralded as a transforming influence on higher education systems globally and, consequently, is enhancing the competitive advantage of countries. It is increasingly becoming evident that an institution-wide ICT strategy covering all evolving functions of competitive HEIs is necessary. Such a system may be designed as an integrated platform but implemented in phases.

In Asia and the Pacific the types of HEIs are diverse and at varying stages of development. Consequently, an integrated ICT intervention warrants a medium-term strategic approach, matched to individual institutions' demands, with options for periodic reviews to align with technology innovations and application demands. The project-based approach often adopted by HEIs for ICT creates fragmented systems with redundancies, challenges of interoperability, rapid obsolescence, and large service and maintenance costs. Much of these can be reduced by adopting a systemic approach involving unique organizational forms, ideas, and human resource development approaches into an integrated ICT system for HEIs. While dispersed models, adopting a bottom-up approach such as project-based and user-led interventions, can be a useful complementing approach, they may not be sufficient to sustain and expand an organization's ICT system's capacity to add significant competitive advantage. Thus, a coordinated top-down as well as bottom-up intervention is necessary.

When considering ICT investments, three broad areas require attention: the infrastructure, the application software and e-resource, and staff development. Often, enthusiasm is depleted after the infrastructure investments are completed; some organization-wide thinking may be applied to procurement of application software, but staff development is mostly neglected. Infrastructure investment in ICT is often driven by the ubiquity of "connectivity," which is often confused with access to the internet. There are other connectivity options, space designs, and equipment choices that can significantly help HEIs to become efficient and competitive and thus require consideration. Similarly, increasing clutter on the web has seen the rise of specialized repositories hosted on local and national servers to increase access speed and search efficiencies, particularly where

internet connectivity is either of poor quality, expensive, or not available. Perhaps the most serious issue affecting the adoption of ICT in HEIs is a lack of sufficient continuous staff development. There is an expectation that staff will somehow develop the required skills, reflective of individual user-led applications instead of institution-led ICT use. HEIs in developed economies invest a lot in human resource development for utilization of ICT, which in turn develops and retains competitive advantage in the knowledge economy.

ICT investments in contemporary HEIs have three interrelated functions; teaching, research, and community engagement. To support these functions, ICT can also enhance governance and management of HEIs through the use of enterprise software. However, since teaching is a core function of HEIs, recent innovations in online delivery of education services have inadvertently concentrated ICT investments mainly in teaching and learning to increase access and to engage in competing globally for the higher education market share. The interconnectedness of teaching and research, underpinned by the need for knowledge innovation, requires explicit links to research repositories, online journals, and research forums. Many of these research forums are extensively subscribed to by external stakeholders, thus contributing to the community engagement function of HEIs. Unfortunately, the latter two higher education functions have not received the same level of attention and investment as teaching and learning. Developing an institution-wide integrated ICT strategy will help bring these disparate activities into a systemic approach to increase the competitive advantage of the sector.

Finally HEIs' efficiency and productivity to support national, regional, and international competitiveness can benefit significantly by adopting enterprise ICT applications to support organizational management and human resources development including staff and institutional performance.

Introduction

Investment in Higher Education and National Competitive Advantage

A shift is taking place in developing countries in which trade in *commodities* is slowly giving way to trade in *knowledge-based products and services.* For economies that complete this transition, competitive advantage is no longer tied to the availability of natural resources, or to the volume of labor-intensive goods produced or exported. Instead, it is tied to the ability to create and be innovative. Such a shift increases the opportunity set of such countries, since the foundation of their economies is their stock of human capital, which can be created or augmented at will. This contrasts sharply with a country's natural resource endowment, which is inherited, and by nature fixed in supply.[1]

This shift suggests that the traditional development path under which the economic base of a country transitions from production of agricultural goods to production of industrial goods and finally to production of knowledge-based products and services may no longer strictly apply in the future. This is particularly true as the industrialization stage of this transition becomes increasingly automated or irrelevant.[2] In fact, it is early adoption of ICT that can help countries to leapfrog over the traditional development pathway into production of knowledge-based products.

However, early adoption of innovative technologies requires reshaping higher education, since a national labor force equipped with the knowledge and skills necessary to innovate and apply these technologies to productive use is a prerequisite to completing the transition referred to above. Further, the ability to innovate is ultimately the foundation of international competitiveness, which in turn is necessary to sustain growth driven by the production of knowledge-based products.

Higher education institutions (HEIs) have a critical role to play in this regard, as it is at these institutions that the ability to innovate is developed and nurtured. Thus, these institutions become the primary engine of growth in economies that shift their economic base toward production of knowledge-based products and services. Consequently, economies undergoing this shift are expanding investment in higher education as a result of its critical role in fostering national competitive advantage. Indeed, in such economies, investment

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[1]   Porter, M. E. 1990. The Competitive Advantage of Nations. Harvard Business Review. March/April, pp. 73–93.
[2]   http://www.economist.com/news/special-report/21621156-first-two-industrial-revolutions-inflicted-plenty-pain-ultimately-benefited.

in higher education is seen as a matter of strategic importance, as it leads to increased competitiveness internationally. Many countries seem reluctant to outsource the advanced training of their students to others to avoid the risk of losing national talents. At the same time there is growth in cross-border delivery of programs by western and Tier-1 Asia and the Pacific HEIs. There has been renewed interest in higher education in Asia and the Pacific for its critical role in fostering a nation's broad-based competitive advantage.[3]

Competitiveness in higher education of a type that nurtures the ability to innovate is associated with two factors, each of which is discussed in turn below:

(i)   The degree of internal efficiency achieved by HEIs depends on how efficient they are in using the resources available to them to achieve their goals. Typically, achieving internal efficiency requires employing results-based staff performance and institutional productivity indicators, as these provide a quantitative measure of the degree to which internal efficiency has been achieved.[4] While the specific forms of these indicators may vary, they all measure the degree to which achievement of the overall goals of the institution in question is being attained. Notably, these goals necessarily include development of the ability to innovate.

(ii) The competitiveness of the educational programs that HEIs offer contributes to external efficiency, and is reflected particularly in the proportion of HEIs' graduates who are able to secure employment. This is because employability reflects the degree to which these institutions offer programs that are both relevant and foster the ability to innovate.

Competitiveness in Higher Education in Asia and the Pacific

The pace of economic growth in Asian developing countries varies widely. As a result, there is wide variation in what constitutes competitiveness in HEIs, as national competitiveness in education relates directly to the demands placed on the labor force of the country in question. In countries with HEIs that are already competitive at the international level, competitiveness is often perceived as success in terms of each institution's international ranking. However, in other countries, competitiveness in higher education has more to do with the degree to which HEIs are able to equip labor market entrants with the skillsets required by domestic employers.

To address this complexity, there are evolving delivery modalities, new labor demands, and new partner engagements. Overall, the private sector is more heavily involved in higher

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[3]   Higher education leaders in Asia increasingly express the need to pursue integrated ICT strategies for competitive higher education. This was evident at 2014 Asia Higher Education Leaders Summit which the Asian Development Bank (ADB) organized in partnership with the University of Hong Kong. ADB presented issues of this paper in the summit. The paper incorporates feedback from summit participants. The analytical work and summit are activities of Regional Technical Assistance (TA-8303 REG): Partnership for Innovation in Education in Asia and the Pacific, financed by ADB.

[4]   Productivity in higher education generally comprises (i) research outputs, (ii) the quality of and innovations in teaching and learning, and (iii) community engagement.

education in Asia and the Pacific than it is in western developed countries.[5] As a result, access to higher education, as well as its quality and relevance, also vary more widely in Asian countries than in western countries. However, it is these factors that shape how internal efficiency in HEIs is perceived domestically. This wide variation in the accessibility, quality, and relevance of higher education in countries of the region notwithstanding, increasing competitiveness, however defined, requires HEIs to embrace ICT due to its significant contribution to the competitiveness of HEIs.

Naturally, the manner in which ICT is adopted, applied, and deployed has much to do with the financial and human resources available to the HEI in question. This in turn greatly depends on the level of per capita income in the country in which the institution is located. The manner in which adoption of ICT is resourced thus varies widely across the region's low, middle, and high income countries. In this regard, supporting the adoption and deployment of ICT by public-private partnerships (PPPs) is one option for increasing not only the accessibility of ICT at these institutions, but also its quality and relevance. Naturally, such PPPs must be structured in a way that is in the mutual interest of both the HEI in question as well as its private sector partner.

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[5] ADB. 2012. *Private Higher Education Across Asia. Expanding Access, Searching for Quality*. Manila

Role of Information and Communication Technology in Competitive Higher Education in Asia and the Pacific

Diversity of ICT Systems Deployed by HEIs in Asia and the Pacific

There is considerable diversity in the degree to which HEIs in Asia and the Pacific have deployed ICT.[6] For purposes of reader convenience, this paper categorizes these institutions into three tiers (Figure 1).In large measure, the tier to which a particular institution belongs is determined by the degree of economic development achieved by the country in which it is located. In turn, the design and architecture of the ICT system adopted by a particular institution mirror the degree of development of the ICT services available to it. In designing such systems, the focus of the institution should ideally be on the type of investment in ICT the institution intends to undertake in the medium to long term, as this allows system redundancies to be minimized when new functions and applications are added.

Figure 1: The Three Tiers of ICT Adoption and Deployment by HEIs in Asia and the Pacific

Tier -3 HEIs IT labs and LAN	Tier-2 HEIs IT Labs & LAN/WAN/ mobile devices	Tier-1 HEIsIT Labs and LAN/WAN/Internet and mobile devices

HEI = higher education institution, IT = information technology; LAN = local area network, WAN = wide area network
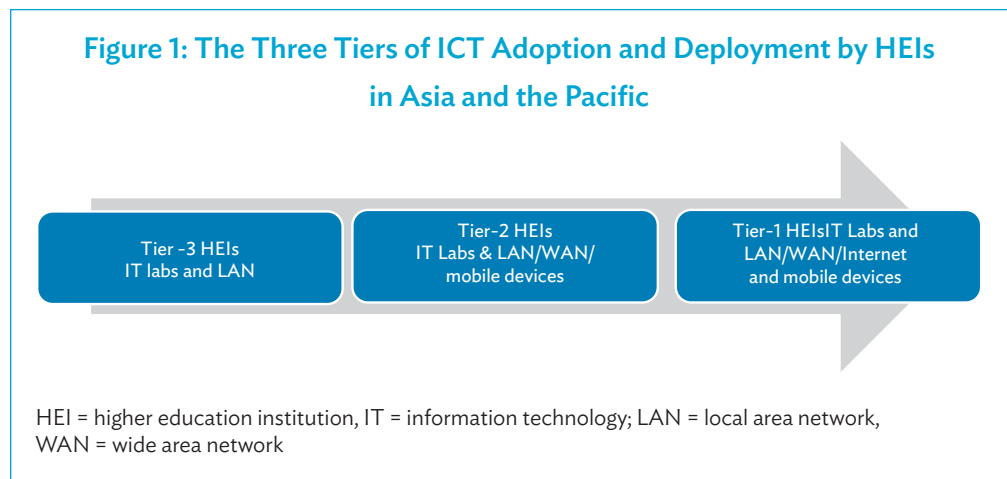
The primary characteristics of each of the three tiers of ICT adoption and deployment depicted in Figure 1 are summarized below:

(i) **Tier 1**. The institutions that comprise Tier 1 are located primarily in urban centers, as such locales generally provide access to superior ICT infrastructure and services

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[6] ADB. 2012. *Access Without Equity. Finding a Better Balance in Higher Education in Asia.* Manila.

such as high-speed internet.[7] The design of the ICT infrastructure adopted by these institutions can best be described as being integrated—services such as management and governance, student enrollment and records, online teaching and learning, library services, and research activities are all delivered through an integrated ICT system. Also, the ICT capacity allows these institutions to compete and collaborate with internationally recognized institutions. Tier-1 institutions offer high-quality online programs and are able to increase access, becoming regional knowledge hubs, thus facilitating cross-border delivery of programs.[8] As might be expected, Tier 1 accounts for only a small percentage of HEIs in Asia and the Pacific.

(ii) **Tier 2**. The degree of access to and quality of ICT services (e.g., access to the internet) that Tier-2 institutions have at their disposal varies widely, in part because these institutions geographically span the entire country in which they are located. In some of these areas, access to the internet is limited, or completely absent. As a result, Tier-2 institutions often compensate for lack of access to the internet by augmenting coverage of their local area network (LAN) and wide area network (WAN) systems. The degree to which ICT infrastructure and equipment are integrated into the overall infrastructure of Tier-2 institutions is limited, which suggests that these institutions typically have not yet adopted ICT as an integral part of their supporting infrastructure. As a result, ICT systems at these institutions tend to be fragmented and contain significant redundancies. The degree to which these institutions are competitive depends on whether the comparator used is domestic or international. For example, many Tier-2 institutions are considered to be premier institutions in that they serve the local communities in which they are located well. Tier-2 institutions represent the majority of HEIs in Asia and the Pacific.

(iii) **Tier 3**. Few institutions in Asia and the Pacific comprise this tier. Most are located in low-income countries in which not only access to the internet, but to electricity itself may be spotty or intermittent. The cost to these institutions of procuring ICT equipment and the licenses necessary to operate prohibits them from large-scale deployment of ICT systems. The ICT systems deployed by these institutions thus tend to be fragmented. This risks duplication—and sometimes even underutilization—of the ICT services provided. The degree of competitiveness achieved by these institutions tends to be viewed in terms of internal efficiency, or in terms of the degree to which the programs offered provide knowledge and skillsets consistent with the requirements of the local economy.

The LANs of Tier-3 institutions tend to provide limited support to the managements of the institutions that own them (e.g., for financial management) or to their students (e.g., for library information, or resources for supporting learning or research).

In contrast, Tier-2 institutions may upgrade their LANs to form WANs that link several institutions or campuses together, which allows them access to more sophisticated ICT applications. Finally, Tier-1 institutions often have sophisticated ICT systems including

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[7]   Examples include the University of Hong Kong, University of Malaysia, and Singapore National University.
[8]   Hawkins, J.N., et al. (eds). 2012. *Higher Education Regionalization in Asia Pacific: Implications for Governance, Citizenship and University Transformation*. McMillan: USA.

internet-based applications that enable considerable quality of service and competitive advantage.

The above notwithstanding, a note of caution is in order regarding the design of ICT systems, regardless of the tier of the institution that owns them. The degree of access to the internet enjoyed by a particular institution does not necessarily predetermine the efficacy of investment in ICT by it, as access to the internet is only one part of an ICT system.

Further, careful forward planning in adopting and deploying ICT can help avoid both delays in adoption as well as future system redundancies. In this regard, expansion of access to ICT may be either relative or incremental.

Relative ICT investment depends both on the purpose to which a particular ICT application is to be put, as well as the context of the HEI in question. Thus, what constitutes innovative ICT for Tier-1 institutions may be completely different from that for Tier-2 institutions. Similarly, ICT applications adopted for the purpose of improving management of the institution itself differ greatly from those adopted for the purpose of making teaching and learning more efficient.

Incremental ICT investment prioritizes particular ICT applications for servicing immediate demand, yet has the option to be expanded later. Incremental expansion and upgrading of ICT systems should thus be phased in a manner that reflects available resources, and should be part of an overall long-term plan.

Integrated ICT Innovations for Competitive Higher Education

Upgrading ICT systems provides a significant opportunity for HEIs to become competitive both nationally and internationally, and to respond to the evolving human resource needs of industry. Such upgrading can also strengthen the internal efficiency of HEIs, and allow development and delivery of programs that increase graduate employability locally and internationally. That said, the success achieved by HEIs in achieving the above objectives through upgrading of ICT systems has thus far been mixed.

In cases in which the results of upgrading of ICT systems have fallen short of expectations, two factors are generally in play: (i) lack of a systemic approach to ICT upgrading as a result of a failure to view such systems from a holistic, long-term perspective, and (ii) lack of a full appreciation of the strengths and weaknesses of particular ICT applications. In many cases, these two factors interact in a way that both creates redundancies and results in costly experimentation. A solution to such problems is an integrated, yet distributed system with an architecture that allows for both progressive expansion and adoption of innovative applications that transcend the commonly targeted delivery of online learning.

Figure 2 presents an ICT integration matrix that depicts both the primary functions of modern HEIs, as well as the considerations that must be taken into account when investing

Figure 2: Primary Functions of HEIs and Considerations When Investing in ICT Systems
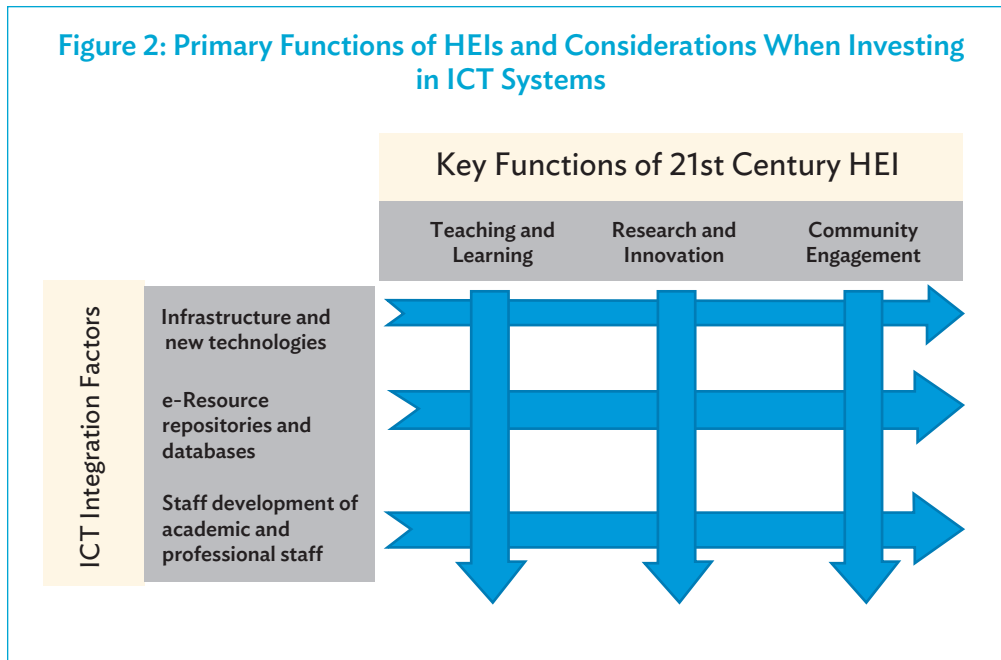
in ICT systems. Recent growth in the demand for undergraduate higher education in Asia[9] has concentrated ICT investment in infrastructure and equipment, particularly for the purpose of online teaching and learning.

Asia and the Pacific is now home to a steadily expanding middle class that is eager to enjoy the benefits of growing incomes that result from higher education. As a result, the region is seeing an increase in the demand for higher education, particularly at the undergraduate level. This presents Asia's HEIs with a business opportunity, in that efficient investment in ICT systems used for the purpose of expanding access to higher education both domestically and internationally can greatly increase both revenue and the prestige that such institutions enjoy. Further, while undergraduate teaching is the core business of most HEIs and hence a major source of revenue, both the capacity to perform research relevant to changing industry demand, as well as engagement with local community leaders, improve the prestige of such institutions. This in turn attracts undergraduate students of increasingly higher quality.

For the most part, the primary focus of investment in ICT systems by HEIs has been to support online teaching and learning. While unintentional, this has led to relative neglect of expansion of ICT support for the other functions of higher education depicted in Figure 2, thus hindering adoption of more integrated ICT systems. Consequently, ICT applications for increasing the internal efficiency of HEIs have to date been undertaken mainly by Tier-1 institutions. This is unfortunate, since such applications can strengthen HEIs in many ways. Examples include making financial management more efficient, increasing transparency, streamlining student support services, strengthening library and information

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9   Altbach, P. 2009. One-Third of the Globe: The Future of Higher Education in China and India. Prospects, 39 (1),pp.11–31.

services, supporting research and innovation, and facilitating engagement with the wider community including partners in industry that provide employment for graduates. The last is particularly important in light of the fact that the primary function of HEIs is to produce labor market entrants equipped with knowledge and skillsets relevant to current demand.

Figure 3 depicts the three major aspects of an integrated ICT system.[10] The first of these comprises the system's hardware, which includes its infrastructure and networks, as well as the access devices that determine the extent to which users—both within and beyond HEIs—can access the ICT facilities concerned. If the designs of the hardware and network are appropriate, the ICT system in question can service all three core functions of HEIs. This is because such a system allows for consolidated technical solutions, increases cost effectiveness, and facilitates compatibility to support an integrated service delivery platform.

The second major aspect of an integrated ICT system is its application software. This includes enterprise software[11] that facilitates management and governance of the institution in question; allows the deployment of e-resources; and supports the system's

Figure 3: The Three Aspects of an Integrated ICT System

Infrastructure networks and hardware options, new technologies

e-Resources, repositories, enterprise applications, electronic reporting

Higher Education service delivery

Human capacity development academic and professional staff and end users

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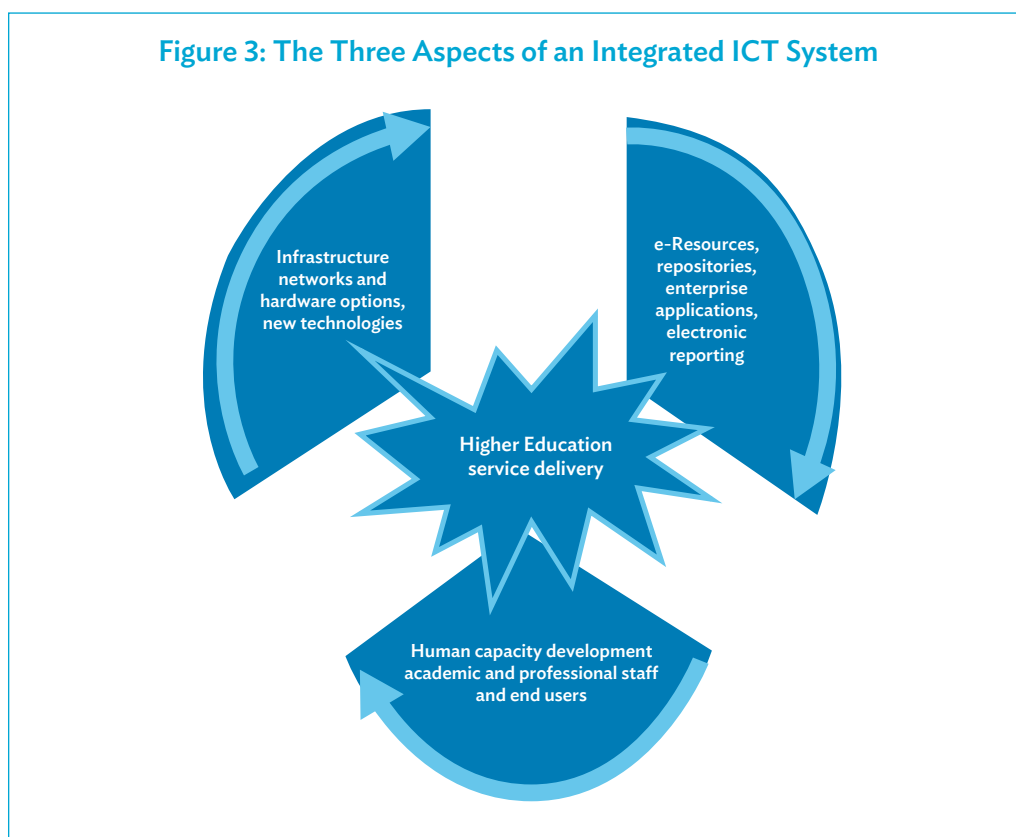
[10]   ADB. 2009. *Good Practice in Information and Communication Technology for Education.* Manila.
[11]   Enterprise software, also known as enterprise application software (EAS), is purpose-designed computer software used to satisfy the needs of an organization rather than individual users. Such organizations can vary from businesses, universities, and schools to interest-based user groups and clubs, retailers, or governments.

learning management platforms, repositories and databases, and electronic templates for teaching, learning, and research.

The third major aspect of an integrated ICT system is staff development, which is often neglected, primarily because it is taken for granted. Academics are not usually information technology or multimedia experts. As a result, they often need help with technical issues. This particularly includes assistance with procurement, adaptation, and adoption of e-learning resources. Without doubt, staff development is the most neglected aspect of integrating ICT systems in HEIs. This is true despite the fact that inadequate staff development is acknowledged to be a major deterrent to adoption of ICT systems in HEIs in Asia and the Pacific.

Infrastructure, Connectivity, and Technical Design

The infrastructure and degree of connectivity adopted by a particular HEI are influenced by a number of factors including (i) the ICT infrastructure available to it, (ii) the quality and types of services available, and (iii) the domestic cost of ICT services.

Innovation in ICT hardware and software is both rapid and continuous. As a result, avoiding accelerated obsolescence when designing ICT systems for HEIs and budgeting for it are of primary importance. The best way to do this is to adopt a medium- to long-term approach to planning such systems rather than a short-term project-based approach.[12] Given the risk of rapid obsolescence of technology, leasing rather to purchasing is also an option. A well-designed WAN with appropriate backup facilities and internet access through a single gateway that serves the entire institution can be more efficient than a fragmented system. This is true both of service delivery as well as maintenance and support.[13]

Is Connectivity a Prerequisite for ICT Adoption in HEIs?

ICT connectivity provides electronic links between people, or to sites that contain information. These information sites can be placed on a local server, or on the web. "Local connectivity" refers to communication between people or sites via a local server, whereas "internet connectivity" refers to communication between people or to sites via the web.

To a significant degree, connectivity as it relates to online teaching and learning has inadvertently become synonymous with internet connectivity. However, internet connectivity is really only necessary when the e-resources (materials used for learning or research) are placed on the web instead of being available through local servers. In fact,

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[12]   Technological innovation can result in rapid obsolescence. Also, availability of information technology devices at relatively low cost such as laptops, tablets, and iPads has changed laboratory designs. Server-clients with wireless connectivity provide an efficient alternative.
[13]   Most of the support provided by external development agencies to ICT for teacher training institutions is detached from central systems. The venue for such support is often individual departments of the ministry of education of the country concerned, or particular HEIs that view such support as a one-off activity.

many e-resources can efficiently be delivered through LANs and WANs, as well as through internet-based systems.

Internet penetration in Asia and the Pacific is currently relatively limited, and overall, the quality of service is poor.[14] That said, disaggregated data show wide variation in the degree of access to the internet and service quality within individual countries, with greater access and better service quality being largely concentrated in major cities, thus privileging Tier-1 institutions.

Ultimately, it is slow internet speed that dampens the enthusiasm of online learners and researchers to the greatest degree, this being particularly true of users accessing and working with resource-rich learning or research materials.[15] However, making improved internet access and service quality a precondition to deploying ICT in teaching, learning, and research ignores the fact that many e-resources can be efficiently delivered through LANs and WANs. Limited access to the internet and poor quality of service thus need not prevent ICT from being efficiently deployed by HEIs in the region. Further, both ICT technological innovations and design flexibility currently available allow easy migration from LANs to WANs, as well as migration from both to internet-based systems. Thus, HEIs can easily adopt ICT by beginning with a well-planned LAN that houses databases and other e-resources on local (institutional) servers. Such LANs are able to support a significant amount of teaching, learning, and research activity.

Similar networks at other HEIs can then be connected to a WAN. Particularly on a national level, WANs can provide significant economies of scale to HEIs in that software that improves both financial and overall management, teaching and learning, and research can be placed on such networks. Virtual private networks (similar to WANs used by the private sector), which often use a single gateway to the internet, can still provide flexibility when designing ICT networks for HEIs.

Further, 3rd generation (3G) and 4th generation (4G) mobile networks—which have significant coverage in most Asian developing countries—can also compensate for limited internet access, although most of these networks still have limited bandwidth.[16] Nevertheless, 3G networks can be used to download content from the internet to local servers, with this content then being redistributed through LANs. Similarly, content thus downloaded from the internet can be cached on a local server. This avoids the necessity of downloading content from the internet multiple times when searching through the same content. Options such as those presented above allow HEIs with limited financial resources or constrained access to the internet to make efficient use of ICT in teaching, learning, and research, Tier-2 and Tier-3 institutions in particular.

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[14]   http://www.internetworldstats.com/stats3.htm--June 2012 provides the following internet penetration statistics: Europe, 75%; the Americas, 61%; and Asia and the Pacific, 32%. Japan, Republic of Korea, and Taipei,China account for most internet penetration in Asia and the Pacific.

[15]   http://www.adb.org/projects/45193-001/main. Because slow internet speeds have been found to demotivate users, alternative options should be considered. Examples include uploading to local servers and redistribution of content on LANs in order to increase speed of access.

[16]   While 3G and 4G technologies were initially developed to serve mobile telephony, the data delivery capability of these networks has improved to the point of providing an alternative to internet broadband connectivity.

Finally, efficient formulation of connectivity solutions—whether these refer to LANs, WANs, or internet-based systems—requires differentiating between what is essential and what is desirable. For example, in considering if, and under which conditions, synchronous (simultaneous communication in real time) vs. asynchronous communication (offline communication) is required, the following questions need to be answered.

(i)   Whom do staff/students interact with? What are the patterns of interaction that take place during learning or performing the job tasks?

(ii)   Do all such interactions facilitate learning in the HEI in question?

(iii)   Is there a place for interaction and learning outside the formal HEI? If so, how does it relate to the core business of the institution in question?

(iv)   Who should provide for such interaction?

The above issues are particularly important in light of the changing expectations placed on HEIs, as well as the now widespread notion that learning should be both ubiquitous and continual.

Innovations in ICT Equipment and Learning Space Design

The design of infrastructure at education institutions can help foster the use of ICT.[17] Examples include internet connectivity in cafeterias and student residence buildings, interactive learning studios and laboratories, smart lecture theaters, leased rooms used as learning spaces in shopping malls, discipline-specific and cross-discipline learning spaces connected to the institution-wide ICT network, and increased use of WANs and wi-fi-enabled zones on campuses. Such innovations signal a significant departure from traditional computer laboratories in which ICT access depended on physical connections via a cable.

As noted above, avoiding accelerated obsolescence of hardware and software requires adopting a medium- to long-term time horizon when planning an ICT system for an HEI. Suggestions in this regard include (i) formulation of a centralized, institution-wide system as opposed to a fragmented system comprising incompatible components; (ii) use of standardized hardware and software, both of which facilitate efficient maintenance and interlinking of software and databases; and (iii) efficient use of the entire array of procurement options for both equipment and service. Examples of such options include outright purchase, leasing or other contractual arrangements, and procurement by PPPs.

The continual innovation in ICT that has taken place in recent decades cannot help but challenge the manner in which we design ICT systems for HEIs. For example, consider the historical progression from personal computer labs, to server-fat clients, to server-thin clients, to mobile devices, to bring-your-own-device (BYOD) systems.[18] Similarly, computer

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[17]   ADB. 2009. *Good Practice in Information and Communication Technology for Education.* Manila.
[18]   The BYOD option may be supported through schemes such as student loans, hire purchase arrangements, and tax rebates to help students purchase laptops, tablets, and iPads.

display technology has progressed from expensive, power-consuming data projectors to cheaper and energy-efficient liquid crystal display (LCD) monitors linked to laptops and other mobile devices. Likewise, LCD monitors in classrooms and other devices can now be readily linked to an institution's central system via wireless connectivity, thus allowing one system to host all teaching and learning resources.

Maximizing the use of ICT for learning purposes is no longer influenced by factors such as the number of students sharing a computer, or the number of computers per student. Instead, availability of e-resources and flexible access have become the most important factors. As a result, the hours during which computer rooms and libraries are open have increased, thus improving access.[19] Likewise, advances in ICT have made virtual (vs. physical) learning spaces possible. All such innovations challenge us to rethink the manner in which ICT systems can help improve the competiveness of HEIs.

ICT Innovations in the Governance and Management of HEIs

While using ICT to improve governance and management can significantly increase the internal efficiency of HEIs, Asia and the Pacific institutions have shown considerable reluctance to adopt such enterprise software. This outcome has in part inadvertently resulted from the approach adopted by the institutions when planning and designing ICT systems, which often has been ad hoc, or driven by special projects or availability of funds. The result has been narrowly defined interventions rather than well-planned, integrated ICT systems that acknowledge the fact that ICT is a central feature of contemporary higher education and, as with any large private sector organization, ICT can play an important inherent role in strengthening HEIs.

This outcome suggests that significant investment in staff development may be necessary for Asia and the Pacific HEIs if full use is to be made of ICT systems in both the educational process and efficient institutional management. The long-term objective of such staff development initiatives should be higher education leaders that view ICT as an integral feature of teaching, learning, and research, as well as institutional management. Given this, all other staff members, with appropriate training and support, would tend to adopt this view over time.

Governments increasingly adopt a performance- and productivity-based budgeting system for their public-funded HEIs. Such a system monitors the performance and productivity of these institutions via timely and accurate reporting of relevant data. To support this effort, efficient integration of ICT with institutional governance and management systems is essential.

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[19]   There are many ways in which HEIs can maximize the benefits of investment in ICT facilities. Examples include allowing access after office hours for purposes of corporate training and continuous professional development, both of which are increasingly becoming significant aspects of university functions.

Enterprise software reports performance-related data regarding the various functions of higher education as well as its organizational units in an integrated way, thus improving internal efficiency. Good enterprise software has significant flexibility to integrate specific applications as required by individual HEIs and/or governments. More specifically, most enterprise systems are able to:

(i)   automate the processes of human resource departments, and provide easy access to employee profiles and performance-related data;

(ii) integrate financial data with other functions such as human resources, and data relating to research grants, budget management, and staff performance;

(iii) offer online procurement of supplies and services that can be integrated with financial data (e.g., expenses relating to travel, research assistants, teaching and learning materials, and library resources);

(iv) allow planning of service delivery based on data relating to student enrollment, space utilization, and staff deployment; and

(v)   integrate administrative functions including archiving of documents, updating databases, and support communication, as well as allowing online submission of documents and notification of approvals.

Enabling Polices for ICT Design and Adoption

Efficient use of ICT as a management tool requires well-articulated policies that operationalize specific strategies; incorporate time-bound quantitative targets; and ensure availability of requisite resources, both financial and otherwise. For example, quantitative targets might relate to increases in the number of faculty members that use online reporting, or the proportion of courses that integrate ICT tools in their design and delivery.

However, using ICT as a management tool requires that staff members be trained in the processes necessary for capturing the information required for efficient productivity- and performance-based management. In addition, technical support that underpins these processes must be provided. While using ICT as a management tool can be discomforting to leaders who are accustomed to traditional management paradigms, over the long term, using ICT as a tool for institutional governance and management makes the system both more efficient and more transparent.

In sum, while ad hoc initiatives that promote the use of ICT as an institutional governance and management tool employed by individuals or particular departments may produce incremental gains in efficiency or productivity, such initiatives are insufficient to institutionalize use of ICT for such purposes.

Staff Performance Monitoring[20]

Most of the literature relating to governance of staff performance in higher education relates solely to publicly funded HEIs. Because the employment conditions of staff members of such institutions are closely aligned to those of civil servants, HEI staff are required to follow civil service rules and procedures. However, such procedures often heavily emphasize self-reporting of data and time-based incentives.

In contrast, ICT enterprise software is able to aggregate staff performance data from a wide variety of sources, and to present them in concise summary form. Further, the data captured by such software are not self-reported. Instead, they are compiled from data reported by the various academic and administrative units. For example, these data might include the number of grants actually funded, the number of academic papers published, the number of candidates that complete a particular postgraduate program, or the number of students attending a particular undergraduate course. This type of reporting greatly increases transparency and accountability.

Finally, commercial software that measures staff performance and organization managerial efficiency for very small to very large organizations is readily available. Thus, the software used can be tailored to the size of the institution concerned. This means that in most cases, the efficiency gains achieved through use of such software outweigh the cost of its deployment, regardless of the size of the institution concerned. In this regard, it is notable that HEIs in many developed countries have adopted ICT systems for monitoring staff workloads and performance as a means of increasing operational efficiency.

Management and Administrative Support

Perhaps the two most important features of good governance of HEIs are transparency and accountability, both of which are improved by using ICT governance and management tools.

As noted above, enterprise software is able to generate comprehensive summaries of various functions of HEIs that are based on data provided by the organizational units of the institutions, rather than data that are self-reported by individuals. Further, such software can analyze demand for particular courses or programs by capturing enrollment data, or analyze demand by delivery modality. Similarly, space utilization data can be used to improve the efficiency of planning when expansion of facilities is being considered. Finally, the internal efficiency of HEIs can be improved through the use of ICT tools such as document archiving with search capability, online procurement and processing of financial transactions, and inventorying of the institution's own assets.

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[20]   Azman (2010) cited in ADB (2012) notes that public universities in Malaysia historically did not take into account institutional and individual performance and productivity. While the Government of Malaysia instituted output-based budgeting in 1997, implementation of the latter experienced many challenges. This resulted from lack of system-wide monitoring, which greatly reduced the potential benefits of output-based budgeting. The solution to such problems is use of enterprise software, which generates summary reports that support output-based budgeting procedures.

Innovations in ICT–Based Teaching and Learning

In an attempt to expand both the scope of their functions as well as their revenue streams, HEIs have taken on increasing amounts of what formerly was considered to be functions peripheral to such institutions. Simultaneously, the pace of learning, multiple learning opportunities, and an abundance of readily accessible knowledge are disrupting existing expectations and practices. To a significant degree, the following aspects of ICT-based teaching and learning have made this possible:

(i) ICT-based teaching can present complex or abstract concepts in a way that is easily assimilated by learners. Similarly, it can help learners visualize relationships and interactions, allow repeated practice of particular procedures until mastery is achieved, and facilitate experimentation as well as collaborative learning together with peers.

(ii) E-learning materials and knowledge products are stored in a central place, and thus can be searched in a targeted manner, reducing the amount of time required for performing research and accessing such materials. Time is at a premium in today's world.

(iii) Connectivity increases access. The internet provides access to a vast number of databases and repositories. Similarly, LANs and WANs provide access to nationally or institutionally hosted databases and repositories. Further, this access can be either synchronous or asynchronous. This allows learning materials to be accessed at all hours, even from remote locations.

(iv) ICT tools with appropriate learner dispositions, such as allowing both self-directed learning and peer support, facilitate uptake of online learning and reduce attrition rates.

(v) In addition to improving access to learning by making materials available online, ICT tools (i) help learners select learning experiences appropriate to their background and level of preparation, as well as their interests and educational goals; and (ii) offer sustained guidance and support throughout the learning process.

(vi) ICT tools facilitate the design of learning objects and aggregation of e-resources into digital repositories such as massive open online courses (MOOCs) and open courseware (OCW) with appropriate pedagogical and curriculum considerations. They also facilitate deconstruction of knowledge, sequencing of information, interaction with peers, and rapid feedback, all of which improve learning outcomes. Both open access and proprietary e-learning resources are currently available.

The ICT teaching and learning tools described in the following three subsections of this report incorporate the beneficial aspects of ICT-based teaching and learning enumerated above.

Learning Management Systems and Other e-Learning Platforms[21]

Learning management systems (LMSs), which are often also referred to as e-learning platforms, are ICT tools used for creating, hosting, and delivering e-resources.[22] Learning activities managed by a LMS may supplement classroom teaching, provide a mix of online and face-to-face teaching, or be completely self-directed. LMSs can be hosted on a LAN, a WAN, or the internet. Advanced LMSs have built-in adaptive technologies that have intelligent systems to review the progress of individual students, and recommend remedial actions. They can likewise generate administrative reports such as class lists, student participation histories, and records of submissions of class assignments.

LMSs can provide one-stop services for particular university courses, allowing students to upload information including assignments from a single location rather than having to visit multiple sites to access different sets of materials. LMSs can also be linked with central student services and staff performance databases. This allows administrators and instructors alike to manage enrollments, student participation, and learning outcomes, thus increasing transparency.

LMSs are generally institution-based. They may be purchased outright, purchased under a licensing scheme, or custom made through the use of open source software.

While LMSs are generally not open access, they may be made open access if the institution involved allows it. In this regard, some institutions open portions of their LMSs to the public through MOOCs or OCW, but require a login to gain access to restricted portions. The capacity of LMSs varies; the more sophisticated LMSs support all types of teaching and learning resources such as videos, interactive simulations, and discussion groups, and can be linked to sites outside the LMS or institution in question.

Adopting ICT-based education delivery platforms is challenging for many HEIs in Asia and the Pacific, particularly in cases where traditional teaching and learning practices are deeply entrenched. In such cases, employing ICT-based teaching methods or making course content available to the public may seem off-putting. This often slows adoption of such methods. In this regard, reluctance to adopt e-learning is often expressed as a fear of losing academic freedom. However, using an LMS as a knowledge delivery vehicle actually entails a transparent contractual arrangement among the instructor, the student, and the institution, which hardly results in a loss of academic freedom.

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[21] Both open source learning management systems (e.g., Moodle) and proprietary systems (e.g., Blackboard) are currently available. As with all aspects of ICT systems, when deciding which LMS to adopt, accelerated obsolescence can be avoided only by taking a medium- to long-term view of the functions likely to be required in the future.

[22] Office Mix, Microsoft's new authoring and delivery tool, will likely reduce the cost of formulating online lessons and tutorials, and of building digital repositories for education, decision support, and knowledge management. Similarly, Google for Education provides special application software for developing, managing, and sharing online learning resources.

Design and Development of e-Learning Resources

E-learning resources (also referred to as learning objects) are digital resources used for teaching and learning. These may be either standalone e-resources, or learning objects that are integrated into course material, which then is uploaded to an LMS. In addition to mastery of the body of knowledge concerned, formulating high-quality interactive e-learning resources requires sophisticated technical skills. As a result, most instructors at HEIs require a significant amount of staff development input, as well as support from ICT professionals, when formulating, procuring, or adapting materials in a manner that facilitates their delivery as e-resources.[23]

Although some e-resources may simply be downloaded from the internet, others are available only through commercial developers. Nevertheless, the array of e-resources currently available is vast. This makes choosing appropriate e-learning resources a challenging task. The capacity to discriminate good quality and most appropriate fit of resources with HEIs' subject contents, and judging the value-added that the e-resource may provide to students' learning experiences, are critical and not readily achieved. For example, choosing appropriate e-learning resources requires an understanding of whether students interact better with lecturers or peers, or with learning materials on an LMS vs. materials on the internet. Further, not all learning experiences require interactions. Moreover, while most communication interactions may need to occur in real time, this is not necessarily true of all learning interactions. Finally, the array of e-resources available is large, as they range from digitized traditional lecture notes to instructive videos, to complex interactive simulations, and even to game-based learning materials.

Options for Procuring e-Resources

There are numerous options for procuring e-resources. These can be

(i)   developed from scratch—an option supported by advocates of user-led innovations;

(ii) procured from commercial developers under online or server-based licenses;

(iii) jointly developed, in which case they may be commercial material that has been customized,[24] or government-commissioned materials distributed as public goods;[25]

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[23]   E.g. Derive 6 was formerly a standalone e-learning resource for advanced mathematics. However, following its purchase by Chartwell-Yorke Ltd., this software was integrated into a repository for mathematics e-learning materials www.chartwellyorke.com. Developing comprehensive repositories for learning programs is the next phase in the development of e-learning resources. These are similar to MOOCs and OCW. Apart from the Massachusetts Institute of Technology (MIT) and Coursera, more than 200 HEIs use OCW.http://education.ctbto.org/index. php?option=com_joomdle&view=wrapper&moodle_page_type=course&id=44&Itemid=625

[24]   An ADB-supported project, Samoa SchoolNet, procured a server license for y-Teach from a private publishing company. See http://www.schoolnet.ws/e-lib.html. Similarly, excellent simulations for senior secondary science education can be found at http://phet.colorado.edu/in/

[25]   The major objective of the National Program on Technology Enabled Learning funded by the Ministry of Human Resource Development of the Government of India is to improve the quality of engineering education in India by developing curriculum-based video presentations and web-based courses. This initiative is being implemented by seven Indian institutes of technology and the Indian Institute of Science in Bangalore. A collaborative project, this initiative is supported by US$22 million in funding from the government. See http://nptel.ac.in/

(iv) downloaded from the internet from sites subscribing to Creative Commons copyrights; or

(v) developed through collaborative partnerships.[26]

For courses in undergraduate programs such as science, engineering, and mathematics that have a significant amount of content in common, the most efficient option may be procurement of a basic set of e-resources through collaborative partnerships, instead of each institution shouldering the expense of procurement individually. Once complete the text and voice content of e-resources appropriate to a particular country can be overlaid, the financing for this customization perhaps being provided by a PPP with an appropriate ICT company. In this regard, support to some HEIs may be required in two areas: (i) Creative Commons licensing, and (ii) adaptation of open access resources such as MOOCs and OCW materials to the particular requirements of Asia and the Pacific HEIs.

Massive Online Open Courses and Open Courseware

While distance education as a means of providing access to HEIs by students in rural or remote areas is not new, using ICT tools for this purpose is. MOOCs and OCW materials have excited many HEIs around the world into considering and adding ICT-based delivery models. Many courses that employ OCW are being translated into a wide variety of languages,[27] which will increase access and enhance global knowledge sharing. Statistics regarding current user demand for OCW provided by MIT suggest that the majority of students using these facilities are self-learners. As a result, the manner in which this might translate into student enrollment in formal programs remains an open question. Further, available data also suggest that students who enroll in programs that use OCW have relatively high rates of attrition, although this is not uncommon for distance or online learning programs.[28]

As with distance education, completion of coursework through online learning requires a particular type of student disposition. Nevertheless, continued monitoring of such statistics may shed some light on how distance and online learning may progress in Asia and the Pacific, where internet penetration rates are relatively low, and how the peak in the demand for higher education forecast in medium-to-long term may impact the current attraction to online and distance learning.[29]

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[26] Funding for some of the material placed on the OCW website of MIT was provided by Singapore University of Technology and Design (SUTD). This material was developed by MIT's Teaching and Learning Laboratory for SUTD. http://www.sutd.edu.sg/concept_vignettes.aspx

[27] See e.g. http://ocw.mit.edu/courses/translated-courses/ . Depending on the intended market, other OCW also provides courses translated into a number of languages.

[28] Financial Times, October 7, 2014. The Future of the University, pp. 23, 26.

[29] Brandenburg, U., et al., 2008, concludes that the demand for higher education for example in the United States will peak during 2025–2030, and then gradually decline. Future traditional investment in higher education development is therefore cautioned against. Economists and higher education leaders increasingly debate about the possibility of a higher education 'bubble' and the implications for future investments in higher education development in OECD countries. E.g. http://www.economist.com/blogs/schumpeter/2011/04/higher_education

ICT Innovations that Support Research, Knowledge Partnerships, and Dissemination

Knowledge through research and development helps HEIs become more competitive. This is particularly true at the national and international level, since research outputs are important in determining the national and international ranking of HEIs. It is thus unsurprising that innovations, citations, the impact of research on policy and practice, and the number of patents granted are increasingly used as indicators of the quality of HEIs, both globally and regionally. Such achievements likewise reflect well on the country in which these institutions are located.

While the research priorities of Tier-1 institutions differ from those of Tier 2 and Tier 3, research capacity should not be limited to a few elite HEIs in each country. Innovations in ICT, as they relate both to hardware and software and to application tools for service provision, provide new opportunities for innovation, development of knowledge products, and knowledge sharing. ICT can be thus quite inclusive in this regard, as it places research capacity within the grasp of nearly all HEIs. This in turn allows the strengths of each type of HEI in each of the region's countries to be put to its best possible use.

ICT-Enhanced Research Knowledge Sharing

Innovations in ICT provide new ways of collecting and sharing knowledge products, including research outputs. The most important of these innovations are briefly described below.

(i) **Open access publishing,** perhaps the most innovative ICT-led initiative in the sharing of knowledge products, is an arrangement under which publishers of traditional academic journals have agreed to provide open access to their publications via the internet. Under open access publishing, either the author or the author's institution is charged for refereeing and publishing journal articles, as opposed to charging the user (or his/her institution) for accessing particular journal articles.[30] Large-scale publishing firms (e.g., Elsevier, Taylor and Francis) now publish open access journals. Further, the ICT systems of these companies are able to translate journal content into 86 languages.[31] This is an attractive proposition for Tier-1 HEIs in that it ensures wider readership for their research outputs than previously, which in turn improves their standing both domestically and internationally.

(ii) **Institution-based publishing,** also known as self-archiving, is a variant of open access publishing. In this case, authors provide open access to their articles prior to their being published. As these repositories are maintained by the institutions concerned, each decides its content. An open source platform, Eprints, is now used by HEIs globally to share their research publications.[32] Institution-based

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[30] HEIs pay to publish research articles in open access journals because publication is quick, and open access allows more people to read and cite the research in question. This improves the research reputation of the institution in question, which in turn results in additional research grants and research collaborators.

[31] ICT capacity as it relates to translating scientific papers into multiple languages continues to improve.

[32] EPrints open source software facilitates the building of open access repositories that are compliant with the Open Archives Initiative Protocol for Metadata Harvesting. It is being used extensively by HEIs throughout the world.

publishing is generally used to disseminate peer-reviewed research, which is written solely for the purpose of expanding the body of human knowledge, as opposed to research that is undertaken in part to generate royalties.

(iii) **Self-publishing** is used to disseminate internal or academic documents such as research papers, opinion pieces, or advocacy and policy debates by individuals or organizations (e.g., think tanks, nongovernment organizations, private research organizations). As a result, these documents are usually hosted on websites owned by the publishing entity. Since these documents are not peer reviewed, they are subjected to less stringent quality control than documents that are formally published. Nevertheless, these documents are often peer rated, a process that provides some feedback but is in fact more an indicator of popularity than of quality. The number of hits on the website that each document receives is also recorded, which provides an alternative indicator of each document's popularity or the breadth of its readership.

While open access publishing and self-publishing require internet access, institution-based repositories can be placed on the LAN of the institution concerned, on a WAN, or on the internet, provided that the institution wishes to do so and has the requisite ICT infrastructure.

Growth in ICT Repositories for Knowledge Sharing

The exponential growth of information hosted on the web makes searching for specific information very time consuming. Digital repositories, using open access platforms such as E-prints, Digital Commons, or DSpace, archive information of a particular type in a single digital space.[33] Figure 4 depicts the significant growth of open access digital repositories (other than commercially developed repositories) over 2005–2012.[34]

The table disaggregates the information by academic discipline. While the multidisciplinary category understandably accounts for the largest percentage share of the total number of repositories, the number of discipline-specific repositories is increasing.

HEIs and researchers in Asia and the Pacific appear to be somewhat reluctant to use digital repositories to share the results of their research, even though the technical capacity for uploading digital repositories to local servers in their entirety already exists. Japan is the only country in the region that has a significant number of digital repositories on the internet. Among the top 10 such repositories, multidisciplinary has the largest percentage, but specialized repositories are increasing. Through negotiation with the curators of these repositories, they may be procured and uploaded to local servers, which can be particularly helpful for HEIs located in jurisdictions lacking internet access.

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[33]   http://www.sherpa.ac.uk/repositories/#partneribers

[34]   Pinfield, S., J. Salter,P. Bath,B. Hubbard, P. Millington, J.H.S. Anders, and A. Hussain. 2014. Open access repositories worldwide, 2005–2012: Past growth, current characteristics, and future possibilities. Journal of the American Society for Information Science and Technology. Retrieved from http://eprints.whiterose.ac.uk/76839/

Figure 4: Growth in Open Access Digital Repositories, 2005–2012
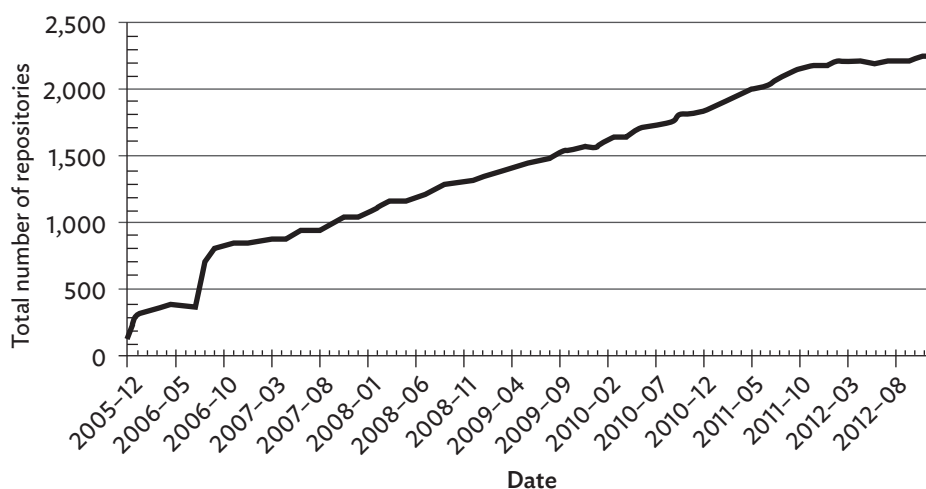
Source: Pinfield, S., et al. 2014. Open Access Repositories Worldwide, 2005–2012: Past Growth, Current Characteristics, and Future Possibilities.

Number and Percentage Share of Digital Repositories of Top Ten Academic Disciplines

Subject	Frequency	Percentage
Multidisciplinary	1,390	61.7
Health and medicine	210	9.3
History and archaeology	179	7.9
Business and economics	149	6.6
Law and politics	146	6.5
Technology general	145	6.4
Science general	144	6.4
Computers and IT	124	5.5
Education	123	5.5
Geography and regional studies	123	5.5

Source: Pinfield, S., et al. 2014. Open Access Repositories Worldwide, 2005–2012: Past Growth, Current Characteristics, and Future Possibilities.

ICT-Based Data Archiving and Sharing

Advances in computer technology have enabled processing of larger volumes of data over shorter time periods. Academics have made full use of this ever-expanding data collection, storage, and processing capability to empirically prove the validity of their theories through quantitative verification. Often referred to as "big data," this trend has advantages that

transcend the volume of data that can be processed. For example, "big data" techniques allow aggregation of datasets from disparate sources, complex analysis that relies on inclusion of a large number of variables, and reduction in error rates when working with large datasets.

Using mutually agreed upon protocols, ICT systems can efficiently archive and share large amounts of data. This is particularly important to agencies that fund research, since they require researchers and research institutions to demonstrate that they can securely aggregate, store, and share the data that relate to the research that is funded. As for data sharing, cloud computing allows researchers from numerous institutions to work on the same datasets simultaneously. Further, it allows the relatively high cost of complex analytical software to be shared, even by smaller institutions that individually would be incapable of affording its cost.[35]

While aggregating, storing, and sharing "big data" are easily within the technical capacity of ICT systems at their current stage of development, accommodating "big data" techniques requires considerable planning for appropriateness of infrastructure and hardware, interoperability between disparate databases, efficient data management and classification systems, etc. Collectively, such characteristics of "big data" management systems enable the metadata harvesting mechanisms necessary for allowing researchers from multiple institutions to simultaneously use metadata harvested from a large number of archives.

As the notion of allowing open access to research data is new to most HEIs in Asia and the Pacific, there is understandably some reluctance to embrace it. To some degree, this results from the research traditions of past decades, which considered limiting access to the results of research as a means of making the research in question appear to be more scarce, and thus more valuable. This contrasts sharply with the view of contemporary knowledge sharing, which holds that the more people that view and use one's research findings, the more high-profile that work becomes, and the greater the amount of value the research creates.

ICT Collaborative Networks for Research

Online collaboration tools such as Google Drive, Open Source, and MS SharePoint facilitate collaboration, as well as joint research and publication. As a result, use of these tools is likely to grow. Further, because public sector funding for research is limited in Asia and the Pacific, collaboration between HEIs and private sector entities will in all probability likewise expand. In this regard, ICT tools can significantly improve the efficiency of collaboration in research. Examples of such cross-border online research collaboration can be seen in the European Union research supported by the Sino-foreign cooperation. Online tools include voice over internet protocol, and collaboration websites. However, appropriate software and infrastructure are a prerequisite for ICT-assisted collaboration in research.

Most academic collaboration networks are sustained in two ways: (i) they have a continued purpose, and (ii) network moderators continually comment on the results achieved.

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[35]   In the absence of online cloud capacity, data may be stored locally on agreed upon software platforms that allow copying onto individual devices and thus physical sharing.

Regardless of whether these are short-term, project-based networks or long-term networks supported through collaboration among several institutions, most become inactive and close when initial funding and enthusiasm fade.

Further, the majority of these networks are Anglo-centric, which limits the degree to which the knowledge they generate can be shared with non-English-speaking researchers and institutions. While current experimentation with Google Translate appears to hold some promise for overcoming such language barriers, for the most part, HEIs located in non-English-speaking jurisdictions remain unable to access knowledge products produced by English-speaking institutions, the reverse likewise being true. In this regard, use of social media is a low-cost option for enabling frequent communication and for moderating inputs among researchers that holds significant promise for simulating collaboration among HEIs globally, particularly if it is integrated into research collaboration networks.

ICT for Increasing Global Competitiveness

The domestic and international ranking of a particular HEI is increasingly used as an indicator of its overall quality. Such rankings are significantly influenced by the number of publications produced, as well as by the global impact of the research undertaken. The exposure that a particular institution receives from its research prowess—large numbers of people reading the research publications it produces—significantly improves its ranking, as such exposure often attracts joint research partnerships, and hence funding from public- and private sector entities alike. Such exposure likewise increases the attractiveness of institutions to high-quality graduate students—some Tier-1 HEIs in the region have positioned themselves well in the regard. Finally, ICT-based research collaboration facilitates national, regional, and international partnerships, further expanding the opportunities for collaboration available to each institution.

Unfortunately, HEIs in Asia and the Pacific have not yet fully embraced the ability of ICT systems to improve indicators of institutional quality as referred to above. In part, this is because they fear losing what they perceive as valuable intellectual property. As noted earlier, such concerns prevent the region's institutions from engaging in open access publishing and archiving of research data and results, which in turn affects their global recognition.

Use of Social Media by HEIs

Despite the increasing general popularity of social media, little research exists regarding the capacity of social media for making the functions of HEIs more efficient. In large measure, lack of a means of verifying the accuracy of information posted on social media websites has limited its use in teaching and learning or other formal functions by HEIs. A notable exception to this is the use of social media by HEIs for purposes of marketing and directing clients to their official websites. Another use of social media by HEIs is that it allows students to share their feelings, thoughts, and concerns as they progress through the university experience. Similarly, the use of social media facilitates participation in informal educational activities such as clubs and associations, thereby enriching the overall experience of students.

Conclusion

While ICT systems can contribute significantly to the domestic and international competitiveness of HEIs, the positive impact of this contribution critically depends on the existence of a well-articulated, institution-wide ICT integration plan that takes account of all of the functions of the institution concerned. Such an approach to integrating ICT systems into an institution's functions is efficient in that it avoids redundancies and mitigates against accelerated obsolescence of ICT investments. Finally, as ever-increasing numbers of HEIs embrace integration of ICT systems into their overall operations, delay in doing so prolongs the inevitable, diminishes the overall domestic and international competitiveness of lagging institutions, and fails students who must ultimately enter an increasingly competitive labor market for which they may be poorly prepared. Regardless of the tier to which they belong, all HEIs in Asia and the Pacific can integrate ICT systems into their operations. The challenge for each institution is that of determining the most appropriate ICT investment.

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Integrated Information and Communication Technology Strategies for Competitive Higher Education in Asia and the Pacific

Early adoption of information and communication technology (ICT) can allow developing countries in Asia and the Pacific to move from labor-intensive, natural resources-based to knowledge-based economies. Higher education institutions must adopt an institution-wide, holistic ICT strategy, not a project-based approach, to avoid redundancies, obsolescence, and large maintenance costs. A coordinated top-down plus bottom-up intervention is best, with three areas requiring attention: infrastructure, application software, and staff development. ICT investments in higher education institutions in support of teaching, research, and community engagement are essential for developing and retaining competitive advantage in the knowledge economy.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to the majority of the world's poor. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.