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**AN ANALYSIS OF HEALTHCARE INFORMATICS AND SYSTEMS
IN SOUTH EAST ASIA: A CURRENT PERSPECTIVE FROM
SEVEN COUNTRIES**

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Abstract

This paper presents an overview of healthcare systems in South East Asia with a focus on healthcare informatics development and deployment in seven countries, namely Singapore, Cambodia, Malaysia, Thailand, Laos, the Philippines and Vietnam. Brief geographic and demographic information is provided for each country, followed by a historical review of the national strategy for healthcare informatics development. An analysis of the state-of-the-art healthcare infrastructure is also given, along with a critical appraisal of national healthcare provision.

Introduction

Healthcare informatics (HI) is an outgrowth of medical informatics that focuses on the clinical aspects and applications of technology in the delivery of healthcare (Norris, 2002). The evolution of healthcare informatics is driven by changes in both, technology and healthcare. HI has become an integral component within the healthcare industry all over the world and provides fundamental, and often inseparable, knowledge bases commensurate with current technologies to healthcare organizations and health professions to progress and provide a better quality of care services to patients and citizens.

Information processing and communication in the healthcare sector are currently centrally involved in virtually all healthcare activities, from obtaining and recording information about patients, communicating with healthcare professionals and accessing

medical literature, to selecting diagnostic procedures, interpreting laboratory results and collecting clinical research data (Georgiou, 2001). Recently, electronic healthcare record (EHR) systems, decision support systems (DSS), hospital information management systems (HIS) have been developed and are being widely used in a clinical context as well as in enterprise resource management systems on the administrative side (Von Lubitz and Wickramasinghe, 2006*a,b*).

Stakeholders and decision makers worldwide are realising the clinical, organisational and financial benefits resulting from the implementation of healthcare IT. Although disparate healthcare systems, budgetary mechanisms, languages and clinical/treatment protocols have delayed a more uniform systems adoption, healthcare IT is becoming an increasingly important matter for the political agenda of governments worldwide.

Almost all Asian countries are now using computers in healthcare centres or hospitals. The concept of HI has been an established science and has developed rapidly in some Asian countries since the 1970s, such as Singapore. However, different countries have different political and budgetary issues and situations which affect the development of their healthcare provision based on current technologies (Lun, 1999).

This paper gives a review of the current state of HI activities in South East Asia by capturing a wide picture of the state of current healthcare provision in seven South East Asian countries. Each country is appraised individually from its history of developing information technology to the current developments in hospitals or clinical centres. Whilst the paper also provides some recommendations, these cannot be fully covered as

healthcare informatics provision in each country will depend on its own future health policies, strategies and budgetary commitments.

Analysis of Healthcare Systems and Healthcare Informatics in South East Asia

The seven countries which are under consideration in this paper will now be examined in terms of three key areas: national healthcare system, history of healthcare informatics and the current prevailing state.

1. The Republic of Singapore

Singapore is a small country with a land size of 697.1 km² and a total population of approximately 4.55 million in early 2007 (Singapore EDB, 2007). The main manufacturing activities revolve around the semiconductor industry. At present, the country stands as the third largest silicon industry in the world (Holliday and Tam, 2004).

The healthcare expenditure of Singapore in 2004 was 3.7% of GDP, and the average life expectancy of its citizens for males and females is 77 years and 81 years, respectively (Singapore Ministry of Health, 2007). The Government of Singapore is committed to provide health promotion to the ageing population by providing wellness programmes through a multitude of Information and Communication Technology (ICT) platforms (Abd Ghani, 2007).

National Healthcare System

According to the World Health Organisation (Singapore Ministry of Health, 2007), the state of healthcare provision in Singapore is considered as the top in Asia and is regarded as being an international model. Singapore has a dual system of healthcare delivery supported by both the public and private sector players. Currently, the public sector provides 80% of hospital care and 20% of primary care (WHO, 2007*a*). Primary healthcare is provided at private medical practitioners' clinics and outpatient polyclinics. Secondary and tertiary specialist care are provided in private and public hospitals.

In 1999, the public healthcare delivery system was reorganised into two vertically integrated delivery networks: the National Healthcare Group (NHG) and Singapore Health Services (SingHealth). Public hospitals and health clinics are organised into a western cluster under the National Healthcare Group and an eastern cluster under the SingHealth Group.

History of Healthcare Informatics

Singapore is one of the leading countries in Asia in applying IT in many industries at a very early stage (since 1980) when the government launched the National Computerization Plan (Sriramesh et al., 2006).

Since 1997, Singapore had introduced a shared electronic medical record (EMR) system which included hospital in-patient discharge summaries, medical prescriptions, drug allergies, laboratory test results and radiography reports. Concurrently, the Singapore Eye

Research Institute firstly introduced the concept of the *OphthWeb* system which was used for testing electronic medical records based on the use of images and objective measures during diagnosis of eye diseases. The *OphthWeb* is a pioneering telemedicine system in delivering optometric treatment services and a testing ground for generating the EMRs for Singaporeans before applying to other clinical specialties (Chew et al., 1998).

In 2004, the Ministry of Health launched *EMRX*, a platform to allow the exchange of electronic medical records between the two clusters, initially for in-patient discharges, but later expanded to other records and to the private sector healthcare institutions and workers. Alexandra Hospital and the Inforcomm Development Authority (IDA) initiated a system labelled *Hospital Without Walls* which allows patients and doctors to access medical records online. The first stage allows emergency hospital staff to file patient records electronically, rather than fill in five different paper forms. Real time access to these records saves time and effort for doctors and nurses thus allowing them to focus more fully on patient care.

Current Aspects of Healthcare Informatics

Both consumers and doctors in Singapore are now familiar and comfortable with the role that ICT plays in the healthcare industry. The Health Portal has become an essential medium to promote healthy lifestyle or wellness programmes to the citizens. On the other hand, continuing medical education plays an important role in keeping medical professionals current with changes in medicine, generally, and in areas relevant to their specialty (SingHealth, 2007). The majority of telemedicine services and e-health

applications in Singapore use a high-speed broadband backbone (Singapore ONE) with bandwidth ranges up to 622mbps (Tay-Yap and Al-Hawamdeh, 2001). As such, the internet is a suitable technology for implementing telemedicine applications in Singapore and this enables patient health records to be shared across and between healthcare stakeholders and is accessible by patients anytime and anywhere via the internet.

2. The Kingdom of Cambodia

The Cambodian population stood at just over 14 million in 2005. A large proportion of the population (84%) lives in rural areas, and only 16% live in urban areas. Since the establishment of the Royal Government of Cambodia in 1993, and up to 2002, the average GDP growth was 5.5%. Due to the low expenditure from the Cambodian government, Cambodia had a ubiquitous system of non-government healthcare providers, including a variety of traditional care categories, drug sellers and western medicine. The Cambodian citizens' life expectancy, on average, for males and females stands at 51 years and 57 years, respectively (WHO, 2007*b*).

National Healthcare System

In 1995, the Ministry of Health (MoH) approved a new health system for the organisation of provincial health services based upon a redefinition of criteria for location of health facilities and a definition of a basic minimum package of health services to be delivered at each level. The reformed health system was composed of three levels:

- The first level, which was the most peripheral, was made up of operational district units serving about 100,000 - 200,000 people, and composed of a referral hospital and a network of health centres.
- The second level, or intermediate level, was made up of a provincial hospital and provincial health department.
- The third, or central, level consisted of the MoH, national institutes, national hospitals, national programmes and training institutions (Mekong Basin Disease Surveillance, 2007).

Since 1999, Cambodia has tried an alternative approach in which the government tendered management of government health services for contract in certain districts to private bidders, and increased public health expenditure to pay for these bids. Contractors were required to provide all preventive, promotional, and simple curative healthcare services mandated for a district by the MoH, known as the Minimum Package of Activities (MPA). They were responsible for services at district hospitals, sub-district health centres, and more remote health posts. The MoH has endeavoured to substantially restructure and broaden the public healthcare system, constructing several hundred health centres offering essential primary healthcare services of MPA and referral services of Complementary Package Activities (CPA), which was a package of services for delivery at referral hospitals and complementary to the package for primary care services. Besides

those efforts, the public services have remained low and resulted in the rapid expansion of private sector health services (Economic Institute of Cambodia, 2004).

As of 2003, there were eight national hospitals, 73 operational districts, 67 referral hospitals, and 823 (87%) health centres out of 942 providing the MPA or minimum package of activities. Fig. 1 is a diagrammatic representation of the distribution of such facilities. It was planned that by the end of 2005, 46 referral hospitals would provide either a secondary or tertiary complementary package of activities (Ministry of Health, 2002).

Governmental health expenditure has been increasing in recent years. In 1999, the approximate total government expenditure on health was US\$2.85 per capita; that figure increased to US\$4.09 per capita in 2005. Overall, health sector financing absorbs approximately 10% of GDP, the highest percentage among developing countries in Asia. An estimated 70% of health sector financing is from out-of-pocket payments, representing approximately US\$24 per capita, with donors paying approximately two-thirds of the remainder (World of Information, 2006).

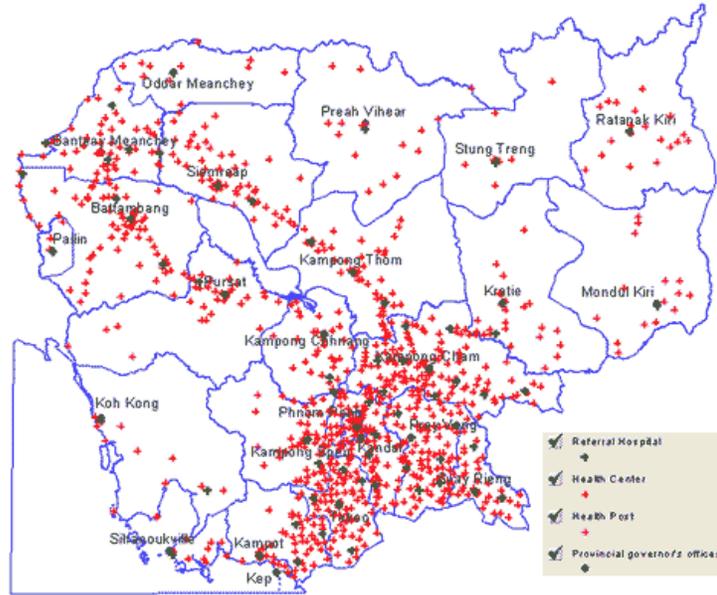


Fig. 1. Map of provincial governor's offices, referral hospitals, health centres and health posts in Cambodia (Source: Cambodia Ministry of Planning, 2004)

History of Healthcare Informatics

Cambodia ranks amongst the lowest countries on the human development index and amongst the highest in terms of poverty. Disparities in healthcare access are great, particularly in rural areas where approximately 40% live below the poverty threshold and health worker shortages prevail. Therefore, computerisation has not been deployed yet and is still regarded as a very new concept.

Most hospitals and health centres were founded during the 1950s or 1960s. Some large public hospitals, such as Calmatte Hospital have some support from French

organizations, have radiological facilities including ultrasound and echocardiogram, but no computer tomography (Pilszczek, 2001); Kampong Trabek Referral Hospital started using computers in their administration and management processes in 1999. Physicians rely more on history records than on physical examination to reach a decision when making diagnoses.

During the period from 1996 to 2005, a human resource development plan had been established to enable a future rational intake and allocation of human resources in support of the health system. Simultaneously, through help from the UNICEF, a Health Information System (HIS) was designed to support the reform process as has the implementation of the new drug distribution system, vital to the functioning of the health system. HIS is used to determine the level of activities per health facility (Ministry of Health, 2007).

Current Aspects of Healthcare Informatics

Due to global, national, economic and political shifts and the pressing needs for healthcare access and quality, the MoH prepared a Strategic Plan which provided a five-year framework from 2003 to 2007. The Plan highlighted the need for improvement of health facilities, and the necessity for healthcare practitioners to possess at least a minimum qualification recognised and regulated by professional groups (Ministry of Health, 2002). Moreover, the MoH is trying to strengthen the collaboration and cooperation with other countries and organizations in order to achieve some progress in the management and delivery of healthcare services.

In 2001, an email-based telemedicine programme was established to leverage the growing internet infrastructure for health purposes (Heinzelman, 2007). Subsequently, in 2003 there was another programme, namely *Internet Village Motoman*, which was launched to bring technology to 15 solar-powered village schools, telemedicine clinics and governor's offices in remote provinces (Ricciardi, 2004).

In 2002, the International University was founded by the Cambodian government and is the largest private University that provides medical education. The Department of Medical Informatics aims to instil the theoretical knowledge of informatics in medicine and pushes for the acquisition of practical skills of work on personal computers.

3. Malaysia

With its total land size of 329.847 km², the population of Malaysia in 2007 stood at approximately 27.17 million (Department of Statistics Malaysia, 2007). Malaysia has achieved remarkable advances in healthcare. Life expectancy increased from 63 years for males and 68 years for females, in 1970, to 70 years and 74 years, respectively, in 2004.

In addition, other factors such as political stability, positive economic growth at 5% of GDP and tolerance among the various ethnicities increase the harmonisation and stability of the country. In other words, the Malaysian community has enjoyed a harmonious life with a full and fair partnership compared to other surrounding countries.

National Healthcare System

Malaysia's healthcare system covers both public and private sectors. About 80% of healthcare services are provided by the public sector, which is still considered one of the best in the region. The Malaysian public healthcare system is structured in a hierarchical pyramid-based concept as shown in Fig. 2. At the base of the pyramid is a broad array of primary healthcare services (such as health centres, polyclinics, mobile clinics and maternal and child clinics) spread throughout the country. The next level includes district hospitals, one in each of the 120 districts, feeding into state general hospitals in each state capital. At the top of the pyramid lies Hospital Kuala Lumpur which is the national tertiary reference centre which provides specialist and super-specialist services for the nation (Ministry of Health Malaysia, 2000).

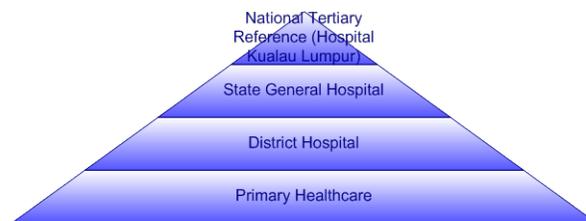


Fig. 2. Malaysian hierarchical healthcare structure

Malaysia has enjoyed a comprehensive range of health services, the government being committed to the principle of universal access to high-quality healthcare which it provides through a nationwide network of clinics, hospitals and healthcare programmes.

Overall, approximately 3.8% of GDP is spent on healthcare services (Ministry of Health Malaysia, 2002).

History of Healthcare Informatics

The Malaysian healthcare system has developed such that, during the last decade, in various parts of the country, there has been an integration of western medical science and the traditional health values (alternative medicine). However, due to the National IT Agenda in 1996, the government launched a *Multimedia Super Corridor (MSC)* which used ICT as a useful tool to improve many industries, including the healthcare sector. Therefore, there have been numerous projects related to ICT that have been initiated by various institutions in the Ministry of Health Malaysia over the last 15 years (Suleiman, 2001).

In 1997, the Malaysian government produced the *Telemedicine Blueprint* (subsequently renamed *Telehealth*) for supporting the future of the Malaysian healthcare system. The focus of the system is on people and services, using telehealth and ICTs as the key enablers to provide an accessible, integrated, high-quality and affordable healthcare system (Ministry of Health Malaysia, 1997).

In 1999, a research project on Clinical Decision Support System (CDSS) initiated and highlighted the associated issues and proposed some solutions for consideration by clinicians and researchers (Philip and Grace, 2001). In-Patient Management Systems (IPMS), Out-Patient Management Systems (OPMS), Laboratory Information Systems

(LIS) and Health Management Information Systems (HMIS) have been simultaneously applied in a number of hospitals. These systems are mainly for managing the hospital administration functions such as billing, patient registration, ward administration, patient appointment, dispensary and stock control. As of 1999, these systems have been implemented in 12 hospitals.

In 2000, the government delivered the first Telehealth project, Personalised Health Information and Education (MCPHIE) and Continuing Medical Education (CME) portals. The MCPHIE portal was designed to deliver personalised health information to individuals through the internet, while CME was designed to provide a platform for healthcare professionals to continue to upgrade their knowledge and skills through the advancement of ICT by providing a virtual library, postgraduate online education programmes and professional community services (Ministry of Health Malaysia, 1997).

The Lifetime Health Plan (LHP) is yet another Telehealth project application that aims to deliver network-based personalised health management of an individual based on medical records. In early 2001, the first deliverable of LHP had been deployed at 3 hospitals (Hospital Kajang, Hospital Seremban and Hospital Kuala Lumpur) in different states (Selangor, Negeri Sembilan and KL Federal Territory), as well as at 42 health centres serving these hospitals.

Current Aspects of Healthcare Informatics

In comparison with other countries in South East Asia, Malaysia has initiated healthcare informatics at a very early stage. Thus, the government has endeavoured to achieve the vision and goals towards enhancing the quality of life. The Malaysian government will develop new IT hospitals in each state nationwide. Every new hospital will be provided with full ICT infrastructure such as local area network (LAN), application software and hardware. The e-health concept has been implemented in daily hospital operation where all departments link to each other via LAN. The patient management system (such as patient registration) has been integrated into the clinical information system for sharing patient information and for generating the patient health record. Thus, doctors, clinicians, healthcare professionals and patients are familiar with the telehealth term and its applications and services (Table 1).

Table 1. Telemedicine applications and services in Malaysia

Category	Application	Service	Technology
Clinical	Clinical Information System (generic illness)	<ul style="list-style-type: none"> • View Lifetime Health Summary • Provide JIT CME • Provides Patient Health Plan • Provide data entry space to generate EMR • Generate LHR 	<ul style="list-style-type: none"> • Internet/store and forward
	Clinical Information System (wellness specific programs)	<ul style="list-style-type: none"> • View lifetime health summary • Request and save health plan • Generate lifetime health plan 	<ul style="list-style-type: none"> • Internet/store and forward
	Personalised Lifetime Health Plan (PLHP)	<ul style="list-style-type: none"> • Generate PLHP of patient for specific problems and diseases. 	<ul style="list-style-type: none"> • Internet
	Teleprimary Care (TPC)	<ul style="list-style-type: none"> • Provide first hand treatment to rural communities. • Early warning system (escalating the information of epidemic diseases to public) 	<ul style="list-style-type: none"> • Internet

		health authority).	
Clinical support	Teleconsultation	<ul style="list-style-type: none"> • Second opinion medical consultation 	<ul style="list-style-type: none"> • Still image/store and forward
	Laboratory information support	<ul style="list-style-type: none"> • Provide test report 	<ul style="list-style-type: none"> • Internet/store and forward
	Radiology information support	<ul style="list-style-type: none"> • Provide x-ray report 	<ul style="list-style-type: none"> • Internet/store and forward
	Pharmacy information support	<ul style="list-style-type: none"> • Dispense drugs 	<ul style="list-style-type: none"> • Internet/store and forward
Education	Continuing Medical Education (CME)	<ul style="list-style-type: none"> • Electronic courses such as medical distance learning and formal distance learning • Creation of Online Professional Community Service • Virtual Resources 	<ul style="list-style-type: none"> • Internet
Consumers	Mass Customised Personalised Health Information and Education (MCPHIE)	<ul style="list-style-type: none"> • Information • Education • Advice • Wellness monitoring of the lifetime health plan • Personalised lifetime health plan 	<ul style="list-style-type: none"> • Internet
Administration	Patient Registration	<ul style="list-style-type: none"> • Maintain patient master index • Generate patient master index number • Enterprise patient registration 	<ul style="list-style-type: none"> • Internet/store and forward

4. The Kingdom of Thailand

Thailand's population in 2007 was approximately 62.8 million with a total land size of 514,000 km² (Mahidol Population Gazette, 2007) which is divided into 76 provinces, gathered, in turn, into 5 groups of provinces by location. Thailand has singularly been affected by an excess of mortality due to HIV-AIDS. This has led to a lower life expectancy, higher infant mortality, lower population and growth rates, and changes in the distribution of population by age and sex than would otherwise be expected.

Thailand's national health spending has risen considerably from 3.82% of GDP in 1980 to 6.1% in 2002, and steadily increased in the following years. However, in comparison

with other neighbouring countries, such as Malaysia or Singapore, the Thai government has not given a high priority to healthcare as the people still bear a larger share in health spending for self-care.

National Healthcare System

Thailand implements a dual system of healthcare which is supported by both the public and private sectors. The Ministry of Public Health (MOPH) is the highest organisation in the healthcare structure. Since 2001, according to the MOPH, the healthcare system has been classified into five levels spread out across the entire country (Fig. 3).

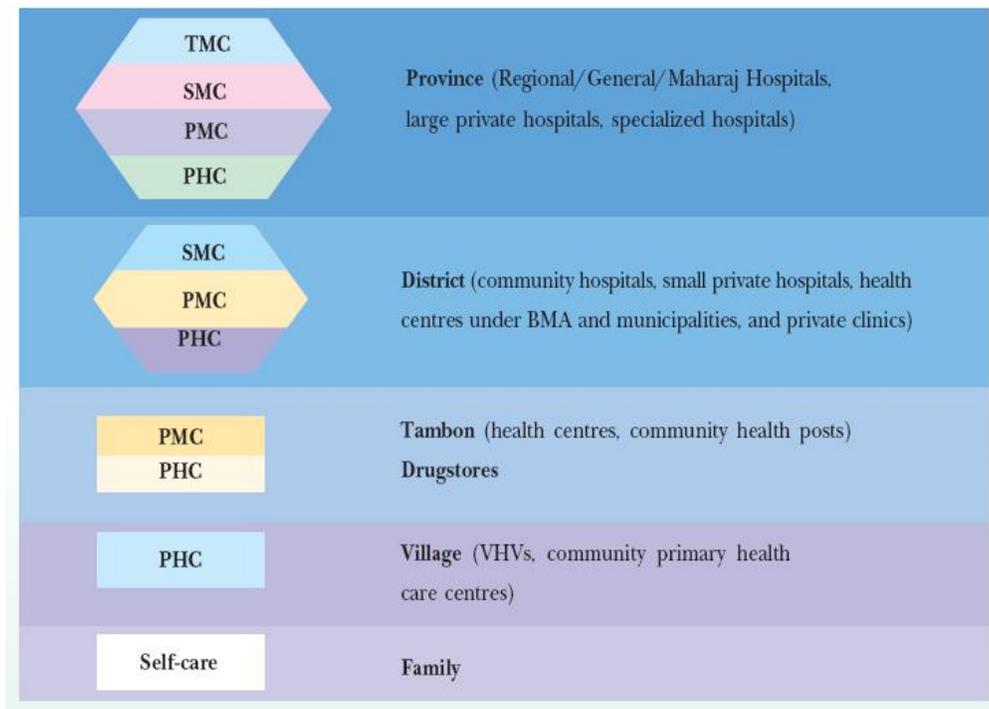


Fig. 3. Levels of health services in Thailand (Source: MOPH, 2007)

Private sector healthcare has expanded faster than the public sector, with private healthcare expenditure currently estimated to be running at double that of the public sector. Private hospitals (over 370) account for 25% of all hospital beds (MOPH, 2007).

History of Healthcare Informatics

Recently, a number of large hospitals have invested their IT budget into management and services to provide better healthcare quality. However, the majority of hospitals in Thailand, especially those in remote communities, still lack IT funds for such software development and deployment (LinuxMedNews, 2006).

During the period 1977-1991, computer technology was introduced for the improvement of the health information system. The capacity of the computerised systems was expanded to all MOPH agencies at both central and provincial levels. Moreover, MOPH planned setting up the software *Management of Information System* to serve health administrators in decision-making at all levels.

Subsequently, the Thai government endeavoured to improve the country's healthcare system starting with telemedicine, such as linking doctors in rural areas with specialists at major hospitals via satellite. The system offered services such as teleradiology, telecardiology, telepathology, video conferencing, distance learning and on-line medical databases. This four-year project, lasting from 1995 through 1998, is expected to serve 61 stations across the country, including a mobile station for transmitting signals (Gross, 1997). During this time, MOPH launched another telemedicine network project which

linked the Information Technology Office and 19 hospitals with health facilities all over the country via satellite and computer networks (Narong, 2001).

Current Aspects of Healthcare Informatics

The Thai government has continued to improve qualities and services in healthcare by introducing new guidelines, namely the 9th National Health Development Plan. Based on this plan, the healthcare information system has been augmented by electronic individual cards system that can be linked between central and local levels (WHO, 2006a).

Furthermore, the Thai government, Thai private and public hospitals have launched the Thailand Centre of Excellence for Life Sciences Pharmacogenomics Project, in collaboration with Oracle, to gather and unify health records electronically. The project involves the development of a large-scale database of unified electronic health records and is intended to provide safer and more effective medications as well as reduced health care costs (McGee, 2005). This programme derived from the fact that many large Thai hospitals and medical groups already use electronic health records and other electronic clinical systems in the care of patients. Furthermore, an official policy to support telehealth has been officially issued by the government (Bangkok Post, 2007).

5. The Lao Peoples' Democratic Republic

Laos had a population of 5.6 million in 2005, a land area of 236,800 km² and a population growth rate of 2%. The country is characterised by its subsistence on agriculture and it remains predominantly rural with agriculture accounting for 56% of

GDP. The estimated total health expenditure is 2.72% of GDP and, per capita, health expenditure is US\$12. These are accrued as follows: approximately 60% from households, 30% from donors and 10% from the government. Hospitals are highly dependent on user fees for recurrent expenditure. In 2005, the Laotian citizens' life expectancy, on average, for males and females stood at 59 years and 61 years, respectively (WHO, 2007c).

National Healthcare System

Between 1975 and 1985, due to the commune structure, the core of primary healthcare was the health centre at commune level. This had a provision of 5 beds on average. Over the past several years, the Laotian government articulated its commitment to expanding and improving its primary healthcare system. Therefore, public health services are now provided through a three-tiered system.

- At the central level, the Ministry of Public Health (MOPH) is responsible for the management of health services throughout the country.
- At the provincial level, services are coordinated by the provincial health office, and include service provision through provincial hospitals (45-249 beds), and supervising / supporting activities of the district health system. District hospitals have between 15 and 25 beds, each, but provide care for a population of about 300,000 people.

- The dispensary level of approximately 700 dispensaries serves villages throughout Laos. Most services in rural areas are provided through an informal network that includes private drug sellers, village health volunteers, traditional healers and traditional birth attendants (Sananikhom et al, 2000).

The state health system is predominant, although a private alternative is growing. There are no private hospitals, but over 2,000 private pharmacies and 484 private clinics, mainly in urban areas.

History of Healthcare Informatics

Due to various political, historical and economical circumstances in Laos, the healthcare industry has been developing at a very slow pace in all levels of health planning and management. To improve the infrastructure, facilities and knowledge of healthcare professionals, the Laotian MOPH, which is the highest organization responsible for the strategic planning for the entire health sector, received significant national funds but remains heavily dependent on aid from large multilateral donors, such as the ADB and the World Bank.

Since the late 1980s, Laotian citizens did not receive high quality healthcare service nor did they have access to adequate facilities. Therefore, a significant number of citizens travelled to Thailand for the treatment of serious illnesses. During this time, the number of private health providers started increasing and, in much the same way, private

pharmacies have opened to meet the demand for medications that could not be obtained through the state health system.

The healthcare infrastructure and facilities, in general, gradually progressed through ADB funding. Thus, the gap in primary healthcare services between rural regions and cities has been decreasing noticeably. Building on this achievement, healthcare organizations started applying IT in their services in order to improve the quality of healthcare delivery and keep pace with patients' demands and the developing trend of the healthcare industry in South East Asia.

In 2005, approximately 18 provinces were scheduled to have completed a programme of a national information infrastructure based on optical fibre technology, with 13 others already being connected and operable. Also based on that infrastructure, a *Vientiane Gigabit Network* project attempted to develop and deploy the national health network application. The application provides a basis for patient records, exchange of records between hospitals, telemedicine applications providing advice at district hospitals from provincial or central hospitals, and contact with the drug control department, amongst other services (Pehrson et al, 2005).

Current Aspects of Healthcare Informatics

According to the history of healthcare informatics evolution in Laos, there is clear indication that IT has just recently begun to penetrate the healthcare sector. There are a

few projects, plans, meetings and conferences to plan and design the further development of more advanced technologies in district or provincial hospitals.

In March 2003, the Pan Asia Networking (PAN) held an All Partners' Conference in Vientiane, Laos. This conference reflected a shift from connectivity to applications and concentrated on the development of applications for distance education, rural connectivity, local languages, telehealth and e-commerce (Swaminathan, 2005).

The Lao Paediatric Residency began in 1997 to train doctors in IT and, lately, some Laotian graduates have used the internet regularly to research about paediatric cases and develop differential diagnoses, evaluations and treatments (Srour, 2007).

In 2001, the Health Strategy to the Year 2020 was promulgated by the VIIth Party Congress. This strategy has four basic concepts: (a) full healthcare service coverage and healthcare service equity; (b) development of early integrated healthcare services; (c) demand-based healthcare services; and (d) self-reliant health services.

6. The Republic of the Philippines

The population of the Philippines was approximately 87 million in 2006 with a total land size of approximately 300,000 km² (ADB, 2007). Private consumption spending contributed 4% to overall GDP growth (ADB, 2004). The remittances from the country's millions of overseas workers, who are primarily health workers, are the main resource and have strengthened the role of private consumption. Moreover, the tendency of

nursing migration to developed countries, such as the UK, is very common in the Philippines (Aiken et al, 2004).

The economy is driven by some industries such as petroleum refining, chemicals, pharmaceuticals, electronics assembly, food processing and fishing, with a GDP per capita of approximately US\$1,250 (Espicom Business Intelligence, 2007). In 2005, The Filipino male had an average life expectancy at birth of 67.8 years, while the female had 72.5 years (National Statistical Coordination Board, 2007).

National Healthcare System

The healthcare system in the Philippines differs considerably from other South East Asian neighbours in that most of the country's medical services are delivered by the private sector.

Under this healthcare system, the Department of Health (DOH) is the lead agency in health. Its major mandate is to provide national policy direction and develop national plans, technical standards and guidelines on health. It has a regional field office in every region and maintains specialty hospitals, regional hospitals and medical centres. Hospital-based services in both the public and private sectors are categorised into several levels:

- First level: referral hospitals are non-departmentalised hospitals providing general clinical and nursing services for patients requiring care on a 24-hour basis;

- Second level: referral hospitals are departmentalised hospitals providing specialty clinical care;
- Third level or end-referral hospitals: are hospitals providing the highest level of medical care that includes specialised and sub-specialised treatments, surgical procedures and intensive care (Dorotan and Mogyrosy, 2004).

In general, public health services possess facilities which are more suitable for financially deprived patients. This situation is due to a low public expenditure on health, which steadily decreases annually, relative to other low-middle income countries (Fig. 4).

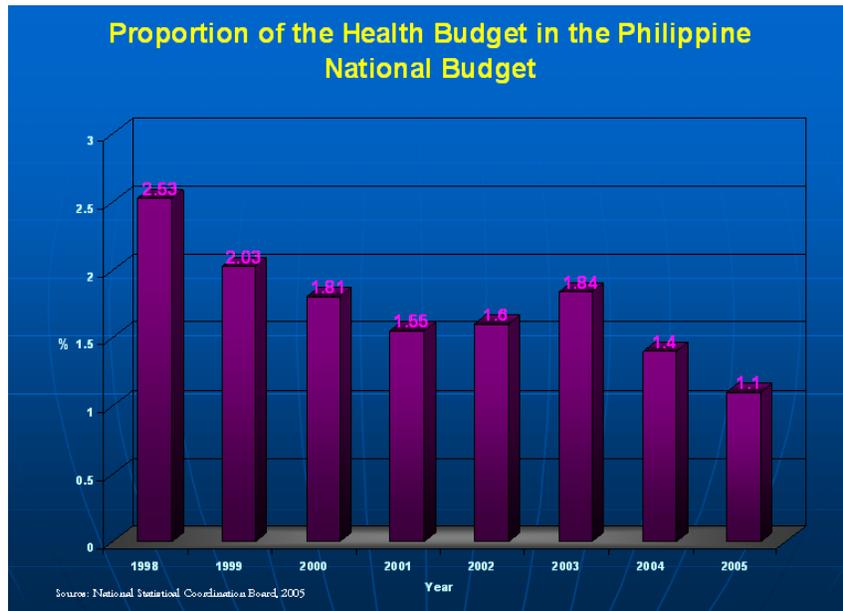


Fig. 4. Proportion of the health budget in the Philippines in 8 years (1998-2005)

(Source: DOH, 2006).

On the other hand, the private sector provides health services in clinics and hospitals, health insurance, manufacture and distribution of medicines, vaccines, medical supplies, equipment, other health and nutrition products, research and development, human resource development and other health-related services.

History of Healthcare Informatics

In the 1980s, the concept of biomedical informatics had been acquired by healthcare professionals in the Philippines. Some applications had been loosely practised as evidenced through the use of widely available general software, such as Microsoft Office applications or database management systems, to store patient information on IBM-compatible machines.

In 1998, the government introduced *e-Health Philippines* which provided an impetus to the health research community for the development of specialty databases by research practitioners and study groups (Villarruz, 2007). Matching this new wave in the healthcare industry, the University of the Philippines - Manila (UPM), launched the first formal course in Medical Informatics. The University had readily worked on healthcare information systems projects, such as the Community Health Information Tracking System – CHITS (Marcelo, 2006). The software collects existing routine health data from vertical programmes in the Field Health Service Information System (FHSIS) and integrates them into a unified and comprehensive computerised information system. Through CHITS, community-based health information is made available, not only to public health agencies requiring community level information, but also to the community

itself which generates the information (CHITS Development Team, 2007). As can be seen, education in healthcare informatics in the country had been significantly strengthened.

Current Aspects of Healthcare Informatics

Regardless of the many developments in healthcare informatics in the Philippines, the nation still suffers from many unsolvable issues that impede progress. Firstly, there is a noticeable lack in human resources due to nursing migration. One peculiar, but common, occurrence is that of many doctors attempting to switch to nursing due to the wider availability of overseas employment (Lorenzo et al, 2007). Secondly, the budget for the healthcare industry is still significantly weak, even with the aid of international organizations such as the ADB or WHO. Lastly, the pace of development between private and public sectors has no harmonisation.

Earlier in 2007, the health plan of WellPoint, which is a private health insurance company, provided US\$42 million worth of free PDAs or PCs to help entice doctors to adopt electronic prescriptions or reduce paperwork by submitting claims electronically. Although WellPoint contracts with 25,000 doctors, only 19,000 physicians participated - one in four passed on the free equipment. A big part of the problem is keeping the technology running, rather than the initial investment. Less than 25% of doctor offices have any form of IT support (McGee, 2004).

At the present, the Philippines, as in other similar South East Asian countries, has established health information systems based on existing computer systems. However, the government's effort seems to be fairly fruitless due to the following factors: (1) poor healthcare financing; (2) the 'brain drain' of health professionals; (3) the excessively high price of medicines, leading to costly out-of-pocket payments and inadequate and irrational use.

In 2005, under the national leadership of the DOH, based on a deeper understanding of the requirements of implementation and coordinated support from development partners, the government formulated a new health reform implementation strategy, known as *Fourmula One for Health*. The strategy organises the reforms into four implementation components, namely: (1) Health Financing, (2) Health Sector Regulation, (3) Health Service Delivery (covering both public health and hospital reforms), and (4) Health Sector Governance in Health. The *Fourmula One for Health* strategy coordinates health reform more closely with public expenditure management and governance reform, including public procurement reform and measures to increase transparency and accountability in public expenditure management (DOH, 2006). The profile shows that the Philippines' government endeavours to solve and focus on the financial issue more than other issues. Thus, IT in the healthcare industry is obviously feebler than in other regional countries despite of some respectable healthcare informatics research.

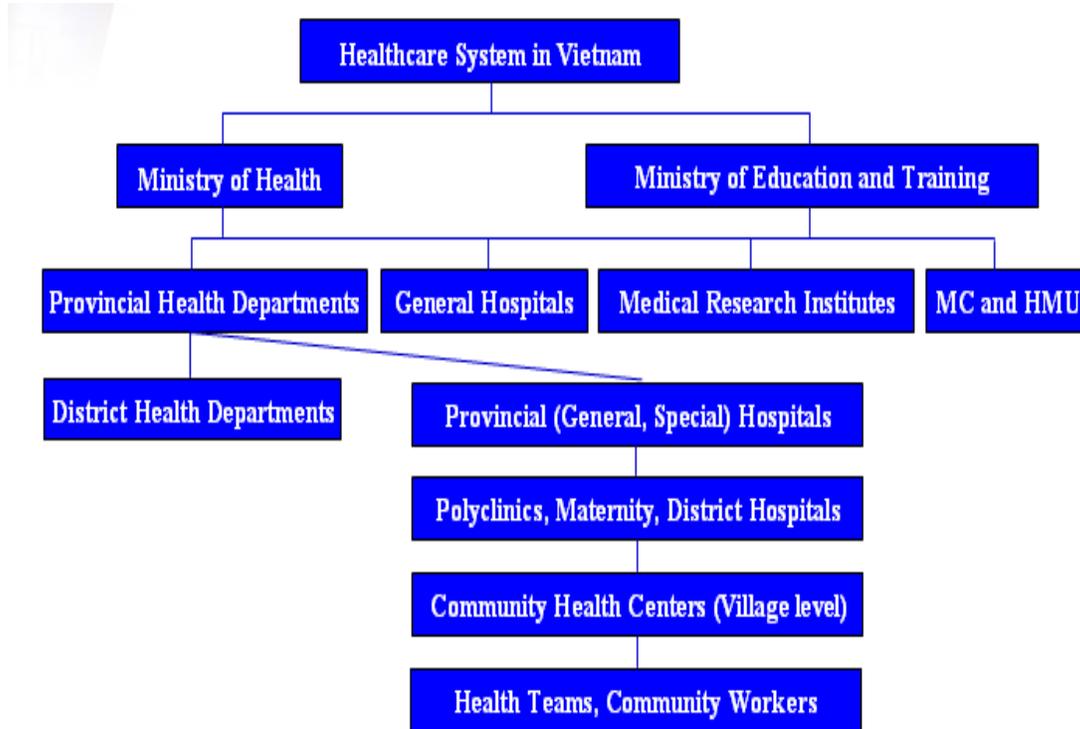
7. Socialist Republic of Vietnam

The population of Vietnam was approximately 84 million in 2005 and the total land size is 333.7 km². The annual growth rate was estimated at 8.4% in 2005 (Country Profiles Foreign and Commonwealth Office, 2007) and thus Vietnam became classified as one of the most densely populated countries in South East Asia. The growth in economy has ranked Vietnam as the second-fastest developing country in the world from 2000 to 2002 due to the change in, and build-up of, IT and high-tech approaches applied into many industries, such as manufacturing, healthcare and the pharmaceutical industries. Thus, advances in modern technology and the developing technological trend have become an imperative impetus for the health industry to exploit such developments into the clinical and healthcare services arenas.

National Healthcare System

The structure of the healthcare service in Vietnam is based on a five-tiered public health system: specialist, provincial and district hospitals are under control of the Ministry of Health (MoH), whereas Commune Health Centres (CHCs) are scattered throughout rural areas with 11,357 health stations (Ministry of Health, 2004). The MoH is not only under the control of the government, but also depends on the participation of a number of international organizations. Due to the government's lack in sharing information, decision making and systematic structure, the healthcare system itself is not well-organised and the regulatory measures issued by the MoH are difficult to apply to the whole sector. However, the healthcare system proves to be a success in the widespread net of CHCs. In every commune, medical staff are responsible for a defined area. Patients

are free to select the services they require either within their region or in different areas, depending on their expenditure capabilities (Nguyen et al, 2007). The diagram in Fig. 5 provides a clearer structure of the Vietnamese public health system and is outlined below.



MC: Medical College

HMU: Hanoi Medical University

Fig. 5. *Hierarchy of Vietnam’s healthcare system as published by the Government*

(Source: Montegut et al, 2004)

Considering that rural citizens form the majority of the total population in Vietnam, the health system has been successful with the establishment of CHCs in most communes.

History of Healthcare Informatics

In response to the global development in technology in every sector or industry, the MoH started in 1995 to develop local and wide networks and apply specialist software in some regions, hospitals and schools of medicine (Hung et al, 2003). This is mainly due to a clear understanding that applying IT in the healthcare sector is not only of paramount importance for its further development, but also that healthcare informatics will enable the provision of better services to patients and the improvement of the national health system. Simultaneously, under the leading government, the healthcare sector further consolidated, developed and deployed many successful applications and software packages in hospitals and medical schools, such as teleradiology, teleconsulting and HISs. However, since Vietnam is a country which has only just embarked on the first steps of developing IT in the healthcare sector, there is a lack of comprehensive, transparent and spontaneous development.

However, some leading research projects have recently been carried out by the Institute of Information Technology (the Vietnam Academy of Science and Technology), and the National Centre for Natural Science and Technology (e.g. the application of Intelligent Systems in medicine), the Centre for Health Information Technology (MoH of Vietnam) and now Vietnam has joined the Asia Pacific Association for Medical Informatics (APAMI). Simultaneously, the Computer Science discipline has embraced the global research and development trend and Vietnamese researchers have begun collaborating with international scientists, engineers and practitioners and touching upon some novel approaches in Image Processing, Computer Vision and Pattern Recognition,

Computational Linguistics and Natural Language Processing, Artificial Intelligence, Machine Learning and Algorithms, Software Engineering, Computer Networks and Security, and Bioinformatics.

Current Aspects of Healthcare Informatics

The health information system in Vietnam is being developed in a haphazard and non-transparent way. A paper-based process – for example for patient records – is still the main mode of operation at all levels of the health system. This is also necessary for legal purposes. However, some large hospitals have started to deploy some form of electronic administrative management, such as the *Medisoft* software which is considered as one of the standard HIS packages that includes Patient Administration Discharge and Transfer information and hospital reporting systems (Minh and Son, 2005). There is still no standardisation of databases or patient records which are needed for the exchange and constant sharing at hospital, regional and national levels. Of 1,000 public hospitals in the whole country, only 5% use computerised systems for management purposes, and their effectiveness does not clearly influence the end-users, such as doctors, nurses and patients (Thu, 2006).

Elements of teleradiology, teleconsultation, telediagnosis and video conferencing have already been deployed in some private clinics and provincial hospitals. A practical illustration of the use of some of those techniques is witnessed by the Rach Gia hospital and Medic Medical Center in Ho Chi Minh City which succeeded in treating patients with serious medical conditions through teleconsultation (Thanh Nien, 2006). However,

any development in telemedicine relies directly on an expensive, albeit necessary, infrastructure and efficient networking system. The speed of data communication in Vietnam is currently based on only 64 Kbps networks in combination with the national Public Switched Telephone Network (PSTN). Therefore the transfer of digital data and medical images between hospitals and localities is highly ineffective. This is in clear contrast with some neighbouring countries, such as Singapore and China, which have heavily invested in an expensive national infrastructure as the backbone for an efficient electronic healthcare system.

In order to intensify the development in healthcare informatics, research, application, and education groups should be established and become key resources based on clear governmental guidelines and directions. The MoH should *(a)* gear the funding acquired from many sources towards an improved network infrastructure leading to an improved healthcare system; *(b)* provide rigorous programmes of training for health professionals to become familiar with, and fluent in, the use of current technologies; *(c)* encourage foreign entities to further collaborate with national research and development resources in order to achieve a marked improvement in health services in line with the systematic direction adopted by developed countries; *(d)* Improve the state management of Information Technology; *(e)* Improve the awareness of health professionals and managers about the benefits of IT; *(f)* Improve the legal base for research and application of IT; and *(g)* develop a market for health information technology.

Conclusions

The healthcare industry in South East Asia is dichotomous and varies from being very well developed in Singapore to being very poor in Laos. However, a number of national factors (political, economical, societal, cultural and educational) affect such industry in each country.

Singapore has spent over two decades in the application and deployment of IT into healthcare in order to improve its quality and services. Throughout this period, many successes, as well as failures, have contributed to positioning it as the top Asian country in terms of healthcare provision and it equally ranks amongst the best in the world. The noticeable factors which have made the Singaporean healthcare successful are mainly attributed to a solidly based financial and strategic commitment.

The Cambodian achievement in the healthcare sector has, thus far, placed it towards the other end of the spectrum. Currently, the expenditure of the government directed towards the health and education sectors has been the highest priority since 1999. Thus, the quality of services has seen a slow but steady improvement and the knowledge of health consumers has also gradually progressed. However, the real challenges for the future of Cambodia's healthcare system will be the improvement of the technical capacity of staff and their continued monitoring and assessment.

The Malaysian approach, whilst different in that its government has elected to implement a top-down strategy through its national agenda and vision – Malaysia's *Vision 2020*

(MSC Malaysia, 2007) – has nevertheless been a successful one and significant effort is being undertaken in order to establish healthcare informatics as a backbone for improved and enhanced patient care and healthcare provision.

Thailand's health system is in transition, reflecting the economic status of the country. The decentralised system which has been introduced by the government has made great strides in improving the health of its people. However, like many other countries in South East Asia, Thailand also struggles with health financing to address its population's healthcare unmet needs (Baum and Strenski, 2006).

Currently, the main problems faced by the Laotian healthcare system are organisation and planning, financing and resources (2-3% of GDP goes to health), and integration and coordination of outside resources. In addition, to increase capacity, Laos needs to educate health personnel both in Laos and abroad, however overseas studies require foreign language fluency, usually English, therefore proficiency in English is the first step towards a more advanced healthcare training.

Despite significant advances in research and development in the Philippines, the healthcare system, in general, and healthcare informatics, in particular, are still hampered by high cost and physical and socio-cultural barriers in the country. There is no indication that the government is focusing on any tangible improvements in its healthcare provision, a fact that is being supported by the astounding migration rate of very highly skilled personnel in the nursing profession.

From the Vietnamese perspective, in order to intensify the development in healthcare informatics, research, application, and education groups should be established and become key resources based on clear governmental guidelines and directions. Many systems such as patient administration systems (PAS), electronic patient records (EPR), hospital information systems (HIS), national health information networking, clinical information systems (CIS), pharmacy information systems and picture archiving and communication systems (PACS) should be firmly integrated within a rational policy of overhauling the entire healthcare system (Nguyen et al, 2007).

REFERENCES

Abd Ghani MK (2007), 'An Integrated and Distributed Framework for a Malaysian Telemedicine System', MPhil/PhD Transfer Report, Faculty of Engineering and Computing, Coventry University.

ADB (2004), *Philippine Economic Growth to Improve Slightly in 2004 and 2005*, [online] Available from < <http://www.adb.org/documents/news/2004/nr2004042.asp> > [Accessed 22th October 2007].

ADB (2007), *2007 Fact Sheet*, [online] Available from <http://www.adb.org/Documents/Fact_Sheets/PHI.asp > [Accessed 10th October 2007].

Aiken LH, Buchan J, Sochalski J, Nichols B and Powell M (2004), 'Trends in International Nurse Migration?', *Journal of Health Affairs*, 23 (3), 69-77.

Bangkok Post (2007), *Telemedicine Looking for a Thai Market*, [online] Available from < http://www.bangkokpost.com/breaking_news/breakingnews.php?id=116984 > [Accessed 15 January 2008].

Baum BH and Strenski T (2006), 'Thailand: Current Public Health Perspective?' *International Journal of Health Planning and Management*, 4 (2): 117-124.

Cambodia Ministry of Planning (2004), *Administrative Health Facility Mapping*, [online] Available from <<http://www.stats.nis.gov.kh/others/ahfm.htm>> [Accessed 5 December 2007].

Chew SJ, Cheng HM, Lam DSC, Cheng ACK, Leung ATS, Chua JKH, Yu CP, Balakrishnan V and Chan WK (1998), 'OphthWeb - Cost-Effective Telemedicine for Ophthalmology', *Hong Kong Medical Journal*, 4(3): 300-304

CHITS Development Team (2007), *About the Community Health Information Tracking System*, [online] Available from < <http://chits.mudfish.info/HomePage>> [Accessed 14 October 2007].

Country Profiles Foreign and Commonwealth Office (2007), *Basic Information – Country Profile: Vietnam*, [online] Available from <<http://www.fco.gov.uk/servlet/Front?pagename=OpenMarket/Xcelerate/ShowPage&c=Page&cid=1007029394365&a=KCountryProfile&aid=1019061877785>> [Accessed 9 October 2007].

Department of Statistics Malaysia (2007), *Key Statistics*, [online] Available from <http://www.statistics.gov.my/english/frameset_keystats.php?fid=b> [Accessed 23 December 2007].

DOH (2006), '2005 DOH Annual Report', [online] Available from <<http://www.doh.gov.ph/>> [Accessed 10th October 2007].

Dorotan EG and Mogyorosy Z (2004), 'Making Your Local Health System?', In *A Resource Book on the Local Health System Development*, Bodart C and Obermann K (Eds.), German Agency for Technical Cooperation, Germany.

Economic Institute of Cambodia (2004), *The Provision of Healthcare in Cambodia at a Glance*, [online] Available from <<http://www.eicambodia.org/downloads/download.php?unumber=7>> [Accessed 5 December 2007].

Espicom Business Intelligence (2007), *The Outlook for Medical Devices in South East Asia to 2012*, [online] Available from <<https://www.espicom.com/Prodcats.nsf/Search/00001406?OpenDocument>> [Accessed 18 October 2007].

Georgiou A (2001), 'Health Informatics and Evidence-based Medicine – more than a Marriage of Convenience', *Journal of Health Informatics*, 7: 127-130.

Gross A (1997), *Thailand Will Enter 21st Century with a Growing Device Market*, [online] Available from <<http://www.pacificbridgemedical.com/publications/html/ThailandJan1997.htm>> [Accessed 14 January 2008].

Heinzelman P (2007), *Telemedicine Project Improving Health in Rural Cambodia*, [online] Available from <<http://www.mtbeurope.info/content/ft609003.htm>> [Accessed 17 May 2007].

Holliday I and Tam KK (2004), 'E-health in the East Asian tigers?', *International Journal of Medical Informatics*, 73(11-12): 759-769.

Hung PM, Phuong NH and Nam VH (2003), *Development of Health Informatics in Vietnam*, [online] Available from

<[http://kosmi.snubi.org/2003_fall/APAMI_CJKMI/2003-10-22/1030%20-](http://kosmi.snubi.org/2003_fall/APAMI_CJKMI/2003-10-22/1030%20-%20Clavel%20-%20Mini-Symposium%20(Wed)/DEVELOPMENT%20OF%20HEALTH%20INFORMATICS%20IN%20VIETNAM%20-%20Pham%20M.%20Hung.pdf)

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[Symposium%20\(Wed\)/DEVELOPMENT%20OF%20HEALTH%20INFORMATICS%20IN%20VIETNAM%20-%20Pham%20M.%20Hung.pdf](http://kosmi.snubi.org/2003_fall/APAMI_CJKMI/2003-10-22/1030%20-%20Clavel%20-%20Mini-Symposium%20(Wed)/DEVELOPMENT%20OF%20HEALTH%20INFORMATICS%20IN%20VIETNAM%20-%20Pham%20M.%20Hung.pdf)> [Accessed 9 October 2007].

LinuxMedNews (2006), *Hospital OS, Key to Sustainable Development in Thai Hospitals*,

[online] Available from < http://linuxmednews.com/1148636889/index_html> [Accessed

14 January 2008].

Lorenzo FME, Galvez-Tan J, Icamina K and Javier L (2007), 'Nurse Migration from a Source Country Perspective: Philippine Country Case Study?', *Health Services Research*, 42 (13), 1406-1418.

Lun KC (1999), 'Health Informatics In the Asia Pacific Region?', *International Journal of Medical Informatics*, 55 (1): 3-7.

Mahidol Population Gazette (2007), *Population of Thailand, 2007*, [online] Available

from <<http://www.ipsr.mahidol.ac.th/content/Publication/GAZETTE.HTM>> [Accessed

13 January 2008].

Marcelo AB (2006), 'Health Informatics in the Philippines', *Proceedings of the Asia Pacific Association of Medical Informatics Conference*, Taipei, Taiwan, 2006.

McGee MK (2004), *Free Computers Not Enough To Get Doctors Using Technology*, [online] Available from < <http://pinoy.md/modules/news/article.php?storyid=122> > [Accessed 14th October 2007].

McGee MK (2005), *Oracle Working to Help Customize Healthcare in Thailand*, [online] Available from <<http://www.informationweek.com/showArticle.jhtml?articleID=165702390> > [15 January 2008].

Mekong Basin Disease Surveillance (2007) Cambodia profile [online] available from < <http://www.mbdsoffice.org/cambodia.htm> > [Accessed 15th October 2007].

Minh DT and Son HT (2005), *Medisoft 2003: A Standard HIS Software in Vietnam*, [online] Available from <[www.apmcsta.org/resource/telehealth%20Medisoft%20\(Vietnam\)%20FINAL.ppt](http://www.apmcsta.org/resource/telehealth%20Medisoft%20(Vietnam)%20FINAL.ppt)> [Accessed 20 October 2007].

Ministry of Health (2004), *Health Statistics Yearbook*, HSID, Planning – Finance Department.

Ministry of Health (2007), *United Nations Development Programme: Kingdom of Cambodia Project Document*, [online] Available from <http://www.moh.gov.kh/content/documents/1/Health%20Sector%20Reform%20III_UNDP%201999.pdf> [Accessed 4 December 2007].

Ministry of Health Malaysia (1997), *Telemedicine Blueprint: Telemedicine Flagship Application*, Copyright 1997 Government of Malaysia.

Ministry of Health Malaysia (2000), *National Telehealth Policies: Telemedicine Flagship Application*, Unpublished Government confidential document.

Ministry of Health Malaysia (2002), *Health Facts*, [online] Available from <http://pnd.moh.gov.my/uploads/health_facts_2002.htm>, [Accessed 3 December 2007].

Montegut AJ, Cartwright CA, Schirmer JM and Cummings S (2004), *An International Consultation: The Development of Family Medicine in Vietnam*, International Family Medicine.

MOPH (2007), *Health Services*, [online] Available from <http://www.moph.go.th/ops/health_48/index_eng.htm> [Accessed 14 January 2008].

MSC Malaysia (2007), Available from <<http://www.msc.com.my/msc/msc.asp>> [Accessed 15 October 2007].

Narong K (2001), 'The Ministry of Public Health Telemedicine Network of Thailand' *International Journal of Medical Informatics*, 61 (2-3): 113-116.

National Statistical Coordination Board (2007), *Life Expectancy at Birth by Sex*, [online] Available from <http://www.nscb.gov.ph/stats/mnsds/mnsds_life.asp> [Accessed 18 October 2007].

Nguyen QT, Naguib RNG and Phuong NH (2007), 'Healthcare in Vietnam: A Current Perspective', *Proceedings of the International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management*, Manila, Philippines: 245-251.

Norris A C (2002) 'Current Trends and Challenges in Health Informatics?' *Journal of Health Informatics*, 8(4) 205-213.

Perhson B, Tanyingyong V, Khan K, Eliasson E, Bilien J and Eriksson H (2005), *Vientiane Gigabit Network: A Broadband City Network and Distributed Interactive Learning Spaces in Laos*, [online] Available from <<http://www.spidercenter.org/upl/filer/529.pdf>> [Accessed 15 October 2007].

Philip CH L and Grace S L (2001), 'A Soft Systems Methodology Model for Clinical Decision Support Systems', *Proceedings of the 12th International Workshop on Database and Expert Systems Applications*, Germany, Munich: 126-148.

Pilsczek FH (2001), *Hospital Medicine in Cambodia: a Visiting Doctor's Perspective*, [online] Available from <<http://www.cmaj.ca/cgi/content/full/165/1/37>> [Accessed 2 December 2007].

Ricciardi L (2004), *A Model for Remote Health Care in the Developing World: The Markle Foundation Telemedicine Clinic in Cambodia*, [online] Available from <http://www.markle.org/downloadable_assets/telemedicine_clinic.pdf> [Accessed 17 December 2007].

Sananikhom P, Reerink L, Elias C and Satia J (2000), 'Reproductive Health in the Lao People's Democratic Republic.' *Journal of Asia-Pacific Population*, 15 (4): 21-37.

Singapore EDB (2007), *Land and Climate*, [online] Available from <http://www.sedb.com/edb/sg/en_uk/index/why_singapore/singapore_facts.html> [Accessed 6 January 2008].

Singapore Ministry of Health (2007), *Singapore's Healthcare System*, [online] Available from <<http://www.moh.gov.sg/mohcorp/careers.aspx?id=5252>> [Accessed 7 January 2008].

SingHealth (2007), *Highlights*, [online] Available from <<http://www.singhealth.com.sg/>> [Accessed 12 January 2008].

Sriramesh K and Rivera S and Chez M (2006), 'E-government in a corporatist, communitarian society: the case of Singapore?' *Journal of New Media and Society*, Sage Publication, 8 (5): 707-730.

Srour M L (2007), *Lao Pediatric Graduates 2006 Report*, [online] Available from <<http://www.healthfrontiers.org/docs/Lao%20Pediatric%20Graduates%20Report%202006A%20&%20CME%202006B.doc>> [Accessed 15 December 2007].

Swaminathan MS (2005), *Connecting People – Changing Lives in Asia: Introduction*, [online] Available from < <http://www.idrc.ca/IMAGES/ICT4D/PanAsia/PAN/intro.html>> [Accessed 9 December 2007].

Tay-Yap J and Al-Hawamdeh S (2001), ‘The Impact of the Internet on Healthcare in Singapore’, *Journal of Computer-Mediated Communication*, 6 (4).

Thanh Nien (2006), *Diagnosis through the internet - Vietnam Medsoft*, [online] Available from <<http://www.tinhocykhoa.com/tinhocykhoa/CDTX.HTM>> [Accessed 25 November 2007].

Thu L (2006), *IT Applications in Hospitals – Vietnam Medsoft*, [online] Available from <<http://www.tinhocykhoa.com/tinhocykhoa/cntt2006.htm>> [Accessed 25 October 2007].

Villarruz W (2007), *Welcome to eHealth Philippines*, [online] Available from < http://www.ehealth.ph/index.php?option=com_content&task=view&id=21&Itemid=101> [Accessed 20 October 2007].

Von Lubitz D and Wickramasinghe N (2006*b*), ‘Networkcentric Healthcare: applying the tools, techniques and strategies of knowledge management to create superior healthcare operations?’ *International Journal of Electronic Healthcare*, vol. 4: 415-428.

Von Lubitz D and Wickramasinghe N (2006a), 'Key Challenges and Policy Implications for Governments and Regulators in a Networkcentric Healthcare Environment?' *International Journal of Electronic Government*, 3(2): 204-224.

WHO (2006a), *Country Cooperation Strategy at a Glance*, [online] Available from <http://www.who.int/countryfocus/cooperation_strategy/ccsbrief_tha_en.pdf > [Accessed 15 January 2008].

WHO (2007a), *Singapore*, [online] Available from <<http://www.who.int/countries/sgp/en/>> [Accessed 12 January 2008].

WHO (2007b), *Cambodia*, [online] Available from <<http://www.who.int/countries/khm/en/>> [Accessed 27 January 2008].

WHO (2007c), *Lao DPR*, [online] Available from <<http://www.who.int/countries/lao/en/>> [Accessed 15 November 2007].

World of Information (2006), *Cambodia profile*, [online] Available from <<http://site.ebrary.com/lib/coventry/Top?channelName=coventry&cpage=1&docID=10120967&f00=text&frm=smp.x&hitsPerPage=10&layout=document&p00=cambodia&sortBy=score&sortOrder=desc> > [Accessed 15 December 2007].