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Industrial Organization and Human Resource Management in Thailand: A Case Study of Telecommunications Industry

氏名　CHADATAN OSATIS

学籍番号　13VE109

埼玉大学大学院経済科学研究科　（博士後期課程）

経済科学専攻　（主指導教員　遠藤環）

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Industrial Organization and Human Resource Management in Thailand: A Case Study of Telecommunications Industry

A Dissertation

By

CHADATAN OSATIS

13VE109

Main Advisor: Associate Professor ENDO Tamaki

Co-Advisor: Professor NAGASHIMA Masaharu

Co-Advisor: Professor TAGUCHI Hiroyuki

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Abstract

Over the past two decades, information, computer and communications have played an increasingly greater role in the Thai economy. The development of the telecommunications industry, particular the internet, broadband networks, mobile applications, IT services, software and hardware, has laid the solid foundations of an integrated platform to facilitate economic and social interactions in modern societies. In this regard, the Thai telecommunications industry has been undergoing significant economic growth, employment creation and research and development. Also, competitive performance and potential growth of this industry attracted heavy private investment of approximately two billion US dollars in 2014, and investment growth in this industry has substantially increased by 68.3 percent per annum between the years 2010 and 2014. However, if we consider the labour aspect, Thailand's labour market has experienced a structural transformation. The potential growth and job creation in the Thai telecommunications industry has been compressed by the tightness of the Thai labour market. Particularly, the relatively high level of unfilled vacancies, resulting from the shortages in ICT personnel, has been the most challenging issue in the Thai ICT labour market. A lag time in the adjustment of the Thai education system, and asymmetric information in the Thai external labour market have led the companies in this industry to overcome the problem of shortage of ICT personnel by themselves. Therefore, the aims of this study are to answer the three research questions as concerns the industrial organization, the shortage situation of ICT personnel in the external labour market and the human resource management as solution to the shortage problems, by using a case study of the Thai telecommunications industry. The main findings from this study are as follows: the Thai telecommunications industry exhibited a pyramid-shaped industrial organization and hierarchical governance structure, in which each tier industrial

actors perform specific tasks and create specific value according to their functional specialization. Also, there have been shortages in ICT personnel in the Thai external labour market, especially in computer network and system professional, computer network technician and programmers. The shortage result from an insufficient supply of ICT graduates, a lag of adjustment of the Thai education system, and also an increase in demand for ICT personnel both ICT sector and non-ICT sector. Therefore, each tier companies of the case study have to develop corporate strategy in order to compete, and specifically they applied the three practices of human resource management, namely review recruitment practice, extend training strategies and broaden the typical pool of talent as the countermeasure to the shortage problem in their internal labour market. In short, there existed internal labour market in the Thai ICT and also telecommunications industries. And, the evidence to support this assertion is the three underlying factors: skill specificity, on the job training and also customary rule within each tier companies in this industry.

Introduction

Over the past two decades, information, computer and communications have played an increasingly greater role in the Thai economy. The development of the telecommunications industry, particular the internet, broadband networks, mobile applications, IT services, software and hardware, has laid the solid foundations of an integrated platform to facilitate economic and social interactions in modern societies (OECD 2015).

In this regard, the Thai telecommunications industry has been undergoing significant economic growth, employment creation, and research and development (Donyapreuth 2011). The telecommunications industry in Thailand accounted for 6.2 percent of total value added in 2012 (WDI 2016a) and 0.72 percent of total employment in 2015 (NSO 2015a). These ratios seem relatively small. However, the Thai telecommunications industry attracted heavy private investment of approximately two billion US dollars in 2014. Further to this, investment growth in this industry has substantially increased by approximately 68.3 percent per annum between the years 2010 and 2014 (WDI 2016b).

The performance of the Thai telecommunications industry, particularly network connection speed and broadband adoption rate, has also shown constant growth in competitiveness. Thailand's average and peak connection speeds and the country's rates of broadband adoption at 4 Mbps and 10 Mbps are among the highest of the major economies in the Asian region (Akamai 2015).

In spite of the competitiveness in performance, the Thai telecommunications industry has been seen as the most complex industry in the world (Oxford Business Group 2014). This is because it is characterized by "a mixture of government-linked companies and private operators functioning under a wide variety of corporate interfaces and a volatile regulatory

structure" (Budde 2014). Within the Thai telecommunications industry, several actors have operated their services in different functional specializations. The dynamics of their relationship and competitiveness can be clarified by its industrial organization.

However, if we consider the labour aspect, Thailand's labour market has experienced a structural transformation, dynamic job loss, job creation, and job mobility. The potential growth and active job creation in the Thai telecommunications industry has been compressed by the tightness of the Thai labour market. Particularly, the relatively high level of unfilled vacancies, resulting from the shortages in ICT personnel, has been the most challenging issue in the Thai ICT labour market. Most companies in this industry have faced severe problems of hard-to-fill vacancies, particularly as concerns jobs at the professional level. Most of which take the long-time of around 7.4 weeks to recruit suitable candidates to fill the vacancies (Yongyuth 2015).

At the same time, on the supply side, the explicit average unemployment rate in Thailand is relatively low at less than 1 percent as of 2011 (NSO 2012). However, the unemployment rate among graduates with bachelor degrees and above was the highest at approximately 40 percent of the total unemployed. Thai graduates have to spend an average of between 6 and 12 months to find suitable employment in the external labour market (Ibid., 2015).

A lag time in the adjustment of the Thai education system, and asymmetric information in the Thai external labour market have led these companies to overcome the problem of the shortage of ICT personnel by themselves. The companies have to design and develop strategies in their internal labour markets, both corporate strategies in general and strategies on human resource management (HRM) in particular, in order to survive, thrive,

and sustain their competitive advantage in the Thai telecommunications industry in the long run.

With this given background in mind, this study aims to answer the following three research questions:

1. What are the historical developments and characteristics of the Thai telecommunications industry, particularly the industrial organization and inter-corporate relationships among a various tiers industrial actors? (Chapters 1 and 2).
2. Is there a shortage of ICT personnel in the Thai ICT external labour market? If so, which types of ICT-related occupations face shortages and which types of ICT-related occupations show potential growth? Also, what are the responses in terms of labour supply and wage level to the shortage problem? (Chapter 4).
3. What kinds of corporate strategies and human resource management (HRM) practices have companies from each-tier in the Thai telecommunications industry, applied to compete and cope with the shortage of ICT personnel in their internal labour markets? (Chapters 3 and 5).

1. Theoretical Approaches

In accordance with the three research questions mentioned above, this study is based on three theoretical approaches in the field of economics: (1) the theory of industrial organization (Tirole 1988), (2) the theory of labour economics (Borjas 2016) and (3) the theory of the internal labour market (Doeringer and Piore 1971; Natenapha 2005).

First of all, the theory of industrial organization addresses the study of the functioning of industry and understanding of the strategic behavior of firms (Tirole 1988; Laffont and Tirole 2000). This theory was developed from the “structure-conduct-performance” paradigm.

The structure, such as the aspects of the number of actors in the industry, or degree of vertical integration with suppliers will determine the conduct of the firms. Also, the conduct of the firm ultimately results in performance, such as efficiency, product variety, innovation rate, and profits. The unit of analysis of this theory is the "firm", which has been defined in the following four aspects: (1) a loophole for the exercise of monopoly power, (2) a static synergy, (3) a long-run relationship, and (4) an incomplete contract (Tirole 1988).

The first definition relates to the concept of efficiency. Firms decide whether to integrate or disintegrate in each step of their economic activities. The second views firms as synergy between different units at a given point of time. Firms are static synergy established to exploit the economies of scale or of scope, in which all units are gathered according to their functions. The third—the contractual view of a long-run arrangement of the firms' units—, bring us to the Williamson theory of the hazards of idiosyncratic exchange in a long-run relationship.

The fourth aspect, that of incomplete contracting, is the most recent. It emphasizes that firms and contracts are in different governance modes. By which, firms are seen as a particular ways of specifying what is to be done in the event of contingencies, not foreseen in the contract. This meaning stems from the idea that contracts are necessarily incomplete because some contingencies are unforeseeable, or because there are too many of them to specify in writing. Therefore, it requires the original contract to be defined only according to the broad lines of the relationship. For example, the ownership of machines and the employment relationship give the power (or authority) to the owner of the firms to choose the ways the machines are used and the personnel are employed. Also, the degree of the firms' integration can be measured roughly by the extent to which authority is distributed between contracting parties (Tirole 1988, pp.16-17).

In an oligopolistic market structure, including the ICT and telecommunications industry in this study, the firms no longer encounter a passive environment. In other words, they have to incorporate strategic interactions, based on various decision-making processes. Such decision making, then, thus relates to the theory of non-cooperative games. Firms can use many instruments in their strategy in order to compete in the industry or the market. These instruments can be classified by the speed at which they can be altered. In the short-run, prices are the usual instrument by which firms are able to change relatively quickly (other instruments include advertising and sale-force efforts). Thus, price competition exists within the context of rigid cost structures, and the products and services characteristics.

Over the longer run, the cost structures and the characteristics of products and services can be adjusted, either together or separately. For example, production techniques can be rearranged and improved upon, resulting in an increase in capacity. Product characteristics, such as quality, product design, delivery delay, locations or outlets and so forth can also be changed. Research and development, in particular, allows firms to expand their choice sets. For example, process innovation can alter the technological production possibilities, and can then can create new products or services (Ibid., 1988, pp.205-206).

The theory of industrial organization sheds light on the understanding of the functioning and structure of the market and the strategic behaviors and interactions among the firms. It sees the firms as a strategic unit, but it does not pay attention to the internal aspects within the firms. Thus, the resource-based view (RBV) has played a critical role in shifting the emphasis in the strategy literature away from external variables, such as industry position and toward internal resources as the sources of competitive advantage (Beltran and Roca 2013, pp.645-646). From a dynamic view of the RBV, human resources are an important aspect contributing to the renewal of firms' capabilities by enabling them to adapt to the changing environment (Ibid., 2013, pp.648-649). In particular, human resource

management is the main instrument to attract, develop and maintain such the important internal resource in accordance with the changing environment overtime.

The second and the third theoretical approaches deal with the theory of labour economics, both for the external labour market in general, and for the internal labour market of the firms. The theory of labour economics adopted in this study is the approach of demand for and supply of labour. Typically, the labour supply curve (LS) is upward sloping, implying that the higher the wage being offered, the larger the labour supplied. Conversely, the labour demand curve (LD) is downward sloping, indicating that firms will want to hire many workers when their labour prices are low, but will refrain from hiring when those prices are high. As workers search for jobs and firms search for workers, the equilibrium is reached and attained when supply is equal to demand, at the equilibrium wage and employment levels (Borjas 2016, pp.3-5).

The shift in demand, for example from technological change, or consumer preference change, will move the existing LD curve to the new one, and move the overall labour market into a new equilibrium. Theoretically, if wages are flexible, they will be an important determinant in equilibrating demand with supply. However, if the current wages are rigid, they will fail to respond to this shift in demand for labour. Therefore, excess demand will be generated in this case.

In the labour market, jobseekers usually take time in applying for appropriate positions, while firms incur expenses in selecting suitable workers. Individuals become unemployed when the return to searching for employment exceeds the return to remaining employed or being out of the labour force (Liu 2013). For example, when there is a demand shock, such as a sudden increase in the demand for newly trained engineers, the equilibrium points of employment and wage levels will be adjusted accordingly. However, firms will face the

difficulty to recruit or hire a new desired number of new engineers. This is because it takes time to train new engineers and the education system, especially at the university level, can produce a fixed number of new engineers per round.

At the same time, unemployment persists at the steady state because some of the existing jobs become no longer available during the matching process, and before all unmatched job-worker pairs are met, and this leads to some workers becoming unemployed. Also, these job losses or lack of positions mainly result from changes in technology or demand (Pissarides 2000, p.5). Therefore, job matching in a real economy does not take place instantaneously because of heterogeneity in the qualities of jobs and workers, difference in the locations and imperfect information about jobs and workers (Ibid., 2000, p.22). In the empirical literature, the mismatch between jobs and workers relates to the sectoral shift hypothesis and to structural unemployment, which is unemployment resulting from fast structural change in the economy as a whole (Ibid., 2000, p.23).

With reference to Janoski, Luke and Oliver (2014), there are three types of unemployment: frictional, cyclical and structural unemployment. Firstly, frictional unemployment is short-term in the sense that employers and workers more or less cannot find each other within weeks or months. This is often addressed through the relationship of vacancy rates in firms and unemployment outside of them. Improving information in the economy through better job placement information is often seen as a solution to this problem.

Secondly, cyclical unemployment refers to jobs not being available because the economy is in a cyclical downturn that occurs with the generally expected business cycle. This is short-term unemployment of one to two years. Thirdly, structural unemployment means that workers who are unemployed then enter into a process of accepting lower level jobs, going on disability, or becoming homeless. There are five types of evidence that

indicate that unemployment is structural: (1) long-term increases in unemployment for more than ten years, (2) slowdown in the speed that jobs are filled, (3) lengthening of the time spent in unemployment, (4) declining participation rate in terms of people actually working and (5) increasing financial instability that makes cyclical crises more frequent than in the past (Janoski, Luke and Oliver 2014, pp.5-9).

Structural unemployment often results from technological changes, which make the skills of many of today's workers obsolete. One way of addressing structural unemployment usually involves retraining workers with obsolete skills to work in the fields that are in need. However, this requires either migration or re-training. Thus, structural employment is relatively long-term and slow to fix.

Another outcome from structural unemployment is the earnings gap. In the absence of an increased supply of educated workers, the earnings gap of those with more and less education would be wider. If there are various educational groups in society, ranging from the lowest to the most highly educated, and if a number of the groups are fixed in relative proportion, then technological changes will increase economic inequality. This is because the relative earnings gap between the less and the more educated will rise (Goldin and Katz 2008).

Typically, this mismatch and structural shift are measured by the so-called Beveridge Curve (BC), which indicates the relationship between unemployment and vacancy in each particular economic period, and reveals the structural change in the labour market. A higher degree in the mismatch, and the labour shortage, characterized by the situation where employers are unable to recruit personnel with the skills they are looking for in the accessible labour market and at the ongoing rate of pay, shifts the BC outwards as unemployment and vacancies coexist at higher levels (Nickell et al. 2001).

Labour shortage is an economic condition in which there are insufficient qualified employees to fill the market place demands to either expand the production sites or substitute old workers at any price. Basically, it can be measured by subtracting labour supply from the labour demand at a specific wage rate. Some exogenous factors, such as economic growth, could also lead to a labour shortage as firms expand their production and thus require more workers in the workplace, given other factors remaining unchanged (ILO 2013, p.47).

The concept of labour shortages can be classified into absolute and relative labour shortages: (1) absolute labour shortages are defined as the required population (or skills) not physically present, relative to the production and service needs. This can extend to the whole of the economy or these are shortages specific to particular occupations; (2) relative labour shortages occurs when an already sufficient number of national citizens within the country's territory are unwilling or unable to fill all the vacancies. Typically, this type of shortage is associated with certain sectors (low wage), regions (remote) and employers (small units) (ILO 2013, p.47).

In response to the shortages of labour in the external labour market, most firms look at paying more attention to the policy and practice of human resource management within their own internal labour market, which relates the third theoretical approach of this study. There are three main forces underlying the existence of internal labour market: skill specificity, on-the-job training and customary rule or law which govern the organizational members (Doeringer and Piore 1971).

Internal labour market (ILM) analysis provides a fact-based platform for making many essential decisions about the human resources of the firms. At the basic level, it examines the flow of personnel into, through, and out of the firm. In other words, it gives answers to fundamental questions about the firm's workforce, such as who gets hired, who performed well, who advanced and who stayed (Mercer 2013).

At the advanced level, ILM analysis provides critical insights into the operation of the firms' management system, answering questions such as "How is talent developed?"; "What actually gets rewarded?"; "What is the value of internal job movement?"; "How do employees' attributes such as education or experience impact performance for each job?", and "How can the firms use human resource tools such as compensation, benefits, selection, career development programs, and training to build the workforce which the firms need?". In other words, the objective of advanced ILM analysis is to help firms understand their current human capital needs and challenges, plan and project for future needs, and create talent solutions that drive business value (Ibid., 2013).

In Thailand, the internal labour market takes on the form of an occupational internal labour market (OILM), which is distinct from that in Japan and other countries (Natenapha 2005). OILMs imply that the personnel have formed their career within one area of specialization (or occupation) and have climbed the corporate ladder within the firms. Jobs are organized in lines of progression and the administrative rules of internalization, which include ports of entry and exit, promotion from within, and on-the-job training.

Industrial adjustment to increased competition and the ensuing reorganization of production have led to a growing need for the flexible deployment of the personnel. In actuality, there are four types of labour flexibility, namely, numerical flexibility, functional flexibility, financial flexibility and temporal working-time flexibility (Regini 2000).

In particular, functional flexibility is the focus of this study. It refers to the ease with which the tasks carried out by employees can be adapted to changes in demands. In other words, firms have to reorganize their existing workforce so as to adapt to new technologies and new ways of utilizing their human resources by means such as job rotation, multi-skilling, retraining, mobility and so on. This ability is based on the mutual acceptance of a broad definition of the tasks implicit in the job and on the existence of internal labour markets, or

incentives to horizontal and vertical mobility within the firms. Important aspects of this type of flexibility are redeployment and retraining, which require the employment rules and the salary systems that motivates the personnel to take over the new tasks, acquire new qualifications and generally accept fast-track adjustment in the organization of work (Ibid., 2000).

Another mechanism is on-the-job training (OJT), according to the theory of internal labour market. The OJT process can be recognized as “osmosis”, “absorb”, “exposure”, “experience”, or “climbing the career ladder up through the promotion practice”. Indeed, OJT involves moving up a promotion ladder by incrementally developing the knowledge and skills required for each higher level. The ability to perform the existing and new tasks is deliberately correlated with the length of time the employees have been around within the firm.

In other words, it is step-by-step trial and error or experimentation mostly through temporary project-based assignments. Through the process of OJT, personnel can move from the “transmission of expertise” toward the “cultivation of capability” (Schrage 2014). The personnel have to play dual roles: one as supervisors or subordinates in the production process, and the other as instructors or students in the learning process (Doeringer and Piore 1971, pp.17-19).

In-between both the production and learning process, there are the essential mechanisms, of the ranking system and the promotion practice helping facilitate the functional flexibility of the personnel in the internal labour market. Frequently, the best learning situation coincides with the most efficient staff arrangements. Subordinates, for instance, often learn by filling in during the temporary absence of their superiors. The subordinate might not perform the job as efficiently as the experienced supervisor, but the

arrangement of team members and the OJT based on project management can provide the solution to the problem of shortages of personnel in the external labour market.

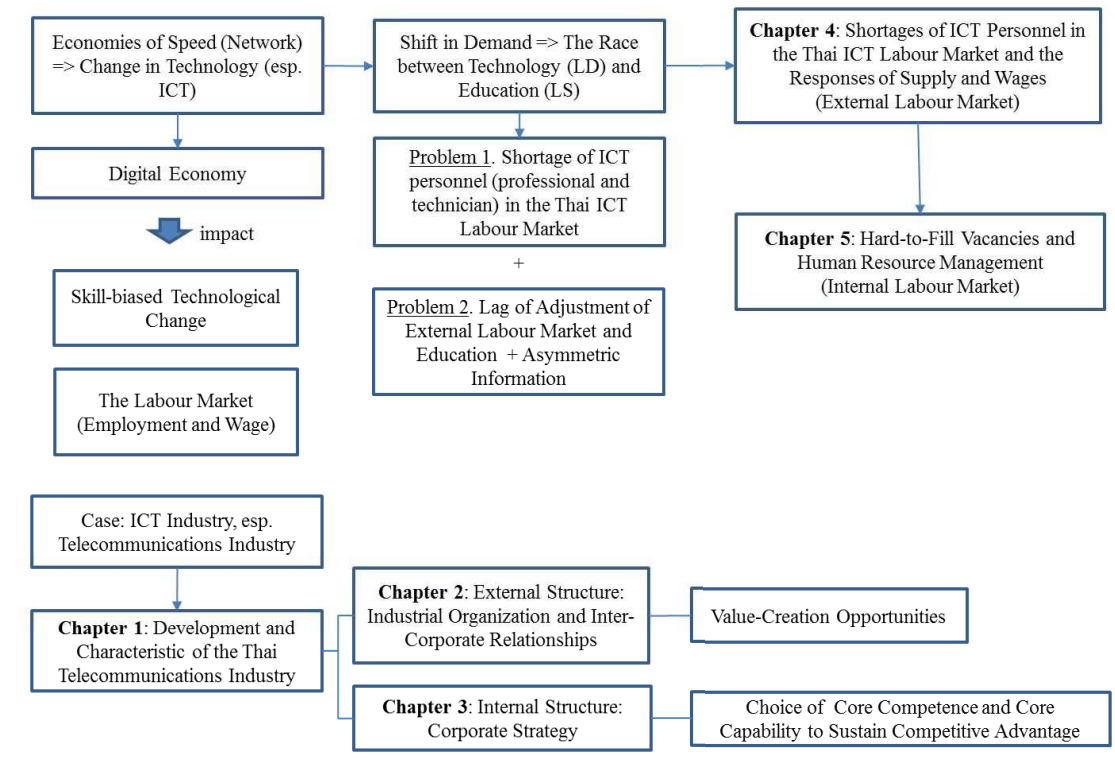
2. Conceptual Framework and Organization of the Study

The advancement of telecommunications industry, particularly the development of telecommunications technology, is at the foundation of the economies of speed (network) in the current era. Many economies have been forced to change from the traditional economy to the digital economy, which refers to "the worldwide network of economic activities enabled by information and communications technologies (ICT)" (Tapscott 1995). A number of disciplines have looked at the impact of the change of technology on the labour market issues (Janoski, Luke and Olvier 2014). These include job loss, job creation, skill-biased technological change, structural unemployment and also change in employment relations (Pissarides 2000; Rubery and Grimshaw 2011; Liu 2013; Janoski, Luke and Oliver 2014).

With regard to the issue of technology and employment, "new technology does not simply displace workers, but further restructures employment relations and social conditions, including depressing wages and benefits, forcing workers to be more flexible in their career choices, imposing geographical mobility, and lengthening working hours" (Janoski, Luke and Oliver 2014, p.91). In other words, new technologies, particularly ICT and telecommunications technology, provide a basis for changes in the employment relationship through their effects on demand for and supply of the workers, unemployment, and job quality in the labour markets (Rubery and Grimshaw 2001; Janoski, Luke and Oliver 2014, pp.96-109).

The focus of this study is on the telecommunications industry in Thailand, which is organized as shown below.

Figure A: Organization of the Study



Source: Created by author.

The organization of the study comprises five chapters. Chapter 1 explores the development and characteristics of the Thai telecommunications industry, and also the challenging issues currently facing this industry. Chapter 2 clarifies the industrial organization, the inter-corporate relationships and the value-creation opportunities among companies at each tier at the industry level. Chapter 3 discusses corporate strategy, using case studies of companies from each tier and the strategies they choose to sustain their competitive advantage in the telecommunications industry in Thailand. Then, Chapter 4 and Chapter 5 analyze the labour aspect, both in the external and internal labour market, in this industry. Chapter 4 identifies the shortages of ICT personnel and the responses in terms of labour supply and wages in the Thai ICT external labour market. Chapter 5 addresses the hard-to-fill vacancies and human resource management, which the companies in the case studies use in

their internal labour market to cope with the shortage problem. The conclusion offers insights into the issues of concern, and policy implications.

3. Data and Methodology

For the analysis of industrial organization, inter-corporate relationship and corporate strategy in the Thai telecommunications industry in Chapters 2 and 3, this study adopted a case study method and used a multilayer perspective to define the industrial actors' tier boundaries and their value creation opportunities. Additionally, secondary data from the National Broadcasting and Telecommunications Commission (NBTC) survey reports, and primary data, such as corporate documents and interviews have been used.

For an analysis of the labour market issue in Chapter 4, raw data of the Labour Force Survey (National Statistical Office Thailand) was used to identify the employment level, and the growth rate of ICT-related occupations for the demand side. For the supply side, the report from the Office of the High Education Commission was used to indicate the number of graduates, and the growth rate of each particular ICT-related field of education. In addition, the wage function of ICT personnel was modelled and estimated as an indirect proxy to reveal excess demand for this group, and to show the determinants affecting their wage levels.

In terms of the data on internal labour market and the HRM issue in Chapter 5, micro-personnel data, corporate documents and face-to-face interviews were utilized to explore the HRM, of the companies in the case studies used to cope with the shortage problem.

Chapter 1

Developments and Characteristics of the Thai Telecommunications Industry

Introduction

If the steam engine and railroad were key foundations of the first industrial revolution, the telecommunications industry is that of the third revolution in the current era (Huet and Tcheng 2010). The role of the telecommunications industry is becoming an important aspect of infrastructure supporting economic growth and innovation in a wide range of customer-focused areas including health care, public safety, education and social welfare in many countries (Settapong et al. 2013).

The Thai telecommunications industry has been greatly promoted by the Thai government from the late 1980s, especially under the government of Prime Minister Chatichai Choonhawan (Sakkarin 2000). In the first phase, the main role of telecommunications aimed to build the infrastructure of the telecommunications network. This was formally announced by the Thai government in the Seventh Five-Year Economic and Social Development Plan (1992–1996). Of particular note, the Eighth Five-Year Plan (1997–2001) was an important driving force of the establishment of the First Telecommunications Master Plan of Thailand in the year 2000. The target of the plan was to transform Thailand into a trade and telecommunications center in the Indo-China region and to develop human resources in the information technology (IT) industry (Donyaprueth 2001).

Then, in the second phase (from 2000s onwards), the Thai government focused on the process of the liberalization of the Thai telecommunications industry (Sakkarin 2000). This included the amendment of relevant regulations to abolish monopolies, the establishment of an independent regulator, the privatization of the Communications Authority of Thailand

(CAT) and the Telephone Organization of Thailand (TOT), and the openness of the market for full competition (Pavlasova 2004). In the liberalization process, most companies both in the public and the private sectors have made many attempts to push and support the reform and liberalization of the telecommunications industry for the sake of competitiveness and efficiency.

However, the Thai government still tightly regulates the telecommunications industry, in part because of its connection to national security. In 2011, the MICT set up the Cyber Security Crime Protection and Prevention Bureau and the Electronic Transaction Development Agency to strengthen the prevention of cyber-crimes. Also, the National Broadcasting and Telecommunications Commission (NBTC) is currently an independent authoritative organization possessing full rights to allocate the spectrum under the Radio Frequency Allocation Act (2010) in the Thai telecommunications industry (Settapong et al. 2013). In other words, the development of the Thai telecommunications industry inevitably invites political intervention and government policy commitment, particularly through financing mechanisms which are necessary for the development of high-tech industries, especially the telecommunications industry (Cairns and Nikomborirak 1998; Mesher and Jittrapanun 2004; Jarunee 2014).

The objective of this chapter is to clarify the developments and characteristics of the Thai telecommunications industry, as well as its contributions to the Thai economy. This chapter comprises four sections. The first section details the industry's stages of development. The second clarifies the characteristics of the Thai telecommunications industry and its relationship to the ICT industry. The third explores its contributions to the Thai economy, particularly in terms of market value. The fourth discusses the current challenging issues facing this industry, particularly in terms of the labour market and employment issue. The final section provides the conclusions of this chapter.

1.1 Historical Development of the Thai Telecommunications Industry

Historically, the Thai telecommunications industry has operated as a type of public monopoly, which has been financed through public debt (Guislain and Qiang 2006). In the first stage of development, the country had little operational experience concerning the telecommunications network and was largely incapable of providing a sufficient amount of funds, as required for investment. Therefore, the Thai government made great efforts to attract foreign direct investment, particularly for capital acquisition, technology transfers and managerial improvement to lay down the foundation of the Thai telecommunications network infrastructure.

The next stage in the development of the Thai telecommunications industry came in the late 1980s. The Thai government decided to restructure this industry with a system of build-transfer-operate (BTO) concessions, and attempted to promote competition among the private investors. Under the BTO concessions, all Thai mobile operators were entitled to (1) build and raise capital for investment in Thailand's mobile cellular networks, (2) to transfer network ownership to an agreement's grantor, for example the Communications Authority of Thailand (CAT), or the Telephone Organization of Thailand (TOT), and (3) to operate a mobile cellular network and service commercially and share approximately 20-30 percent of total revenue with the grantors (Bengt and Markendahi 2013).

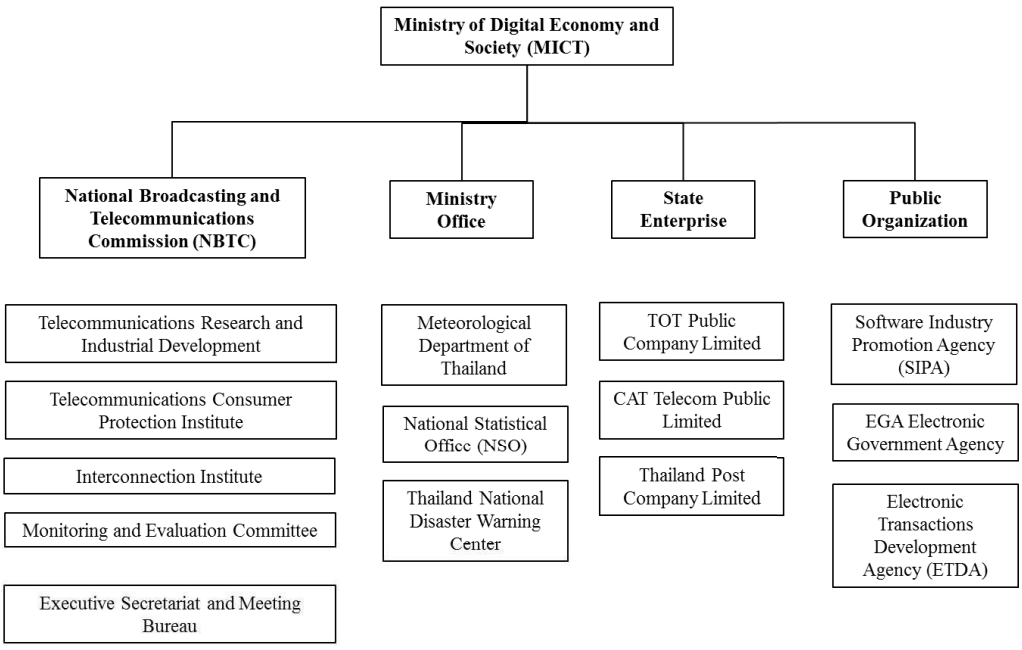
The third stage of development occurred in the 2000s. The Thai government aimed to liberalize the Thai telecommunications industry and established the First Telecommunications Master Plan in 2000. In October 3rd 2002, MICT and its related governmental bodies, including the National Telecommunications Commission (NTC) and National Broadcasting Commission (NBC), were established on October 3rd, 2002 by the

Bureaucratic Restructuring Act of B.E. 2545 (2002) to regulate and develop the Thai ICT industry and Thai telecommunications in particular.

However, in September 2006, following the military takeover from the Thai government and decided to merge the NTC and NBC into a convergence regulator, under the new name of the National Broadcasting and Telecommunications Commission (NBTC) on October 7th 2011 under the Act on Organization to Assign Radio Frequency and to Regulate the Broadcasting and Telecommunications Service B.E. 2553 (2010), or the Radio Frequency Allocation Act (2010) (Settapong et al. 2013 and NBTC 2013). Currently, NBTC is the main authoritative organization regulating and possessing full rights to allocate the spectrum under the Radio Frequency Allocation Act (2010) in the Thai telecommunications industry. Also, in 2011, the MICT set up the Cyber Security Crime Protection and Prevention Bureau and the Electronic Transaction Development Agency to strengthen the prevention of cyber-crimes, and protect national security (Settapong et al. 2013) and established the community-focused telecenters, which function as the central hub for ICT activities to foster opportunities in education and training in rural areas (Oxford Business Group 2014).

Figure 1-1 shows the organization chart of MICT (renamed to the Ministry of Digital Economy and Society (MICT)) and its related organizations. There are four agencies under the supervision of MICT: (1) NBTC, (2) ministry offices (which include the Meteorological Department of Thailand, National Statistical Office (NSO), and Thailand National Disaster Warning Center), (3) state enterprises (which include TOT Public Company Limited, CAT Telecom Public Limited, and Thailand Post Company Limited), and (4) public organizations (which include Software Industry Promotion Agency (SIPA), EGA Electronic Government Agency, and Electronic Transactions Development Agency (ETDA)).

Figure 1-1: Organization Chart of Ministry of Digital Economy and Society (MICT) in Thailand



Source: www.mict.go.th; www.nbtc.go.th.

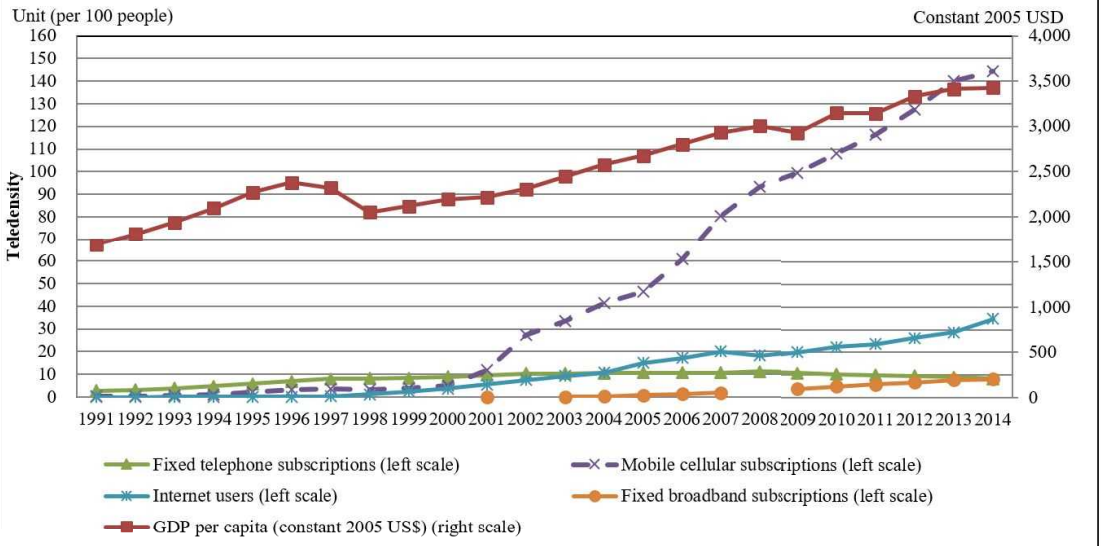
Each related organization holds the specific mission according to its name. For example, the missions of the National Statistical Office (NSO) Thailand are to manage and organize the national statistical and information system to support national development and competitiveness and also develop statistical production and service to better serve users' needs (NSO 2016). The missions of the Software Industry Promotion Agency (SIPA) are to support and promote the software industry and entrepreneurs by lifting and driving the capacity of the software industry and entrepreneurs to be able to compete at international level (SIPA 2016). Specifically, the most relevant agency to the telecommunications industry in Thailand is the NBTC. The NBTC is an independent authoritative organization acting as a regulator to regulate and possess full rights to allocate the radio spectrum in the Thai telecommunications industry. The mission of the NBTC is to regulate Thailand's telecommunications fairly, transparently and equitably on the basis of international standards, and to enhance the capacity of the Thai telecommunications industry to keep pace with the

latest developments in order to ensure the best quality and universal services at a reasonable price, and to efficiently adapt to a constantly evolving environment[1]. There are five related agencies working under the NBTC: (1) the Telecommunications Research and Industrial Development Institute, (2) the Telecommunications Consumer Protection Institute, (3) the Interconnection Institute, (4) the Monitoring and Evaluation Committee, and (5) the Executive Secretariat and Meeting Bureau.

Returning to the issue of historical development, this chapter uses teledensity to measure recent situation of the Thai telecommunications industry's stage of development[2]. Typically, teledensity is "a measurement of how many telephones are available, expressed as the number of telephone lines for every 100 people in a country"[3]. However, teledensity in this chapter comprises the four indicators of fixed telephone subscriptions, mobile cellular subscriptions, Internet users, and fixed broadband subscriptions. Figure 1-2 shows per capita GDP and teledensity development in the Thai telecommunications industry. Since 1991, the number of fixed-line subscriptions was higher than the number of mobile cellular subscriptions and Internet users[4]. Nevertheless, the turning point came in 2011, when the Thai government made greater efforts in the liberalization of the Thai telecommunications industry. The number of mobile cellular subscriptions substantially increased with an approximately 150 percent change in 2015, while the number of fixed-line telephone subscriptions has gradually decreased. Additionally, by 2014 almost 35 percent of Thai people had access to the Internet, a figure which has continuously increased since the year 2011.

[1] Retrieved from www.nbtc.go.th on December 7, 2016.
[2] In addition to regulating the Thai telecommunications industry, the NBTC has also published Telecoms Data Center (TDC) reports which comprised many types of indicators of the development of the Thai telecommunications industry, including the Network Readiness Index (NRI), Internet Capacity, Interconnection, and International Internet Gateway (IIG). However, these reports have not been published on an ongoing basis.
[3] Retrieved from http://www.macmillandictionary.com/dictionary/british/teledensity on December 7, 2016.
[4] Internet users are individuals who have used the Internet (from any location) in the last 12 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc. (WDI 2016a).

Figure 1-2: Per Capita GDP and Teledensity Development in the Thai Telecommunications Industry



Source: Author's tabulation using World Development Indicators.

However, indicators of fixed broadband subscriptions have only been provided since 2001[5]. Its share level is relatively low, and its growth rate has only slightly increased. However, according to Akamai's State of the Internet Report (2015), broadband connection speeds and penetration rates in Thailand at 4 Mbps and 10 Mbps are the highest amongst the major economies of Asia. In terms of average and peak connection speed, the country ranks 42nd (8.6 Mbps) and 20th (51.5 Mbps) on the global scale, ahead of Malaysia, the Philippines, Vietnam, Indonesia, India, and China. Also, on the global ranking of broadband adoption at both 4 Mbps and 10 Mbps, Thailand comes in at the highest rank at 5th (95%) and 41st (20%), ahead of all the above-mentioned Asian countries (Akamai 2015). Thanks to the context of substantial support by the government and increasing demand, the development of the Thai telecommunications industry has shown greatest potential both in growth and in performance. The Thai government mandates that these services must involve high-speed fibre optics and be connected to high-speed telecommunications lines featuring cutting edge

[5] Fixed broadband subscriptions refers to fixed subscriptions to high-speed access to the public Internet (a TCP/IP connection), at downstream speeds equal to, or greater than, 256 kbit/s. This includes cable modem, DSL, fiber-to-the-home/building, other fixed (wired)-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband. It excludes subscriptions that have access to data communications (including the Internet) via mobile-cellular networks. It includes both residential subscriptions and subscriptions for organizations (WDI 2016a).

telecommunications technology as an important infrastructure to support economic growth. The next section will clarify the characteristics of the Thai telecommunications industry.

1.2 Characteristics of the Thai Telecommunications Industry

Telecommunications are the important infrastructure input for every kind of goods and services in most economic activities (WDR 1994). Indeed, the telecommunications industry has been the main foundation of economies of speed (network) in the current era. Table 1-1 shows the concepts and characteristics of the economies of scale, scope and speed (network). The first type of economies was conceptualized as the economies of scale. Its main concept is that of efficiency, particularly mass production at a large scale of production and a decrease in average cost. Its characteristics are the existence of the fixed cost indivisibility of a large-scale production plant. In other words, economies of scale refer to the industrial society, which based on the progress of standardization and specialization incurs surpluses for society from a decrease in unit costs through quantitative expansion (Kagami and Tsuji 2001).

Table 1-1: Concepts and Characteristics of Economies of Scale, Scope and Speed

Aspects	Economies of Scale	Economies of Scope	Economies of Speed
Concepts	Efficiency	Combination	Connection
Characteristics	Existence of fixed cost of large scale production plant	Existence of a common factor of production	Development of telecommunications technology
Typical examples	Heavy industries, steel, chemical, petroleum	Financial institution, and assembling processing (automobile, electronics)	Telecommunications
Indicator gaps	Income divide	Income divide	Digital divide

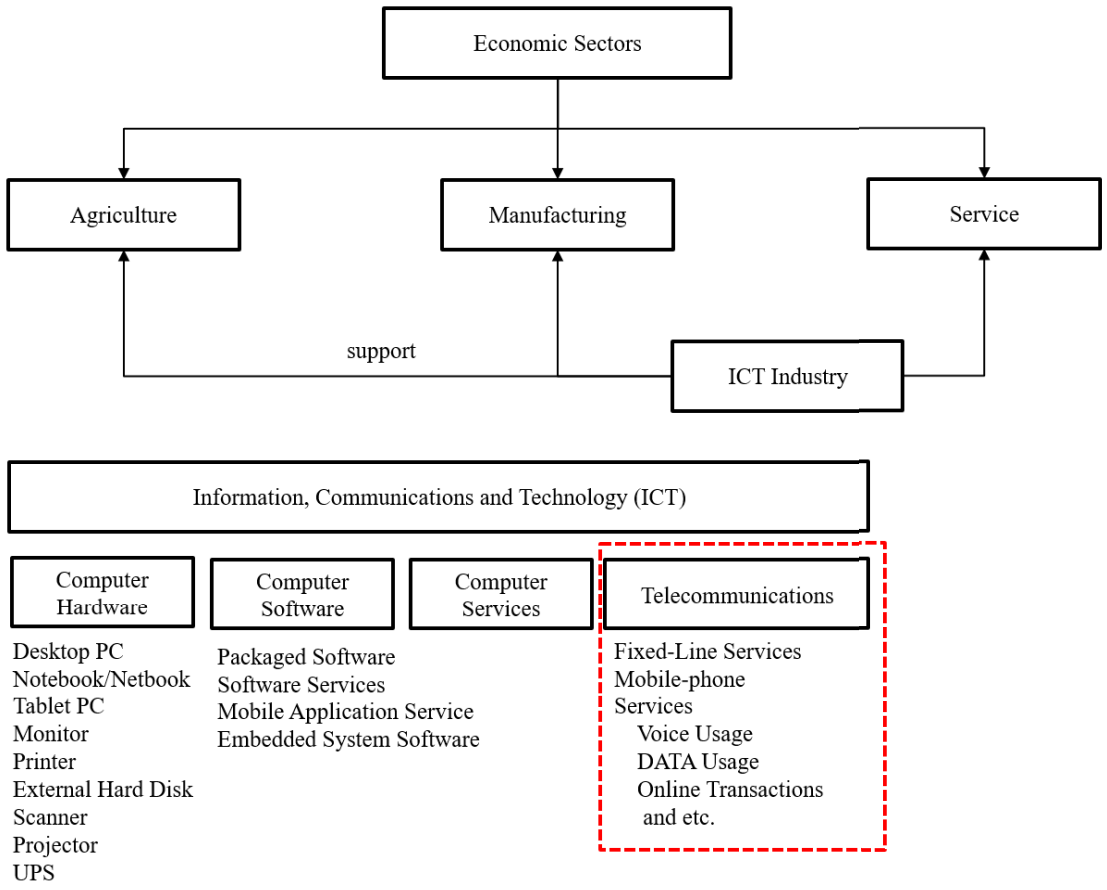
Source: Author's arrangement based on JICA (1989) and Kagami and Tsuji (2001).

The second type is economies of scope, the main concept of which is combination. Its characteristics are the existence of a common factors of production. The cost of production of several products at one factory is smaller than a case that them being produced separately. Typical examples include financial institutions, banking and securities and assembling procession such as automobiles and electronic industries. The surpluses come from the effective utilization of common resources or the reduction of common costs through producing many products in a firm and integrating business efforts among different firms (Ibid., 2001).

The final type is economies of speed (network). Its main concept is the connection with high speed (network externalities), which require the development of telecommunications technology. A typical example is the telecommunications industry. In other words, economies of speed refer to the information society, which is based on the progress of network linkages. People can get information on ongoing changes within the society in real time and react to those changes immediately. Also, people can make use of the information to prepare for their future (JICA 1989; Kagami and Tsuji 2001).

In the Thai context, the telecommunications industry was regulated by the NBTC, and is related to the MICT as shown in Figure 1-1. Figure 1-3 shows the position of the ICT industry in the Thai economy and its related supporting sectors. The ICT industry is an important industry supporting economic activities in all three industrial sectors (agriculture, manufacturing and service). There are four sub-sectors working under the ICT industry as follows: computer hardware, computer software, computer service and telecommunications (NECTEC 2005; NSTDA 2012).

Figure 1-3: ICT Industry and its Supporting Sectors



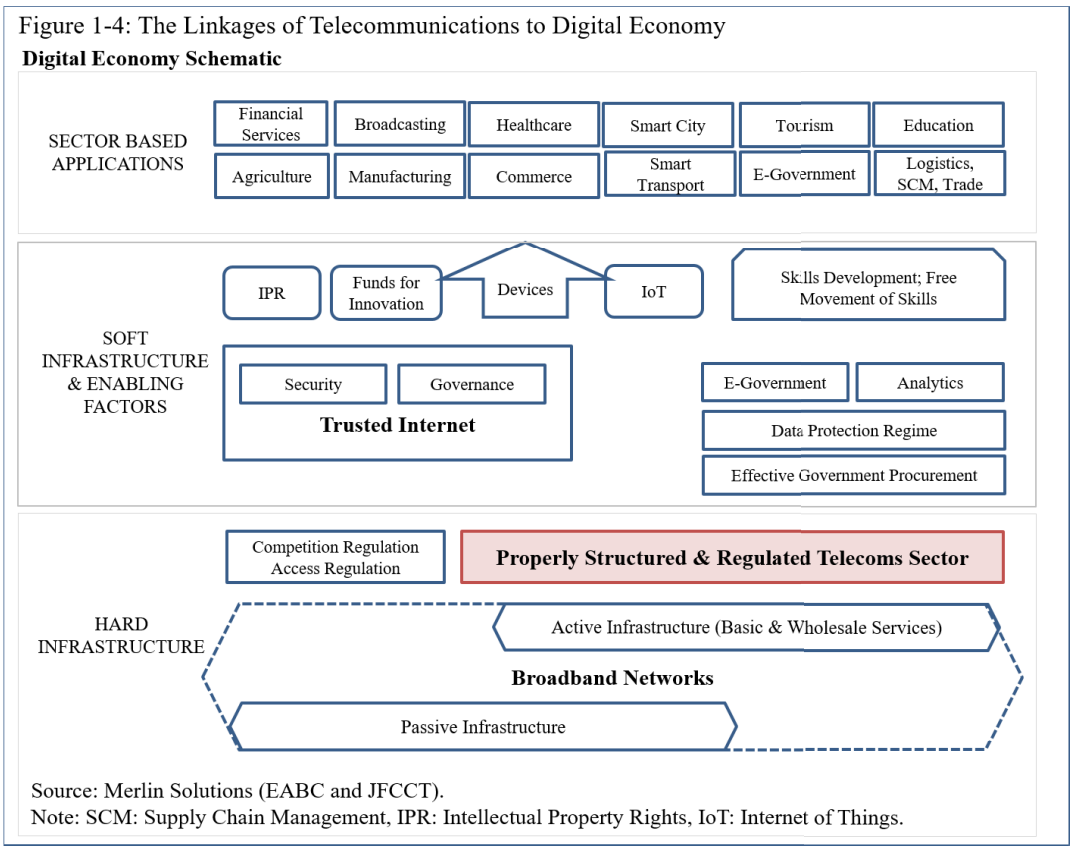
Source: Author's arrangement using NECTEC (2005) and NSTDA (2012).

The telecommunications industry is, in fact, one of the ICT's sub-sectors and indivisibly related to the ICT industry. The Thai telecommunications industry can be further divided into the two areas of telecommunications equipment and telecommunications services. Examples of telecommunications equipment include signal processing technology, data network parts, wired and wireless communication systems, and mobile phones. Also, examples of telecommunications services include mobile-cellular services, voice usage, data usage, online transactions, and so on (NECTEC 2005 and NSTDA 2012).

As mentioned earlier that the Thai MICT was renamed the Ministry of Digital Economy and Society, and the telecommunications industry has been indivisibly related to the MICT, or digital economy and society in Thailand. Figure 1-4 shows the linkages of the

telecommunications industry to the schematic of the digital economy. The telecommunications industry is acting as the supporting infrastructure for the digital economy. The development of telecommunications technology is an important characteristic of economies of speed (network) as explained in Table 1-1. The schematic of the digital economy consists of three components: hard infrastructure, soft infrastructure (and enabling factors), and also sector-based applications. The first component, or hard infrastructure, can be considered the backbone of the digital economy. In other words, the hard infrastructure is the network and system, which require the support of the broadband networks, the proper telecoms infrastructure and the regulated telecoms sectors as the solid foundation. The second component, or soft infrastructure (and enabling factors) can be regarded as the blood and flesh, which help enable the functioning of the digital economy. It mainly relates to the database, and requires a trusted internet in terms of security and governance.

Figure 1-4: The Linkages of Telecommunications to Digital Economy



Source: Merlin Solutions (EABC and JFCCT).
Note: SCM: Supply Chain Management, IPR: Intellectual Property Rights, IoT: Internet of Things.

Other important enabling factors of the soft infrastructure include the data protection regime, effective government procurement (e-government and digital analytics), and also skills developments and skills mobility. The third and final component is sector-based applications. These sector-based applications are specific and customized to the needs of each sector, for example, financial services, broadcasting, healthcare, smart city, agriculture, tourism, education, manufacturing, commerce, smart transport, logistics, supply chain management (SCM), trade and so on.

In short, the telecommunications industry, particularly the properly regulated telecoms sector, is acting as the hard infrastructure or the main foundation of the economies of speed (network), or the so-called digital economy in the current era. This industry cannot act as a standalone to function in the digital economy. It needs linkages to the soft infrastructure (or enabling factors) and also the sector-based applications as shown in Figure 1-4.

The characteristics of the Thai telecommunications industry can be explained as a complex commercial industry because it is embedded in "a mixture of government-linked companies and private operators functioning under a wide variety of corporate interfaces and a volatile regulatory structure" (Budde 2014, p.3). The key actors inside the Thai telecommunications industry comprise not only the regulator tier of MICT and NBTC, but also other key actors responsible for different roles inside the Thai telecommunications industry. These key actors can be further divided into the following seven tiers: (1) the regulator-tier NBTC, (2) the principle-tier telecoms operators, (3) the vendor-tier multi-national corporations (MNCs), (4) the first-tier contractors, (5) the second-tier subcontracting companies, (6) the third-tier subcontracting teams, and (7) the supplier tier. The industrial organization and inter-corporate relationships among all actors within the seven tiers is the main discussion of Chapter 2.

As shown in Table 1-2, there are three government-linked organizations, namely, CAT Telecom, TOT Corp, and TT&T as well as three private operators, namely, AIS, DTAC and True Move, which are operating telecoms services in the Thai telecommunications industry. These organizations have been divided by the market segments in which they have been operating. In the first phase, there were only CAT Telecom and TOT Corp which operated telecoms services in the Thai telecommunications industry. CAT Telecom was the international telephony provider of the country while TOT provided local and long-distance calls. Then, during the process of liberalization, other private organizations have entered into this industry, which can be further divided into the three market segments of international carriers, fixed-line carriers, and mobile carriers as shown in Table 1-2.

The first market segment is international carriers consisting of the two government-linked companies TOT Corp and CAT Telecom. However, the responsibilities of these two organizations for providing international carriers services have decreased due to the development of mobile technologies, mobile applications and social networks, such as Line, Facebook, and other social network applications.

Table 1-2: Telecoms Operators by Market Segment in the Thai Telecommunications Industry

Market Segment	Operator
International carriers	1. CAT Telecom (formerly Communications Authority of Thailand)
	2. TOT Corp (formerly Telephone Organization of Thailand)
Fixed-line carriers	1. True Corp (formerly Telecom Asia)
	2. TOT Corp (formerly Telephone Organization of Thailand)
	3. Thai Telephone & Telecommunications (TT&T)
Mobile carriers	1. Advanced Info Services (AIS)
	2. Total Access Communications (DTAC)
	3. True Move
	4. TOT Corp (formerly Telephone Organization of Thailand)
	5. CAT Telecom (formerly Communications Authority of Thailand)

Source: Budde (2014), p.4.

The second market segment is fixed-line carriers. There are three organizations, including private and government-linked companies to provide fixed-line carriers services in this industry. These three organizations are True Corp, TOT Corp and TT&T. The third and final market segment is that of mobile carriers comprising five organizations, including both private and government-linked companies providing mobile-line carriers services in the Thai telecommunications industry. These five are AIS, DTAC and True Move (the so-called "big-three" in the Thai telecommunications industry) as private companies and TOT Corp and CAT Telecom as government-linked companies.

As mentioned earlier, there are many key actors responsible for different roles inside the Thai telecommunications industry which will be further discussed in Chapter 2; thus, Table 1-2 focuses on the basic characteristics of the Thai telecommunications industry, which can be viewed as a complex commercial industry. This is because both government-linked and private companies operate in providing fixed-line carriers, mobile-carriers and international carriers services in this industry in Thailand. Also, these organizations and companies have operated and functioned under a volatile regulatory structure, resulting from changing politics, rules and regulations and the seizing of power by the military. The next section will clarify the contributions of the Thai telecommunications industry and its market values.

1.3 Contributions and Market Values of the Thai Telecommunications Industry

In general, one can understand the significance of telecommunications to economic development through consideration of two important factors. The first factor is the telecommunications industry's contribution to total GDP. The second is the correlation between per capita GDP and teledensity. First of all, let's consider the industry's contribution to total GDP. In the case of Thailand between 1986 and 2014, the telecommunications industry accounted for 4% of total GDP on average (NBTC 2011). This percentage appears

insignificant. However, in terms of the industry's growth rate, Thai consumers have been substantially increasing their consumption of telecoms services. The average annual growth of post and telecoms expenditure during the same range of years was 9.02%, which was triple the average annual growth in general expenditure (3.02%) (NBTC 2011).

Additionally, there are three sets of statistics to reflect upon regarding the extent of this increasing demand for telecommunications services. The first is that almost 35 percent of Thai citizens can access the Internet. The second is that the average annual growth in Internet use has been approximately 30 percent during the period 2000-2010. Finally, the third is the substantial growth in demand for smart phones in Thailand reaching 230 percent in 2010 (Oxford Business Group 2014).

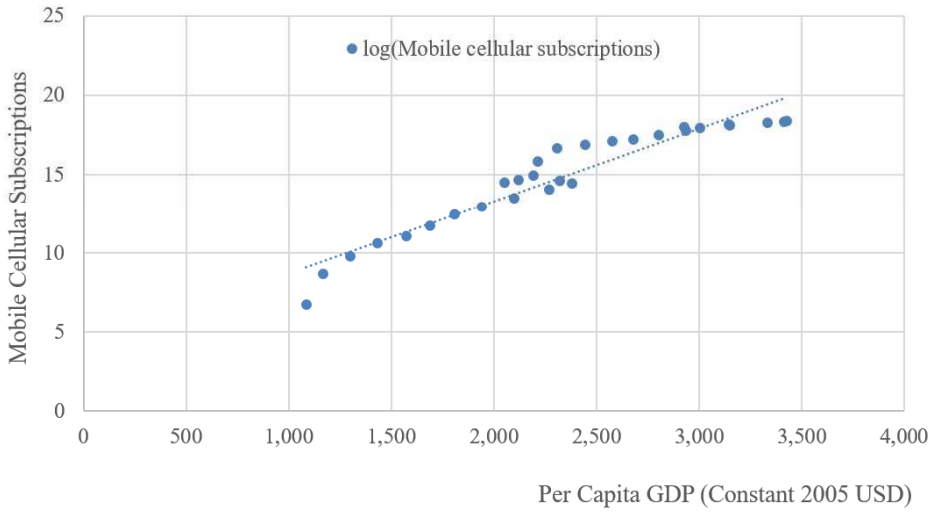
In addition to household consumers, most companies in Thailand spend approximately 58.7 per cent of total ICT expenditures on telecommunications services, and 15.7 per cent on computer hardware, 11.2 per cent on computer services and 11.1 per cent on computer software, respectively. The private hospital sector accounts for the largest amount of the telecommunications service at approximately 1.6 million baht per establishment per annum. Ranked second is the information, computer and communication sector, which consumed approximately 102,035 baht per establishment per annum (NSO 2015b). This great demand in telecommunications equipment and services, both from households and establishments, resulted in the substantial growth rate of investment in telecoms with private participation in Thailand[6]. The annual average growth rate of telecoms investment between 2010 and 2014 is approximately 68 percent. Also, its investment level reached two billion US dollars in 2014 (WDI 2016b).

[6] Investment in telecoms projects with private participation covers infrastructure projects in telecommunications that have reached financial closure directly and indirectly serving the public. Moveable assets and small projects are excluded. The types of projects include operations and management contracts, operations and management contracts with major capital expenditure, greenfield projects (in which a private entity or a public-private joint venture builds and operates a new facility), and divestitures (WDI 2016b).

The second factor in understanding the contributions of telecommunications to economic development is the correlation between per capita GDP and teledensity. The cross-tabulation in Figure 1-5 shows that there was a positive correlation between per capita GDP and the number of mobile cellular subscriptions in Thailand during the 1986-2014 period. The productivity gained in the telecommunications industry has strengthened productivity throughout the rest of the economy, which relies on high quality voice and data communications in production, distribution, and marketing processes. In other words, advances in intermediate inputs like telecommunications services can greatly advance the efficiency of an overall economy insofar as a fixed amount of these services can yield increased and better quality output (Somkiat and Taratorn 2002; Rifkin 2014).

Telecommunications services also result in qualitative benefit in terms of social development. For example, these services can greatly widen public access to and public participation in civil society, which enhance opportunities for education and creativity. Also, such improvements, in turn, can strengthen the public's contributions to the development of the Thai economy as a whole (Prasert 2010, p.13).

Figure 1-5: Per Capita GDP VS Mobile Cellular Subscriptions in Thailand (1986-2014)



Source: Author's Tabulation using World Development Indicators.

What's more, the market values of the telecommunications industry can indicate its contribution to the Thai economy, and identify its stage of development. In fact, the development of the telecommunications industry in Thailand is in that of a follower, rather than leader in the telecommunications technology. This is because all actors (companies) in the Thai telecommunications industry have adopted the passive strategy, by getting technology transfer from foreign countries rather than developing and innovating technology, including mobile technologies, and internet technologies by themselves.

Table 1-3 shows the market structure and market value of the Thai telecommunications industry during 2010-2012. The market structure of this industry can be divided into two types; telecommunications equipment and telecommunications services. As mentioned earlier, most companies in Thailand have spent approximately 60 per cent of total ICT expenditures on telecommunications services (NSO 2015b). Table 1-3 confirms that the market value of the telecommunications services is double that of the telecommunications equipment in all three consecutive years (2010-2012). Also, mobile service segment, particularly mobile non-voice has shown the highest growth rate at 34.2 percent, followed by internet service at 11.2 per cent and data communication service at 8.6 percent. At the same time, the level and the growth rate of market value on telecommunications equipment are high for mobile handset, particularly smart phone, wireless equipment and also infrastructure cabling. When these market values are categorized into the types of users, namely, operator (telecoms operators, such as the big-three), government and state enterprise, corporate and small office, home office (SOHO) and household, it is clear that SOHO and household spent the largest amount of expenditures on both telecommunications equipment and telecommunications services in 2011 as shown in Tables 1-4 and 1-5, respectively.

Table 1-3: The Structure and Market Value of the Thai Telecommunications Industry, by Types of Equipment and Services (2010-2012)

Types of Telecommunications Equipment and Services				Value (Million Baht)			Growth (%)	
				2010	2011	2012	2010/ 2011	2011/ 2012
1	**Telecommunications Equipment**			**133,780**	**145,404**	**160,419**	**8.7**	**10.3**
	1.1	***Telephone Handset***		58,774	62,092	68,145	5.6	9.7
		1.1.1	Fixed Handset	2,897	2,980	3,019	2.9	1.3
			- Conventional Fixed Handset	1,236	1,303	1,381	5.4	6.0
			- IP Phone	1,170	1,254	1,296	7.2	3.3
			- Fax	491	423	342	-13.8	-19.1
		1.1.2	Mobile Handset	55,877	59,112	65,126	5.8	10.2
			- Conventional Mobile Handset	30,983	29,992	27,931	-3.2	-6.9
			- Smart Phone	24,894	29,120	37,195	17.0	27.7
	1.2	***Core Network Equipment***		45,725	50,376	54,916	10.2	9.0
		1.2.1	Core Network	33,222	35,710	37,986	7.5	6.4
		1.2.2	Infrastructure Cabling	12,503	14,666	16,930	17.3	15.4
	1.3	***Wireline Equipment***		13,723	14,640	15,490	6.7	5.8
		1.3.1	Access Equipment	5,345	6,147	6,741	15.0	9.7
		1.3.2	LAN Cabling	2,904	3,438	4,166	18.4	21.2
		1.3.3	PBX/PABX	5,474	5,055	4,583	-7.7	-9.3
			- Conventional PBX	4,312	3,799	3,262	-11.9	-14.1
			- IP PBX	1,162	1,256	1,321	8.1	5.2
	1.4	Wireless Equipment		15,558	18,295	21,868	17.6	19.5
2	**Telecommunications Services**			**248,729**	**263,442**	**283,966**	**5.9**	**7.8**
	2.1	***Fixed Line Service***		23,211	22,444	21,363	-3.3	-4.8
	2.2	***Mobile Service***		153,221	162,486	176,626	6.0	8.7
		2.2.1	Mobile Voice	126,274	127,832	130,121	1.2	1.8
		2.2.2	Mobile Non Voice	26,947	34,654	46,505	28.6	34.2
	2.3	***Internet Service***		33,098	36,096	40,155	9.1	11.2
		2.3.1	Internet Gateway	9,612	10,126	11,035	5.3	9.0
		2.3.2	Internet Access Service	23,486	25,970	29,120	10.6	12.1
	2.4	***International Telephone Service***		15,694	16,617	17,793	5.9	7.1
		2.4.1	IDD/VoIP	14,536	15,422	16,586	6.1	7.5
		2.4.2	Calling Card	1,158	1,195	1,207	3.2	1.0
	2.5	***Data Communication Service***		23,505	25,799	28,029	9.8	8.6
		2.5.1	Leased Circuit	10,856	11,678	12.652	7.6	8.3
		2.5.2	Others	12,649	14,121	15,377	11.6	8.9
Total Telecommunications Market				**382,509**	**408,846**	**444,385**	**6.9**	**8.7**

Source: NSTDA (2012).

Table 1-4: Market Value of Telecommunications Equipment by Type of Users (2011)

Types of Telecommunications Equipment	Total		Operator		Corporate		SOHO and Household	
	Value (Million Baht)	Market Share (%)	Value (Million Baht)	Market Share (%)	Value (Million Baht)	Market Share (%)	Value (Million Baht)	Market Share (%)
Fixed Handset	2,980	100	449	15.1	2,346	78.7	185	6.2
Mobile Handset	59,112	100	-	-	3,074	5.2	56,038	94.8
Core Network	50,376	100	50,124	99.5	252	0.5	-	-
Wireline Equipment	14,640	100	4,773	32.6	9,560	65.3	307	2.1
Wireless Equipment	18,295	100	2,598	14.2	10.,099	55.2	5,598	30.6
Total Telecoms Equipment	**145,404**	**100**	**57,944**	**40.9**	**25,331**	**17.5**	**62,129**	**42.7**

Source: NSTDA (2012).

Table 1-5: Market Value of Telecommunications Services by Type of Users (2011)

Types of Telecommunications Services	Total		Government and State Enterprise		Corporate		SOHO and Household	
	Value (Million Baht)	Market Share (%)	Value (Million Baht)	Market Share (%)	Value (Million Baht)	Market Share (%)	Value (Million Baht)	Market Share (%)
Fixed Line Service	22,444	100	2,716	12.1	5,656	25.2	14,072	62.7
Mobile Service	162,486	100	1,950	1.2	39,484	24.3	121,052	74.5
Internet Service	36,096	100	1,877	5.2	8,519	23.6	25,700	71.2
Inter Call Service	16,617	100	1,479	8.9	9,206	55.4	5,932	35.7
Data Comm. Service	25,799	100	5,495	21.3	20,252	78.5	52	0.2
Total Telecoms Service	**263,442**	**100**	**13,517**	**5.1**	**83,117**	**31.6**	**166,808**	**63.3**

Source: NSTDA (2012).

Also, each type of users has specific needs for using telecommunications equipment and services. The telecoms operators spent the most on core network and wireline equipment for telecommunications equipment. The corporate user consumed fixed handset, wireline and wireless equipment the most in terms of telecommunications equipment, and data communications service and international call service the most in terms of telecommunications service. SOHO and household have mostly spent their expenditure on mobile handset and wireless equipment in terms of telecommunications equipment, and on mobile service and internet service for telecommunications services. Government and state enterprises have mostly spent their expenditure on data communications service, followed by fixed line service in telecommunications service as shown in Table 1-5.

In brief, the telecommunications industry in Thailand can be classified into two categories: telecommunications equipment and telecommunications services. The highest market value and growth rate have come from telecommunications services, with much spent by SOHO and household users followed by corporate users. In terms of telecommunications equipment, the mobile handset, (particularly smart phone), and the core network equipment (particularly infrastructure cabling) have shown the highest market values and growth rates. The telecoms operators have spent much on core network, while corporate users have spent much on fixed handset, wireline and wireless equipment, and SOHO and household have spent much on mobile handset, and wireless equipment. At the same time, in terms of

telecommunications service, the mobile service, (particularly mobile non-voice), and internet service show the highest market values and growth rates. Two-thirds of total market value has been spent by SOHO and household, especially mobile service, and internet service. Also, one-third of the total market value was spent by corporate users, particularly on data communications services and international call services.

The market value of both telecommunications equipment and services have exhibited an increasing trend. Also, there has been demands from many types of users. However, this industry faces many challenging issues, for example volatile and complex regulations on spectrum allocation, the ability to absorb the telecommunications technology transfer from foreign countries, the capacity to compete and develop the Thai telecommunications industry among various actors, and particularly the shortage of the capable individuals to work within this field. The next section will identify the challenging issues currently facing the Thai ICT industry, particularly the problem of the shortage of ICT personnel.

1.4 Challenging Issues in the Thai ICT Industry

As relates to the problem of the middle-income trap, Thailand is now facing intense competition from many less-developed countries with cheap labour as well as being hampered by the inability to catch up with advanced, developed nations in terms of high technology and innovation. ICT technology is an increasingly vital element in international competitiveness to substantiate and sustain the country's economic growth. It is not only having the right kind of technology and innovation matching the nation's context, but it is also concerned with the ability to effectively absorb and utilize technology, as well as make efficient use of available resources to produce better quality as well as lower cost services. Human resources are one of the critical components for developing technological capability, apart from financial and infrastructure components. This is because technological capability and the ability to develop and innovate is essentially embodied in the people, rather than in

the machines. Nevertheless, the Thai ICT industry including the telecommunications industry has encountered the problems of the shortage of ICT personnel, with its subsequent result of weakness in other areas, such as technical information services, the ability to improve technology and compete, and so on. Table 1-6 summarizes the challenging issues, particularly the inadequate supply of technical human resources (or ICT personnel in this study) in the Thai ICT industry. In fact, there are many challenging issues concerning the development of Thailand's technological capability in ICT industry (Sumeth 1992). For example, the inadequate supply of ICT personnel at the technician level, inadequate technical information services, inadequate technical services, the linkage between the tax structure and the science and technology (S&T) community, and also the attitude of entrepreneurs on firm-level personnel development. Each issue requires specific policy and implementation to counteract with both by short-term and long-term measurements. However, the study focused on the labor market and employment issue, particularly the inadequate supply of ICT personnel in the Thai ICT industry as thoroughly discussed in Chapter 4. The content from Table 1-6 roughly indicates that there has been a general shortage of science and technology (S&T) personnel, particularly that of engineers, in the Thai labour market, and the ability of Thai S&T personnel is also incompetent in terms of catching up with the newer technologies that are always being upgraded. In response to the problem of the shortages of ICT personnel, the study of TDRI suggested two kinds of solutions: short-term and longer-term. For short-term solutions, they proposed four immediate measures: (1) providing special training courses to enable scientists and technicians to handle engineering tasks, (2) making it easier for foreign engineers to work in Thailand, (3) lifting the two percent growth ceiling for engineering and science teaching positions in public universities, and (4) organizing a major campaign to boost S&T undergraduate enrollments and improved remuneration systems to attract and retain high-caliber academic staff (Sumeth 1992).

Table 1-6: Challenging Issues regarding the Shortage of ICT Personnel in the Thai ICT Labour Market

Major Problems Identified	**Measures to Enhance Efforts to Acquire and Improve Technology**
Inadequate Supply of Technical Human Resources There appears to be a general shortage of science and technology (S&T) personnel, in particular of engineers, while the ability of S&T personnel is questionable, as newer technologies proliferate and push many existing technologies into obsolescence.	S&T Personnel Development Apart from finance and infrastructure, human resources are another critical component of developing technological capability, as technological capability is, after all, essentially embodied in people and not in machines. To reduce current shortages and increase future supplies of S&T manpower, several measures, both immediate and long-term, were put forward. The immediate measures proposed include: • Providing special training courses to enable scientist and technicians to handle engineering tasks • Making it easier for foreign engineers to work in Thailand • Lifting the 2 percent growth ceiling for engineering and science teaching positions in state universities • Organizing a major campaign to boost S&T under-graduate enrollments and improved remuneration systems to attract and retain high-caliber academic staffs. Long-terms measures involve: • Recommendations for substantial investment to train more and better science and engineering graduates • The granting of some 800 overseas study scholarships, particularly in the four capabilities*. • Initiation of an on-going upgrading of the curricula in science and engineering • Encouraging management to accord better recognition and remuneration to deserving scientists, engineers and skilled technicians.

Source: Sumeth (1992).

Note: * The four core capabilities include:

1. Acquisitive capability: a firm's ability to search, assess, negotiate and procure the needed technologies and to install and start-up production facilities.
2. Operative capability: the operation, control and maintenance of production facilities as well as skill development, production planning and quality control.
3. Adaptive capability: technology digestion and minor product and process modifications.
4. Innovative capability: the capacity to make radical product and process modifications to carry out in-house R&D and to invent new products and processes.

For longer-term solutions, they also proposed four measures: (1) substantial investment to train more and better science and engineering graduates, (2) the granting of eight hundred overseas scholarships, particularly in the four capabilities of acquisitive capability, operative capability, adaptive capability, and innovative capability, (3) the on-going upgrading of the curricular in science and engineering, and (4) better recognition and remuneration to deserving scientists, engineers and skilled technicians. In addition to short-term and longer-term solutions proposed by the study of TDRI, many companies in this industry also created their internal strategies, particularly the human resource management to cope with this shortage problem. This will be the main analysis in Chapter 5.

1.5 Conclusion

The Thai telecommunications industry has been recognized as one of the main foundations of the economies of speed (network), or the so-called digital economy in the current era. This industry was given a special promotion by the Thai government since the late 1980s and was greatly liberalized during the 2000s, driven by the first Telecommunications Master Plan of Thailand (2000). The aims were to transform Thailand into a trade and telecommunications center in the Indo-China region and to develop human resources in the Thai ICT industry.

Although much efforts were made in pursuing the liberalization process, the Thai government still tightly controls and regulates the Thai telecommunications industry for the sake of national security. One particular example is that, in 2011 of, the MICT setting up the Cyber Security Crime Protection and Prevention Bureau and also the electronic transaction development agency in order to strengthen the prevention of cyber crime and national security in the current digital era. Therefore, the specific characteristics of the Thai telecommunications industry can be described as a complex commercial industry since it is

embedded in “a mixture of government-linked companies and private operators functioning under a wide variety of corporate interfaces and a volatile regulatory structure” (Budde 2014). The historical development of this industry involves not only changing technology but also changing politics resulting in regulatory bottlenecks and complexity and also the holding back of competitiveness.

Nevertheless, the development of the Thai telecommunications industry has yielded the most competitive performance among the neighbouring countries in the ASEAN region. The contribution of the Thai telecommunications industry to the national GDP is not explicitly high at the moment, but the growth rate in terms of market values both for telecommunications equipment and telecommunications service has been noticeably robust. In other words, the Thai telecommunications industry has shown potential growth and competitive performance. However, when we turn to focus on the labour market and employment issues, the Thai ICT industry including the telecommunications industry is currently facing a shortage of ICT personnel, with the knock-on results of shortages in other areas especially the capabilities to compete, develop and innovate. Deliberate analysis on the shortage of ICT personnel and the responses in terms of wages and supply in the Thai ICT external labour market will be given in Chapter 4 and the immediate measures which companies in this industry have applied to counteract the shortage problem will be provided in Chapter 5. Before moving on the labour market and employment issues, both in external and internal labour markets, the following two chapters will clarify the industrial organization and inter-corporate relationships among the actors responsible for different roles inside the Thai telecommunications industry (Chapter 2), as well as identify the corporate strategies which they adopted to cultivate the capabilities at the company level (Chapter 3).

Chapter 2

Industrial Organization and Inter-Corporate Relationships in the Thai Telecommunications Industry

Introduction

Chapter 1 presented the historical developments, characteristics, contributions and challenges in the Thai telecommunications industry. In particular, the specific characteristics of this industry involved a mixture of government-linked companies, private operators, and other several actors functioning in a complex commercial environment. These several actors are operating to provide different kinds of services and are competitively inter-related to create and add value in the Thai telecommunications industry. Thanks to its contributions and potential growth in terms of market value and demand for both telecommunications equipment and telecommunications services, this industry has received the heavy attention and investment.

However, other challenges are prevalent within the complexity and competitiveness among the several actors in this industry. These challenges related to the friction in collaboration among the actors playing important roles within the Thai telecommunications industry. If this situation is not resolved, it may become increasingly complex or even lead to conflict resulting in holding back the industry's competitiveness. On the other hands, if all the relevant actors collaborate, not only will operations become smoother, but also the foundations of competitiveness will become stronger.

Therefore, the objective of this chapter is to clarify the industrial organization and inter-corporate relationships among the main actors in the Thai telecommunications industry. The chapter consists of five sections. The first explores the industrial organization of the Thai telecommunications industry. The second describes the value-creation opportunities among

all industrial actors in this industry. The third explains their inter-corporate relationships both on vertical and horizontal axes. The fourth identifies the workflow of the new sites of telecommunications towers in Thailand and identify how each actor is involved. The final section provided the concluding remarks.

In terms of data and methodology, this chapter uses a case-study and a multilayer perspective to define the industrial actors' tier-boundary and their value creation opportunity[7]. Also, the secondary data from the National Broadcasting and Telecommunications Commission (NBTC) survey reports, and the primary data including corporate documents and interviews have been utilized to depict the aspects of the Thai telecommunications industry relevant to the study of this chapter.

2.1 The Pyramid-Shaped Industrial Organization and the Hierarchical Governance Structure of Thailand's Telecommunications Industry

As discussed in Chapter 1, there are several actors including government-linked and private companies operating to provide telecommunications services in the three market segments of international carriers, mobile carriers and fixed line carriers in the Thai telecommunications industry. The mobile carriers market has shown the strongest growth in terms of development and involved three private telecoms operators, the so-called big-three of AIS, DTAC, and True Move. These big-three telecoms operators have competed to differentiate themselves from one another in the areas of network quality, advertisements (promotional packages), and value-added services[8] (Somkiat and Taratorn 2002).

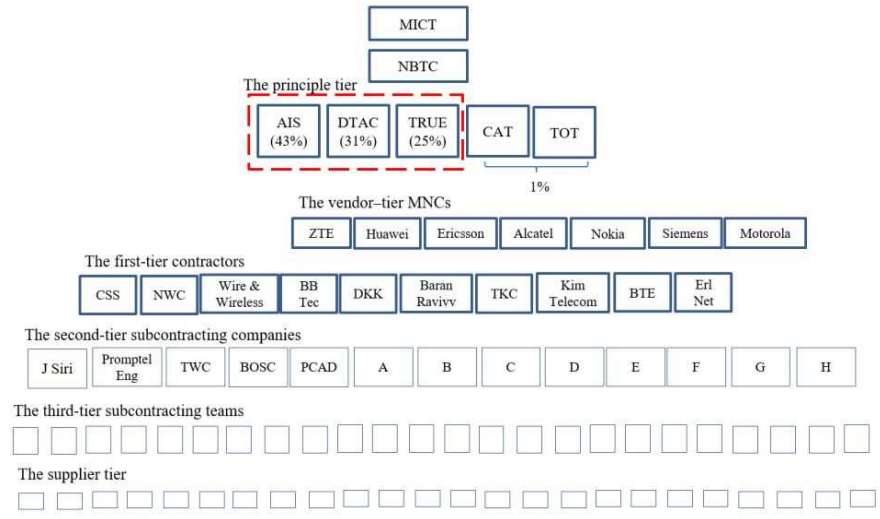
Traditionally, the inter-corporate structure and relationship in most industries in Thailand incorporates a pattern of business groups within its own network boundary (Suehiro

[7] A multilayer perspective is mostly used to analyze any structure or system with several layers or levels, for example the complex network in the architect framework (www.collinsdictionary.com/dictionary/english/multilayer).
[8] Value-added services in the telecommunications industry include voice services, non-voice services, data usage, and online transactions.

and Natenapha 2014). However, new technologies can give rise to new patterns of inter-corporate structures and relationships (Beynon, Nehaniv and Dautenhahn 2001). A cornerstone of Thailand's telecommunications industry is the integration of the three important factors of specialized telecommunications products, multi-national telecommunications corporations' technology, and coordination-rich organizational capabilities, which require substantive relationships, harmonious cooperation and close communications among all involved actors[9].

Therefore, the industrial organization of the Thai telecommunications industry is classified and shaped according to the main tasks of actors along the pyramidal hierarchical structure. As shown in Figure 2-1, the actors in the Thai telecommunications industry can be divided into seven tiers: (1) the regulator-tier NBTC, (2) the principle-tier telecoms operators (AIS, DTAC, and True Move), (3) the vendor-tier multi-national corporations (MNCs), (4) the first-tier contractors, (5) the second-tier subcontracting companies, (6) the third-tier subcontracting teams, and (7) the supplier tier.

Figure 2-1: The Pyramid-Shaped Hierarchical Structure of the Thai Telecommunications Industry



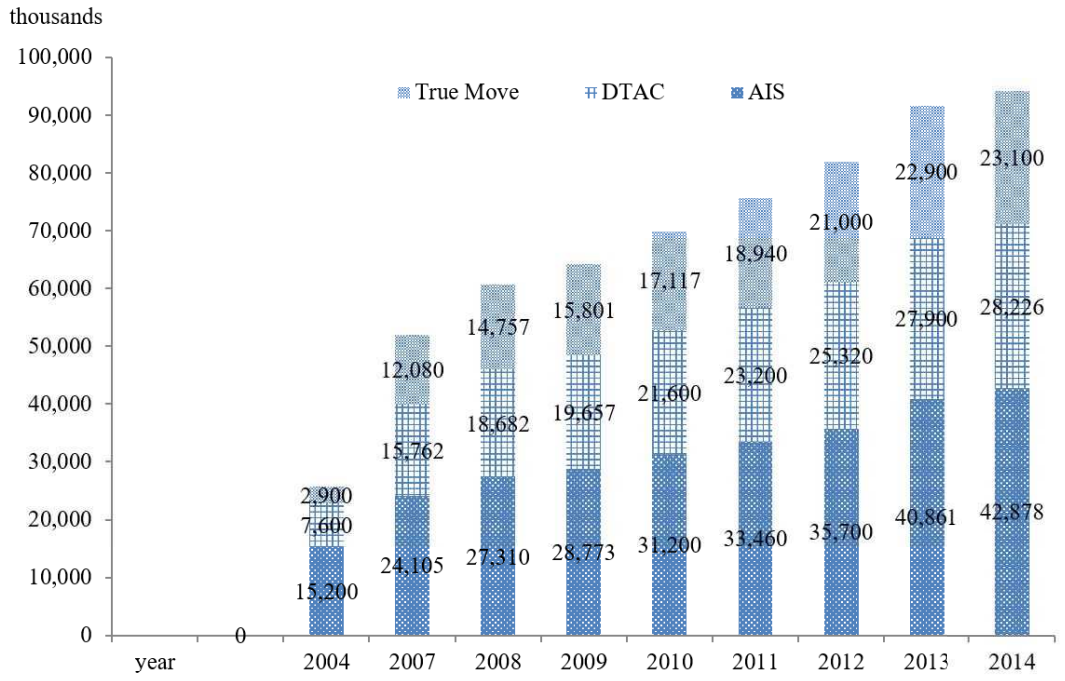
Source: Created by author based on interviews and the telecommunications directory (MICT 2014).

[9] Concept of coordination-rich organizational capabilities was discussed in a context of Japanese production system (Fujimoto 2012). This study applied the concept due to its compatibility with the context of inter-corporate relationships in the Thai telecommunications industry.

Each tier of actors performs a specific set of tasks reflecting the tier's value creation along the hierarchy. On the vertical axis, these tasks do not overlap. In actuality, this hierarchical structure possesses a vertical integration system because they require collaboration for a smooth flow of operations. On the horizontal axis, the relationships among the industrial actors may give rise to competition, reflecting the efforts of each tier of actors to increase their own profits and to strengthen their own share of the market.

The shape of the hierarchical structure in the Thai telecommunications industry is pyramidal. The Ministry of Digital Economy and Society (MICT) is positioned at the top of the pyramid. MICT leverages the authorization to NBTC in order to regulate and have full rights to allocate the frequency spectrum in the Thai telecommunications industry. In other words, the NBTC acts as the spectrum granter, distributing licenses for use of the radio-frequency spectrum to the big-three telecoms operators. Therefore, the big-three operators can provide cellular mobile services on the 850 MHz, 1800 MHz, 3G–850 MHz, and 2.1 GHz bands. However, the most important regulator on the global stage is the International Telecommunications Union (ITU), whose regulations the MICT and NBTC of Thailand must comply with to meet International standards (ITU 2013). Inside the Thai telecommunications industry, the most well-known and influential is the principle-tier or the so-called the big-three telecoms operators of AIS, DTAC and True Move. These principle-tier telecoms operators are required to abide by the NBTC rules and regulations. After gaining government authorization for roll-out project activities, they will fulfil their main function by engaging in mobile-cellular service operations and developing telecoms infrastructure based on the build-transfer-operate (BTO) model. AIS has consistently gained the biggest market share of mobile–phone subscribers at approximately 43 percent, followed by DTAC for 31 percent and True Move for 25 percent as shown in Figure 2-2.

Figure 2-2: Market Share of Mobile Subscribers of the Big-Three (2004-2014)



Source: Compiled and created by author based on Budde (2014).

The brief profile of the big-three telecoms operators is summarized in Table 2-1. To begin with AIS, or Advanced Info Service Public Company Limited, was established in 1986 and was the first private telecoms operator in Thailand. Five years later, the company was listed on the Stock Exchange of Thailand (SET) on 5th November 1991. Its core business is in the cellular mobile telephone network on the 900 and 1800 MHz frequency under the digital Global System for Mobile communication (GSM) technology and mobile telephone service on the 2.1 GHz frequency under the digital UMTS technology. AIS has consistently gained the largest share of the Thai mobile market with approximately 43 per cent of the total market share as shown in Figure 2-2. Also, the company has created the largest capitalization of 689,785 million baht (as of October 2015), and yields a dividend return of approximately 5.19 per cent.

Table 2-1: Profile of the Big-Three in the Thai Telecommunications Industry, as of 2014

1. Abbreviation	ADVANC (AIS)	DTAC	TRUE
2. Name of Company	Advanced Info Service Public Company Limited	Total Access Communication Public Company Limited	True Corporation Public company Limited
3. Established year	1986	1989	1990
4. Date of listing	05/11/1991	22/06/2007	22/12/1993
5. Major shareholders	1. Intouch Holdings (40.45%) 2. Singtel Strategic Investment Pte Ltd. (23.31%) 3. Thai NVDR (5.50%)	1. Telenor Asia Pte Ltd. (42.62%) 2. Thai Telco Holding (22.43%) 3. TRT PCL (9.93%)	1. Charoen Pokphand Group of companies (27.96%) 2. China Mobile International Holdings (18.00%)
6. Number and % of minority shareholders	31,513 (36.22%)	24,351 (29.37%)	47,932 (30.86%)
7. Top Management	Allen Lew Yong Keong (Chaiman), Somchai Lertsutiwong (CEO)	Boonchai Bencharongkul (Chairman), Larks-Aake Valdemar Norling (CEO)	Dhanin Chearavanont (Chairman), Suphachai Chearavanont (President)
8. Changes in ownership structure	Shinawatra family --> Temasek (Singapore) --> Temasek Group Companies Cedar and Aspen Holdings	Bencharongkul family --> Telenor group (Norway)	No change. Ultimate owner is the CP Group or Chearavanont family
9. Businesses	Cellular mobile telephone network in the 900 and 1800-megahertz (MHz) frequency under the digital Global System for Mobile Communication (GSM) technology and mobile telephone service in 2.1GHz frequency under the digital UMTS technology.	Wireless telecommunication service in 800 MHz and 1800 MHz frequency bands. In 2013, DTAC TriNet was launched to provide superior services on 3 combined frequency networks (2G 1800 MHz, 3G 850 MHz, 3G 2.1 GHz)	Core businesses in three categories: (1) Online business under TrueOnline, consisting of fixed-line phone and value-added services, business data services, Internet and Broadband Internet services, WiFi and WE PCT; (2) Cellular business under True Mobile Group, operating mainly 4G LTE and 3G services under the brands TrueMove H; (3) Pay TV business under TrueVisions.
10. Market share (Subscribers)	43.70%	30.20%	24.50%
11. Market capitalization (Millions of Baht, as of Oct. 2015)	689,785	142,660	258,383
12. Dividend yield (%)	5.19%	12.02%	n.a.

Sources: The Stock Exchange of Thailand, "Companies/Securities in Focus." Annual reports.

The major shareholders of the company are Intouch Holdings with 40.45 per cent, Singtel Strategic Investment Pte Ltd with 23.21 per cent and Thai NVDR with 5.50 per cent. As concerns its corporate history, there was a change in the ownership from the Shinawatra family to the Temasek Group (Singapore). The second of the big-three telecoms operators is Total Access Communication Public Limited Company, or DTAC. The company was established in 1989 and listed on the SET on 22nd June 2007, eighteen years after its establishment. The company's major shareholders include Telenor Asia Pte Ltd. with 42.62 per cent, Thai Telco Holding with 22.43 per cent and TRT PCL with 9.93 per cent. Like AIS, the ownership of DTAC changed hands from the Bencharongkul family to becoming part of the Telenor Group (Norway). DTAC's core business focuses on the wireless telecommunications service on the 800 MHz and 1800 MHz frequency bands.

Notably, in 2013, the company launched DTAC TriNet to provide superior services on the three combined frequency networks of 2G 1800 MHz, 3G 850 MHz and 3G 2.1 GHz to their customers. DTAC has consistently gained the second biggest market share of approximately 30 per cent of the total share of the mobile market. The company has created the smallest market capitalization of 142,660 million baht compared to the other two telecoms operators but has yielded the highest dividend return of 12 per cent.

The third and final of the big-three telecoms operators in the Thai telecommunications industry is True Corporation Public Company Limited, or True Move. The Company was established in 1990 and was the last of the private telecoms operators among the big-three to enter into the market. The company was soon listed on the SET on 22nd December 1993. True Move has gained the smallest market share of approximately 24 per cent of the total market share. However, the company is ranked 2nd in terms of market capitalization of 258,383 million baht. Its core businesses are not only limited to mobile cellular services, but comprise three business categories. The first is its online business under True Online, including fixed-

line phone, value-added services, business data services, internet, broadband internet service, WiFi and WE PCT. The second is the mobile cellular business under True Mobile Group, which mainly operates 4G LTE and 3G services under the brands True Move-H. The final category is the Pay TV Business under True Vision. The major shareholders remain Charoen Pokpand Group with 27.96 per cent, and also include China Mobile International Holding with 18 per cent, and Thai NVDR with 6.49 per cent. Throughout its history, there has been no change in ownership. The ultimate owner of the company has been the CP Group belonging to the Chearavanont family.

Table 2-2 presents the profile of the big-three telecoms operators in terms of economic performance, more specifically, the equity capital, total assets, revenue, net profits, return on assets (ROA) and return on equity (ROE) of AIS, DTAC and True Move during the period 2005-2014. AIS has clearly shown the best economic performance in terms of net profits, ROA and ROE as shown in Table 2-2. This may result from the fact that AIS was the first telecoms operators and the company's executives have been made up of professionals in this specific field (Suehiro and Natenapha 2006). However, the other two companies have competed for revenue and net profit, with their positions interchanging. For example, True Move was ranked 2nd for revenue during 2011-2014; however, DTAC has consistently performed better as regards net profits, ROA and ROE. The lowest performance of True Move in terms of net profits, ROA and ROE may result from the fact that the company did not originate from telecoms, like AIS and DTAC. Nevertheless, the total assets of True Move have had the highest value in stock.

Table 2-2: Economic Performance of the Big-Three, 2005-2014

Big-Three	2005	2010	2011	2012	2013	2014
(1) Equity Capital (Millions of Baht)						
1.ADVANC (AIS)	71,081	41,480	39,254	43,353	45,748	46,750
2.DTAC	n.a.	30,435	34,871	34,929	32,708	32,591
3.TRUE	n.a.	12,470	20,777	13,347	4,081	70,350
(2) Total Assets (Millions of Baht)						
1.ADVANC (AIS)	119,014	97,457	86,672	100,968	112,026	126,350
2.DTAC	87,049	99,313	103,847	101,018	105,054	106,426
3.TRUE	108,058	115,022	151,518	180,363	205,852	234,570
(3) Revenue (Millions of Baht)						
1.ADVANC (AIS)	92,517	111,280	127,324	142,684	143,654	150,029
2.DTAC	43,198	72,351	80,144	90,261	94,984	90,868
3.TRUE	44,193	62,378	84,823	90,271	104,398	117,660
(4) Net Profits (Millions of Baht)						
1.ADVANC (AIS)	18,909	20,667	22,218	34,883	36,274	36,033
2.DTAC	9,784	10,885	11,813	11,278	10,569	10,729
3.TRUE	-4,269	1,959	-2,694	-7,428	-9,063	1,425
(5) Return on Assets or ROA (%)						
1.ADVANC (AIS)	15.75	n.a.	41.68	49.78	44.36	39.95
2.DTAC	n.a.	n.a.	17.24	15.54	15.54	13.82
3.TRUE	n.a.	n.a.	11.76	0.18	1.12	2.61
(6) Return on Equity or ROE (%)						
1.ADVANC (AIS)	27.17	n.a.	55.25	84.46	81.42	77.91
2.DTAC	n.a.	n.a.	22.78	32.32	31.25	32.86
3.TRUE	n.a.	n.a.	-16.49	-43.53	-104.00	3.83

Sources: The Stock Exchange of Thailand, "Companies/Securities in Focus." http://www.set.or.th/set/companyhighlight. Retrieved on 22 October 2015.

Returning to Figure 2-1, all of the big-three subcontract the roll-out projects to first-tier contractors or to vendor-tier MNCs after gaining authorization from the NBTC. When reaching the expiration of the concession contracts, the big-three can choose either to transfer the infrastructure to the government or prolong the continuation of the contract. The vendor-tier provides consumers with telecommunications products and technologies. All vendor-tier members are MNCs. Each pursues an aggressive and active strategy for competitively selling their products and technologies to the big-three telecoms operators, CAT, and TOT.

The robustness of the MNCs' strategies reflects the fact that the selection of telecoms equipment and technology of each brand is the most important initial step in their pursuit of profitability. Because the vendor-tier MNCs operate chiefly in the field of telecoms technology, another important task they must carry out is the training of key principle-tier, first-tier, and second-tier actors. Also, this training enables each tier of actors, particularly the principle-tier, first-tier and second-tier actors to match their competences with one another and with the overall marketplace.

The next layer, or tier, in the Thai telecommunications industry's pyramidal structure consists of the first-tier contractors. Between approximately ten and twenty companies make up this tier and act as telecommunications intermediaries between the principle-tier operators and the second-and-third-tier subcontractors. The first-tier contractors chiefly perform such tasks as civil work, telecoms equipment installation and integrated commissioning[10]. Their business activities comprise the steps of derive demand, design, develop, and deliver. Firstly, they derive demand on the basis of the roll-out project contracts drawn from the principle-tier telecoms operators or the vendor-tier MNCs. After acquiring the projects, the first-tier main contractors design telecom antenna and subcontract project-development tasks including the aforementioned tasks of telecom-equipment installation and integrated commissioning to the second-tier subcontractors. At the same time, they strictly supervise and coordinate every step in the workflow to ensure satisfactory quality and timely customer deliveries.

The main task of the second-tier subcontracting companies is on site construction (relatively the same as those tasks performed by the first-tier contractors). Many local companies belong to the second-tier category because such companies are not that difficult to

[10] Civil work refers to site construction which is the third stage of workflow of the new sites of telecommunications tower as shown in Figure 2-3 in Chapter 2. The phrase "civil work" is a technical term and is used in formal agreement between the principle-tier telecoms operators and the first-tier contractors for the roll-out projects of the telecommunications tower, which are divided into two parts. The first part is civil infrastructure or civil work including tower structure, shelter, aviation warning and grounding system, rectifier battery and air con system. The second part is telecoms infrastructure including WiMax, WiFi equipment, feeder, connector, outdoor and indoor antenna, TMA, booster, repeater and ANF.

start up. These companies tend to be quite small, each consisting of about a dozen employees. Therefore, the second-tier subcontracting companies often need workers for on-site construction work, and they get workers from the third-tier subcontracting teams, which typically involve between six and ten people. These on-site construction workers prefer a nomad work style to that of an established company. The last tier, the supplier tier, carries out its main task of supplying materials for telecoms antenna construction.

In brief, the Thai telecommunications industry operates within the context of a pyramid-shaped industrial organization and hierarchical governance structure. This hierarchical structure reveals that each tier's actors perform specific tasks and create particular values according to their functional specialization. The next section will further explore the value creation of each tier of actors in the Thai telecommunications industry. The aspects of value creation in this study consist of the following four elements: the core tasks, core competences, core capabilities and challenges.

2.2 The Value Creation Opportunities of the Key Actors in the Thai Telecommunications Industry

The value creation opportunities of each tier of actors in the Thai telecommunications industry are summarized in Table 2-3. As explained above, the raison d'être of these actors is to perform specific tasks. These specific tasks reflect the pursuit of value creation and also facilitate the classification of actors in specific tiers. Companies can gain a competitive advantage by building foundational competences; therefore, they need to be more deliberate in understanding which competences affect business performance (McKinsey Global Institute 2011).

Table 2-3: The Value Creation Opportunities of the Key Actors in the Thai Telecommunications Industry

Tiers	Tasks	Core Competences	Core Capabilities	Challenges
The regulator tier	• Strictly regulate the industry • Approve RF-spectrum license	• Market-based licensing regime • Liberalizing development	• Credibility • ITU's global standards	• Meet ITU's global standards • Catch up to and compete with other countries' technological development • Overcome domestic digital divides
The principle tier	• Acquire RF-spectrum licenses • Raise capital for investment • Operate and provide mobile-cellular services	• Government connections • Network quality management • Pricing and marketing	• Political bargaining power • Cost-efficient technology • Operational excellency • ISO/IEC 27001-2013 (ISMS)	• Reach and maintain high-speed pace of technological development • Achieve continuity of concessions with the government • Secure airtime money
The first tier	• Design telecoms antenna • Supervise civil work, telecoms equipment installation, integrated commissioning	• Connection with principle tier • Telecoms engineering • Quality assurance • Auto CAD/CAM (i.e. antenna designs)	• ISO 9001-2008 in telecommunications • The principle-tier standards (C-FBOQ, C-PAT, C-PAC, C-FAT, C-FAC) • Negotiating skills	• Reach and maintain high-speed pace of technological development • Achieve continuity of project contracts • Achieve desirable capital and cash flows • Manage time
The second tier & the third tier	• Perform civil work, telecoms equipment installation, and integrated commissioning	• Civil-engineering design • Construction management • Telecoms engineering	• ISO 9001-2008 in telecommunications • The principle-tier standards (C-FBOQ, C-PAT, C-PAC, C-FAT, C-FAC) • Coordinating skills	• Reach and maintain high-speed pace of technological development • Achieve continuity of project contracts • Achieve desirable capital and cash flows • Manage time
The vendor tier	• Provide telecoms technology to other key actors • Strengthen know-how & technology transfers	• Communications technology • Sales and marketing strategies (regional → global)	• Untethered and wireless communications integration systems • ISO/IEC 27001-2013 (ISMS)	• Compete successfully in the field of technological development • Achieve and maintain compatibility with market contexts • Acquire satisfactory knowledge & technology transfers
The supplier tier	• Supply materials & equipment • Perform logistics	• Supply inventories • Logistics management	• Comprehensive industrial analysis • Warehouses and fleets	• Avoid excesses or shortages of supplies • Deal with the depreciation of materials

Source: Created by author based on interviews, Natee (2011), NBTC (2011), Settapong et al. (2013), Oxford Business Group (2014), Acccenture (2015b, 2015c), Sutthisak (2016).

A core competence is a set of integrated skills and technologies that enables a company to provide a particular value or benefit to the customers. It transcends any particular product or service. In actuality, it is the root of competitiveness and the source of fundamental growth (Hamel and Prahalad 1996; Accenture 2015a). Competence is accumulatively based on capability, which is defined as resource leverage for the benefit of business performance (Fukushima and Yamaguchi 2009). To achieve resource leveraging, companies must accumulate and orchestrate their own resources and multiply their resources' effectiveness (Hamel and Prahalad 1996, p.171). Challenges essentially refer to the risks accompanying acts of initiative, interdependence, and integration risks that each tier must bear to varying extents (Adner 2006).

First, the vendor-tier MNCs establish strategic standardization in terms of telecommunications technology[11]. They act as innovators who provide telecoms technology to the principle-tier operators and who transfer knowledge as well as technology in the field of innovation. Their competences lie in communications technology and also sales and marketing strategy. The competition field which was once regional in the past (for example, Alcatel-Lucent versus Siemens in Europe, Nortel versus AT&T in the United States, NEC versus Fujitsu in Japan and Samsung versus LG in South Korea) has reached a global scale (Hamel and Prahalad 1996). Therefore, untethered and wireless communications integration systems and also ISO/IEC 27001-2013 (ISMS) are recognized as the vendor-tier's fundamental capability[12]. The challenges besetting the vendor-tier MNCs include fierce

[11] Standardization has become a strategic tool with which big firms form a consortium to establish industry-wide standards. This process has yielded many consensus standards that change the division of labour in the firms in each tier. Standardizations or consensus standards are based on two practices: adjusting the scope of knowledge (the scope of work) and selecting new business partners who adopts the standards (Tatsumoto, Ogawa and Fujimoto 2011).

[12] ISO/IEC 27001-2013 is the International Standard that describes the best practices for Information Security Management Systems (ISMS). More specifically, ISO 27011 is the specific standard guidelines for telecoms-based organizations (Sutthisak 2016).

competition in technology development, possible incompatibilities with a given market context, and the inefficient transfers of knowledge and technology.

Next, the regulator-tier NBTC strictly oversees all the industrial actors within the nation's geographical boundaries. The NBTC also can approve or deny RF-spectrum licenses. There are two core competences necessary for creating a "fair" playing field and for maximizing efficiency: the first is the ability to engage successfully in market-based licensing regimes, and the second is the talent for promoting the development of liberalization. The NBTC's critical resources include its own credibility and the ITU's global standards. The regulator-tier's challenges include the difficulties often inherent in meeting the ITU's global standards, catching up to, and competing with other countries' levels of technological development, and coping with domestic digital divides.

If the vendor-tier MNCs standardize telecoms technology, the principle tier must set industry-wide standards for the work process itself. They create values by operating and providing mobile-cellular services after acquiring RF-spectrum licenses and raising capital for investment. The principle-tier telecoms operators' fundamental source of competitiveness lies in their connections with the Thai government, their handling of network quality management, and also their pricing and marketing strategies. The core capabilities of the principle tier are its adept pursuit of political bargaining power, of cost-efficient technology, and of operational excellence. The challenges consist of achieving a high-speed pace of technological development, establishing a continuity of concessions with the Thai government, and securing airtime money[13].

[13] Mobile cellular subscribers spend money in order to talk, to transmit data (by means other than talking), and to engage in online transactions. Many cell-phones plans are based on the number of airtime minutes that subscribers can use each month. Pay-as-you-go plans, for example, enable cell phone owners to pay in advance for talking time and these owners can add more airtime as needed by day, week, or month.

The tasks, core capabilities, and challenges of the first-tier contractors, the second-tier subcontractors and the third-tier subcontracting teams are relatively the same. Whereas the first tier acts as *supervisors* who design telecoms antenna and who supervise civil work, telecoms equipment installation, and integrated commissioning, the second and the third tiers act as *practitioners* who perform all the above-mentioned tasks. The core capabilities are the same for each of these three tiers: the capabilities involve chiefly ISO 9001-2008 in the field of telecommunications, the principle-tier standards (e.g., C-FBOQ, C-PAT, C-PAC, C-FAT, C-FAC), and negotiating skills[14]. Whereas the core competences of the first tier comprise connections with the principle tier, CAD for antenna designs, and telecoms engineering, the core competences of the second-tier subcontracting companies and the third-tier subcontracting teams consist of civil-engineering design, construction management and also telecoms engineering. The challenges are relatively the same for these tiers: reaching and maintaining a high-speed pace of technological development, achieving desirable capital and cash flows, securing a satisfactory continuity of project contracts, and managing time well.

Lastly, the supplier tier creates value by supplying the materials and equipment related to telecoms projects and handling logistics. This tier's core competence includes the ability to supply inventory items and to manage logistics. The tier's crucial resources (in the form of core capabilities) involve comprehensive industrial analysis as well as such material capital as warehouses and fleets. The supplier tier's challenges lie in the constant risk of either accumulating an excess or incurring a shortage of supplies as well as the equally constant risk of material depreciation.

[14] The principle-tier standards for telecoms site construction include C-FBOQ, C-PAT, C-PAC, C-FAT and C-FAC, which stand for Construction Final Bill of Quantities, Construction Provisional Acceptance Test, Construction Provisional Acceptance Certificate, Construction Final Acceptance Test and Construction Final Acceptance Certificate respectively. The first-tier contractors have to follow these standards on a step-by-step basis.

In brief, the actors in the Thai telecommunications industry can be divided into seven tiers: (1) the regulator-tier NBTC, (2) the principle-tier telecoms operators (the so-called big-three including AIS, DTAC and True Move), (3) the vendor-tier MNCs, (4) the first-tier contractors, (5) the second-tier subcontracting companies, (6) the third-tier subcontracting teams, and (7) the supplier tier. Actors in each tier create the economic value of tasks, reflecting the underlying competences and capabilities which are the fundamental source of their competitiveness in the Thai telecommunications industry. All these actors not only strengthen their competences and capabilities for competitiveness, but they have to efficiently manage the challenges or risks of each tier as well. The next section will describe the inter-corporate relationships among industrial actors on both the vertical and the horizontal axes.

2.3 Inter-Corporate Relationships on Vertical and Horizontal Axes

The value chain governance of the Thai telecommunications industry is a type of hierarchy[15]. It is characterized by vertical integration. The dominant form of governance is managerial control, flowing from the actors at a higher hierarchical rung to the those on a lower rung. Complexity is high because it is difficult to codify the transactions. The steps of the workflow are known to the key actors in specific detail. The degree of explicit coordination is high. The degree of power asymmetry is also high. As mentioned in the second section, the principle tier has established industry-wide standardization for pertinent work processes. The first-tier contractors have to strictly follow the principle of the workflow. The principle-tier telecoms operators provide the work process manual, as it were: a kind of guideline for work orders and purchase orders to the first tier in the formal agreement between the two. The first-tier contractors have to follow a precise workflow in

[15] There are five types of governance in global value chains: (1) markets, (2) modular, (3) relational, (4) captive and (5) hierarchy (Gereffi, Humphrey and Sturgeon 2005).

every specific step in a rigidly defined process. In a particular transaction, the principle-tier actors will test design services and construction services and approve a certificate in every step until the final stage of project delivery.

In the Thai telecommunications industry, there are four main work process stages: (1) site acquisition, (2) site preparation, (3) site construction, and (4) site operation which will be discussed in the following section. On the vertical axis, the inter-corporate relationship seems to be one of cooperation rather than competition. Regardless of whether the projects are given to the vendor-tier MNCs or the first-tier contractors, all stakeholders have to cooperate with one another to perform their tasks and to ensure the principle tier that they can complete the projects according to quality assurance standards and deliver the projects in a timely manner. However, on the flip side, vertical axis relationships implicitly involve competitive forces, especially from the second-tier subcontracting companies seeking to climb up the chain in pursuit of a first-tier status.

Nevertheless, there are obstacles to this upward push, and the biggest ones concern difficulties in acquiring financial funding and in establishing close connections with the principle tier and the government actors. Also, there is no precedent where the first-tier contractor competitively climbed up the chain to a principle-tier position in the Thai telecommunications industry. The vendor-tier MNCs are like outside actors that create value in the form of telecoms technology. One more important role played by the vendor-tier MNCs in this inter-corporate relationship is that of transferring know-how and technology to the principle tier and the first tier through training and development. For example, Communication System and Solution PLC (CSS), a company belongs to first-tier, has gained the updated technology know-how from participating in the session of training and

development from the vendor-tier MNCs Huawei[16]. Also, NeonWorx Communications (NWC), a company of first-tier contractor, has participated in the seminars held by Communication Asia (Singapore) and Mobile World Congress (Barcelona, Spain) to gain knowledge and understandings on telecoms products and technology, and also market trends[17]. In terms of training and development, the second-tier subcontractors can also support the first-tier contractors—this kind of relationship is known as reverse-back training. For example, when CSS received work orders and purchase orders from the principle-tier telecoms operators, of which the company doesn't have the capability to deal with, such as to install a new kind of telecoms equipment, the company will subcontract the tasks to the second-tier subcontracting companies which are experts in the specific field and thus acquire the know-how from them.

On a horizontal axis, the inter-corporate relationship is naturally one of competition rather than cooperation. Actors in the same field have to compete for market share and profitability. The business strategy of increasing productivity is then the key element. The gain of one player may imply loss for another. A win-win relationship hardly ever occurs on the horizontal axis. However, there are some exceptions to this general rule in the Thai telecommunications industry. Take, for example, CSS which has specialized in the area of civil work currently collaborating with NWC a specialist in the field of telecoms equipment installation, integrated commissioning, and in-building coverage (IBC). The collaboration between these two companies took place so that they could ensure the principle tier of both the high quality and the timely completion of an entire given project. Additionally, the second-tier subcontracting company, J-Siri Co.,Ltd, which is the main subcontracting company of CSS on civil work in Southern Thailand, has collaborated with other

[16] Based on the interview with the CEO of CSS on July 28, 2015.
[17] Based on the interview with the Director of NWC on August 4, 2015.

subcontracting companies on on-site construction projects[18]. The companies shared the projects in order to maintain their own customer base[19]. As with J-Siri, PromtTel Engineering engages in a similar strategy of sharing – and for the same general reasons[20]. PromptTel Engineering, specifically, is the main subcontracting company for NWC regarding telecoms equipment installation, integrated commissioning and IBC in the Bangkok Metropolitan Area.

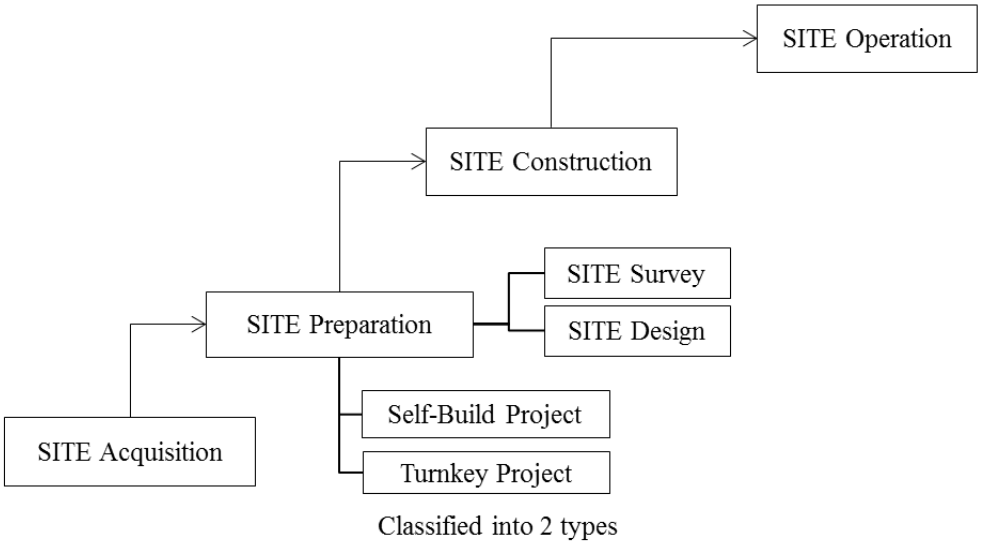
In short, even though the first-tier contractors and the second-tier subcontracting companies are on the same specific tier level, they strike a notable balance between competition and cooperation in their inter-corporate relationship in order to create, maintain, and strengthen the long-run value in the Thai telecommunications industry. After gaining understanding of the key actors within the seven tiers, their value creation opportunities and their inter-corporate relationship on both vertical and horizontal axes in the Thai telecommunications industry, the next section will clarify the workflow of the new sites of telecommunications tower and identify the involvement of actors in each tier.

2.4 Workflow of the New Sites of Telecommunications Tower

As shown in Figure 2-3, the first step in the workflow of the new sites of telecommunications tower begins with the site acquisition, which is mostly performed by the principle-tier telecoms operators either by their own internal employees or external agencies through subcontracting.

[18] Based on the interview with Managing Director of J-Siri Co.,Ltd. on August 26, 2015.
[19] The companies maintained the customer base by not refusing requests for on-site construction projects from the first-tier contractors but by finding diverse ways to perform the requested tasks, for example collaborate with other subcontracting companies, which are working in the same second-tier level. After all, the actors that make up the second-tier subcontracting companies are the actors most susceptible to the cycles of the telecommunications industry. The cycles characteristic of the Thai telecommunications industry tends to have peaks of 3-4 years and silent periods of 1-2 years. Incidentally, the strongest impact of the industry cycle on the key actors has generally occurred in the second-tier level.
[20] Based on the interview with Managing Director of PrompTel Engineering on August 5, 2015.

Figure 2-3: Workflow of the New Sites of Telecommunications Tower



Source: Created by author based on the interviews and internal documents.

Following the government's zoning policy to develop telecommunications tower, all areas are acquired by renting. RF planners who are responsible at this stage have to measure the standard of latitude and longitude in each rental area before moving to the second step of site preparation. The step of site preparation can be further broken down into the two smaller steps of site survey and site design. In this step, either the vendor-tier MNCs or the first-tier contractors are responsible for getting the projects from the principle-tier telecoms operators. Also, there are two types of the projects. One is the turnkey project and the other type is the self-build project. The turnkey project is the whole telecoms project which either the first-tier contractors or the vendor-tier MNCs get from the principle tier. Then the first-tier contractors or the vendor-tier MNCs will decompose the scope of work and subcontract specific tasks to the relevant actors. Upon reaching the time of quality assurance, all relevant actors come together in order to perform the technical tests and approve the certificates issued by the principle tier before delivering the projects.

For the self-build project, the scope of work will be initially divided into specific tasks by the principle tier which will make each formal agreement with each contracting actor. The price of the self-build project is relatively lower compared to the price of the turnkey project. However, the principle tier has to compensate this with longer spans of time and larger amounts of deals. The third step is site construction, which is mainly involved in civil work, telecoms equipment installation, integrated commissioning and IBC as mentioned earlier in the second and third sections. In this step, a large number of the second-tier subcontracting companies and the third-tier subcontracting teams mainly get involved whereas the first-tier contractors act as supervisors of the projects. The final step is site implementation which is mainly performed by the first-tier telecoms operators. Since the work process of telecommunications tower helps clarify the involvement of actors in each tier in the Thai telecommunications industry and relates to the analysis of human resource management in Chapter 5, the following sub-sections will explain the work process on site preparation, site construction and site implementation, highlight the important tasks and identify the involvement of actors in each tier in more detail.

2.4.1 Site Preparation: The Main Tasks Performed by CSS and its Second-tier Subcontractors

After the principle-tier telecoms operators have completely performed the step of site acquisition (rental area to construct the mobile phone stations), the first-tier contractors will begin the work process from the second step or site preparation including site survey and site design service as the basis for the third step or site construction of mobile phone stations. In the site preparation step, the principle-tier telecoms operators will provide the principle handbook in accordance with the legal agreement with the first-tier contractors. The contents

of this handbook comprise (1) the responsibility matrix, (2) implementation plan, (3) scope of work and technical requirements, (4) bill of quantities and unit price, and also (5) the construction and implementation handbook. However, in the implementation process, the real transactions between the two companies strictly focus on specific purchase orders and work orders in the scope of work and technical requirements. The principle tier issues several purchase orders and assigns work orders in accordance with the agreement terms with the first-tier contractors. The work order documents are provided with the particular details of the work under such relevant specified purchase orders for the first-tier contractors to strictly perform. Take the site preparation for telecoms tower construction as an example, the first-tier contractor initially conducts the field work of the site survey before it can start the process of site design service[21]. The first-tier contractor has to submit the documents of the design services (the so-called DE-DOCUMENTS) to the principle tier in order to get initial approval and the process of design service will begin following the first-tier contractor getting the approval of the DE-DOCUMENTS for new sites of telecommunications tower. The next step is to submit the principle-tier telecoms operators with the final bill of quantities specifying the details of the actual quantities and unit prices of the design services for that new site (in legal term, DE-FBOQ) in order to get approval from the principle tier. Then the principle tier performs the design acceptance test (DE-AT) for the design service for that new site. In the case of disapproval, the sequences of the procedure are re-run. However, if the principle tier does give approval, the principle tier will sign to approve the design works acceptance certificate (DE-SAC) for the design services in order for the first-tier contractor to continue to the construction services in the third step of the workflow which will be explained as follows.

[21] Based on the interview with the CEO of CSS on July 28, 2015, the first-tier contractor has to take approximately 150-200 photos for this site survey and hold meeting an average of six times before the process of design service can be started.

2.4.2 Site Construction (Main Tasks Performed by CSS and its Second-tier Subcontractors)

For the site construction of telecommunications tower, the first-tier contractor has to begin by providing the principle-tier telecoms operators with the documents for the construction services (C-DOCUMENTS) and get the approval from the principle tier before the process of site construction can begin. Then, after getting approval, the first-tier contractor has to submit the construction plan bill of quantities, which specify the details of the planned quantities and unit prices of the construction services for the new site of the telecommunications tower (C-Plan BOQ) and then the principle tier will ready the site for the install acceptance test (Site Ready for Install-AT) for that new site. In the case that the principle tier disapproves the C-Plan BOQ, the first-tier contractor has to submit the revised C-Plan BOQ again and again until receiving the formal approval. If the first-tier contractor can pass the Site Ready for Install-AT and the C-Plan BOQ and get formal approval from the principle tier, the principle tier will then sign its approval of the site ready for install certificate (Site Ready for Install Certificate (A58)). However, the process of the site construction in the field-work has not yet been started. The first-tier contractor and its second-tier subcontracting companies are required to pass several steps of tests in order to get approval and the certificates, which are performed and provided by the principle-tier telecoms operators.

To illustrate, after getting approval for both the Site Ready for Install Certificate and the final bill of quantities (C-FBOQ) (specifying the details of the actual quantities and unit prices of the construction services), then the principle tier will perform the construction provisional acceptance test (C-PAT) for the construction services for that new site. In the

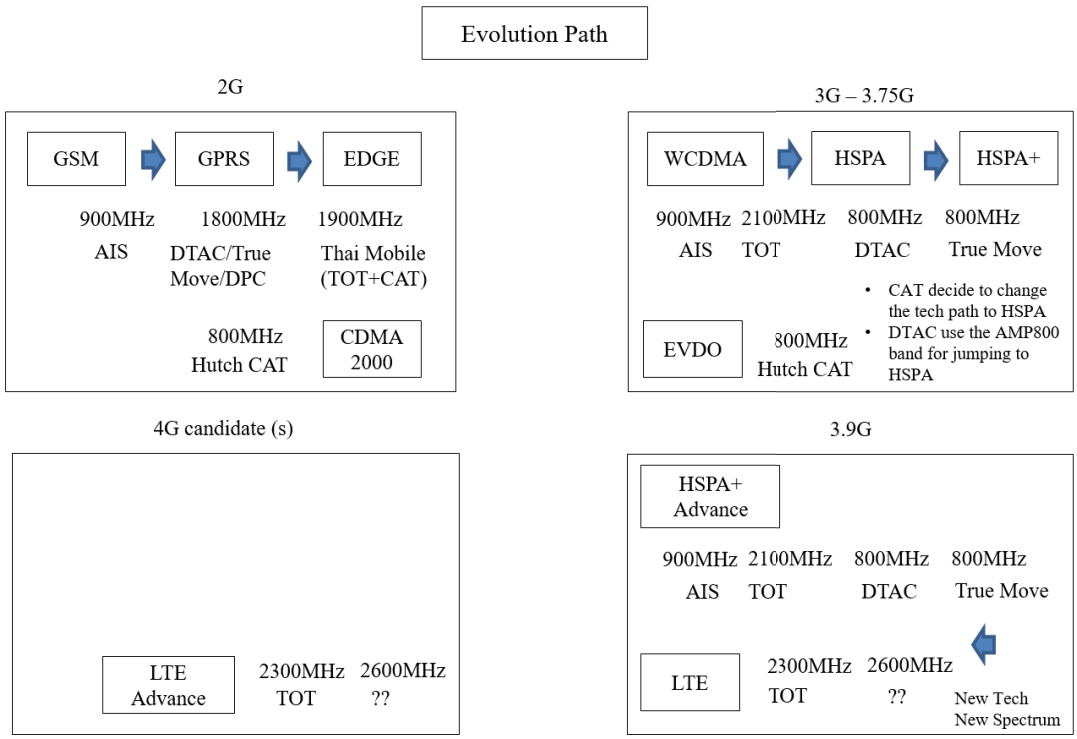
case of the construction services for the new site passing the construction provisional acceptance test (C-PAT) and the final bill of quantities (C-FBOQ), the next step is that the principle tier will sign approval for the construction provisional acceptance certificate (MS-95) (C-PAC). Following the approval of the C-PAC by the principle tier, the principle tier will perform the construction final acceptance test (C-FAT) for the construction services for that new site. If the C-FAT or the construction final acceptance test passes, again, the principle tier will sign its approval of the construction final acceptance certificate (C-FAC) for the construction services for the new site. At this step of getting approval from the principle tier regarding the C-FAC, the work process in the real construction site can actually be started. As shown in Table 2-3, the core capabilities of the first-tier contractors and the second-tier subcontracting companies include the capabilities to strictly perform and pass the tests and certificates of the principle tier's standards for example, C-FBOQ, C-PAT, C-PAC, and C-FAC. The step-by-step work process in the site construction explained above helps confirm the importance of strategic standardization which all industrial actors in the Thai telecommunications industry are required to follow.

2.4.3 Site Implementation: Process of the RF Planning of the LTE Radio Access Network (RAN)

In the context of mobile and cellular communication systems, RF planning is the process of assigning radio frequencies, transmitter locations and the parameters of a wireless communications system in order to provide sufficient coverage and capacity for the services required (e.g. mobile telephony). The RF plan of a cellular communication system involves two main objectives: coverage and capacity. Coverage relates to the geographical footprint within the system that has sufficient RF signal strength to provide for a call and data session. Capacity relates to the capability of the system to sustain a given number of subscribers. As

shown in Figure 2-4, the capacity and coverage of the RF or mobile spectrum are interrelated and shared by the principle-tier telecoms operators of AIS, DTAC, True Move and also the government-linked companies such as TOT and CAT. To improve the quality of coverage, the aspect of capacity has to be sacrificed. At the same time, to improve the capacity some aspects of coverage have to be sacrificed. Also, the coverage and capacity of mobile cellular services provided in the Thai telecommunications industry has concerned the evolution of mobile technology, which is currently at 4GLTE and the mobile technology has continually been improving.

Figure 2-4: Evolution Path of Mobile Spectrum in the Thai Telecommunications Industry



Source: Jedsada (2012).

The LTE RF planning process mainly consists of the following four phases: Phase 1: Initial RF Link Budget, Phase 2: Detailed RF Propagation Modeling, Phase 3: Fine Tuning and Optimization, and Phase 4: Continuous Optimization. Even though the site implementation has been chiefly performed by the principle-tier telecoms operators, the step of RF Planning requires collaboration with actors from other tiers especially first-tier contractors and second-tier subcontractors. The RF planner will be dispatched from the principle-tier telecoms operator in order to coordinate the telecommunication site with the first-tier contractors and second-tier subcontractors in terms of identifying the latitude and longitude to set up base-transceiver stations.

2.5 Conclusion

In conclusion, this chapter identified the industrial organization, the value creation opportunities and the inter-corporate relationships of actors on each tier of the Thai telecommunications industry. The Thai telecommunications industry operates within the context of pyramid-shaped industrial organization and hierarchical governance structure. Industrial actors in each tier perform specific tasks and create specific value along the chain of the hierarchy. The industrial structure characterizes a dominant managerial control over the telecommunications system; wherein the degree of explicit coordination is high and also the degree of power asymmetry is high.

The top position is dominated by a few powerful incumbents including NBTC and the big-three telecoms operators. Moving down the Thai telecommunications industry's pyramidal organization, one discovers that the number of actors grows significantly. The economic value of tasks reflects the underlying core competences and core capabilities which are the fundamental source of competitiveness in the Thai telecommunications industry. The vendor-tier positions are at the core of innovation in global telecoms technology. The

regulator-tier NBTC sits atop the Thai telecoms industry and plays an important role in regulating and allocating the RF spectrum. The principle-tier telecoms operators and the first, second, and third-tier actors carry out complementary functions within the Thai telecommunications industry. These various actors across all tiers have to evolve roughly at the same pace (for example, a pace consistent with telecoms' technological development) while the supplier-tier actors carry out supplementary functions geared towards the supply of telecoms equipment and materials.

This pyramid-shaped industrial organization and hierarchical governance structure can be seen as sources of substantial growth and competitiveness in the Thai telecommunications industry. Also, the strength of this assertion is rooted in the fact that each tier comprises actors which perform specific tasks and create specific value according to each tier's functional specialization. The industry's coordination-rich organization capability ensures the presence of two important components: first, that a system of checks and balances is in place along the chain of command especially through the strict processes of workflow during the site preparation, site construction and site implementation, and second, that each particular transaction between the principle-tier telecoms operators, the first, second, and third-tier actors are efficient and accurate especially as concerns the written purchase orders and work orders in the formal agreement. The next chapter concerns corporate strategy by addressing the choices of core capabilities actors in each tier choose to strengthen and sustain their competitiveness in the Thai telecommunications industry.

Chapter 3

Corporate Strategy: Choices of Core Capability to Sustain Competitiveness

"Companies can gain a competitive advantage by building foundational capabilities, therefore, companies need to be more deliberate in understanding which capabilities impact their business performance".

McKinsey Global Institute 2011

Introduction

As discussed in Chapter 2, companies can gain a competitive advantage by building foundational competences, in which a core competence is a set of integrated skills and technologies that enables a company to provide a particular value or benefit to the customers. It is the root of companies' competitiveness and the source of fundamental growth (Hamel and Prahalad 1996 and Accenture 2015a). Indeed, competence is accumulatively based on capability, which is defined as resource leverage for the benefit of business performance[22] (Fukushima and Yamaguchi 2009).

Companies' capabilities reside in two places. The first is in its process which is the methods by which people have learned to transform the inputs of labour, energy, materials, information, cash and technology into outputs of higher value. The second is in the company's values, which are the criteria that the company use when making prioritization decisions (Christensen 2000). These processes and value are interrelated in a sense that value is created through internal business processes (value-creating processes) with the aims to (1)

[22] Leverage is defined as the influence or power used to achieve a desired result, or the increase in force gained by using a lever (http://www.merriam-webster.com/dictionary/leverage). To achieve resource leveraging, companies must accumulate and orchestrate their own resources and multiply their resources' effectiveness (Hamel and Prahalad 1996).

increase shareholder value through revenue growth and productivity improvement and to (2) increase the company's share of customer spending through customer acquisition, satisfaction, retention, loyalty and growth (Kaplan and Norton 2004, pp. 7-9).

In other words, a company has to choose and focus on a few critical internal processes that deliver differentiating value propositions and that are most critical for enhancing productivity and maintaining the company's franchise to operate through making prioritization choices (Kaplan and Norton 2004, pp.12-14). Therefore, the company needs to develop real strategies that create economic value, which will ultimately determine the company's success (Porter 2001). Corporate strategy, which is the focus of this chapter, refers to an integrated set of choices that uniquely positions the company in each industry to create competitive advantage and superior value relative to the competition. Strategy (what the company intends to do) must be connected with the capability (what the company is able to do). Nevertheless, companies cannot assume that strategy and capability will come together automatically. On the contrary, they have to make the effort to pull them in sync and continuously calibrate them over time (Hout and Carter 1995).

The objective of this chapter is to explore the corporate strategy of case study's companies in each tier, namely, the principle-tier telecoms operator, the first-tier contractor, and the second-tier subcontractor. This chapter comprises six sections. The first section describes the concept of strategy applied in this chapter. The second section discusses the strategy of the principle-tier telecoms operators on operational excellency on mobile network expansion and network quality in broadening coverage and deepening capacity. The third section identifies the strategy of the first-tier contractor, which focuses on the operational excellency in telecoms engineering especially roll-out telecoms projects according to the

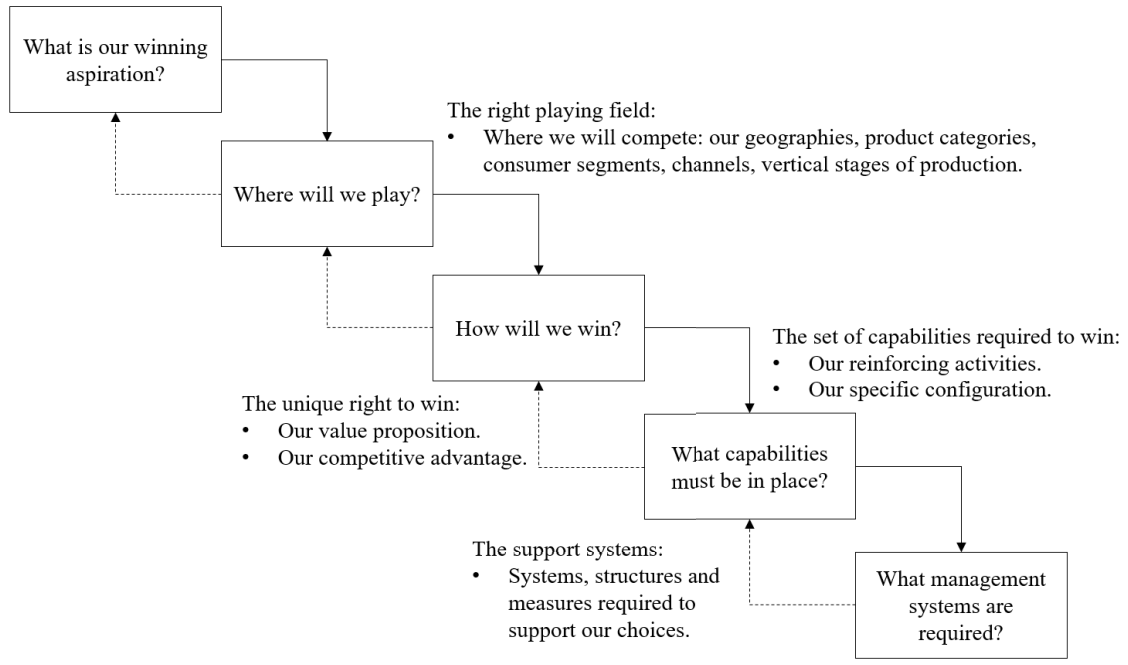
principle-tier standards and quality assurance. The fourth section clarifies the strategy of the second-tier subcontractor, which is also operational excellency in telecoms engineering particularly roll-out telecoms projects according to the principle and the first-tier standards. The fifth section compares and discusses the different aspects of the strategies applied by the aforementioned three tiers case study companies. The final section provides the concluding remarks.

3.1 Strategy: Choice of Core Capability to Strengthen and Sustain Competitiveness

The concept of strategy has existed as a discipline over a long time. Its definition varies greatly due to the diverse schools of thought with each having its own focus of attention[23] (Mintzberg, Ahlstrand, and Lampel 1998). However, for the sake of simplicity, this chapter follows the definition of strategy as proposed by Michael Porter. That is, strategy is a choice, and it is the choice to win. Strategy concerns selecting the set of activities in which the company can best perform to create a sustainable difference of value creation in the marketplace (Porter 2001). Figure 3-1 shows the conceptual framework on strategy (Lafley and Martin 2013). Specifically, strategy helps companies to acquire a refined vision of coherent value creation (Zenger 2013) and to consistently build the right core capabilities by initially answering the following five interrelated questions: (1) What is your winning aspiration? (2) Where will you play? (3) How will you win? (4) What core capabilities must be in place? (5) What management systems (operational process and technology) are required?

[23] These ten schools of thought are: (1) the design school: strategy formation as a process of conception, (2) the planning school: strategy formation as a formal process, (3) the positioning school: strategy formation as an analytical process, (4) the entrepreneurial school: strategy formation as a visionary process, (5) the cognitive school: strategy formation as a mental process, (6) the learning school: strategy formation as an emergent process, (7) the power school: strategy formation as a process of negotiation, (8) the cultural school: strategy formation as a collective process, (9) the environmental school: strategy formation as a reactive process, (10) the configuration school: strategy formation as a process of transformation.

Figure 3-1: Strategy: An Integrated Cascade of Choices



Source: Lafley and Martin (2013).

To begin with, as concerns winning aspirations, a company must seek to win in a particular place and in a particular way. Aspirations are visionary statements about the ideal future, which must be tied with some specific benchmarks that measure progress toward them. This set of aspirations helps enable the company to see meaningful purpose in what the company is doing and serves as a starting point to define where to play and how to win. Indeed, these are the two most critical questions in strategy formulation. The successful execution of a strategy requires three components: describe the strategy, measure the strategy and manage the strategy (Kaplan and Norton 2004). While the winning aspiration broadly defines the scope of the company's activities, questions concerning where to play and how to win describe the specific activities, for example, what the company will do, and where and how it will do this in order to achieve its aspirations. In other words, if "where to play" comprises the right context and playing field in terms of, say, geographies, product categories,

consumer segments, channels, and vertical stages of production, "how-to-win" describes the choices of the set of capabilities, such as the reinforcing activities or the specific components in order to win on that selected field. In other words, to determine how to win, a company must decide on which capabilities help uniquely create value and sustainably deliver that value to the targeted customers in a way that is distinct from the company's competitors. Michael Porter termed this "competitive advantage". This competitive advantage is the specific way in which a company utilizes its advantage in order to create superior value for the company's targeted customers and, in turn, superior returns for the company.

Capabilities are intangible knowledge-based assets beset in the company's human capital, information resources and reinforcing activities (Kaplan and Norton 2004). Specifically, the organized human capabilities such as knowledge, skill, experience and teamwork are essential to unleash the potential of technological processes, which will be the subject of discussion in Chapter 5 (Teece 2010). The companies are required to accumulate and orchestrate these intangible knowledge-based assets including other resources and multiply the resources' effectiveness to reach breakthrough results (Hamel and Prahalad 1996).

The last element in this framework is the management systems. Management systems are the systems, structures and measures that foster, support and measure the strategy. They relate to the activities which perform certain functions to obtain the effective acquisition, allocation and utilization of the companies' internal resources in order to accomplish the selected strategic goals (Wren 1979). These management systems must be purposefully designed to support the choices and capabilities and to ensure that these choices are communicated to the whole company.

In brief, a company's strategy is a choice, reflecting a winning aspiration on how it intends to create value for both shareholders and customers and also to strengthen and sustain competitiveness. To make a decision on the choices, the company needs to ask the five interrelated questions concerning the aspirational purpose, the particular place (context), the particular way, the core capabilities and the management systems fostering and supporting the company's strategy or selected choices. The next three sections will clarify the strategy of case study's companies in the following three tiers: the principle-tier DTAC, the first-tier CSS and the second-tier J-Siri.

3.2 The Principle-Tier Telecoms Operators' Strategy on Network Expansion and Network Quality: The Case of DTAC

The core value proposition of DTAC is to provide the best quality mobile network services to end-users. Positioning itself as a principle-tier telecoms operator, the corporate strategy of DTAC is on of "operational excellence on network expansion and network quality". The company aims to broaden the coverage and deepen the capacity of its mobile network. The operational highlight was in the year 2013, a year of major transformation for the Thai telecommunications industry with the commencement of the 3G2.1 GHz network. DTAC has made a choice to rebrand its mobile network as TriNet, signifying the tri-brand capabilities of the three combined frequency networks including 2G1800 MHz, 3G850 MHz and 3G2.1 GHz to deliver excellent experience to customers especially in the area of data usage and mobile content. The company has invested 12.5 billion Thai baht (approximately 341 million US dollars) with the intention to increase the number of 3G2.1 GHz base stations to approximately 5,000 in the year 2013, thus raising the company's total 3G base stations to more than 10,000, which doubled (Budde 2014). DTAC has also formed a new team and

partnered with a large number of vendors and subcontractors to focus specifically on tuning the multi-vendor network environment and mobility parameters for these three combined frequency networks in order to ensure customers get the best network quality (DTAC 2013).

The company chooses and focuses on a few core capabilities, particularly on data usage and mobile content including voice usage, data usage, mobile financial services, content application, mobile network operator and mobile internet users. In particular, a new high-potential growth area has been that of mobile content in the so-called digital economy. Therefore, the company has actively created three special business fronts responding to the needs of the digital content industry: (1) music industry (Deezer), (2) TV/Movie industry (Watchever) and (3) Publishing industry (Readever) respectively (Ibid., 2013).

In addition, the billing system and marketing function (promotion, campaign, branding) are other important capabilities that could attract a large number of subscribers. On the marketing front, three achievements resulting from the corporate strategy mentioned above should be highlighted. Firstly, DTAC became a market leader in postpaid with the highest net additional subscribers among the big-three telecoms operators. Secondly, DTAC has reached the milestone of one million devices sold, largely due to the introduction of DTAC TriNet phones and the expansion of sales channels online. Lastly, the highly successful customer relations management (CRM) campaign of “the longer you stay, the more love we have” was widely accepted by customers as measured by the indicator of smartphone penetration in the DTAC network which has increased (the Thailand mobile penetration rate was 135 percent of the total number of population in 2013).

On the network front, DTAC has continued to aggressively rollout the new sites of its telecoms towers with nearly 6,000 base stations of 3G 2.1 GHz in 77 provinces across the

country of which around 2,000 sites were in Bangkok and the metropolitan areas. By the end of 2013, DTAC achieved 55 per cent of 3G2.1 GHz population coverage and 80 per cent of coverage by the end of 2015. DTAC also aims to upgrade all existing base stations in order to consistently allow for a better 3G2.1 GHz coverage experience. Approximately 300 million baht was invested to sustain the power source of telecoms base stations throughout the country. Also, the company has regularly conducted drive tests of the mobile network to ensure the company's mobile network quality. Specifically, the improvement of TriNet resiliency was one of DTAC key activities in aligning with the strategy of operational excellence on network expansion and network quality.

Concerning business intelligence and customer insights, DTAC focused on turning insights into actions in order to build strong foundations on specific value creation, especially the provision of mobile cellular services, for its customers. Key decisions were made with support from the facts and figures generated from the business intelligence (BI), which allows management to make well informed decisions in a timely manner[24]. BI also play key parts in enabling the execution of key initiatives related to "Internet for All" and "Loved by Customers" activities which support the strategy of operational excellency.

Additionally, DTAC placed much importance on building the capabilities of their human resources, as reflected by the establishment of the DTAC academy, aiming to develop DTAC human resources through the edutainment (education + entertainment) learning style. In 2013, DTAC academy has delivered 1,200 programs to over 5,500 participants. As mentioned before, the choices which the principle-tier telecoms operators made are concern "operational excellence on network expansion and network quality". The company aims to

[24] BI is one of internal divisions of the company comprising three functions: extract, transform and load (ETL) data for the sake of business profitability and progression (http://www.jba.tbs.tu.ac.th/files/Jba137/Column/JBA137SrisomrukC.pdf).

provide a variety of mobile services to customers on all fronts including voice usage, data usage, mobile financial services, content application, mobile network operation and mobile internet. In other words, the principle-tier telecoms operator draws its scope within the site implementation stage, and leverages the scope of work on the site preparation and the site construction stages to the first-tier contractors and the second and the third tier subcontractors as shown in Figure 2-3 in Chapter 2. The next section discusses the corporate strategy of the first-tier contractors, which have chosen the strategy of operational excellency on telecoms engineering, particularly on roll-out telecoms projects according to the principle-tier standards.

3.3 The First-Tier Contractors' Strategies on Operational Excellency on Telecoms Engineering and Quality Assurance: The Case of CSS

Thanks to constant upgrading of mobile signal transmission by the big-three telecoms operators, the first-tier contractors have consistently gained business opportunities in developing new sites, upgrade sites, telecoms equipment installation and also integrated commissioning through the roll-out telecoms projects. The first-tier campany in case study, namely, Communication and System Solution Public Company Limited (hereafter referred to as CSS) was founded on 25 January 1994, with the initial objective of distributing and installing passive fire protection materials and equipment for high buildings and factories. The first focus of the business model is to deal and distribute, or being the distributor of the electrical wires of various types and other electrical systems equipment from leading international manufacturers such as general cables for use in buildings and factories, internal and external lighting, transformers, conduits and materials and equipment related to passive fire protection. Then, in 1999, CSS began to move into new areas of business in the

telecommunications industry added to the new business model so as to derive demand, design, develop and deliver. The company offer design, procurement and installation services through the roll-out, upgrade and also maintenance of telecommunications systems. During the incubation period, the company adopted the strategy of entering into a strategic partnership (joint venture) with Downer (Australia) Co., Ltd in 2002 in order to design and build networks for mobile telephone signals in various projects. During the initial stages, CSS gained technology, knowledge and expertise transfer from Downer (Australia) Co.,Ltd. However, in 2008, the joint venture between the two companies ceased operation. Since then, CSS has to be responsible for new telecommunications tower sites on its own.

However, in 2015, during the expansion of the telecommunications business area, the company made a joint venture with Neon Work Communication Co., Ltd. (hereafter referred to as NWC) (via 70 per cent of stock share) with the objective to increase the channels of telecommunications markets, expand the new base of customers, enhance the capacity of competition and elevate the stability of the company over the long run. In other words, it was a strategy of expansion by building a strategic partnership with NWC which specializes in an area of telecommunications equipment installation (integrated commissioning). As seen from Table 3-1, CSS is successful and specializes in civil work, or site preparation and site construction accounting for 75 percent of revenue in one project (both self-build project and turnkey project). NWC has successfully specialized in telecommunications equipment installation, particularly In-Building Coverage (IBC) and integrated commissioning accounting for 25 percent of revenue in one project[25]. When the two companies formed a strategic partnership with each other, this kind of strategy helps strengthen the core capabilities, diffuse know-how, transfer technology as well as ensure the completion of the

[25] In-Building Coverage (IBC) is the system for enabling the coverage and capacity of mobile phone signaling in the time of use in indoor buildings (www.mcf.amta.org.au/files/In.Building.Coverage.pdf).

projects following quality assurance and in a timely manner. As regards CSS in the area of telecommunications system design and development over the course of several years, the telecommunications industry has substantially and continuously been growing, together with changes in technology and consumer behaviour. The company first recognized the opportunities for the installation of telecommunications towers in 1999. Currently, the company provides the design, purchasing and installation services of the telecommunications system, both mobile telephone signal systems and complete basic telephone systems, through a professional team of engineers with over 10 years of experience. When taking on a telecommunications tower development project, the company will study and design a steel-framed tower, using one of several designs through a computer program that allows changes to be made to the proportions, forms, height and weight of the mast (antenna) in order to meet the customers' requirement and for the efficient transmission of mobile signals. The company also then produces a design ready for the telecommunications equipment such as the signal transmission systems of different mobile phone operators, power systems and electric wiring systems. The next strategy is networking with the second-tier subcontracting companies on a long-term basis. The company will hire a subcontractor to prepare the construction area, lay the foundations, construct the steel frame and install the telecommunications equipment, with the company`s engineers supervising construction, connecting the signal and testing whether the quality of the work meets the customer's specifications or not. After the step of quality assurance from the company project supervisor, the last stage is to deliver the complete project to the customers according to the due schedule. In addition, the company provides after-sale services with a one-year warranty period to ensure customer satisfaction and confidence in the quality of work.

Table 3-1: CSS and NWC Strategic Partnership

Agenda	CSS	NWC
1. Status of Company	Public Limited Company (also listed in SET)	Company Limited
2. Size of Company	440 employees (Department of Telecoms Engineering Services: 66 persons)	70 employees (Department of Telecoms Engineering Services: 15 persons)
3. Kind of Business (in ICT Directory)	Main: Commerce Sub: Telecommunications	Main: Telecommunications
4. Revenue (million baht)	Approximately 6,000.	Approximately 2,000
5. Segmentation of Clients	Main: TRUE, DTAC and Key Vendors inc. Alcatel, Huawei, ZTE, Nokia and Siemens	Main: AIS and CLMV regions (since NWC subsidiary branches are also locating in CLMV, SE Asia)
6. Area of Expertise	Civil Work (Site Preparation, Site Construction), account for 75% of revenue in one telecommunications tower project	Telecommunications equipment installation, particularly In-Building coverage (IBC) and integrated commissioning, accounting for 25% of revenue in one project
7. Awards (Certificates)	ISO 9001:2008 accreditation for the management of telecommunications systems installations from United Registrar of Systems (Thailand) Co.,Ltd.	None
8. Operational Excellence	Internal systematic execellence on HR/Account certified by SET	Top management team gaining expertise and experience from MNC: AlanDick Communications Ltd.
9. Strengths	Financial Fund (Working Capital)	Market expansion in SE Asia (via a network of company branches)

Source: Created by author based on interviews.

The company directly works with main customers especially the principle-tier telecoms operators through the project-based contract and also is indirectly hired from hands-on contractors through vendor-tier MNCs. The characteristics of the telecommunications towers installed cover the following types: (1) self-supporting tower, (2) guyed mast tower and (3) pole. The company has established a good reputation in the installation of telecommunications towers in terms of the quality of the materials and products meeting the specifications and work being completed on schedule. This is reflected by their continuous

work on large projects directly from the big-three telecoms operators and hands-on indirectly from the main vendors, for example Huawei, ZTE, Alcatel, Nokia, Siemens and so on. Competition in the installation of telecommunications towers depends primarily on the policies of the mobile service providers (the big-three) towards investment and signal network development, which is in turn influenced by government policy. However, even though mobile service providers may assign companies from their own group to carry out installation and renovation of telecommunications towers, the increasing volume of work and the need for speed and completion of the work on schedule means that the mobile service providers have to subcontract outside companies to carry out this work. Opportunities of getting work from the operators for the design, purchasing or installation of telecommunications systems (work orders and purchase orders) depends on the relationship with the owner of the network, experience and past results, the ability to provide a quality service and meet deadlines and a strong financial status. The key elements in the relationship are trustworthiness and transparency. In addition, since the company is an independent operator, it is able to accept installation projects from every mobile service provider. It is normal practice for the employer to set a price for the work, leaving the contractor's profit up to their bargaining power when trying to purchase materials and telecommunications equipment at favorable prices and conditions. Based on the interviews, the projects from AIS had the lowest profit margins since AIS provides strict orders (both in terms of work orders and purchase orders) for the first-tier contractors on suppliers (materials) to use. However, the responsibilties of project delay and product quality are on AIS's shoulder. DTAC, with its European management style, is in between since it provides a package for the first-tier contractor to choose and operate on its own. The responsibilty for any delays or shortcomings lie with the first-tier contractor itself. True Move provides the greatest freedom and the

largest profit margin, for the first-tier contractor to choose at will every factor including the suppliers of materials, the subcontracting companies and so on. However, with reference to the written agreement, the strict and specific penalties for the delay of project delivery as well as quality assurance are specified and the first-tier contractors are fully accountable.

Therefore, the first-tier contractor, CSS, realizes the importance of risk management as a systematic and effective risk control. The risk in this tier is classified into three parts: (1) risk from business operation, (2) financial risks, and (3) other risks. In terms of risks in the design, procurement and installation of communication systems, this concerns mainly those from inconsistent revenue delivered from projects: the company's services of designing and installing communication systems is to render activity in the form of short-term projects, without the agreement of a long term contract. Therefore, the income derived from such projects is inconsistent and considered unstable income over the long-term future. Nevertheless, the company is independent from the owners of telecommunications or mobile networks operators but have to maintain good relationships and gain expertise and knowledge from the principle-tier telecoms operators and the vendor-tier MNCs.

Next, concerning risks from delays in project completion, the design, procurement and installation of telecommunication systems usually involve projects with durations of between three months to one year (see appendix 3-A: CSS Project-Based Contracts). In some projects, the delay in project completion is subjected to indemnification. Late project completion may result in higher costs of production to the company as well as exposure to the risk of being charged for such delays. To prevent the risk of delay in project completion, the company has imposed an advanced plan by coordinating with related parties such as suppliers, sub-contractors, and engineers from the customers, as well as, closely following-up and

monitoring the product delivery and installation tasks and allocating proper personnel to handle the quantity of work. The regular following up work procedures allow the company to address the problems and execute quick solutions and deliver projects within specified time frame. So far, the company has no records of delays in project delivery or being subject to claims for damages concerning such delays.

Lastly, there exist risks from the dependency on the core engineers. To undertake, proceed and complete the project with the scheduled time-frame, the company requires personnel with expertise and experience and competent skills, especially engineers whose duties cover design, work control and management until completion. Engineer duties and work performance have direct impact on the costs of production, duration and customers' requirements. Therefore, losing these engineer teams may affect the availability to undertake work as well as the capacity of managing projects. With awareness of the importance of personnel which is considered as being at the core of business operations, the company emphasizes improving the loyalty of its employees by setting appropriate salary rates and compensation rates, provisions of welfare and incentives to maintain employee dedication to the organization over the long term. In addition, the company provides training courses and seminars to its employees on a regular basis with the aims to: (1) develop the technical knowledge and skills and to manage the appropriate positions, (2) enhance the competitiveness of the company and to decentralize the management authority to reduce dependency on individual personnel. That's why the company has major engineers with competent expertise and who have been working with the company for more than ten years in the design and installation of telecommunications systems. Indeed, during the past ten years, only one engineer has resigned from the company from the total of thirty-six engineers on board.

In conclusion, utilizing the same strategy as DTAC in the principle tier and through emphasis on "choose and focus on the core (capabilities), leverage (subcontracting or outsourcing) and to manage the long-term relationship", the first-tier contractor CSS also maintains its own core capabilities of (1) deriving demand by adopting an active and aggressive policy to get large projects on a continual basis, (2) designing the telecommunications towers (in this area of expertise, based on the interviews, the internal core group of personnel is CAD-CAM). However, in a peak period, the company may outsource this scope of work to the architecture company which can design as well as certify the completed design for the telecommunications tower), (3) developing the scope of work on site preparation and site construction by utilizing only a few core engineers to coodinate and supervise the project with the subcontracting companies in the lower tier, and (4) delivering the project requiring many steps to perform tests and approving the certifications (PAT,FAT-PAC-FAC, as mentioned in Chapter 2).

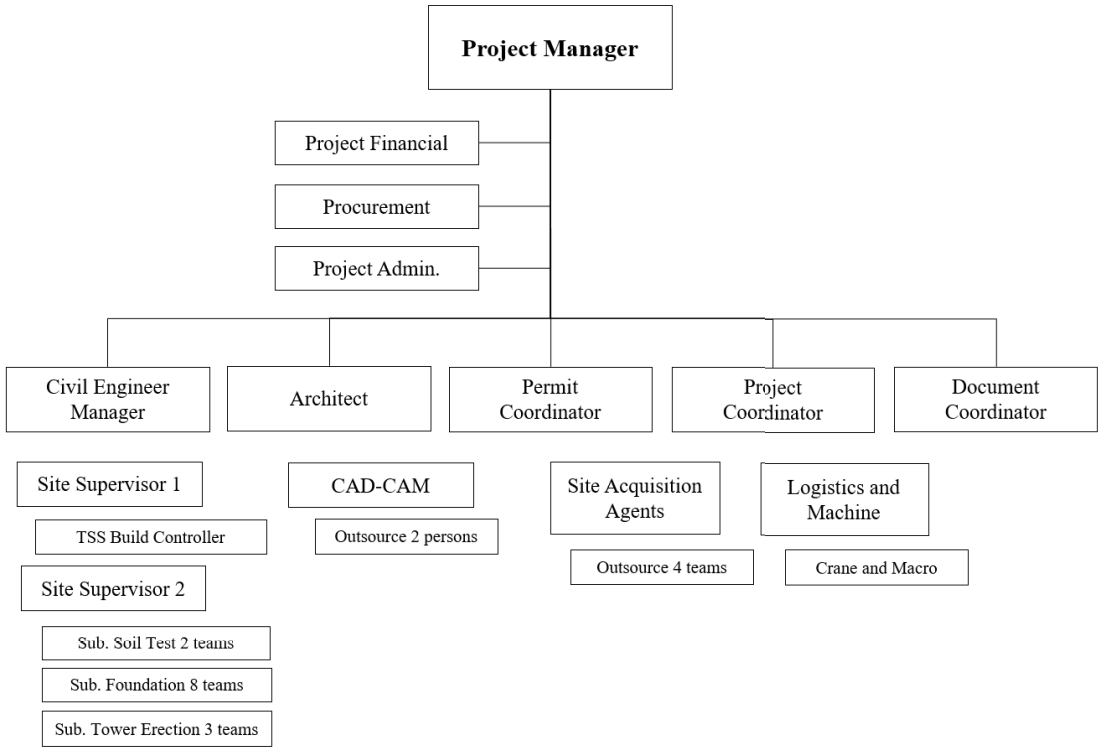
With a limited number of core personnel, a scope of organizational core capabilities as well as a serious time schedule to deliver projects (from appendix 3-A: CSS Project-Based Contracts, we can see that the period for the large projects is short-term and strict), another important strategy for the first-tier contractors is to leverage by subcontracting or outsourcing the non-core capabilities to the lower-tier subcontractors, and also strategic partnerships with other companies, such as Downer CSS, and NWC.

3.4 The Second-Tier Subcontractor's Strategy on Operational Excellency on Telecoms Engineering and Specialization: The Case of J-Siri

J-Siri Co.,Ltd, the second-tier subcontractor, provides main business services regarding communication and system solutions, civil engineering design, construction

management and real estate management. This company is a subcontracting company of the first-tier contractor, CSS with which it has a long-term relationship also based on trustworthiness and transparency. Figure 3-2 shows the organization chart of J-Siri Co.,Ltd. The owner of the company is at the top position as project manager. The main business units comprise two units: civil engineer and architect. Also, there are three supporting units of permit coordinator (for the site acquisition), project coordinator and also document coordinator. There are ten individuals employed in the company. However, the most important engine for constructing the telecoms tower projects is the network of relationships with subcontracting teams in each area of expertise including the TSS building controller, soil test, tower foundation, tower erection, site acquisition, crane and macro for logistics and machines.

Figure 3-2: J-Siri Organization Chart



Source: J-Siri.

The company's permanent employees have been employed as a civil engineer manager, architect CAD-CAM, project coordinator, site acquisition permit coordinator, and also document coordinator. To illustrate, the permanent employees who form the core group of J-Siri Co.,Ltd comprise two civil engineers, one architect, two site acquisition coordinators, one project coordinator, one document controller, one permit coordinator, and one project financial officer. The third-tier subcontracting teams which have a long-term relationship with J-Siri Co.,Ltd are composed of (1) foundation platform eight teams (one team comprises between six and seven persons), (2) tower erection three teams (one team comprises of between six and seven persons), and (3) twenty real estate construction professionals. The machines, materials and vehicles necessary to perform the work of J-Siri Co.,Ltd, are: (1) a boom truck six-wheel crane for transporting the tower, (2) a back hoe (for digging the soil), (3) three cars, (4) two pick-up trucks, (5) two engineering cameras to measure the vertical height of the towers, (6) electricity power supply generators, (7) water pumps and (8) the relevant technical tools for telecommunications tower construction.

Table 3-2 shows the scope of work shared by the first-tier CSS and the second-tier J-Siri on new site preparation and construction project (True Move-BFKT Phase 4-5). There are at least two parts to the project: (1) foundation platform and tower erection (civil work), and (2) electrical power system (such as integrated commissioning and IBC). The real owner of the project, BFKT (collaboration between True and NBTC), is operated by True Move. Also, True Move subcontracts the project to the first-tier CSS. Then, the first-tier CSS Plc. makes a subcontracting agreement with the second-tier J-siri Co., Ltd. There are three scopes of work that the second-tier subcontractor, J-Siri Co.,Ltd, do not perform since the first-tier contractor, CSS Plc, performs these three scopes of work by themselves.

Table 3-2: Site Construction: Foundation Platform and Tower Erection

Scope of Work	The first-tier contractor (CSS Plc)	The second-tier subcontractor (J-Siri Co.,Ltd.)
Site Acquisition SAR MS20/Lease MS60		◯
TSS/TSSR	◯	◯
GA Drawing		◯
Soil Test	◯	
Detailed Design	◯	
Document for Build Permit	◯	◯
Submit Build Permit		◯
Tower and Transport	◯	
Yard for Tower Stock		◯
Transport Tower Yard to Site		◯
SKOM/MS90 (Site Kick of Meeting)	◯	◯
Site Clearing and Excavation		◯
Tower/Anchor Foundation inc. Material		◯
Backfill and Embankment		◯
Tower Erection and Platform		◯
MDB Fence	◯	◯

Source: Based on internal documents and author's interview.
Note: 1.MS20: Site Option Approved and MS60: Lease Contract Signed.
2.TSS: Technical Site Survey, TSSR: Technical Site Survey Report.
3. GA: General Arrangement (Layout Drawing).
4. SKOM/MS90: Construction on Site (uninterrupted physical construction has started on site).

These are (1) soil test, (2) detailed design, (3) tower and transport (supply of tower steel and logistics), which were highlighted by grey area. In brief, J-Siri is the lower-tier subcontracting company working with CSS Plc for site preparation and site construction, particularly civil work in the southern region of Thailand. According to the organization structure and the scope of work, J-Siri also adopted a strategy of "choose and focus on the core, leverage (by outsourcing or subcontracting) and manage the good relationships with the subcontracting teams. In the interview, the owner of J-Siri emphasized that the key mechanisms for the company to survive and thrive are, in fact, the third-tier subcontracting teams especially the (1) tower foundation teams for eight teams, and (2) erection tower teams for three teams rather than the company's internal personnel. The characteristics of the third-

tier subcontracting teams comprise around six - seven persons who will work and commute to jobs using one pick-up truck. They prefer this kind of subcontracting rather than being hired as daily labourers or permanent employees. Their skills are like those in the construction industry but more specialized in telecommunications. Therefore, the key strategy of the second-tier subcontractors is to maintain a good long-term relationship with them. The core employee of J-Siri is the civil engineer manager who holds the responsibility of coordinating and supervising the project. The company has to support the subcontracting teams with the machines, crane, macro, logistics of the materials, etc. and manage a good relationship especially in terms of advance payments (for them to cover debts, pay their children's education fees and others), as well as provide continual projects on which they can work and earn money for a living.

The cycle of telecommunications business—big boom and silent periods, mostly affect subcontracting companies in the second and third tiers. During peak periods, a second-tier subcontracting company like J-Siri will experience its strongest demand for personnel, while experiencing a silent period lower-tier subcontracting companies need to have their own specific strategies for survival. For J-Siri, it is a strategy of horizontal diversification. As shown in appendix 3-B, the company extends the scope of work beyond site preparation and site construction of a telecommunications tower into an area of an upgraded site with the building and construction of other types of real estate as well as performing the task of site acquisition. The detail of the scope of work and the strategy of horizontal diversification of J-Siri is shown in appendix 3-B: J-Siri Project-Based Contracts.

3.5 Different Aspects of the Strategies of the Three Tiers Case Study Companies

This chapter analyzed the corporate strategy of the case studies of companies within the three tiers in the Thai telecommunications industry comprising the principle-tier DTAC, the first-tier CSS and the second-tier J-Siri. Strategy in this study is defined as the choice of capabilities to strengthen and sustain the competitiveness of the companies. The strategy which these case study companies have applied in order to strengthen and sustain the competitiveness in the Thai telecommunications industry consists of three aspects: choose and focus on the core, leverage and management of long-term relationships. Choose and focus on the core refers to the core capabilities which companies in each tier have chosen in accordance with their core tasks as shown in Table 2-3 in Chapter 2. Leverage indicates the achievement of resource leverage, whereby the companies have to accumulate and allocate productive resources, and also multiply resource effectiveness. In other words, the final result of the resource leverage creates competitive advantage and the superior values of the companies. Lastly, the companies have to manage the long-term relationships based on trustworthiness and transparency with a variety of actors in each tier in this industry in accordance with the core tasks. Table 3-3 below summarizes the strategy of these companies in the principle tier, the first tier and the second tier in the Thai telecommunications industry. In terms of choose and focus on the core, all case study companies from all three tiers focus on operational excellency. However, one differing aspect is the core areas which each company in each tier choose in accordance with the core tasks.

Table 3-3: Different Aspects of Strategies among the Three Tiers Case Study Companies			
Strategy: Choose and focus on the Core, Leverage and Manage Long-Term Relationships			
Tiers	**Operational Excellency**	**Competitive Advantage**	**Manage Relationships**
The principle-tier	• Network expansion • Network quality: broaden coverage and deepen capacity • 4th site implementation	• Network excellency • Customer loyalty (CRM)	• With foreign shareholders: AIS Singapore Temasek, DTAC Norway Telenor, True Move China Mobile • With regulator tier: NBTC RF spectrum license • With vendor tier: training, technologies • With first tier: telecoms project based contracts
The first-tier	• Telecoms engineering (supervision): roll-out project quality excellence in accordance with the principle-tier standards • 2nd site preparation and 3rd site construction	• All-in-one solutions and services: one-time big deal or turnkey project • Quality assurance	• With foreign experts: joint venture • With vendor tier: training, technologies • With same first tier: strategic partnership • With second tier: network of subcontracting • With supplier tier
The second-tier	• Telecoms engineering (practitioner): roll-out project operational excellence with the principle and first tier standards) • 1st site acquisition (partial), and 3rd site construction	• Specialization in the focused field • Coordination	• With first tier: telecoms project based contracts • With the same second tier: collaborative alliance • With third tier: network of subcontracting teams • With supplier tier

Source: Author's creation based on the interviews.

The principle-tier DTAC chooses operational excellency in network expansion and network quality by broadening the coverage and deepening the capacity of its mobile networks. In other words, the company is responsible for the fourth stage of workflow of telecommunications sites, or site implementation. Competitive advantage which is created by the company's capability in resource leverage consists of two areas: network excellency (TriNet) and customer loyalty from the customer relationship management (CRM), particularly the "Internet for All", "Love by Customers", "The Longer You Stay, The More Love We Have" initiatives. The last area of strategy concerns managing the long-term

relationships with actors from various tier, including foreign shareholders (for example, AIS with Singapore Temasek, DTAC with Norway Telenor, and True Move with China Mobile), the regulator-tier NBTC on RF spectrum license, the vendor-tier MNCs on training and telecoms technologies and also the first-tier contractors on subcontracting telecoms project-based contracts.

Next, the first-tier CSS chooses operational excellency on telecoms engineering, particularly roll-out project quality excellence in accordance with principle-tier standards. In other words, the company is responsible for the second and the third stages of the workflow of telecommunications sites, or site preparation and site construction. As shown in Table 3-3, operational excellence in the core areas of the first-tier and the second-tier companies are relatively the same, namely, on telecommunications engineering. However, the different aspect is that of the core tasks. That is, the core task of the first-tier company is on supervision (of supervising the telecoms roll-out projects), whereas that of the second-tier company is that of practitioner (performing the telecoms roll-out projects). The competitive advantage, which the company's resource leverage can bring about is the all-in-one solutions and services. In other words, the superior value which the first-tier contractors can give to the principle-tier telecoms operators is the guarantee of a one-time big deal (or turnkey project as discussed in Chapter 2), in addition to quality assurance. In order to bring about such a competitive advantage of all-in-one solutions and services, the first-tier contractors have to make much effort to manage the long-term relationships with many actors across the tiers in the Thai telecommunications industry, especially first-tier contractors like themselves in a type of strategic partnership (in this case, CSS with NWC). Additionally, the first-tier contractors have managed long-term relationships with actors from other tiers including foreign experts in a joint venture (CSS with Downer Australia to become Downer CSS),

vendor-tier MNCs on training and telecoms technologies, the second tier in a network of subcontracting and also with the supplier tier.

Finally, like the first-tier contractor, the second-tier subcontractor also chooses operational excellency in telecoms engineering, particularly roll-out project operational excellence in accordance with principle-tier and first-tier standards. As mentioned above, the second-tier subcontractor acts as a practitioner rather than a supervisor. In other words, the company coordinates with the third-tier subcontracting teams to perform the roll-out telecoms projects in the site construction. Compared with the first-tier contractor, the second-tier subcontractor possesses relatively similar core areas, particularly as regards telecoms engineering. However, the company cannot compete with the first-tier contractor in terms of connection (with the principle-tier telecoms operators) and also capital. With this capability of resource leveraging, there are two aspects of competitive advantage at the second-tier company: specialization in the focused area and coordination skill. Like the strategies of the principle-tier and the first-tier companies, the second-tier subcontractors have to manage long-term relationships with various actors across the tiers, for example with the first tier on deriving telecoms project-based contracts, with the same second tier on collaborative alliance, with the third tier on a network of subcontracting teams and also with the supplier tier[26].

3.6 Conclusion

In short, strategy concerns choices. Not ordinary choices, but choices to win. These choices involve five related question areas: a winning aspiration, where to win, how to win, core capabilities and management system. All the case study companies from the three tiers of principle-tier telecoms operators, first-tier contractors and second-tier subcontractors in the

[26] As mentioned earlier, the typical cycle of the Thai telecoms industry is 3-4 years of growth and 1-2 years of silence Those experiencing the most serious impact are second-tier subcontractors. They have to form collaborative alliances with other second-tier companies since they would like to maintain the customers' base by not turning down the proposal of telecoms projects even during busy periods. On the contrary, they give such telecoms projects to other second-tier subcontracting companies within their collaborative alliance.

Thai telecommunications industry have adopted the strategy of choose and focus on the core, leverage, and managing long-term relationships. They all have chosen operational excellency; however, they differed in the focused core areas. This brings about differences in competitive advantage and superior value which the companies in each tier can give to their customers. Lastly, they all manage long-term relationships with actors from multiple tiers; however, the differences among each tier concern the types and degrees of tightness of this relationship management.

Chapter 4

Shortages of ICT Personnel and the Responses in the Thai ICT Labour Market

Introduction

Chapter 2 explained the industrial organization and inter-corporate relationships of the Thai telecommunications industry, with the industrial actors of each tier actively performing specific tasks and creating particular value along a pyramid hierarchical structure with a striking balance between cooperation and competition. The substantial growth of market value in this industry has resulted in growing demand for ICT-related professionals and technicians (hereafter referred to as ICT personnel) in the Thai labour market.

However, the Thai ICT labour market has been characterized by friction or tightness, which has meant that most firms, especially principle-tier telecoms operators and first-tier contractors have encountered difficulty in securing their required labour and filling the vacancies of the particular positions[27].

Currently, there has been an intense demand for ICT personnel in most economic activities, with demand outstripping supply at an annual average growth rate of 4.25 per cent (NSO 2015a). Firms in this industry have to spend approximately 7.4 weeks to fill vacancies at the professional level, compared to 5.2 weeks and 2.2 weeks for the highly skilled group and low skilled group, respectively (Yongyuth et al. 2012). At the same time, on the supply side, the unemployment rate of the graduates with a bachelor's degree and above was highest at 40 per cent of the total unemployed in Thailand. Most graduates in this group spend

[27] Four companies from the interviews, including the principle-tier telecoms operators (True Move and DTAC), and the first-tier contractors (CSS and NWC) stated that they have faced the problem of shortages of ICT personnel. The author interviewed Deputy Director Resourcing Center on 27 July 2015 for True Move; Unit Head-People Partners, Technology Group, People Partner Department and Senior Vice President, People Group on 13 August 2014, 10 and 17 December 2014 for DTAC; CEO of CSS and Deputy Managing Director (Telecoms) on 9 December 2014; Managing Director; Director; Sales and Marketing Director; Operations Director and Senior HR Officer on 4 August 2015 for NWC.

between six and twelve months to find a job appropriate their skills in the Thai labour market (Yongyuth et al. 2012). The ability to fill a vacancy in the field of ICT was lowest at 14.9 per cent (compared to the average 41 per cent)[28]. In other words, labour shortages in the ICT industry were shown to be the most serious of problems.

Generally, the responses to the shortages include requesting the existing employees to take on more work, using employment agencies to fill vacancies, using social networks to find potential recruits, using ex-employees to fulfill tasks, and outsourcing work to other companies (Gambin et al. 2016). In the Thai ICT labour market, there has been particular collaboration between private firms and educational institutes to counteract the problem. For example, Sri Patum University (SPU) and the Association of Thai Software Industry (ATSI) initiate ICTE-TPQI or ICT Examination Project to manage the certificates of the ICT personnel[29]. Also, IMC Institute Thailand, Telecom Academy and CompTia Thailand develop training courses and certificates for the professionals and technicians in the Thai ICT sector[30].

However, the shortage of ICT personnel is still a chronic problem in the Thai labour market. According to the 2015 Establishment Survey on the Use of ICT, the number of graduates in ICT-related fields of education stood at merely 108,444 persons, with the highest proportion with bachelor's degrees at 65.2 percent, followed by the high vocational level at 18.5 percent. On the other hand, the employment level of ICT-related occupations was 451,981 persons. Of the employment figure, only 17.3 percent graduated in an ICT-related field of education. As of the year 2015, the shortage of ICT personnel in the Thai labour

[28] See Appendix 4-A: The 2013 Labour Demand of Establishment Survey.
[29] ICTE-TPQI (Information Communication and Technology Examination Project): a collaboration between Sri Patum University (SPU) and the Association of Thai Software Industry (ATSI) (www.tpqi.go.th).
[30] IMC Institute Thailand provides ICT-related training courses, ICT market research, IT consulting services, and also new brain development. It was supported by the Association of Thai ICT Industry (ATCI) (www.imcinstitute.com).

market stood at approximately 13,169 persons. The highest demand level was for the following occupational groups: (1) computer hardware and system and network technicians (5,346 persons), (2) computer network designers and analysts (4,410 persons) and (3) application programmers (2,406 persons) (NSO 2015b).

The objectives of this chapter are to explore the employment characteristics and the shortage situation concerning ICT personnel in the Thai ICT labour market by identifying the employment demand level, supply of the graduates, and their growth rates. In addition, the wage regression of ICT personnel is modeled and estimated as an indirect proxy to reveal excess demand for this group, and reflect the determinants affecting their wage levels.

The organization of this chapter is as follows. The first section identifies the tightness of the Thai labour market by indicating the UV (Unemployment and Vacancies) ratio. The second section explains the specific characteristics of employment, the employment level and the growth rate of each particular ICT-related occupation in the Thai ICT industry. The third section describes the ICT-related education system and indicates the supply of the graduates and the growth rate of the ICT-related field of education. The fourth section exhibits, and estimates the wage function of ICT personnel, and the determinants affecting the wage level of this group. The final section presents the conclusions on the shortage situation of ICT personnel and the responses in terms of wages and supply in the Thai ICT labour market.

In terms of data and methodology, the Labour Force Survey of National Statistical Office Thailand was used to identify the employment level, and the growth rate of ICT-related occupations for the demand side. For the supply side, the report from the Office of the High Education Commission was used to indicate the number of graduates and the growth rate of each particular ICT-related field of education. In addition, the wage regression of ICT

personnel was modelled and estimated as an indirect proxy to reveal the excess demand for this group, and to reflect the determinants affecting their wage levels.

4.1 The Tightness of the Thai Labour Market through the UV Ratio

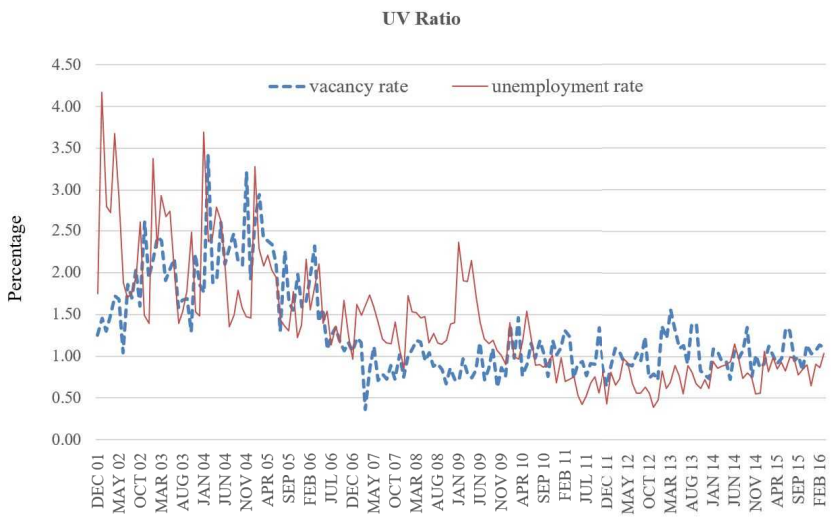
Typically, job vacancies have been used to measure labour shortages and skill mismatches at aggregate or occupation level. Vacancy rates – obtained by dividing the stock of unfilled job openings to total employment – are analyzed with unemployment rates in order to draw the so-called Beveridge Curve (BC)[31]. Unemployment is the state of labour market participation that a worker occupies for a relatively short period of time when he or she seeks the complementary state of acceptable employment (Mortensen 2011). Over the business cycle, vacancy rates and unemployment rates are negatively correlated, with high vacancy rates and low unemployment rates when the economy is growing and vice versa when the economy is contracting. In normal times, the typical employment relationship lasts for several years, while unemployment spells are relatively short for most workers. This co-movement along the downward sloping line designs the particular pattern of the BC for each particular business cycle. In the short-run the downward sloping line is fixed but the line can shift to reflect the structural changes in the labour market in the long-run (Petrongolo and Pissarides 2001; Shimer 2007; Fellman 2009; Quintini 2011; Hobijn and Sahin 2013). A higher degree in skill mismatch and labour shortage, characterized by the situation where employers are unable to recruit personnel with the skills they are looking for in the accessible labour market and at the ongoing rate of pay, shifts the BC outwards as unemployment and vacancies coexist at higher levels (Nickell et al. 2001; Quintini 2014). Firms decide how many job vacancies to create, each of them has some chance of attracting an unemployed

[31] The Beveridge curve, or UV-Curve was developed in 1958 by Christopher Dow and Leslie Arthur Dicks-Mireaux. They indicated the unemployment and vacancy data in the unemployment-vacancy (UV) space and derived an idealized UV curve in order to show a relationship between unemployment and vacancy in each particular period, and also somehow reveal the structural change in the labour market.

worker in the labour market. As the number of job vacancies increases, the unemployment rate falls. Firms face more intense competition to hire workers (Shimer 2007). A low unemployment rate, thus, reflects the tightness of the labour market[32].

Recalled from a theoretical assumption on the UV ratio that over the business cycle vacancy rates and unemployment rates are negatively correlated, with high vacancy rates and low unemployment rates when the economy is growing and vice versa when the economy is contracting. Due to limitations in the data on the rates of vacancy and unemployment in the particular ICT labour market in Thailand, Figure 4-1 shows the vacancy rates and unemployment rates in the overall Thai labour market during 2001-2015. The employment situations in the Thai labour market reflected by these two rates can be divided into two periods.

Figure 4-1 Vacancy Rate and Unemployment Rate in the Thai Labour Market, 2001-2016



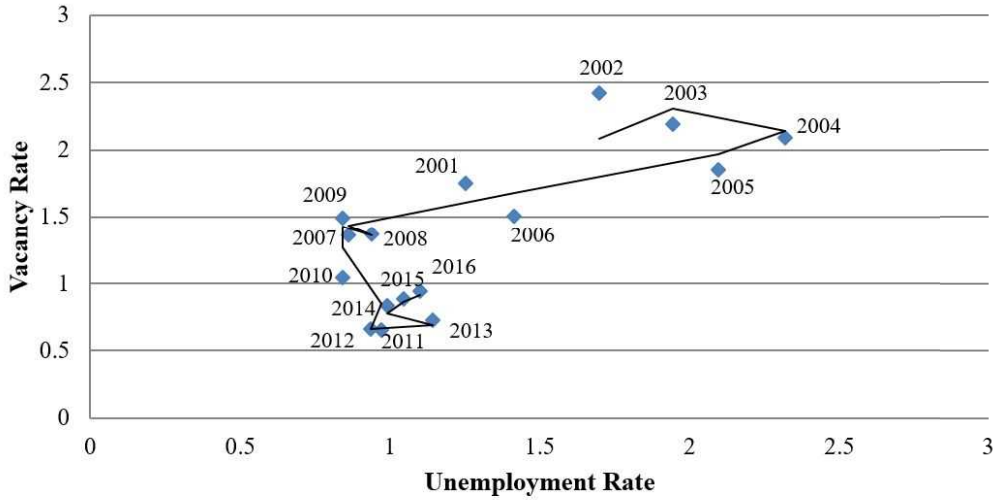
Source: Author's tabulation using data on employment indicators, Bank of Thailand.
Note: Monthly data from Dec 2001-Mar 2016 (Bank of Thailand), retrieved on May 25, 2016.

[32] A typical measure of labour market tightness is the ratio v/u, where v is the number of vacancies posted in the labour market and u is the number of unemployed. A tight labour market means that unemployment is a falling rate and there are few job vacancies available. The decline in job vacancies tends to push up wages as firms find it more difficult to recruit workers. On the contrary, a flexible labour market means that the labour markets quickly adjust to a competitive equilibrium, which involves the following features: (1) easy to hire and fire workers, (2) labour is occupationally and geographically mobile and (3) government intervention does not distort the market (www.economicsshelp.org and www.stlouisfed.org).

The first period was from 2001 to 2007, and the second period from the year 2008 onwards. From Figure 4-1, the turning point of these two rates fell into the interval year 2006-2007, which showed substantially high unemployment rates and sharply falling vacancy rates. This can somehow reflect the structural change of the Thai labour market in the sense that it gradually transitioned from a flexible to a frictional (tight) type. In other words, unemployment rates were high (3.5-4 per cent) and volatile during the first period (the years 2001-2004), and since then they have been gradually decreasing and shown a very low rate (less than 1 per cent). At the same time, vacancy rates in the first period showed the same pattern as the rates of unemployment, which were high and volatile during the first period, followed by a sharp drop in the second period of less than 1.5 per cent up until now.

In addition, another point of focus in Figure 4-1 is that unemployment rates were higher than vacancy rates in the first period, which reflects a flexible type of Thai labour market. However, in the second period, particularly since the year 2009, vacancy rates have been higher than rates of unemployment. This reveals a transition into a tighter type of the Thai labour market, indicating a very low rate of unemployment of less than 1 per cent, up until now. In order to see the clearer correlation between vacancy and unemployment rates, which are the main indicators to show the tightness of the Thai labour market, Figure 4-2 presents the shape of the UV curve in the Thai labour market during 2001-2016, which reflects a transition from flexible to frictional (tight) type of the Thai labour market. During 2001-2007, the Thai labour market was relatively flexible as reflected by the high rate of vacancy and unemployment of around 2.5 per cent. This implied that during this period more job opportunities were provided and also a large supply of workers was available. Both sides had more chances and could perform a more efficient job-worker matching process in a flexible labour market.

Figure 4-2 The UV Curve in the Thai Labour Market, 2001-2016



Source: Author's tabulation using data on employment indicators, Bank of Thailand.
Note: Retrieved data from Bank of Thailand on May 25, 2016.

However, in the year 2007, the Thai labour market became tight and there was a concentration between vacancy and unemployment rates, moving at around 1-1.5 per cent. Particularly, during 2007-2009, the number of job vacancies was larger than the supply of workers, reflecting a higher rate of vacancy than that of unemployment. Since then, the situation has worsened and the labour market showed a higher degree of friction, particularly during the period of 2011-2013. The rate of job vacancy was lower at 0.5 per cent and also unemployment rate stood at around 0.5-1 per cent. In other words, fewer job vacancies were provided, and also a lower supply of workers was available. Recently, the overall Thai labour market has remained tight. However, a more flexible trend has been displayed for both availabilities of jobs and supply of workers during 2014-2016, as reflected by the increasing trend of higher rates of both vacancies and unemployment.

In sum, the labour market dynamic in Thailand has followed the cycle of recession and recovery of the world economy with expansion before 2008 and contraction following

that. The Thai labour market has gradually transitioned from being flexible before 2008 to being tighter with lower rates of both vacancies and unemployment. However, from 2014 onwards, a more flexible trend with an increasing ratio in job vacancies and unemployed persons has been shown.

Since the focus of the chapter is on the Thai ICT labour market, the next two sections will discuss the issue of demand for and supply of ICT personnel in the Thai ICT labour market. The International Standard Classification of Occupations (ILO-ISCO08) was used as criteria to define and categorize the ICT-related occupations and data from the Labour Force Survey of National Statistical Office Thailand was used to identify the employment demand level, and growth rate of ICT-related occupations. Also, the International Standard Classification of Education (ISCED-97) was used as an indicator to define the field of education, and data from the Office of High Education Commission Thailand was utilized to indicate the graduate supply level and the growth rate of the graduates in ICT-related fields of education.

4.2 Employment Characteristics, Employment Demand Level and the Growth Rate of the ICT-related Occupations in the Thai ICT Labour Market

The employment level and the employers' demand for skills is driven by the product and service market strategies of the firms (Gambin et al. 2016). In accordance with the shift from labour-intensive products to the production of technology-based products and the transformation into the digital economy, the employment level of ICT personnel has substantially increased in the Thai labour market. As outlined in the first chapter, the development stage of the Thai economy is currently undergoing the economies of network

(speed), in which the ICT industry has played a much more important role. This shift has also resulted in a change in the structure of the Thai labour market.

Looking at recent employment structure, around 40 per cent of Thai labourers are working in agriculture, forestry and fisheries occupations. Approximately 50 per cent of the total number of the Thai labourers graduated from the primary level of education, and 35 per cent from the secondary level. Only 5 per cent of them have an engineering background. The age ranges are widely distributed with about 10 percent in each range of ages (for example, 9.7 per cent of total number of Thai labourers are 21-25 years old, 12.1 per cent are 26-30 years old, and so on). In terms of employment status, one-third have been employed as salaried workers in the private sector and one-third have worked as own-account workers, and concentrated in small and medium sized companies[33]. Nevertheless, the employment structure of the ICT-related occupations in the Thai labour market are specific as shown in Table 4-1. First, in terms of gender, the ratio of male and female ICT personnel is 60:40 per cent of the total number of ICT personnel in the Thai ICT labour market. Second, ICT personnel in the Thai ICT labour market are concentrating in working in municipal areas. The third characteristic is that they are young, as reflected by 65 per cent of the total number of ICT personnel being aged between 21-35 years old. Also, after 35 years old, they prefer start-ups of their own companies than being employed as salaried workers in the private sector (Mullika 2004). This also results in a gap of succession, especially in age range of 46-50 years old.

[33] See Appendix 4-B: The Employment Characteristics of the Thai ICT Labour Market and Appendix 4-C: The Occupational Level, Education Background and Monthly Wage of the Thai ICT Personnel for further details.

Table 4-1 Employment Structure of ICT-related Occupations in the Thai ICT Labour Market

Variables	Charateristics	Percentage
1. Gender	Male	60
	Female	40
2. Region	Municipal areas	70
	Non-municipal areas	30
3. Age (Years)	21-30 years	39.4
	31-40 years	42.6
	41-50 years	8.0
	51-60 years	9.6
	Above 60 years	0.4
4. Employment Status	Own account workers	40.5
	Contributing to family workers	3.5
	Salaried worker (state own enterprises)	9.6
	Salaried workers (private sector)	46.5
5. Monthly Wage (Baht)	Less than 10,000	1.8
	10,001-20,000	26.0
	20,001-30,000	3.6
	30,001-40,000	7.4
	40,001-50,000	7.6
	50,001-60,000	3.4
	Over 60,000	6.2
6. Expertise Levels	Manager	5
	Professional	21
	Technician	74
7. Education Background	7.1 Professional level	
	Bachelor degree	nearly 100
	Engineering	92
	7.2 Technician level	
	Bachelor degree	50
	High vocational	50
	Engineering	40
	Non-engineering	60

Source: Summarized characteristics based on LFS2012/Q4
Note: Percentage of the total number of ICT personnel in the Thai ICT labour market. Please see appendix 4-B for further detail.

Next, half of the ICT personnel in the Thai ICT labour market have been employed as salaried workers in the private sector and in the large-sized firms (more than 200 employees) with around 40 percent being own-account workers. However, most of them get low rates of return, as reflected by 60 percent of them earning approximately 10,001-30,000 baht per

month. In terms of expertise and education background, approximately 74 per cent of ICT personnel in the Thai ICT labour market have worked at the technician level, followed by 21 per cent at the professional level, and the remaining 5 per cent at the manager level. At the professional level, nearly 100 percent of ICT personnel have graduated with bachelor's degrees, and 92 percent have an engineering background. At the technician level, half of the ICT personnel have graduated with bachelor's degrees and the other half have from high vocational level. Approximately 40 per cent have an engineering background, while 60 per cent do not.

In brief, the distinctive characteristics of employment of ICT personnel in the Thai ICT labour market can be summarized as follows: male and female ICT personnel can work in ICT-related occupations, and they have been employed as salaried workers at large-sized firms in the private sector, concentrated in municipal areas. They are young in age with an entrepreneurial spirit for start-ups, but still getting a low rate of return. Approximately two-thirds have been employed at technician level and one-third at professional level.

In order to identify increasing demand for workers in the Thai ICT industry, Table 4-2 shows the level and the growth rate of employment in ICT industry during 2011-2016. First of all, the total employment level for all occupations in the Thai labour market is about 38 million persons, which accounts for 52.7 per cent of the total number of population.

Table 4-2 Employment Level, Employment Growth Rate, and Unemployment Rates in Thailand, 2011-2016

Employment Level in Each Sector	Employment data from the Labour Force Survey (LFS) (thousand persons)						Employment Growth Rate (%)		Unemployment rate (%)
	2011	2012	2013	2014	2015	2016 (Q1)	Percent Change, 2011-2016	Compound Average Growth Rate	Average 2011-2016
Total, all sectors (thousand persons)	38,465	38,941	38,906	38,077	38,016	37,684	-2.0	-0.0034	0.79
1. Agriculture Sector	14,883	15,434	15,407	12,733	12,272	11,154	-25.1	-0.05	N/A
2. Non-Agriculture Sector	23,582	23,508	23,500	25,345	25,744	26,530	12.5	0.02	N/A
2.1 Information Computer and Communication	181	214	199	248	242	243	34.0	0.05	N/A
2.2 Professional, Scientific and Technical Activities	268	239	257	317	374	375	39.9	0.06	N/A
Unemployment Rate (%)	0.68	0.66	0.72	0.84	0.89	0.97	42.7	0.06	N/A

Source: Author's calculation using LFS, from Bank of Thailand, retrieved on May 25, 2016.
Note: Availability of employment data for Information Computer and Communication, and Professional, Scientific and Technical Activities starting from the year 2011.

However, the overall employment level has decreased and shown a negative growth rate of 0.3 per cent per year for all occupations during these five years. The employment level of the agriculture sector, which accounts for 35 percent of the total employment level, showed the highest negative growth rate of approximately 5 percent per year. On the other hand, the employment level for the non-agriculture sector, which accounts for 63 percent of the total employment in the Thai labour market, showed a positive growth rate at 2 per cent per year. In particular, the employment level in "the information, computer and communication sector" has substantially increased from 181,000 persons in 2011 to 243,000 persons in 2016 with average annual growth rate at 5 per cent. At the same time, the number of workers in the professional, scientific and technical activities sector has increased from 268,000 persons to 375,000 persons with an average annual growth rate of 6 per cent. In other words, the growth rates of employment in the information, computer and communication sector and professional, scientific and technical sector during 2011-2016 have been highest at 34 per cent and 40 per cent respectively. Also, the growth rates of employment in these two sectors are three times higher than that in the non-agriculture sector as a whole.

Nevertheless, the workers who have been employed in information, computer and communication, and professional, scientific and technical sectors have not necessarily worked in ICT-related occupations. In other words, workers in non ICT-related occupations, such as accountants, human resources managers, sales and marketing officers, and so on, could be counted and included in the above two sectors as well. Therefore, Table 4-2 may merely show the increasing importance of these two sectors in terms of the employment level and its growth rate in the Thai labour market. However, it cannot identify the demand level and the growth rate of the ICT personnel who perform the particular ICT-related occupations in the Thai ICT sector.

The ICT-related occupations in the Thai ICT sector have been concentrated in code 25 (ICT professionals) and code 35 (ICT technicians) (NSO 2015a) [34]. The ICT personnel are defined as those people who have the ability to design, develop, operate, maintain and upgrade ICT systems and related functions. They are needed in the ICT sector, but increasingly they are also employed across the wider non-ICT sector, for instance financial services (OECD 2012). Their work is varied, and workers in this industry typically specialize in one field such as programming or networking and so on. The occupational titles assigned to ICT personnel vary depending on their functional specialization. They may be called engineers, web developers, network administrators or by other titles. However, no matter the

[34] Categories and definitions of ICT-related occupations in this chapter follow the International Standards of ILO-ISCO08, in which the technician group (code 35: ICT technicians) reflects technological level (skill levels and skill types) rather than relating to education level in Thailand. In the Thai context, there are three types of employees related to technological occupations: (1) engineer, (2) technician, and (3) craftsman, in which each come from different routes of education levels and types. Engineers are those who graduate at bachelor level, while technicians graduate at high vocational or vocational levels and craftsmen graduate at high school level. Nevertheless, the category of ICT technician in this chapter follows the International Standards and also includes employees who graduate with a bachelor's degree and above.

profession, the ultimate goal of the ICT personnel is to ensure that the system is usable, efficient, always up-to-date and responsive to customer needs[35].

Table 4-3 summarizes the core tasks and the skills types for ICT personnel at the professional level and technician level. The required skills types of ICT personnel in the ICT industry include systems and infrastructure, enterprise architecture, data management and storage, networking, security, compliance, risk management, application development, agile techniques, knowledge and understanding of customers' industries as well as user experience design.

Table 4-3: Core Tasks and Skill Types of ICT Personnel at Professional and Technician Levels

	Professional	**Technician**
Tasks	• Increase the existing stock of knowledge; apply scientific concepts and theories. • Teach about the foregoing in a systematic manner; or engage in any combination of these activities. • Conduct analysis and research and developing concepts, theories and operational methods. • Advise on or apply existing knowledge related to sciences, mathematics, engineering and technology.	• Perform technical and related tasks connected with research and the application of scientific concepts and operational methods. • Undertake and carry out technical work connected with research and the application of concepts and operational methods in the fields of physical sciences including engineering and technology. • Provide technical support.
Required Skills Types	• Systems and infrastructure • Enterprise architecture • Data management and storage • Networking • Security/compliance, risk management • Application development • Agile techniques • Knowledge and understanding of customers' industries • User experience design	

Source: ILO (2008) and UKCES (2013).

[35] www.career-space.com on "What does an information technology professional do?".

The core tasks of ICT personnel at professional level are to supervise, advise and teach about the scientific concepts and theories in a systematic manner. Also, they have to conduct analysis and research, and develop concepts, theories and operational methods. On the other hand, the core tasks of ICT personnel at technician level are at the practice and application level. They have to perform technical tasks, initiate and carry out various technical services, and also provide technical supports.

In the Thai context, according to National IT Committee, ICT personnel can be analyzed and divided into three categories according to differences in levels of expertise and paths of educations (Makishima and Somchai 2003). The first category consists of those with high and sophisticated ICT skills. Their route of education concerns the post-graduate level of the universities with high standards. ICT personnel at this expertise level have to be able to design and develop all functional areas related to ICT. To cultivate the capabilities at this expertise level, ICT companies in the private sector should actively collaborate to design appropriate course curricula offered by domestic universities and also dispatch their senior ICT experts or specialist to gain knowledge and experience in the vendor-tier MNCs in foreign countries. The second category involves those with moderate and advanced ICT skills. Normally, most domestic universities can produce graduates with such skills at bachelor's degree level. The desirable characteristics at this expertise level related to always updating and upgrading ICT knowledge and skills in order to be compatible with local market needs which consistently change. The ICT personnel at this expertise level have to be able to utilize ICT knowledge and skills to analyze and administer all functional areas related to ICT at the company level. The final category involves those with basic and general ICT skills. Such skills can be trained over short periods. The most appropriate trainees are graduates in non-ICT fields of education with at least a bachelor's degree. The ICT personnel at this expertise

level have to be able to operate, test and support all functional areas related to ICT at company level.

The ICT-related occupations, or ICT personnel in this study have also been divided into the three levels of managers, professionals and technicians as shown in Table 4-4. First, the manager level consists of only one occupation, namely, the ICT service manager. Second, the professional level comprises eight types of occupations. The occupational titles vary in terms of areas of specialization. These are the system analyst, application programmer, system administrator, software developer, web and multimedia developer, database designer and administrator, computer network professional and other database and network professionals (not elsewhere classified).

Table 4-4 Employment Level, and Growth Rate for ICT-related Occupations in Thailand, 2012-2015

Occupations	Employment Demand Level (Persons)				Growth Rate (%)	
	2012	2013	2014	2015	Percent Change, 2012-2015 (%)	Compound Average Growth Rate 2012-2015 (%)
Grand Total, all occupations employment	**39,344,908**	**39,261,663**	**38,592,110**	**38,504,228**	**-2.1%**	**-0.7%**
Total, all ICT-related occupations	**235,956**	**278,091**	**281,604**	**278,695**	**18.1%**	**5.7%**
1. Manager level	**11,240**	**16,384**	**9,136**	**8,210**	**-27.0%**	**-9.9%**
1.1 ICT service manager	11,240	16,384	9,136	8,210	-27.0%	-9.9%
2. Professional level	**50,976**	**43,924**	**62,148**	**74,358**	**45.9%**	**13.4%**
2.1 System analyst	8,996	5,916	4,995	11,401	26.7%	8.2%
2.2 Application programmer	23,325	15,548	14,450	12,189	-47.7%	-19.5%
2.3 System administrator	4,265	2,404	5,831	3,799	-10.9%	-3.8%
2.4 Software developer	1,316	6,004	7,369	8,333	533.2%	85.0%
2.5 Web and multi-media developer	6,503	7,919	16,612	16,822	158.7%	37.3%
2.6 Database designer and administrator	1,372	4,982	10,772	19,631	1330.8%	142.8%
2.7 Computer network professional	3,265	0	2,119	1,147	-64.9%	-29.4%
2.8 Database and network professional N.E.C	1,934	1,150	0	1,036	-46.4%	-18.8%
3. Technician level	**173,740**	**217,783**	**210,319**	**196,127**	**12.9%**	4.1%
3.1 Civil engineering technician	54,897	68,185	50,767	44,941	-18.1%	-6.5%
3.2 Electrical engineering technician	19,485	34,888	25,767	29,992	53.9%	15.5%
3.3 Electronic engineering technician	10,559	10,847	22,495	9,502	-10.0%	-3.5%
3.4 Mechanical engineering technician	18,003	23,622	23,663	14,691	-18.4%	-6.6%
3.5 Telecommunications engineering technician	1,014	1,859	1,448	3,210	216.6%	46.8%
3.6 ICT operation technician	29,860	29,073	39,688	29,316	-1.8%	-0.6%
3.7 ICT user support technician	8,410	12,489	11,636	19,412	130.8%	32.2%
3.8 Computer network and system technician	13,415	12,105	12,953	12,368	-7.8%	-2.7%
3.9 Web technician	7,254	12,399	17,609	20,411	181.4%	41.2%
3.10 Broadcasting and audiovisual technician	10,843	12,316	4,294	12,283	13.3%	4.2%

Source: Author's calculation using LFS data (NSO, each year).
Note: Grey highlight refers to shortage of ICT personnel in the specific ICT-related occupations.

Third, the technician level consists of ten types of occupations. The occupational titles comprise various kinds of engineering technicians. These are the civil engineering technician, electrical engineering technician, electronic engineering technician, mechanical engineering technician, and telecommunications engineering technician. Other kinds of technician are also the ICT operation technician, ICT user support technician, web technician, and broadcasting and audiovisual technician.

Table 4-4 indicates the employment demand level and growth rate of specific ICT-related occupations in the Thai ICT labour market from 2012 to 2015. The ratio of ICT-related occupations accounts only for 0.6 per cent of total employment level in the Thai labour market. During this period, the employment growth rate for all occupations has decreased by 0.7 per cent per year, whereas, the employment growth rate for all ICT-related occupations has increased by approximately 5.7 per cent per year. The highest share of employment level in all ICT-related occupations is that of technician level (73.6 per cent), followed by professional level (21.6 per cent) and manager level (4.8 per cent), respectively. At each level, the particular ICT-related occupations can be further divided into two dimensions: one is on the employment level whether it is low or high and two is on the employment growth rate and whether it is negative or positive.

Firstly, employment level at manager level was not only the lowest at 4.8 percent, but employment growth rate was also negative at 9.9 percent per year. Also, it comprises only one type of occupation — the ICT service manager. Secondly, employment level at professional level accounts for 21.6 per cent of the total employment level of all ICT-related occupations, yet its growth rate has been the highest at 13.4 per cent per annum. At the professional level, there are four ICT-related occupations showing the highest growth rate. These include database designer and administrator, software developer, web and multimedia

developer and system analyst with the annual growth rate of 142.8 percent, 85.0 percent, 37.3 percent, and 8.2 percent respectively. On the other hand, the rest of the following four ICT-related occupations exhibited a negative growth rate: computer network professional, application programmer, database and network professional n.e.c, and system administrator at approximately for 29.4 percent, 19.5 percent, 18.8 percent, and 3.8 percent per year, respectively. Thirdly, employment level at technician level accounts for 73.6 per cent of the total employment level of all ICT-related occupations, which was the highest. However, its growth rate has slightly increased by approximately 4.1 per cent per year, compared to the employment growth rate of the professional level at 13.4 per cent per year. There are ten ICT-related occupations at the technician level, of which five occupations showed a positive growth rate of employment in contrast to the remaining five occupations showing negative growth.

The ICT-related occupations showing positive growth rate of employment at the technician level are telecommunications engineering technician, web technician, ICT user support technician, electrical engineering technician, and broadcasting and audiovisual technician with annual growth rates at 46.8 percent, 41.2 percent, 32.2 percent, 15.5 percent, and 4.2 percent, respectively. However, the remaining five occupations showing negative growth rate are mechanical engineering technician, civil engineering technician, electronic engineering technician, computer network and system technician, and ICT operation technician, at 6.6 percent, 6.5 percent, 3.5 percent, 2.7 percent, and 0.6 percent, respectively.

Nevertheless, the negative growth rate of employment does not necessarily imply a decrease in demand for these ICT-related occupations. Instead, the negative growth rates shown in this study actually reflect the shortages situation of particular occupations. As the aforementioned survey of NSO 2015 showed, the serious shortages of ICT personnel have

occurred in the following three particular occupations: (1) computer hardware and system and network technician, (2) computer network designer and analyst and (3) application programmer (NSO 2015b). Therefore, the negative growth rates of employment shown in Table 4-4 reveal the shortages situation of ICT personnel rather than the decreasing demand for those kinds of ICT personnel in the Thai ICT labour market. In order to confirm and explore whether the negative growth rate of employment of particular ICT-related occupations shown in Table 4-4 actually reflect the shortage situation of supply or not, the analysis of the supply of the graduates in ICT-related fields of education is necessary and will be provided in the third section of this chapter.

Before moving on the situation regarding the supply of graduates in ICT-related fields of education, the results in Table 4-4 can be further arranged and segmented based on the two dimensions: employment level and employment growth rate. The outcomes are given in Table 4-5 and Table 4-6, which classify the four segments of ICT-related occupations at the professional level and the technician level, respectively. The high employment level of the particular occupations indirectly implies the current stage of Thai ICT industry development and the high growth rate implicitly reflects the industry's future trends. As shown in Table 4-5, most ICT personnel at the professional level in the Thai ICT labour market have specialized in functional application program, and system analysis and administration, whereas few ICT personnel specialize in a higher level of expertise in database design, software development and also computer network operation and development.

Table 4-5 The Four Segmentation of ICT-related Occupations at Professional Level in the Thai ICT Labour Market

Growth rate	Employment Level	
	High	Low
Positive	1. System analyst	3. Software developer
	2. Web and multimedia developer	4. Database designer and administrator
Negative	5. Application programmer	8. Computer network professional
	6. System administrator	
	7. Database and network professional n.e.c	

Source: Author's arrangement based on Table 4-4.

Table 4-6 The Four Segmentation of ICT-related Occupations at Technician Level in the Thai ICT Labour Market

Growth rate	Employment Level	
	High	Low
Positive	1. Electrical engineering technician	2.Telecommunications engineering technician
		3. ICT user support technician
		4. Web technician
		5. Broadcasting and audiovisual technician
Negative	6. Civil engineering technician	9. Electronic engineering technician
	7. ICT operation technician	10.Computer network and system technician
	8. Mechanical engineering technician	

Source: Author's arrangement based on Table 4-4.

At the same time, shortages of ICT personnel at professional level have occurred in fields which show high employment levels, namely, application programs, system analysis and administrators. This is reflected by the negative growth rate of employment in these ICT-related occupations. On the other hand, occupations with a higher level of expertise, such as those in database design, software development and also computer network professionals showed a substantial increase in growth rate and reflected the future direction of the Thai ICT industry development even though their employment levels are still low at this moment.

At technician level, most ICT personnel have been concentrated in the fields of electrical engineering, civil engineering, mechanical engineering and ICT operations as shown in Table 4-6. Still, few ICT personnel have worked in the fields of telecommunications engineering, electronic engineering, computer networks and systems,

and also web, broadcasting and audiovisuals. Based on the assumption of the study that the negative growth rate of employment in particular ICT-related occupations, in fact, reflects a shortage of supply rather than the decrease in demand. Therefore, the occupations currently in shortage at technician level are the civil engineering technician, electronic engineering technician, mechanical engineering technician, ICT operation technician, and computer network and system technician as reflected by the negative growth rate of employment.

In brief, the four segments of ICT-related occupations at professional level and technician level, which are divided by two dimensions, including employment level and employment growth rate shown in Tables 4-5 and 4-6 help reflect the shortage situation of ICT personnel, the current stage of ICT industry and also the future direction of ICT industry development. At the professional level, the stage of development in the Thai ICT industry has still positioned in functional application programs, system analysis and administration. Nevertheless, it is catching up to a higher level of expertise in database design, software development as well as computer network operation and development. At the technician level, the Thai ICT industry is currently concentrated in the fields of civil engineering, electrical engineering, mechanical engineering, and ICT operations. However, it has been directed towards the added value areas of telecommunications engineering, web, broadcasting and audiovisuals.

As concerns the workflow of the new site of telecommunications towers mentioned in the second chapter, the main task of the principle-tier telecoms operators is site implementation, while the main task of the first-tier contractors and the second-tier subcontractors is for site preparation and site construction. Due to different types of tasks required by actors in each tier, the demand for knowledge, skill and expertise embedded in the ICT personnel of each tier also varies and differs. In other words, the principle-tier

telecoms operators have high demand for ICT personnel at professional level, particularly computer network professionals, system analysts, system administrators, database designers and administrators, software developers, web and multimedia developers and also application programmers. In contrast, the first-tier contractors have high demand for ICT personnel at technician level particularly in civil engineering, electrical engineering, mechanical engineering, computer network and system technicians and also ICT operations.

In the external ICT labour market, the shortage of ICT personnel has occurred in the specific ICT-related occupations of computer network professionals, application programmers and system administrators at professional level and civil engineering technicians, mechanical engineering technicians, electronic engineering technicians, computer network and system technicians and also ICT operation technicians at technician level. The aforementioned three tables (Tables 4-4, 4-5 and 4-6) reflect the situation in the Thai ICT labour market in terms of which occupations have seen large or little employment, which occupations have encountered shortages of ICT personnel, and also which occupations have shown the signs of future development. Nevertheless, the results from these three tables cannot explain the reasons behind the shortage situation. In fact, there are many reasons to explain this such as the production site expansion, economic growth, economic structural transformation, remoteness of the companies, unattractive wage rates, company image, and also an insufficient supply. As mentioned earlier, the shortage situation of ICT personnel needs to be cross-checked with the situation of supply of the ICT-graduates; therefore, the next section will explore the ICT-related education system and identify the situation concerning the supply of graduates from ICT-related fields of education.

4.3 Supply of the Graduates and the Growth Rate in the ICT-related Fields of Education

The most important factor enabling the Thai ICT industry to drive economic and social development in the desired direction is the development of human resources both in terms of quantity and quality. Since ICT is a highly technical field, which needs particular education and training, the ICT personnel must be able to apply at specific kind of technology appropriate to the social context in which they are operating (Makishima and Somchai 2003).

In the Thai labour market, there are four key types of public academic institutes which have been responsible for offering ICT courses and degrees. The first type is public and private universities under the supervision of the Ministry of University Affairs. They provide bachelor's degrees and post-graduate degrees, by offering the six fields of ICT-related education of computer engineering, applied computer, electronic, telecommunications, information technology, and statistics.

The second type is a public institute under the supervision of the Ministry of Education, namely, the Rajamangala Institute of Technology. There are twelve campuses in Bangkok and twenty-two campuses in other provinces throughout the whole kingdom. They have been responsible for higher diploma certificates (two years of education) and bachelor's degrees (four years of education) and have provided four ICT-related fields of education including computer engineering, applied computer, electronic and information technology.

The third type is the Rajabhat university. They are also a public university under the Ministry of Education. However, there are a large number of third-type campuses situated in almost every province in Thailand. They have also been responsible for higher diploma certificates (two years of education) and bachelor's degree (four years of education), and

have provided three ICT-related fields of education, namely, electronic, computer studies and computer management.

The fourth type is the vocational institute under the supervision of the Department of Vocational Education. They provide only higher diploma certificates and offer two ICT-related fields of education, which are electronic and applied computers (Mikishima and Somchai 2003).

As mentioned previously, the number of graduates in an ICT-related field of education in 2015 was 108,444 persons. The highest proportion was that of bachelor's degree at 65.2 percent, followed by high vocational level at 18.5 percent (NSO 2015a). However, the number of ICT graduates in the past was very few in Thailand. Puntasen et al. (2001) examined the total number of graduates in ICT-related fields of education from the above four sources of institution during 1992-1998. The number of graduates with a variety of qualifications was merely 8,573 persons in 1992 and this has steadily increased to 24,867 persons in 1998. During this period, graduates at high vocational level have accounted for the largest share (approximately 60 per cent), followed by those with bachelor's degrees (37 per cent) and those with a post-graduate degree (3 per cent). Most graduates of the ICT-related field of education during 1992-1998 chose applied computers, while telecommunications showed the lowest ratio.

Table 4-7 shows the number of graduates and the growth rate for the ICT-related field of education in the Thailand during 2008-2015. The number of graduates from all fields of education has been approximately 300,000 persons with an annual average growth rate of 1.2 per cent. Also, the number of the graduates from the ICT-related field of education has accounted approximately for 10 per cent of all graduates in the Thai education system (30,000 persons per year). According to ISCED-97, the fields of education can be categorized

into two areas: (1) non-science and technology and (2) science and technology. The ratio of graduates from the fields of non-science and technology have been higher than those graduating from science and technology at approximately 78:22 per cent of all graduates for every year.

The ICT-related fields of education, which is the focus of the chapter, falls under the science and technology field and it has accounted only for 10 per cent of the total number of graduates in Thailand. In addition, the number of graduates from the ICT-related field of education has decreased and shown a negative growth rate at 1.4 per cent per year during 2008-2015, while the number of graduates from a non-ICT field of education has increased and shown a positive growth rate at 1.4 per cent per year. In 2008, the highest ratio of ICT-graduates came from computer science (approximately 50 per cent); nevertheless, this ratio has substantially decreased to 22 per cent in 2015. Additionally, the growth rate of ICT-graduates from computer science has negatively decreased by approximately 11.9 per cent per year.

Table 4-7: Number of the Graduates, and Growth Rate for Selected Fields of Education in Thailand, 2008-2015

Fields of Education	Number of Graduates (Persons)						Growth Rate (%)	
	2008	2009	2011	2012	2014	2015	Percent Change, 2008-2015	Compound Average Growth Rate(%)
Total, all graduates	**289,071**	**279,208**	**295,671**	**277,592**	**282,215**	**315,305**	**9.1**	**1.2%**
1. Non Science and Technology	220,265	214,539	224,999	216,024	215,927	245,842	11.6	1.6%
2. Science and Technology	68,806	64,669	70,672	61,568	66,288	69,463	1.0	0.1%
2.1 Non ICT	36,990	33,660	40,993	43,028	38,159	40,705	10.0	1.4%
2.2 ICT	31,816	31,009	29,679	18,540	28,129	28,758	-9.6	-1.4%
2.2.1 Maths and Stats	2,119	2,279	2,372	1,791	3,522	4,624	118.2	11.8%
2.2.2 Computer Science	15,547	12,451	8,000	4,999	8,258	6,383	-58.9	-11.9%
2.2.3 Engineer	6,250	7,078	8,130	5,010	7,802	8,303	32.8	4.1%
(1) Computer	1,904	1,938	2,208	1,288	2,104	2,018	6.0	0.8%
(2) Electrical & Electronic	3,678	4,265	5,121	3,362	4,762	4,735	28.7	3.7%
(3) Telecoms & ICT	282	375	355	176	575	897	218.1	18.0%
(4) Software, Network, Intern	386	500	446	184	361	653	69.2	7.8%
2.2.4 Technical (Technology)	7,900	9,201	11,177	6,740	8,547	9,448	19.6	2.6%

Source: Author's calculation using http://www.info.mua.go.th/information/
Note: Grey highlight refers to shortage of the graduates in the field.

However, such a decreased ratio has been replaced by the ICT-graduates in the three fields of education of telecommunications and ICT engineering, maths and statistics, and software, network and internet engineering at a compound average growth rate of 18.0 percent, 11.8 percent and 7.8 percent, respectively.

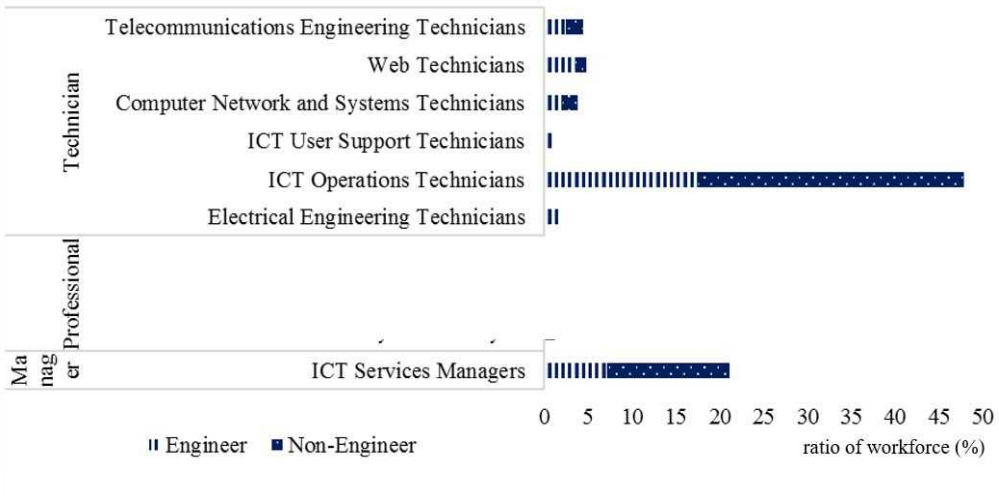
Next, the second and the third highest ratio of the ICT-graduates have been in the field of technical (technology) and the field of engineering with approximately 25 percent and 20 percent of the total number of ICT-graduates respectively. Compound average growth rates for these two fields of education have also increased at 2.6 per cent for the field of technical (technology) and 4.1 per cent for the field of engineering. In particular, there are four courses offered in the field of engineering which relate to ICT in the Thai education system. These are computer, electrical and electronic, telecoms and ICT and also software, network and internet. The number of graduates from electrical and electronic engineering has shown the highest ratio (more than 50 per cent of the total number of ICT-graduates in engineering) and its growth rate has also increased 3.7 per cent per year. Still, a small number of graduates have come from telecoms and ICT engineering, and also software, network and internet engineering, accounting for 10 per cent and 8 per cent of the total number of ICT-graduates in engineering, respectively. Nevertheless, their growth rates are quite high, approximately at 18.0 percent and 7.8 percent per year.

As discussed earlier, the ratio of ICT personnel at technician level has been the highest at 74 percent of the total number of ICT personnel in the Thai ICT labour market, and the ratio of those at professional level has accounted for 21 percent. Expertise levels of those at professional level is, acceptably, higher than those at technician level. Therefore, the required education background, both in terms of the level and major of ICT personnel at these two levels are differ in accordance with the required expertise levels. Figure 4-3 shows the

education background of the ICT personnel of particular ICT-related occupations in the Thai ICT industry. Results show that the degree of specialization of ICT personnel at professional level is higher than those at technician level, reflected by the ratio of ICT personnel graduating from an engineering background. In other words, one hundred percent of systems administrators and application programmers at professional level have graduated with an engineering background.

This is in contrast to the education background of ICT personnel at technician level, which showed a mixture between non-engineering and engineering backgrounds. For example, some telecommunications engineering technicians, web technicians, computer network and systems technicians have graduated with an engineering background, while some have earned a degree in non-engineering. In other words, those who have graduated in non-engineering can also be employed in some ICT-related occupations, particularly at technician level in the Thai ICT industry.

Figure 4-3 ICT-related Occupations by Education Background in the Thai ICT Labour Market



Source: Author's tabulation using LFS 2012/Q4 (NSO).

In brief, the number of ICT-graduates accounts only for 10 per cent of all the graduates in the Thai education system. Also, its growth rate has also shown a negative rate at approximately 1.4 per cent per year. On the other hand, the growth rate of non-ICT graduates has shown a positive rate at approximately 1.4 per cent per year during 2008-2015. The top three ICT-related fields of education showing high growth rates are telecommunications and ICT engineering, maths and statistical and software, network and internet engineering, while the growth rate of ICT graduates from computer science has shown a substantial decrease. The degree of specialization of ICT personnel at professional level is higher than those at technician level. Almost all ICT personnel at the professional level have an education background in engineering while those working at the technician level are from both engineering and non-engineering backgrounds.

In addition to the responses of supply to the shortages of ICT personnel in the Thai ICT labour market, wage is another key indicator playing an important role in the Thai labour market adjustment. The next section will identify the wage levels and wage growth rates of each particular ICT-related occupation and indicate the regression estimates for wages of ICT personnel in the Thai ICT labour market.

4.4 Wage Determination and Equilibrium Wage Differential in the Thai ICT Labour Market

At equilibrium, the law of supply and demand determines the structure of wages in the labour market. Reciprocity, when there is excess demand or excess supply leading to disequilibrium, wage adjustment is one of the key mechanisms to clear and bring the market back to equilibrium. The Thai labour market has shown a relative increase in demand for ICT personnel recently partly due to skill-biased technological change in the so-called digital economy. In particular, the rapid adaptation of ICT results in an important impact on the

wage structure of ICT-related occupations in the Thai ICT labour market. In other words, skill-biased technological change can generate an outward shift in the relative demand curve and an increase in the wage level of this profession.

Theoretically, an increase in the wage level of specific ICT-related occupations can indirectly reflect the excess demand or shortages of these occupations. Most employers typically use an increasing level of wage to attract a larger number of workers to be employed in such particular occupations. Therefore, this study assumed that the wage level and the wage growth rate of ICT-related occupations facing shortages in the Thai ICT labour market should be high and increased. Table 4-8 shows the wage level and wage growth rate of ICT-related occupations in the Thai ICT labour market during 2012-2015. The results of wage level and wage growth rate for the occupations which are in serious shortages, including computer hardware and system and network technician, computer network design and analyst (or computer network professional) and application programmer during 2012-2015 show that the wage level has been low and also the wage growth following a negative rate, which contradicts the study's assumption. The wage growth rate of computer network and system technician has been decreasing by approximately 3.2 per cent per year and the wage growth rate of computer network professional has also been decreasing by approximately at 6.7 per cent per year. The wage growth rate of the application programmer was positive, yet slightly increased at 5.1 per cent per year, compared to the increasing annual wage growth rate of the system administrator and system analyst at 81.7 percent and 20.2 percent respectively. The wage levels of these occupations have not increased despite facing a serious shortage of supply, and their wage growth has also been negative. Therefore, the shortages of ICT personnel in these three ICT-related occupations may result from unattractive wage levels and negative wage growth rate as one of the reasons.

Table 4-8 Wage Amount and Wage Growth Rate for ICT-related Occupations in the Thai ICT Labour Market, 2012-2015

Occupations	Wage (Baht/Month)				Growth Rate (%)	
	2012	2013	2014	2015	Percent Change 2012-2015 (%)	Compound Average Growth Rate (%)
Total, all occupations	**15,172**	**20,773**	**25,101**	**19,466**	**28.3%**	**8.7%**
1. Manager level	**38,103**	**39,662**	**49,366**	**46,349**	**21.6%**	6.7%
1.1 ICT service manager	52,158	71,981	44,305	81,067	55.4%	15.8%
2. Professional level	**26,552**	**37,790**	**36,651**	**32,941**	**24.1%**	**7.5%**
2.1 System analyst	15,000	92,563	34,384	26,065	73.8%	20.2%
2.2 Application programmer	25,018	66,754	36,189	29,023	16.0%	5.1%
2.3 System administrator	5,200	19,089	20,622	31,188	499.8%	81.7%
2.4 Software developer	26,234	40,740	31,768	27,002	2.9%	1.0%
2.5 Web and multi-media developer	27,364	30,366	32,881	27,891	1.9%	0.6%
2.6 Database designer and administrator	31,684	21,324	21,321	22,428	-29.2%	-10.9%
2.7 Computer network professional	23,789	0	18,635	19,290	-18.9%	-6.7%
2.8 Database and network professional N.E.C	20,000	24,936	0	25,285	26.4%	8.1%
3. Technician level	**24,997**	**26,648**	**32,680**	**27,918**	**11.7%**	**3.8%**
3.1 Civil engineering technician	16,467	25,688	19,398	37,707	129.0%	31.8%
3.2 Electrical engineering technician	21,250	34,610	23,469	29,262	37.7%	11.3%
3.3 Electronic engineering technician	13,271	49,453	32,538	21,636	63.0%	17.7%
3.4 Mechanical engineering technician	18,691	22,609	60,522	22,631	21.1%	6.6%
3.5 Telecommunications engineering technician	37,868	40,557	39,632	43,512	14.9%	4.7%
3.6 ICT operation technician	21,308	36,284	20,333	64,181	201.2%	44.4%
3.7 ICT user support technician	21,966	20,549	69,268	20,946	-4.6%	-1.6%
3.8 Computer network and system technician	14,073	28,774	11,505	12,747	-9.4%	-3.2%
3.9 Web technician	13,411	62,134	28,411	27,317	103.7%	26.8%
3.10 Broadcasting and audiovisual technician	17,362	16,614	17,164	22,396	29.0%	8.9%

Source: Author's calculation using LFS data (NSO, each year).
Note: Grey highlight refers to the decrease in wage in the specific ICT-related occupations.

However, there are three particular ICT-related occupations at technician level showing an alignment with this study's assumption (that the shortage should result in an increase in wage levels and wage growth rates). These three occupations are the ICT operation technician, civil engineering technician, and electronic engineering technician which show increasing annual growth rates in wages of approximately 44.4 per cent, 31.8 per cent and 17.7 per cent respectively. Nevertheless, the results of the wage level and wage growth rate of the ICT-related occupations both at professional and technician level shown in Table 4-8 fluctuated and could not confirm whether the negative wage growth rate had a

causal relationship with the shortages of the aforementioned occupations or not. Therefore, this study will estimate the wage determination of ICT personnel in the Thai ICT labour market in order to see its responses to the shortage situation or the excess demand which has been currently happening.

Under the labour supply and labour demand approach, ones know that $Excess\ Demand_i = LD_i - LS_i$, where LS_i and LD_i denotes the labour supply and labour demand in the labour market. Therefore, the main determinant of the employment level, or L* is the average wage (W*) in each industry. Theoretically, LS_i is determined by wage and non-wage income, while LD_i is determined by wage and GDP at the very least. The labour supply decreases when the wage decreases and when the non-wage income increases, whereas the labour demand increases when the wage decreases and when GDP increases (Liu 2013). Thus, the wage function can indirectly indicate a situation of excess demand from the wage's responses. In other words, such an increasing wage growth rate in a particular occupation can signify a shift in increasing demand for that occupation. Therefore, this study considers the following model estimation:

$$LD_i = \alpha_0 + \alpha_1.W_i + \alpha_2.YrSchool + \varepsilon^d \quad (4.1)$$

$$LS_i = \beta_0 + \beta_1.W_i + \beta_2.Wkh_i + \varepsilon^s \quad (4.2)$$

where W is average wage, $YrSchool$ is years of schooling and Wkh is working hours. While, ε^d and $\varepsilon^s$are residuals. Labour demand increases when wage decreases. On the other hand, labour supply increases when wage increases. Years of schooling are used as an indirect proxy to indicate human capital level, with an assumption that labour demand increases when years of schooling increases. At the same time, working hours are used as an indirect proxy to indicate the level of working hours supplied by labour, with an assumption that labour supply

increases when working hour increases, which indicates that $\alpha_1 < 0, \alpha_2 > 0, \beta_1 > 0, and\ \beta_2 > 0$.

A large number of vacancies in the labour market can cause the stagnation of the labour market, resulting in a low level of productivity. Consequently, wages may increase which could increase the labour supply, thus driving the employment level into an equilibrium. Therefore, reactions of wages to the labour shortages, or excess demand plays an important role in the labour market adjustments. In other words, an economy where labour demand exceeds labour supply, an increase in wage will help induce the larger number of supply into the labour market. Due to the limitation of data, in this study, LS_i is determined by average wage and working hour, and LD_i is determined by average wage and years of schooling. Thus, at the equilibrium, labour demand equals to labour supply, the employment level is therefore given by a point where $LD_i = LS_i$ as follows:

$$\alpha_0 + \alpha_1.W_i + \alpha_2.YrSchool_i + \varepsilon^d = \beta_0 + \beta_1.W_i + \beta_2.Wkh_i + \varepsilon^s \quad (4.3)$$

$$(\alpha_1.W_i - \beta_1.W_i) = (\beta_0 - \alpha_0) + (\beta_2.Wkh_i) - (\alpha_2.YrSchool_i) + (\varepsilon^s - \varepsilon^d) \quad (4.4)$$

$$(\alpha_1 - \beta_1).W_i = (\beta_0 - \alpha_0) + (\beta_2.Wkh_i) - (\alpha_2.YrSchool_i) + (\varepsilon^s - \varepsilon^d) \quad (4.5)$$

$$W_i = \frac{(\beta_0 - \alpha_0)}{(\alpha_1 - \beta_1)} + \frac{\beta_2}{(\alpha_1 - \beta_1)}.Wkh_i - \frac{\alpha_2}{(\alpha_1 - \beta_1)}.YrSchool_i + \frac{(\varepsilon^s - \varepsilon^d)}{(\alpha_1 - \beta_1)} \quad (4.6)$$

$$W_i = C + \delta.Wkh_i - \gamma.YrSchool_i + \varepsilon_i^{s-d} \quad (4.7)$$

where $C = \frac{(\beta_0 - \alpha_0)}{(\alpha_1 - \beta_1)}, \delta = \frac{\beta_2}{(\alpha_1 - \beta_1)}, \gamma = \frac{\alpha_2}{(\alpha_1 - \beta_1)}$, and $\varepsilon_i^{s-d} = \frac{(\varepsilon^s - \varepsilon^d)}{(\alpha_1 - \beta_1)}$

Finally, we get wage equation 4.7, which depends on the working hours and years of schooling and we will then estimate parameters by using OLS (ordinary least square) to test whether there is a shortage or excess demand for ICT personnel, or the wage of this group should be higher than others at a statistically significant level. Also, the wage determinations of ICT personnel in the Thai ICT industry will be identified to understand which factors affecting the wage level and wage growth rate of the personnel in this profession.

Before getting the final results of regression estimates for the wages of ICT personnel in the Thai ICT labour market, wage equations are estimated as follows:

$$W_i = C + \delta.Wkh_i + \alpha.Wkh_i^2 + \mu.Bonus_i + \theta.Size_i + \gamma.Age_i + €.Gender_i + \pi.YrSch_i + \vartheta.EduICT_i + \varepsilon_i^{s-d} \quad (4.8)$$

where W_i is the average wage of ICT industry, Wkh_i and Wkh_i^2 are total working hours and square total working hours, $Bonus_i$ is level of bonus, $Size_i$ is size of firms, Age_i is average age, $Gender_i$ is the dummy variables, which 0 is female and 1 is male, $YrSch_i$ is years of schooling, $EduICT_i$ is the dummy variables, which 0 is non-ICT major and 1 is ICT major field of education, and ε_i^{s-d} is a random unobservable term. The estimated result is as shown in Table 4-9. The sample covers the data of the Labour Force Survey for the year 2012 and 2015 for the fourth quarters. The t-statistics are in parentheses. The focus point of the results shown in Table 4.9 is on the variable education major ICT (Edu_Major_ICT). Concerning the results from both models for 2012 and 2015, it can be interpreted that the wage level of ICT personnel who graduated in an ICT-related field of education is higher than those from a non-ICT field of education. This implies that there is excess demand for ICT personnel, particularly those who directly graduated in an ICT-related field of education, as reflected by the relatively higher wage level.

Table 4-9 Regression Estimates for Wage of ICT personnel in the Thai ICT Labour Market

Variables	Definitions	2012	2015
C	Constant	-8753.5	-287953.8
		(-27.8)***	(-141.4)***
Total_hr	Total working hour	105.8	-146.5
		(17.6)***	(-3.2)***
Sq_Total_hr	Total working hour*2	-1.5	-14.5
		(-24.1)***	(-27.4)***
Bonus	Bonus	-0.049	0.6
		(-2.6)***	(657.1)***
Size	Size of firms	237.3	5071.5
		(30.8)***	(135.5)***
Age	Age (years)	290.9	553.9
		(197.6)***	(69.6)***
Gender	Male or Female	-1651.1	-6384.2
		(-51.3)***	(-42.4)***
Yr_of_schooling	Education Level	1150.7	19991.4
		(292.6)***	(187.1)***
Edu_Major_ICT	ICT-related field of education	678.1	2115.5
		(5.1)***	(10.9)***
N	Sample size (persons)	13,266,894	2,464,274
Adj R2		0.009	0.185

Source: Author's calculation using LFS data (NSO, 2012 and 2015).
Note: The dependent variable is wage level. Estimates are sample weighted to be representatives of ICT personnel in the Thai ICT labour market. *** indicates that the estimate had a statistically significant difference from zero at the 1 percent level.

Due to the higher value of R^2 in model 2015, this study will use it to explain the determinants affecting the wage levels of ICT personnel in the Thai ICT labour market. The result from model 2015 indicates the statistically significant negative effect of total working hours on wage, implying that the productivity of ICT personnel does not depend on working hours. It may depend on other factors such as the high level of expertise and intense utilization of specific knowledge and skills instead. On the other hand, the variables of bonus, age, years of schooling and size of firms indicate a positive effect on wage. This implies that the performance or profits of firms will result in a higher level of bonus, which will then lead

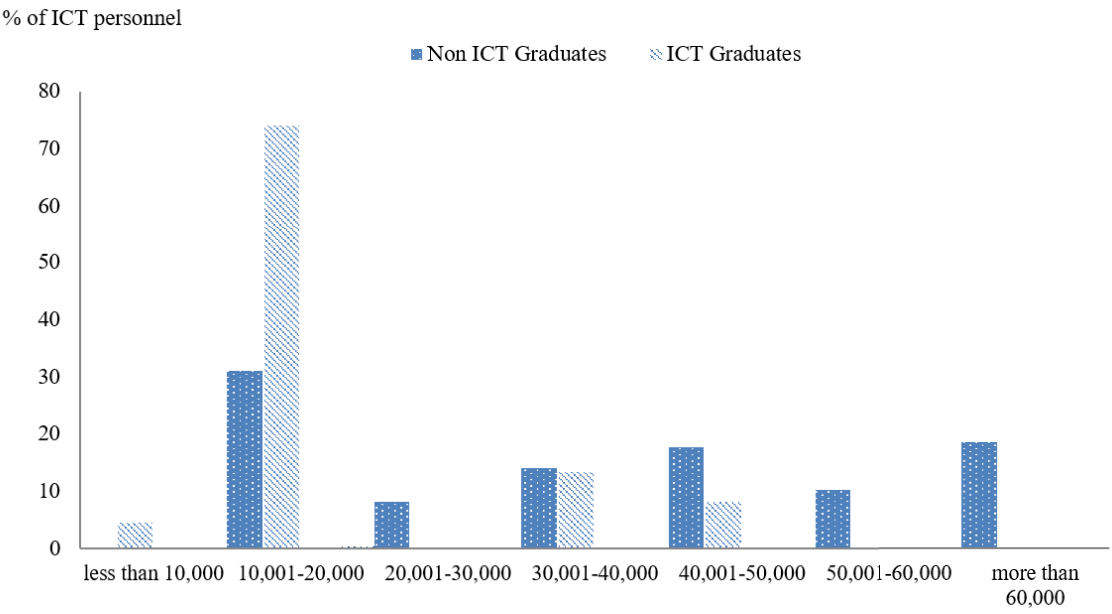
to the higher wage level of ICT-related occupations. Also, the older the ICT personnel are, and the higher the education level ICT personnel have, the higher level of wage they will earn in the Thai ICT labour market. In particular, they will get a higher level of wage if they have been employed in large-sized firms, as reflected by the positive effect of the variable size of firm. The results from the variable on gender present an interesting interpretation. That is, female ICT personnel get relatively higher wage levels than their male colleagues.

In brief, there is excess demand or a shortage of ICT personnel, particularly those who directly graduated in an ICT-related field of education. This is reflected by the fact that ICT personnel who graduated in an ICT-related field of education received a relatively higher wage level, compared to those who did not. The determinants affecting the higher wage level of the personnel in this profession are age, education level, size and performance of the firms. Age and education level reflects the knowledge, experience and expertise level; wherein the higher the level of these two variables, the higher the wage level ICT personnel can earn. The size and performance of the firms also have a positive effect on wage; wherein the larger the size of the firms and the better the performance they have, the higher the wage level the firms can pay. On the other hands, long working hours exhibit a negative impact on ICT personnel's wage level. This implies that productivity affecting the wage level of this group results from their level of knowledge, experience and expertise as well as intense utilization of it rather than depending on how long their working hours are during the workweek.

In alignment with the regression estimates of wage and the determinants affecting the wages of ICT personnel in the Thai ICT labour market, the following Figures 4-4 and 4-5 indicate the structure of the wages of the ICT personnel in 2012 and 2015. ICT personnel in these two figures are divided into two groups: those who graduated in ICT and those who did not. As shown in Figures 4-4 and 4-5, most ICT personnel were concentrated the low wage

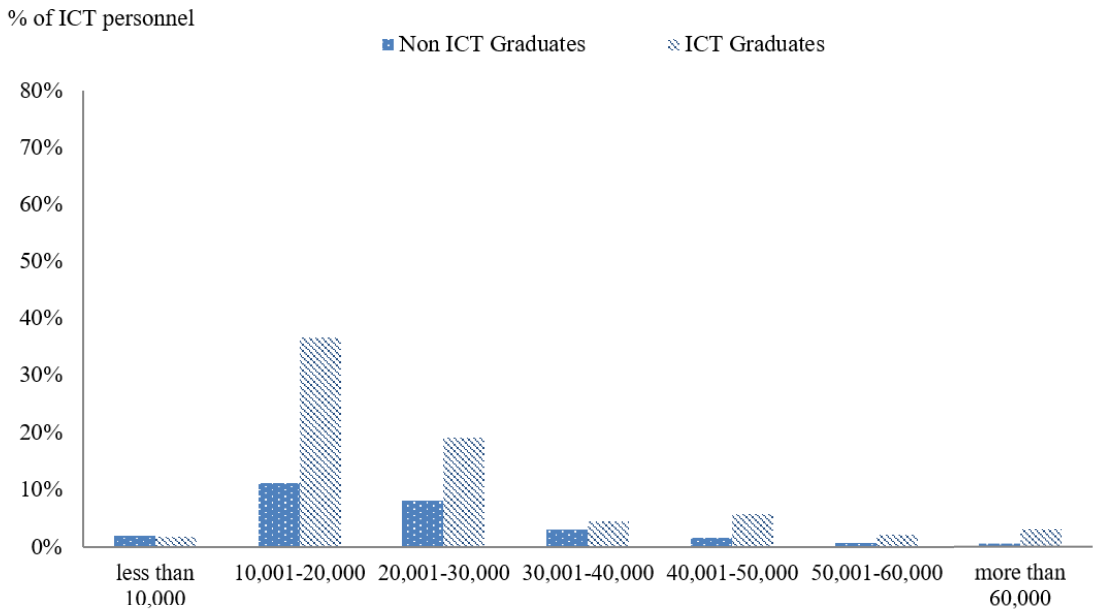
level, ranging between 10,001-20,000 baht per month both in 2012 and 2015. When comparing the two figures, it was found that ICT personnel who graduated in the ICT field have earned a lower level of wage than those who did not graduate in ICT field in 2012. However, the wage structure changed in 2015. ICT personnel who graduated in the ICT field earned a higher level of wage than those who did not, implying skill-biased technological change and the increasing demand for ICT personnel who directly graduated in an ICT-related field of education.

Figure 4-4 Monthly Wage of ICT Personnel in the Thai ICT Industry (2012)



Source: Author`s tabulation using LFS 2012/Q4 (NSO).

Figure 4-5: Monthly Wage of ICT Personnel in the Thai ICT Labour Market (2015)



Source: Author's tabulation using LFS 2015/Q4 (NSO).

After gaining an understanding of the shortages of ICT personnel in the Thai ICT labour market by separately analyzing all three important factors of demand, supply and wage, the next section will synthesize these factors and summarize the situation regarding the shortage of ICT personnel and the responses in terms of supply and wages in the Thai ICT labour market.

4.5 Conclusion

This chapter explored the tightness of the Thai labour market through the UV ratio, the shortage of ICT personnel and also the responses in terms of supply and wage in the Thai ICT labour market. The number of ICT personnel accounts merely for 0.6 per cent of total employment in the Thai labour market. However, the employment growth rate particularly for information, computer and communications as well as professional, scientific and

technical sectors has substantially increased. The employment demand for ICT personnel in the Thai ICT labour market in this study has been categorized into three levels: manager, professional and technician; of which two-thirds worked at technician level, one-third at professional level and a small number at manager level.

Shortages of ICT personnel have occurred in all the aforementioned three levels of expertise, especially professional and technician levels as shown by the negative employment growth rates of the particular ICT-related occupations. These shortages are computer network professional, application programmer, and system administrator at the professional level, and also ICT operation technician, civil engineering technician and mechanical engineering technician at the technician level. At the same time, some ICT-related occupations reveal a substantial increase in demand, namely, software developer, web and multimedia developer and database designer and administrator at the professional level, and also telecommunications engineering technician, web technician and ICT user support technician at the technician level.

Considering the supply of the ICT graduates, the responses reveal an inadequate number of ICT graduates and a lag time in the education system adjustment. The ratio of the ICT graduates accounts only for 10 per cent of the total number of graduates in the Thai education system (approximately 30,000 persons per year) and its growth rate has also consistently decreased by 1.4 per cent per year during 2008-2015. In particular, the substantial decrease in the number of Thai ICT graduates has been in the field of computer science. However, there are three ICT-related fields of education showing an increasing growth rate: telecommunications and ICT engineering, maths and statistics and software, network and internet engineering. The increasing number of ICT graduates in these three fields has been in alignment with the increasing demand for the ICT-related occupations,

especially software, web and multimedia developer, database designer and administrator, telecommunications engineering technician and ICT user support technician in the Thai ICT labour market.

Regarding the wage level and wage growth rate of ICT personnel, the responses are that the wage levels are unattractive. Most ICT personnel in the Thai ICT labour market have low levels of wage, ranging between 10,000-30,000 baht per month. Also, the wage growth rate of some ICT-related occupations, particularly computer network professionals, database designers and administrators, computer network and system technicians, and ICT user support technicians have been decreasing (2012-2015). Wage, which is an important variable in labour market adjustment, can be used as an indirect proxy to indicate shortage or excess demand for specific types of occupations. An increase in demand typically results in higher wages. There has been a substantial increase in wage growth rates for the ICT-related occupations of system analyst, system administrator, civil engineering technician, electronic engineering technician and ICT operation technician. Again, such an increase in wage implicitly reflects an increase in demand. In addition, the results of regression estimates for ICT personnel in the Thai ICT labour market show that ICT personnel who directly graduate in an ICT-related field of education have earned a relatively higher wage than those who did not. Also, this confirmed an increasing demand for ICT personnel, especially those who directly graduated in an ICT-related field. Determinants affecting the wage level of ICT personnel in the Thai ICT labour market consist of the variables of age, education level, size of company, and performance of company. However, the variable of working hours did not.

In sum, shortages of ICT personnel, particularly ICT-related occupations in the Thai ICT labour market, have resulted from an insufficient number of ICT graduates and a decreasing growth rate in ICT graduates supply, as well as unattractive wage levels and

decreasing wage growth rates for some ICT-related occupations. The responses to the supply of ICT graduates are fairly aligned with the direction of demand for ICT personnel, particularly for software, internet, network, telecommunications and ICT fields of education, while the responses to the wages of ICT personnel signal contradictory results.

In actuality, an increase in the number of graduates with bachelor's degree is the only way to alleviate the shortage of ICT personnel in the Thai ICT labour market. However, the academic institutions in the Thai education system have still played a passive role and this is also evidenced by the lag time of adjustment. The responses to counteract the shortages of ICT personnel differ and are specific according to each level of specialization. However, most responses to the labour shortages have related to the Thai education system. As aforementioned, the Thai education needs adjustment time to cope with the shortages situation, and it can supply the ICT graduates with a fixed number per year. Therefore, most companies in the Thai ICT industry have to be self-responsible, and also dependent on the mechanism of the internal labour market on their own. The next chapter will explore the hard-to-fill vacancies and human resource management which companies in each tier have adopted to solve the shortage problems.

Chapter 5

Hard-to-Fill Vacancies and Human Resource Management in the Thai Telecommunications Industry

Introduction

Chapter 4 shows the tightness of the Thai labour market and the shortage of ICT personnel both at professional and technician levels in the Thai ICT external labour market. Most companies in this industry have faced recruitment difficulties or hard-to-fill vacancies, particularly for computer network professionals and application programmers at professional level and for computer systems and network technicians at technician level.

At industry level, approximately 91 per cent of the total number of companies reported that they do not require the help of the government to solve the ICT-related problems including the shortage of ICT personnel (NSO 2015b) [36]. Indeed, most companies in the case studies claimed that the Thai education system could not respond to their demand for ICT personnel recruitment in time. Therefore, they have to develop human resource management (HRM)[37] practices in their internal labor markets in order to attract, maintain and develop ICT personnel as a response to this shortage problem[38].

They have prioritized highly skilled personnel with thorough knowledge of technological-based management and managerial skills as their valuable asset and have kept

[36] The number of companies in this report is approximately 2.2 million establishments.

[37] Human resource management is a set of interrelated activities, functions and processes aimed at attracting, developing, and maintaining a company's human resources (Lado and Wilson 1994). It includes policies and practices to recruit, select, develop, utilize, reward, and maximize the potential of human resources in the companies (Sorasak, Jirasek, and Nutthawut 2014). Human resource can also contribute to the renewal of the companies' capabilities and competences by enabling companies to adapt to the changing environment. Particularly, when the companies focus on "employee flexibility" (whether in terms of numerical, functional or financial flexibility (Regini 2000)) as a strategic resource that becomes fundamental for companies to change their routines, services, products, or even markets over time (Beltran and Roca 2013). In this flexible operation, employees have to be willing and be able to work in a variety of areas and with broad skills (Purcell 1989, p.77).

[38] Interview with CEO of CSS on 28 July 2015 and Unit Head People Partners Technology Group of DTAC on 17 December 2014, and 24 March 2015.

long-term employment relations since the capabilities of these qualified personnel help strengthen and sustain the companies' success and competitiveness (Ross and Bamber 2000; Nittana and Walsh 2010).

However, the constraint lies in the shortage problem as shown in Chapter 4. In particular, the case study companies in the Thai telecommunications industry have faced difficulties in recruiting ICT personnel, particularly ICT professionals at the principle-tier companies and ICT technicians at the first-tier companies. The characteristics of shortages of ICT personnel differ between the companies in each tier due to the different requirements in expertise levels. The principle-tier companies, whose core tasks are to operate and provide mobile-cellular services, mostly required for ICT personnel at professional level to perform network quality management and operational excellency. On the other hand, the first-tier contractors, whose core tasks are to design telecommunications antenna and supervise civil works[39], telecommunications equipment installation and integrated commissioning, exhibit a greater demand for ICT personnel at technician level to perform telecommunications engineering, and also CAD/CAM antenna design.

Therefore, companies in each tier have adopted different practices of HRM in response to the hard-to-fill vacancies and the shortage of ICT personnel. Nevertheless, there are three typical practices of HRM that counteract the shortage problem as follows: (1) review recruitment practices, (2) extend training strategies in the workplace, and (3) broaden the typical pools of talent (CEDEFOP 2014). Thus, the objectives of this chapter are to explore the situation of hard-to-fill vacancies in the Thai telecommunications industry, and to

[39] Civil work refers to site construction which is the third stage of the workflow of the new sites of telecommunications towers as shown in figure 2-3 in Chapter 2. The word "civil work" is a technical term and is used in formal agreement between the principle-tier telecoms operators and the first-tier contractors for the roll-out projects of the telecommunications tower, which are divided into two parts. The first part is civil infrastructure or civil work including tower structure, shelter, aviation warning and grounding system, rectifier battery and air con system. The second part is telecoms infrastructure including WiMax, WiFi equipment, feeder, connector, outdoor and indoor antenna, TMA, booster, repeater and ANF.

clarify HRM practices which case study companies use to counteract shortage problem especially within their internal labor markets. This chapter consists of four sections. The first explores the situation of the hard-to-fill vacancies and HRM practices of the principle-tier case study companies. The second clarifies the hard-to-fill vacancies and HRM practices of the first-tier companies. The third compares and discusses the different aspects of HRM practices between the principle-tier and the first-tier companies. The fourth presents the conclusions of the chapter.

In terms of data and methodology, micro personnel data and corporate documents were used to analyze the hard-to-fill vacancies and the characteristics of the ICT personnel of case study companies. Also, face-to-face interviews were conducted to clarify their HRM practices in response to the shortages of ICT personnel and hard-to-fill vacancies at company level.

5.1 Hard-to-Fill Vacancies and HRM Practices at the Principle-tier Companies

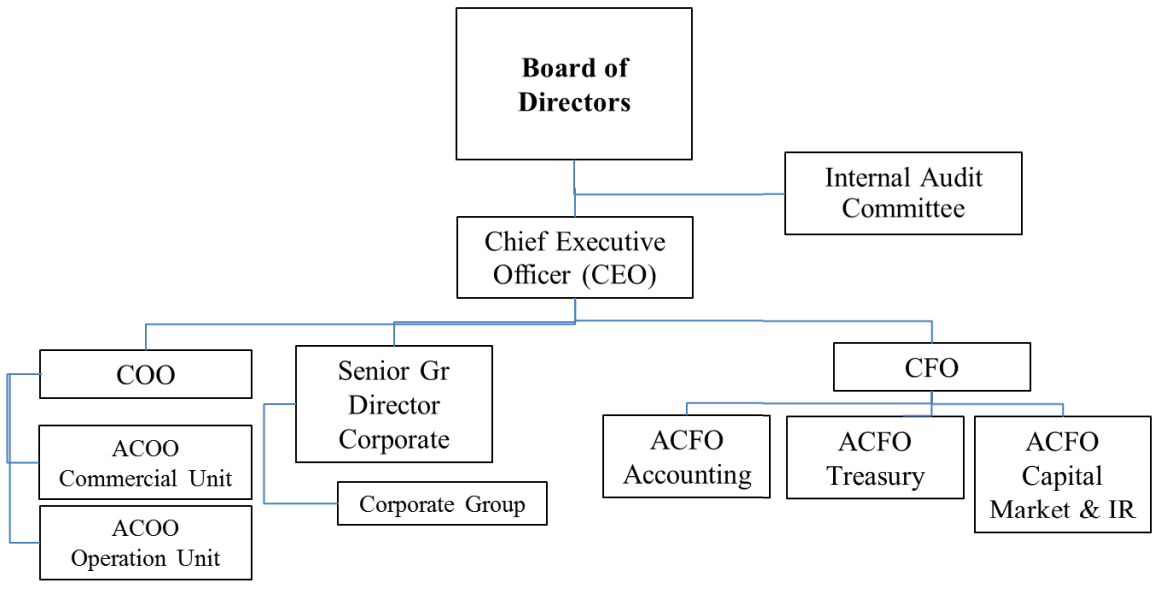
The principle-tier company in this case study, namely DTAC, is the second leading telecoms operator in Thailand. As mentioned earlier, the company was established in August 1989 by the Bencharongkul family with the aims to provide the best quality mobile network to the end users. Therefore, the company's core tasks are to operate and provide a mobile cellular service, acquire radio frequency (RF) spectrum licenses and raise capital for investment.

As discussed in Chapter 3, the core competences and capabilities of the companies are cultivated and cumulated through their internal human resources. The number of personnel at DTAC is approximately 4,400 persons, of which 10 percent have worked in the technology

group and 18 percent in the engineering group. These two groups are the core employees responsible for operating mobile network services and the RF process.

Figure 5-1 shows the organization chart of DTAC. The main business units are divided into two units: operation (COO), and financial (CFO). COO is further divided into two units: commercial unit and operation unit, while CFO is further divided into three units: accounting, treasury, and capital market and internal revenue (IR). The focused business unit of this chapter is on the operation unit, which can be further divided into the two groups of the technology group and the engineering group. The share of personnel in these two groups are approximately one-third of the total number of personnel in the company. The difference between the personnel in the technology group and the engineering group concerns the functional description of their job positions.

Figure 5-1: DTAC Organization Chart



Source: DTAC (2013).

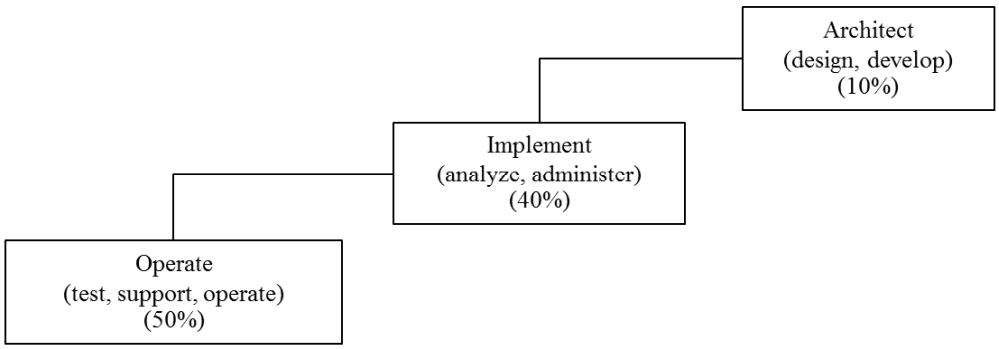
As shown in Figure 2-3 in Chapter 2, the core functions of the engineering group focus on site preparation and site construction by coordinating and consulting with the first-tier contractor on the telecoms project-based contract, whereas the core function of the technology group concern the site implementation, particularly the mobile network and RF process. In other words, the engineering group has worked in hard infrastructure, while the technology group has worked in soft infrastructure, and also sector-based applications, as shown in Chapter 1 on the digital economy scheme.

Since the micro-personnel data retrieved from the people partner unit of DTAC are representative of the personnel in the technology group, the analysis on hard-to-fill vacancies and HRM practices will address the technology group accordingly. Figure 5-2 shows three levels of expertise among the personnel in the technology group at DTAC as follows: the operate, implement and architect levels. There are approximately 440 persons employed in the technology group, which accounting for 10 percent of the total number of personnel employed at DTAC[40]. The ratios of personnel working in each expertise level of operate, implement and architect are 50:40:10 percent of all 440 personnel in the technology group.

The core task of the operate level is to test, support and operate, which involves the lowest level of expertise. The core task of the implement level is to analyze and administer, which requires the middle level of expertise. The core task of the architect level is to design and develop, which is the highest. Each expertise level can be further divided into the three functional areas of network and system, platform and value-added service (VAS) and software and application.

[40] TG-People Partner Unit, People Partner and Recruitment Division, retrieved data on March 24, 2015.

Figure 5-2: The Three Expertise Levels in Technology Group, Core Functions and Share of Personnel (%)



Source: Author`s arrangement based on interview.

Therefore, the broad range of jobs in the technology group at DTAC can be divided into three expertise levels on a vertical axis and three functional areas on a horizontal axis and then further categorized into a nine-grid box as shown in the following Table 5-1. To put it simply, the nine-grid box of technology-related jobs in the technology group at DTAC is divided according to expertise levels and functional areas.

The lowest expertise level is that of operate, of which the core tasks are to test, support and operate on the three functional areas mentioned above. The name of most jobs on this level end with the word "operation". The first functional area is the network and system which comprises a various type of jobs related to the network and system, according to the name. These include core network operation (voice and data), transport operation (IP/IP RAN)[41], IP and wireless broadband network operation, and also system operator.

[41] IP stands for Internet Protocol is the principal communications protocol in the Internet protocol suites. (https://www.dmoz.org/Computers/Internet/Protocols) and RAN stands for Radio Access Network.

Table 5-1: Nine Grid Box of Technology-related Jobs at DTAC

Expertise Levels	Functional Areas		
	Network & System	**Platform & VAS**	**Software & Application**
Architect (Design & Develop)	A. 1. Core network architect 2. Transport planning and architect	B. 1. Radio planning and optimization (eg. RPO BMA North, RAN Architecture) 2. Billing generation and RA (revenue assurance) 3. Service platform design 4. Mobile developer (iOS) for digital platform	C. 1. iOS software developer 2. UI/UX designer 3. IT specialist (mobile application developer iOS and Android) 4. Channel and campaign development (ie messaging)
Implement (Analyze & Administer)	D. 1. Voice core design and implement 2. Data core design and implement 3. IP core network engineer 4. Online system analyst (engineer)	E. 1. Enterprise infrastructure design and implement 2. VAS design and implement 3. Enterprise service engineer	F. 1. SDP and partner solution 2. Internet and mobile solution 3. Data and digital analytics, 4. Strategic project roll out and evaluation specialist
Operate (Test & Support)	G 1. Core network operation (data and voice) 2. Transport operation (IP/ IP RAN) 3. System operator 4. IP and wireless broadband network operation	H 1. Billing operation 2. Enterprise infrastructure operation 3. VAS operation (messaging/roaming)	I 1. Service operation 2. Programmer

Source: Author's arrangement based on corporate document of DTAC, JobDB, and interviews.

The second functional area is platform and VAS, which consists of the three key components of the company's platform, namely billing, enterprise infrastructure and VAS. Billing operation is the platform to capture and collect the money stream from the mobile network usage of the customers. It is one of the key functions because the success of this function can generate high revenue, according to the interviews with the TG-People Partner unit of the IT group[42]. Next, the enterprise infrastructure operation is responsible for operating internal information systems so as to ensure security and effective integration with all related systems and applications within the enterprise. Lastly, VAS (value-added services) are important components of telecommunications services which help create the company's distinctiveness and which are always in need of an upgrade. Mobile's VAS comprise voice

[42] Interviewed with TG-People Partner Unit, People Partner and Recruitment Division on Wednesday 17 December, 2014 at True Coffee, Chamchuree Square.

service, non-voice service, data usage, online transactions, messaging and roaming services as well as other kinds of services created to serve customers' demands.

The third functional area is that of software and application. Most personnel working in this functional area are programmers, operators and also developers related to various kinds of mobile solution services, for example, iOS software developers, UI/UX designers, mobile application developers, Internet and mobile solution, data and digital analytics, SDP (Software-Defined Protection) and partner solution, channel and campaign developers and so on.

As mentioned earlier, half of the total number of personnel in the technology group are working on the operate level. Their core tasks are to test, support and operate in the three functional areas of network and system, platform and VAS, and also software and application. In general, there are rarely any hard-to-fill vacancies at this operate level compared to the implement and architect levels.

This is because the educational backgrounds required for working in this expertise level are a mix between S&T (science and technology) and non-S&T, for example electrical engineering, computer engineering, information technology, computer information science, management information systems, mathematics, economics, education, business administration, and so on. The educational institutes are also various, extending beyond the scope of technology institutes, for example Pratumwan Institute of Technology, Prince Songkla University, Rajamangala Institute of Technology, Mahanakorn University of Technology, King Mongkut's Institute of Technology, Kasetsart University, Ramkamhaeng University, and so on. Nevertheless, the minimum education level required for the operate group is bachelor's degree.

Though shortages of ICT personnel rarely happen at the operate level, hard-to-fill vacancies still occur in boxes G and I. This is because the number of graduates in computer science and computer engineering have consistently decreased and there still remains a small number of graduates from network engineering and software engineering in the Thai external labour market as discussed in Chapter 4. In addition, this group of personnel have been in demand not only for companies in the telecommunications industry, but also for companies in non-telecommunications industries, such as banking, finance, insurance, hospital, software, data warehouse and other industries as well.

The middle level of expertise is the implement level. Their core tasks are to analyze, administer, and design in some specific areas. Like the operate level, technology-related job positions at the implement level can be divided into the three functional areas of network and system, platform and VAS, and software and application. The job positions of the first two functional areas network and system and platform and VAS are relatively the same as those at the operate level. However, they differ aspect in the level of expertise. The expertise level at the implement level requires greater years of experience, higher expertise level and also specific certificates for some job positions. The job positions in the network and system functional area include IP core network engineer, data and voice core design and implement, and online system analyst. The job positions in the platform and VAS functional area are the enterprise infrastructure design and implement, enterprise service engineer, and VAS design and implement. The third functional area is software and application. The job positions in this functional area are various according to specific service solutions, for example, SDP and partner solutions, internet and mobile solutions, data and digital analytics, and also strategic project roll out and evaluation specialisms.

There are approximately forty percent of the total number of personnel in the technology group working in the implementation level. Like the operate level, all personnel in this level have to graduate with a bachelor's degree at the very least. However, the different aspect is that of the educational majors and institutional types. Almost all of the personnel on the implement level have educational majors in engineering or IT, and have earned degrees from institutes of technology, or faculties of engineering from high ranking universities in Thailand, for example, Chulalongkorn University, King Mongkut's Institute of Technology (Ladkrabang, Thanyaburi), Kasetsart University and so on, and their majors concentrated on electrical engineering, computer engineering, statistics and so on.

Most hard-to-fill vacancies at the implement level exist in all boxes D, E and F, resulting from the small supply of graduates in the field of ICT, software, internet, and network engineering as discussed in Chapter 4. Also, another reason for recruitment difficulty is the aspect of years of experience and specific certificates for some jobs. According to the interviews, the years of experience required by the principle-tier companies are at least three years for entry level and at least five years for the middle level. In particular, some positions require ten years of experience, for example engineer specialist touch point E2E process development and design (required experience in Lean Six Sigma), or the job position of enterprise service engineer (AIS) requires three years of experience at entry level and six years of experience at middle level in the field of computer network, data network, mobile telecoms, project management and VAS. In addition, according to the Deputy Director Resourcing Center of True Move, the Thai engineering graduates prefer continuing with their master degrees than entering into the labour market and gaining work experience after their

immediate graduation[43]. Therefore, most ICT professionals in the Thai external labour market are new graduates rather than experienced ones.

Finally, the highest level of expertise is the architect level. Their core tasks are to design and develop in all three functional areas of network and system, platform and VAS, and software and application. Overall, the personnel working at architect level have to be able to manage core network planning and architecture design in order to ensure the efficiency and optimization of the designed system in terms of cost, coverage and capacity management. Also, they have to be able to design and develop the voice and data core network in aligning with the technology strategy, roadmap and enterprise architecture, and have to be able to gather past data records and information related to the core network platform, services and system for use as supportive data to estimate the technology strategic plan and support the future growth of the company[44].

The number of technology-related job positions in the functional area of network and system is small but they require the most sophisticated and highest level of expertise. This includes core network architecture and transport planning and architecture. Next, the jobs in the platform and VAS function are mostly related to RF. This includes radio planning and optimization (RPO), which is divided into regional areas comprising five main regions and ten minor areas such as North, South (for example, RPO BMA North[45], RAN Architecture), billing generation and RA (revenue assurance), service platform design, and mobile developer (iOS) for digital platforms[46]. Like the jobs at the implement level, the jobs in the software and application functional area at architect level are various according to the

[43] Interviewed with Deputy Director Resourcing Center of True Move on 27 July 2015 at True Headquarters.
[44] DTAC's Functional Description of Architect (Hays Groups).
[45] RPO BMA stands for Radio Planning and Optimization of Base transceiver station Measure Average (telecoms antenna) which can be recognized as the most important job for the principle-tier main telecoms operators as discussed in Chapter 2 (http://www.fujitsu.com/downloads/MAG/vol38-2/paper07.pdf).
[46] Interview with Deputy Director Resourcing Center of True Move on 27 July 2015 at True Headquarters.

specific types of software and application as well as specific service solutions. These positions include iOS software engineer, UI/UX designer, IT specialist (mobile application developer iOS and Android), channel and campaign developer (such as, messaging).

Approximately ten percent of the total number of personnel in the technology group have been employed at the architect level. Like the educational background of the personnel at implement level, the personnel at this architect level have to graduate from IT or engineering fields and with a bachelor's degree at the very least. However, the different requirements are those concerning the number of years and fields of work experiences. The personnel at the architect level have to have work experiences in the specific fields shown in box C, such as iOS software, UI/UX for an average of seven years and above. Their fields of education include electrical engineering, information technology, computer and information science, management information systems, mathematics and so on. The education institutions are various and not limited to technology institutes like those in the implement level. ICT professionals at the architect level have earned degrees both from domestic and foreign universities, for example, Chulalongkorn University, King Mongkut's Institute of Technology (Thonburi), Ramkamheang University, Kasetsart University, NIDA, Monash University, Institute de'l Enfant Jesus, Swinburne University of Technology, University of Newcastle, and so on.

Based on interviews with the TG-People Partner Unit of DTAC, the architect level requires the longest time to fill the vacancies in all three functional areas including application architect, infrastructure or platform architect, and also network architect[47]. This is because there are few ICT professionals holding the sufficient qualifications and expertise to work at the architect level without any needs of training. Also, ICT professionals at this

[47] Interview with TG-People Partner Unit, People Partner and Recruitment Division on March 24, 2016.

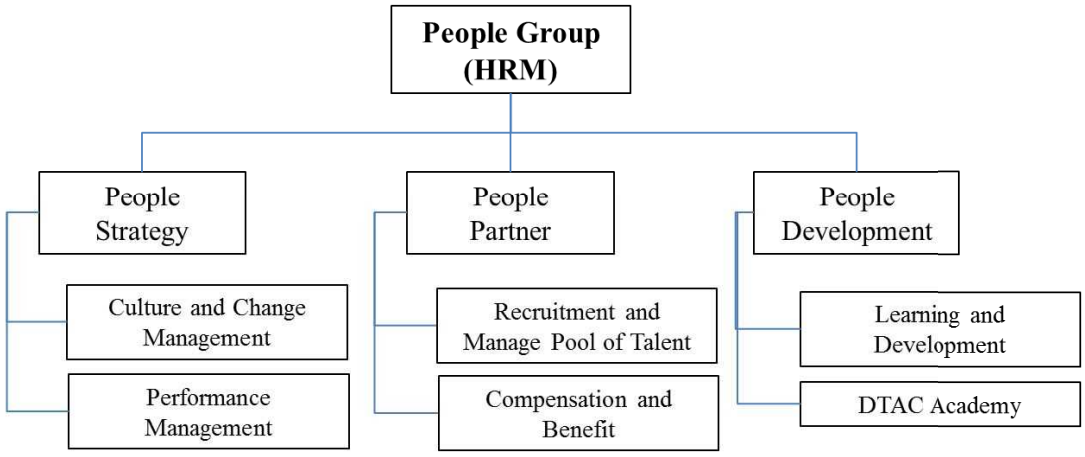
architect level need to gain IT certificates such as IP/TCP (Internet Protocol/Transmission Control Protocol), core network and project management for the authorization of each particular roll-out project. What's more, like the reasons for the shortage at the operate level, ICT professionals at the architect level are in demanded not only in the telecommunications industry, but also in the non-telecommunications industries, such as banking, finance, insurance, hospital, software, data warehouse and other industries as well.

In sum, difficulties in recruiting personnel with ICT professional at the principle-tier companies result from the shortage of skilled people in all three functional areas and three expertise levels. As discussed in Chapter 4, the educational market for ICT professionals has been subject to structural changes. The educational institutes and universities in Thailand can supply only a small number of graduates in the ICT-related field of education, resulting from the lag adjustment in the supply of the graduates which cannot be aligned with the demand in a timely manner.

Therefore, the principle-tier companies have to develop practices of HRM in their internal labour markets to counteract this shortage of ICT personnel on the one hand, and to protect their core competences, the root of their fundamental growth and competitive advantage, on the other. In particular, the case study companies, DTAC and True Move, have developed the following three practices of HRM: (1) review the recruitment practices, (2) extend the training strategies and (3) broaden the typical pool of talent through re-assignment in a fast-track talent management program in response to the shortage problem.

The main business unit responsible for the aforementioned tasks is the people (HRM) group. Figure 5-3 shows the three divisions of the People Group (HRM) at DTAC: (1) People Strategy, (2) People Partner and (3) People Development.

Figure 5-3: DTAC HRM Group



Source: Author's creation based on interviews.

The first division, People Strategy, is accountable for culture and change management, and also performance management. The second division, People Partner, is accountable for the recruitment, pool of talent management, and also compensation and benefit. The third division, People Development, is accountable for learning and development, and also the DTAC Academy[48]. Thus, these three practices of HRM, which the principle-tier companies use to counteract the shortage of ICT professionals are cooperatively and connectedly responsible by through the People Group (HRM) as shown in Figure 5-3. In other words, People Strategy and People Partner mutually review recruitment practices and also broaden the typical pools of talent, while People Development focuses on extending training strategies.

[48] DTAC Academy was established in 2011 under the responsibilities of the division of "People Development: Learning and Development". It is a three-year development program, putting people into different curriculum programs which lay down the necessary competencies. The focus of training is on both general competencies and leadership development and focus areas, such as sales, customer services, technical and technology. It is a roadmap for people growing to the future through a functional training and development career path. There are eight competences which DTAC Academy considers important: (1) analytical thinking, (2) conceptual thinking, (3) customer service orientation, (4) initiative and innovation, (5) decision making, (6) achievement orientation, (7) continuous learning and (8) teamwork. In the past, DTAC focused on (3) customer service orientation because this competency drove company success in the past. However, now the company has added and focuses on (1) analytical thinking and (2) conceptual thinking because the company considers these two competencies as important for every position and as helping elevate the quality of work. (Interview with Senior Vice President/People Group of DTAC on 13 August 2014 at DTAC Headquarters).

The core task of all three divisions cannot be totally separated. Rather, collaboration among these three HRM practices is needed to respond to the shortage problem.

The first practice HRM is to review recruitment method. Typically, there are two levels of recruitment for ICT professionals in the Thai telecommunications industry. The first level is the entry level or the graduate students, whereby the companies directly use recruitment channels of campus recruitment and walk-in applications. The second level is mid-careerists who hold work experiences in the specific field, whereby the companies use the recruitment channels of personal referrals, and professional searches and networks. Most mid-careerists are recruited from ICT professionals in the first-tier and the second-tier companies.

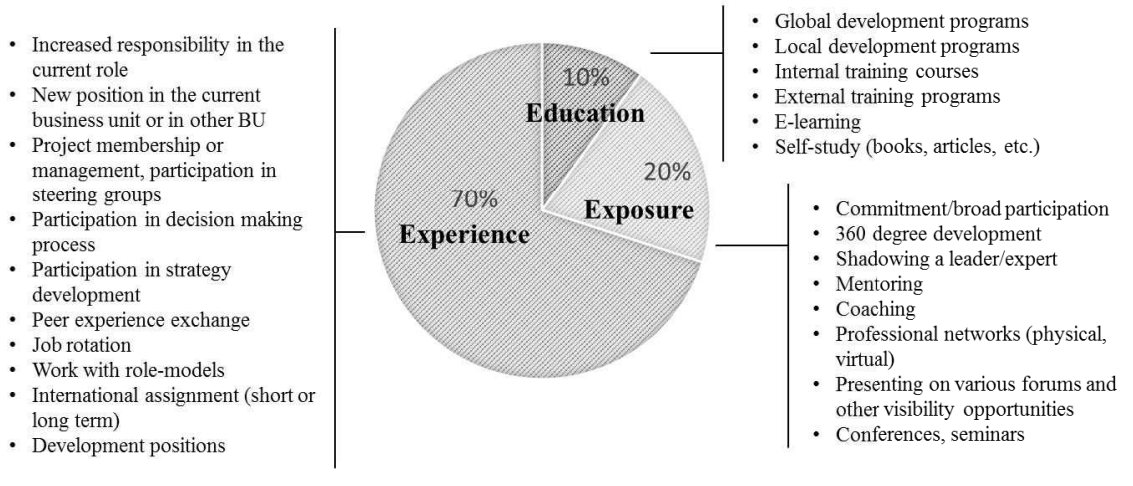
However, due to the shortage of ICT personnel in the Thai ICT labour market, the principle-tier companies in the Thai telecommunications industry have to widen the channels and methods of recruitment beyond the typical recruitment practices in order to fill the hard-to-fill vacancies of ICT professionals both at entry level and mid-career level from the external labour market. Specifically, DTAC has extended recruitment channels through a variety of methods, for example, using a head-hunting agency, posting online advertisements on JobsDB, motivating the use of personal referrals through networks of DTAC colleagues. The company also implements a more proactive approach to recruiting the best performing students from the leading universities in Thailand by providing them internship opportunities on a project-based basis to gain work experience and get accustomed to the workplace atmosphere at DTAC.

In addition, in the case of True Move, the company has created the networking relationship with the targeted universities. For example, True Move collaborated with Mahidol university to design and develop engineering curriculum in telecommunications

enterprise and architecture and the company has also provided a two-month project-based apprenticeship for junior and sophomore students under the project of "True Next Generation" in order to expand the relationship with their targeted students.

In addition to reviewing the recruitment practices, the principle-tier companies have extended their training strategies by establishing their own corporate academic institutes, for example, True academy and DTAC academy. For example, True Move created the "True Star" program to select high-potential ICT professionals, accounting for one percent of the engineering group, and intensively supporting them in training and development of their capabilities in a fast-track manner. Also, DTAC has developed the DTAC 3E Talent Development Model in order to grow their internal talents. Figure 5-4 shows the DTAC 3E Talent Development Model. The 3E stands for experience, exposure and education, which have been proportionally weighted as 70:20:10 percent respectively. The company extended their training strategies by paying the highest attention to on-the-job training, or 70% E-Experience in the 3E Talent Development Model.

Figure 5-4: DTAC 3E Talent Development Model: Let Your Talent Grow



Source: DTAC Corporate Document.

The first E, Experience, refers to OJT, which both ICT professionals and DTAC people develop through actual assignments since the company has tried to encourage senior employees to share their knowledge and experience with their juniors. For example, DTAC has supported their personnel to gain experiences through various internal channels, for example, increasing responsibility in the current role, new positions in the current business unit or in other business units, participation in the decision making process and in strategy development, peer experience exchange, job rotation, work with role-models, international assignments and development positions.

The second E, Exposure, deals with encouraging both ICT professionals and DTAC people to attend certain projects and conferences, to engage in and share some important projects, information, initiatives and professional networks (both physical and virtual stances) as well as mentoring, coaching and shadowing a leader or expert. The third E, Education, is concerned with OFF-JT by letting ICT professionals and DTAC people participate in global or local development programs, internal training courses, external training programs, e-learning and also self-study.

In addition to the provision of training through various internal channels, the company has also extended training through diverse external channels for their human resource development, for example, international assignment, global development programs, presentation on various forums, and other visibility opportunities, conferences and seminars and also external training programs. Another alternative of external training used by the principle-tier companies in the Thai telecommunications industry is industry-based educations or vendor-based certification schemes, which have become one of the main approaches for ICT skill provision and skill development in the fast-moving area of ICT skills (ITU 2008, pp.12-15).This is because the placement system for professional jobs

including those of ICT professionals, requires specific education or training certificates, which are formally incorporated into licensing requirements (Doeringer and Piore 1971).

In Thailand, the IMC Institute, Telecom Academy or ComTia Thailand have become alternative external industry-based training institutes to equip and upgrade ICT skills for ICT professionals working in the principle-tier companies. Table 5-2 shows the industry-based training courses divided by the functional areas of network and system, platform and VAS, software and application, and soft skills in Thailand. These industry-based training courses have been provided by IMC Institute (Thailand), whose main mission is to conduct research on ICT markets and develop human capital in emerging IT technology trends in Thailand. As shown in Table 5-2, industry-based training courses provided by IMC institute (Thailand) aim to cultivate capabilities of ICT professionals and are not limited to those who work in the principle-tier companies in the Thai telecommunications industry[49]. The courses can be divided into four functional areas: network and system, platform and VAS, software and application, and soft skills. Each functional area can be further divided into specific training tracks, for example big data and data science, business intelligence (BI) and cloud computing tracks for network and system; IT security, IT architecture and strategy and mobile development tracks for platform and VAS; software engineering, software development, IoT (Internet of Things) tracks for software and application; and also management, sales, IT leadership, IEEE (Institute of Electrical and Electronic Engineers) courses for soft skills.

[49] These industry-based training courses are open to all participants from all industries, and not only limited to principle-tier telecoms operators such as AIS, DTAC and True Move.

Table 5-2: Industry-based Training Courses by Functional Areas in Thailand

Network and System	Platform and VAS	Software and Application	Soft Skills
Big Data and Data Science • Big Data - Certification Course - in Action for Senior Management - using Hadoop Workshop (technical) - Programming using Hadoop for Developer • Designing NoSQL Databases for Business Application • Practical NoSQL Database using Cassandra • Introduction to Data Science/Machine Learning/Big Data Analytics using Spark/Big Data Warehouse with Cassandra & Spark • R Programming for Data Scientist Business Intelligence (BI) • Business Intelligence Design and Process • Data Visualisation Workshop • Web-based Data Visualization with JavaScript Cloud Computing • Practical Cloud Computing for Senior Management • Practical AWS Workshop • Practical Azure Workshop • Azure IoT, Machine Learning and Advanced Analytics • CCC Cloud Essentials + Comp TIA Exam • CCC Virtualization Essentials	IT Security • ISO/IEC 27001:2013 - Fundamental Training Course for Executive - Introduction and Implementation - Implementation and Interpretation Course • Information Security - Awareness Training Course - Risk Management • Guideline for Information Security Awareness Building Course IT Architecture/Strategy • Enterprise Architecture in Cloud Era • Digital Strategy for Enterprise • Enterprise Architecture Intensive Course • SOA - Governance for Executives - Design Patterns - Architect Workshop Certification - Consultant Workshop Mobile Development • iPhone Development using SWIFT • Advanced iPhone Development using SWIFT • Automate Testing for iOS Application on Swift/Android • Mobile Social Application Development for Android OS with Java • Designing Cross-Platform Mobile Application with Cloud Architecture	Software Engineering • Agile Workshop: An alternative software development • Basic Software Testing • Agile Testing in Practice • Advanced Software Testing Techniques • Requirement Analysis, Design and Management • ISTQB- Certified Tester Foundation Level (CTFL) Training Software Development • Source Code Management using Git • Test-Driven Development on Java • Large Scale Java Web Programming on Cloud Platform • Designing and Implementing Hybrid Cloud Application • Java EE Architecture • Microservices with Scala • Java Web Service and SOA Development IoTs (Internet of Things) • Sming Framework IoT Device (ESP8266) (C++) • Raspberry Py Win10 IoT Core (C#) • Raspberry Pi Python Programming (Python) • Arduino Programming IoT Starting Point • Internet of Things Development with Android	Management • IT Leader as a Coach • Practical Time Management • Management Training for The Digital Era Sales • Sales Technique Training for The Digital Era • Effective Negotiation Skills • How to Create Value Added to IT Solution IT Leadership • Effective Collaboration Work using modern IT Tools • Constructive Feedback Simulation Workshop • Constructive Feedback Simulation Workshop • Promoting IT Service Excellence • Building High Performing Team • Communication 3.0 • Cross Functional Management • Presenting with Confidence: Simulation Workshop • Dialogue for IT People IEEE Courses • IEEE Technical Presentation Workshop • IEEE Technical Writing Workshop Project/Service Management • Project Management Essentials • Agile Project Management • IT Service Management Overview ITIL & ISO 20000 (v2011) • CMMI®-DEV v1.3 in Practice • Overview CMMI for Services v1.3

Source: Author's arrangement using IMC Institute Database (IMC Institute 2016).

Note: SOA: Service-oriented architecture, ISTQB: International Software Testing Qualification Board, CCC: Cloud Credential Council, JAVA EE: JAVA Platform Enterprise Edition, IEEE: Institute of Electrical and Electronic Engineers, Swift: Programing language for Apple developer, IoTs: Internet of Things, ISO/IEC 27000:2013: Standard for Information Security Management.

ICT professionals who want to attend the training courses in the network and system functional areas, including Big Data and Data Science, Business Intelligence, and Cloud Computing tracks have to hold a mid-level of expertise at the very least. These courses take approximately 2-5 days of training and charge approximately 10,000-21,000 baht per course. However, there are three courses on big data and data science which require an advanced level of expertise to attend, including Introduction to Data Science, Machine Learning and Big Data Analytics using Spark. Also, there are two courses with the longest required attendance (120 hours) and the highest cost (59,000 baht), namely, Big Data Certification Course and Practical Cloud Computing for Senior Management.

The aims of the courses are to develop the understanding and ability of ICT professionals in big data, business intelligence and cloud computing areas. Their capabilities will be cultivated and built on design, for example, NoSQL database for business application, web-based data visualization with Javascript, and on developing the network system, for example, azure IoTs, CCC (Cloud Credential Council) cloud essentials, CCC virtualization essentials, and business intelligence process, to name a few.

Like the requirement of the courses in the network and system functional area, ICT professionals who want to take the courses in platform and VAS, including IT Security, IT Architecture and Strategy and Mobile Development tracks have to hold a middle level of expertise at the very least. However, the range of prices is relatively lower and the period of attendance is also relatively shorter. The range of prices for IT security is the most varied, from 6,900-8,900 baht per course for the Information Security Awareness Training course to 21,900 baht per course for ISO/IEC 27001:2013 Introduction and Implementation. These courses take approximately 1-2 days of attendance. The aims of the IT security course are to raise awareness, develop understanding of IT security systems and also the ability of IT

security implementation and risk management. Therefore, the focused aspects of the courses in IT architecture and strategy are on the architecture, strategy and governance of an enterprise's IT and SOA (service-oriented architect). The aims of the courses are to develop skills in enterprise architecture in the cloud era, digital strategy for enterprise, SOA governance, SOA architecture and consultancy.

The prices of the courses are set at 10,000 baht per course and takes 1-2 days of attendance, except for the two courses of SOA Architect Workshop Certification and SOA Consultant Workshop. They require an advanced level of expertise, take 3-5 days of attendance, and charge the highest price at 39,000 baht for SOA Architect Workshop and 24,900 baht for SOA Consultant Workshop.

The courses for mobile development function vary according to the variety of mobile technologies, for example, iPhone Development using Swift (programming language for Apple developers), Automated Testing for iOS Applications on Swift or Android, Mobile Social Application Development for Android OS with Java, and Designing Cross-Platform Mobile Application with Cloud Architecture. The aims of the courses are to cultivate the capabilities of ICT professionals to be able to design and develop the mobile technologies in an updated, upgraded and timely manner.

The third functional area is that of software and application, which comprises the three training tracks of software engineering, software development and IoTs tracks. The requirement of the expertise level to attend are diverse, for example, from the basic level for the Basic Software Testing course, to advanced level for Advanced Software Testing Techniques and Designing and Implementing Hybrid Cloud Application. However, most of the courses require a middle level of expertise. The charged prices are the lowest compared to the other two functional areas of network and system, and platform and VAS. Their price

range starts from 7,500 baht, to the highest 15,000 baht for ISTQB-Certified Tester Foundation Level (CTFL) Training. The period of attendance is approximately 1-4 days[50].

The last type of training course is that for soft skills, which include the five training tracks as follows: management, sales, IT leadership, IEEE (Institute of Electrical and Electronic Engineers), and project and service management courses. There is no requirement of expertise level and they take only one day of attendance for the first three training tracks of management, sales and IT leadership. Their price levels are also the lowest at, approximately 7,000-11,000 baht per course. The latter two courses involving IEEE and project and service management require longer attendance and cost higher. IEEE courses take two days and cost 13,000 baht per course, while project and service management courses take three days and cost approximately 12,000-18,000 baht per course. These courses are suited for ICT professionals who change or plan to change their career track from the specialist (professional) track to the generalist (managerial) track since such a change requires the ICT professional to be supplemented and supported by these varying kinds of soft skills.

In brief, the industry-based training courses provided by IMC institute (Thailand) as shown in Table 5-2 are alternative external training courses for ICT professionals working at principle-tier companies in the Thai telecommunications industry. The courses can be divided into functional areas, which are aligned with the three functional areas at DTAC, namely, network and system, platform and VAS, and software and application. Nevertheless, it added soft skills training tracks, including management, sales, IT leadership, IEEE and project and service management which are most suitable for ICT professionals who change or plan to change their career tracks from specialist (professional) to generalist (managerial).

[50] ISTQB is the International Software Testing Qualification Board (www.istqb.org).

Most training courses require a mid-level of expertise at the very least, except some courses which may require basic or advanced levels depending on the complexity of the course contents. The aims of the training tracks are relatively the same, which are to cultivate the capabilities of ICT professionals in each specific area, for example, big data, data science, business intelligence, cloud computing, IT security, IT architecture and strategy, mobile development, software engineering, software development, and IoTs tracks.

However, it seems that the training tracks in (1) network and system, namely, big data and data science, business intelligence, and cloud computing charge the highest prices and take the longest time of attendance, followed by the training tracks in (2) platform and VAS, which comprise IT security, IT architect and strategy and mobile development and then the training tracks in (3) software and application covering software engineering, software development, IoTs tracks, and finally the training tracks in (4) soft skills comprising management, sales, IT leadership, and IEEE courses. The principle-tier companies have used these industry-based trainings as an alternative channel to develop the capabilities of their internal ICT professionals, and also as the second practice of HRM to extend their training strategies.

The third practice of HRM in response to the shortage problem is to broaden the typical pool of talent, through re-assignment in a fast-track talent management program. The employment system in the principle-tier DTAC is “job-centred”, which emphasizes the job value of each job title, and then matches people who have the qualifications and capabilities suited for the job. Figure 5-5 shows the system of ranks and positions which has been adopted at DTAC since 2012. In other words, DTAC has utilized the position classification system, which separates into the two tracks of professional track (specialist) and managerial track (generalist). There are eight position classifications for the professional (or specialist)

track, from P1 (officer) to P8 (vice president) and six position classifications for the managerial (or generalist) track, from M1 (team head) to M6 (CEO). As shown in Figure 5-5, professionals or specialists can change their career track to be managerial from the 4th level (manager or senior manager), which is not difficult to move.

This is because the level of managerial skill at M1 or the team head is still basic and does not require high level of leadership skills. However, the move of career track from P5 (assistant vice president) to M3 (department head) is very difficult resulting from the hardship involved in developing leadership skills[51]. The move of job progression is a step-by-step basis, from P1 (officer) to P2 (senior officer); P2 (senior officer) to P3 (which can be further divided into supervisor and assistant manager), and then to P4 (which can be further divided into manager and senior manager), up until P5 (assistant vice president) and P6 (vice president). Each step takes at least two years and the criteria is based on performance (rather than seniority). Also, the fastest case of being promoted to P4, senior manager, is ten years of experience.

Figure 5-5: DTAC Ranks and Positions

Professional Track (Specialist)	
Ranks	**Positions**
P6	Vice president
P5	Asst Vice President
P4	Senior Manager
	Manager
P3	Asst Manager
	Supervisor
P2	Senior Officer
P1	Officer

Managerial Track (Generalist)		
Ranks	**Positions**	**Equivalent to**
M6	CEO	
M5	Group Head	Executive Vice President
M4	Division Head	Senior Vice President
M3	Department Head	Vice President
M2	Unit Head	Asst Vice President
M1	Team Head	Senior Manager/Manager

Source: DTAC Corporate Document.

[51] Interview with Senior Vice President of People Group of DTAC on 13 August 2014 at DTAC Headquarters.

At P4, the senior manager and manager in the professional track can change to be a managerial track, which is equivalent to M1, or team lead and also at P5, the assistant vice president (AVP) can move managerial track to M2, or unit head. However, due to the pyramid-shaped structure of the ranks and positions system, the ratio of the positions above P5 (AVP) or M2 (unit head) is merely eight percent and the ratio of those above P4 (senior manager or manager) or M1 (team head) is only ten percent. Therefore, the vertical move in positions is relatively within a limited range.

The company, then uses functional flexibility in the horizontal move instead. By providing the functional descriptions for each job position, the employees will know what the expectations are from the company, what the job results are which they have to deliver (accountability), and to whom they have to report. In other words, the company has set an accountability-based functional description on a broad scale, and gives line managers (supervisors) and subordinates the flexibility to design the activities and rotate the assignments (re-assignment) in their team in detail[52].

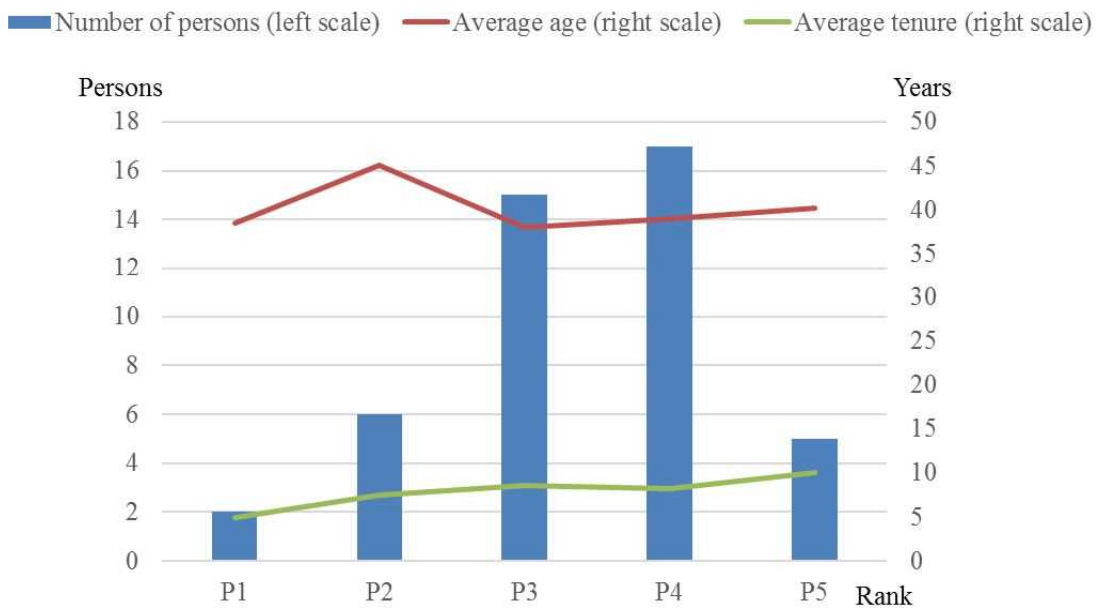
Ports of entry among the personnel are mainly screened by educational attainment[53]. At DTAC, a new recruit in the information technology group has to hold a bachelor's degree at the very least. As discussed earlier, the characteristics of ICT professionals employed in each level (operate, implement, and architect) are not exactly the same. ICT professionals at the operate level are a mix of S&T and non-S&T backgrounds and graduated from both institutes of technology and ordinary universities. Most ICT professionals at the implement level are also a mix; however, almost all of them are from high-ranking universities, institutes of technology and S&T-oriented. In other words, most have backgrounds in technology and

[52] Interviewed with Senior Vice President/People Group of DTAC on 13 August 2014 at DTAC Headquarters.
[53] The phrase "port of entry" in human resource management refers to the entry level of recruitment at the companies, which is usually divided by education attainment. For example, DTAC divided the ports of entry into two levels: entry level for new graduates and mid-career level for experienced and senior experts or specialists.

engineering fields of education. ICT professionals at the architect level have to have the highest and the most sophisticated level of expertise in specialized fields of telecommunications, such as RF, RAN architecture, core network architecture, iOS software, and UI/UX as shown in Table 5-1; therefore, their education backgrounds are specific and require working experience in particular areas.

In accordance with the ranks and systems shown in Figure 5-5, Figure 5-6 shows the number of employees, average years of age and average years of experience by ranking the levels of ICT professionals in the technology group at DTAC[54]. A large number of personnel have been employed at P3 and P4, with an average age of 38 and 39, respectively. The average age of personnel within P1-P5 ranges from 38-45, confirming the high level of expertise of the personnel within the field.

Figure 5-6: Number of Employees, Age, and Tenure by Rank Level



Source: Author's tabulation using personnel data of DTAC (48 persons).

[54] Based on the number of 48 persons in the technology group (approximately 12 per cent of the total number of personnel in the technology group at DTAC), which include 21 persons from the operate group, 16 persons from the implement group, and 11 persons from the architect group.

The average years of experience (tenure) is also high, ranging from 5–10 years. This is broken down to 5 years at P1; 7.5 years at P2; 8.6 years at P3; 8.2 years at P4; and highest of 10 years at P5. As discussed earlier, due to the pyramid-shaped structure of the ranks and positions system, the ratio of positions in P4 and above is only ten percent, and for P5 and above it is merely eight percent. Therefore, a large number of ICT professionals in the technology group is concentrated among P3-P4, as shown in Figure 5-6.

The turnover rate among ICT professionals in the technology group is less than ten percent per year compared to those in call centers and customer services, accounting for more than thirty percent per year. The relatively low turnover rate may result from the merits of the three practices of HRM which the company has developed in their internal labour market. However, the principle-tier telecoms operators still require and rely on the expertise, knowledge, and also technology transfer from foreign countries. As mentioned in Chapter 1, Thailand has positioned itself as a follower, rather than a leader in mobile technologies. Therefore, ICT professionals in the Thai telecommunications industry have the relatively short career path of being specialists (or professional track) compared to other countries like Singapore, Taiwan or Korea. In other words, when they reached the hurdle of R&D and innovation, it cannot help them to change the career track to a managerial one. Most ICT professionals in Thailand reach career goal as project directors who direct a project-based management rather than as ICT experts who specializes in a field of R&D and innovation.

Hence, the responses to shortages of ICT professionals at principle-tier companies cannot be comprehensive only within the internal labour market. The companies have still to rely on the external market, while being active in reviewing their recruitment practices, extending their training strategies, and broadening their typical pool of talent. The next

section will delve into the situation regarding hard-to-fill vacancies and the practices of HRM in response to the shortages of ICT personnel at the first-tier contractors.

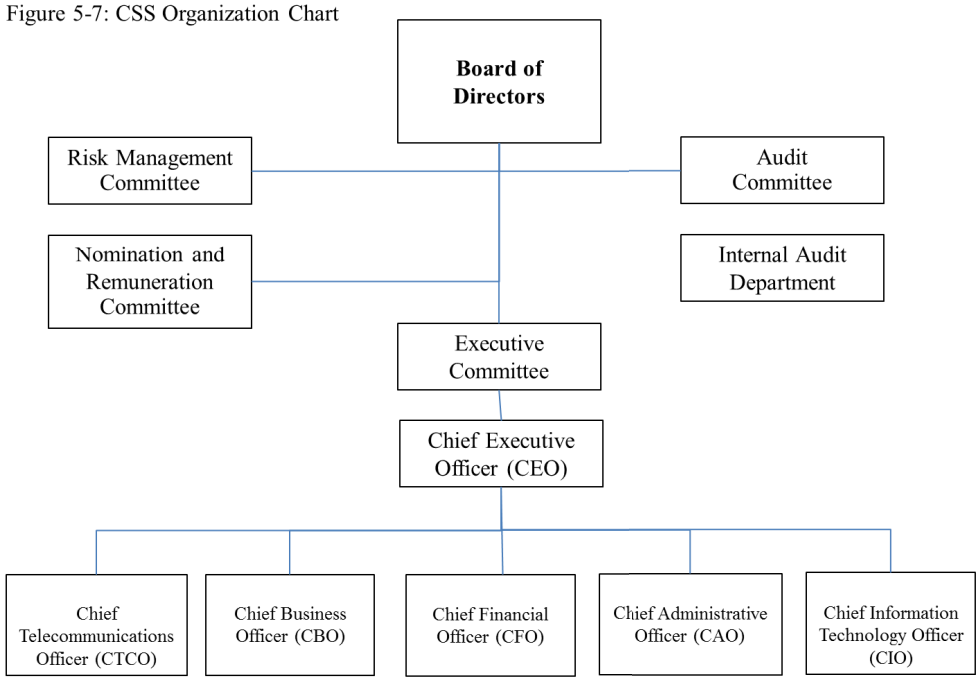
5.2 Hard-to-Fill Vacancies and HRM at the First-tier Companies

Communication and System Solution Public Company Limited (hereafter refer to as CSS) was founded on 25 January 1994, with the initial objective to distribute and install passive fire protection materials and equipment for high buildings and factories. As mentioned before, in 1999, the company expanded business into the telecommunications industry by offering design, procurement, installation services and also maintenance of telecommunications systems. At the first stage in the telecommunications business, the company formed a joint venture with a leading Australian company and set up Downer CSS, to provide services on the design and building of networks for mobile telephone signals. During this period, CSS gained knowledge, expertise and technology transfer from Downer for the site preparation (including site design and site survey) and also the site construction of the telecommunications projects. However, after 10 years of the partnership, Downer made the decision to cease its operations within Thailand.

Then, in 2015, CSS entered a partnership with Neon Work Communication (hereafter referred to as NWC), which is also a first-tier contractor in the Thai telecommunications industry. The objectives of this partnership are to increase the channels of telecommunications markets, expand the new base of the customers, enhance the capacity of competition and elevate the status of stability for the company in the long run. As discussed in Chapter 2, the core tasks of the first-tier contractor are to design telecoms antenna as well as supervise civil work, telecoms equipment installation, integrated commissioning. The high-performing core ICT professionals and technicians who have knowledge and expertise in the area of telecommunications are compatible and crucial components in this.

Figure 5-7 shows the organization chart of CSS, comprising the five business units of telecommunications (CTCO), business (CBO), financial (CFO), administrative (CAO), and information technology (CIO). As mentioned earlier, the initial business area of CSS is to get the deals and distribute the electrical wires and related equipment. Therefore, CBO was the main business unit responsible for sales and distribution in the past. Nevertheless, when the company positioned itself as a first-tier contractor by expanding into the telecommunications business, the core tasks shifted to the design of telecoms antenna, development of the telecoms sites and delivery of the telecoms projects either to the principle-tier telecoms operators or vendor-tier MNCs. In alignment with this shift, CTCO has been responsible for these core tasks and this chapter will focus on this business unit. The number of personnel working at CSS is approximately 440 persons of which 33.5 per cent work in CBO, followed by 32.3 per cent in CAO, 15.7 per cent in CTCO, 10.9 per cent in CFO and 4.3 per cent in CIO.

Figure 5-7: CSS Organization Chart



Source: CSS Annual Report (2014).

All 440 personnel are categorized into four career tracks, in accordance with the company's salary structure. These career tracks are: (1) generalist, (2) specialist (engineer), (3) specialist (others, such as architect, accounting, financial and IT), and (4) managing director tracks. Table 5-3 shows the category of career tracks and the characteristics of personnel by age, tenure and salary in each career track at CSS. The share of personnel in the generalist track is two-thirds of the total number of personnel (305 persons), while the share of personnel in specialist track is one-third (108 persons). The personnel in specialist tracks can be further divided into the two groups of engineering and other specialists such as architect, accounting, financial, IT, and law. Also, the last track is the Managing Director (MD), with five MDs responsible for each business division (CBO, CTCO, CFO, CIO and CAO) as shown in Figure 5-7.

Table 5-3: CSS Personnel Data, by Age, Tenure, Salary

	Total			Under 35 years		
General	N= 305			N= 202		
		Average	Gap		Average	Gap
	Age	33.4	40	Age	29	16
	Tenure	5.3	20	Tenure	3.7	16
	Salary	28,851	211,000	Salary	22,579	71,000
		Male	Female		Male	Female
	Ratio	46.9	53.1	Ratio	43.1	56.9
Specialist (Engineer)	N= 50			N= 15		
		Average	Gap		Average	Gap
	Age	39	29	Age	31	10
	Tenure	6.7	15	Tenure	2.1	6
	Salary	47,060	182,000	Salary	25,000	38,000
		Male	Female		Male	Female
	Ratio	80.0	20.0	Ratio	80.0	20.0
Specialist (Others)	N = 58			N = 29		
		Average	Gap		Average	Gap
	Age	37.3	30	Age	30	30
	Tenure	6.9	19	Tenure	11	9
	Salary	44,226	150,000	Salary	29,000	39,000
		Male	Female		Male	Female
	Ratio	39.7	60.3	Ratio	27.6	72.4
Managing Director	N = 5					
		Average	Gap			
	Age	50.2	5			
	Tenure	15	20			
	Salary	244,000	30,000			
		Male	Female			
	Ratio	80.0	20.0			

Source: Author's tabulation using micro-personnel data of CSS as of 2014.
Note: Gap is calculated by deducting maximum value by minimum value of each variable.

The characteristics of the personnel in the generalist track are that they are middle aged and also have a mid-level of expertise (average age is 33.4 years old and average tenure is 5.3 years of services). The average monthly salary is 28,851 baht, which is the lowest among the four career tracks. The ratio of gender between male and female personnel is relatively the same at 47:53. On the other hand, the specialist (engineer) career tracks show fairly different characteristics. They are senior, have longer years of experience, a high level of salary and are male-oriented. These characteristics are reflected by their average age and average tenure being 39 years old and 6.7 years of service, the average monthly salary 47,060 baht, and the gender ratio between male and female of 80:20. The characteristics of other specialists are relatively the same as those of engineering specialists. However, the difference is in the ratio of gender, which is female-oriented. On average, they are 37.3 years old, possess 6.9 years of experience, and earn 44,226 baht per month.

Lastly, the characteristics of the MD track are as follows: high seniority, longest years of experience and highest level of monthly salary. On average, they are 50.2 years old, possess 15 years of experience and earn the highest salary at approximately 244,000 baht per month. One female MD is responsible for the CFO, while four male MDs are responsible for the rest (CTCO, CAO, CIO and CBO).

The right-hand side of Table 5-3 showed the characteristics of the personnel under 35. This age has set as criteria because the average age of the personnel in CSS is approximately 33.5 years old. The characteristics of personnel under 35 years in each track (generalist, specialist (engineer), specialist (others)) can be used to signify the gap in the area of HRM, particularly age, salary, and tenure gaps. This gap in each variable is important especially for succession and promotion plan and practice.

When comparing the characteristics of the total personnel and those under 35 years in Table 5-3, the problem of a gap is shown in the specialist tracks of both engineering and others, especially in terms of tenure and salary. There is a gap in the tenure in the engineering specialist track, between 6.7 years of service and 2.1 years of service. This implies that HRM should pay attention and prepare a succession plan in order not to face the problem of shortage and stagnation in this engineering specialist track when the personnel in this group move up their career ladder. In contrast, the problem shown in the track of other specialists is promotion bottleneck and the motivation issue. This is reflected by the relatively longer years of tenure (11 years of service) in the young group (under 35 group), implying that there is stagnation among the young personnel in this group not being able to move up. In brief, the main finding from Table 5-3 is that CSS faces the problems of shortages and stagnation in the engineering specialist track, while the other specialist track shows the problem of promotion bottleneck and the motivation issue.

These four career tracks are regulated by the ranks and positions system shown in Figure 5-8. The ranks and positions system at CSS comprises nine rank levels, from the highest level L1 (Managing Director) to the lowest L9 (Worker). Like the principle-tier DTAC, the employment system of the first-tier CSS is job-centered, and there are three ports of entry of which the company uses educational attainment as the main criteria. The first port of entry is that of personnel graduating from vocational and high vocational levels. These personnel are placed into L9 (Worker) for vocational graduates and L8 (Staff) for high vocational graduates. The number of personnel in this group are 111, accounting for one-fourth of the total number of personnel at CSS.

Figure 5-8: The Ranks and Positions System of CSS

				UC (CEO)	(1)
				L1 Managing Director	(4)
				L2 Deputy MD	(3)
				L3 Asst MD/Head BU	(7)
				L4 Manager/Senior Mgr	(11)
		L5-2 Asst Manager	(0)	L5-2 Asst Manager	(2)
		L5-1 Asst Manager	(4)	L5-1 Asst Manager	(7)
		L 6-3 Section Head	(1)	L 6-3 Section Head	(0)
		L 6-2 Section Head	(8)	L 6-3 Section Head	(7)
		L 6-1 Section Head	(17)	L 6-1 Section Head	(17)
		L 7-3 Asst Section Head	(18)	L 7-3 Supervisor	(8)
		L 7-2 Senior Officer	(34)	L 7-2 Supervisor	(18)
		L 7-1 Officer	(102)	L 7-1 Specialist	(41)
		Generalist Track		**Specialist Track**	
L8 Staff	(53)				
L9 Worker	(58)				

Source: CSS annual report and micro-personnel of CSS as of 2014.
Note: Number in parentheses is a number of personnel in each rank and position.

The second port of entry is for new graduates or personnel graduating with bachelor's degree or above. They start at L7, which is further divided into the two tracks of generalist or specialist. Education background, for example engineering, IT, accounting, law, architecture (specialist track) or social science, management (generalist track), will be used as the criteria to sort out personnel into either specialist or generalist tracks. As we can see from the number of personnel in each rank and position (the number in parentheses shown in Figure 5-8), most personnel are stuck upon reaching L7-3 and face difficulty in moving up the career ladder. This is because the ratio of positions above L6-1 is twenty percent. Also, the ratio of positions above L6-2 fell to merely ten percent. Thus, most personnel have been employed at L7-1, which accounts for 34 per cent of the total personnel in the company, followed by 13.8 per cent at L9, 12.6 per cent at L8, and 12.4 per cent at L7-2. In other words, the share of personnel employed between L9 and L7-3 is 79 per cent of the total personnel, while only 21 per cent of the total personnel have been employed above L6-1.

The final port of entry is at L4 and above. This port of entry is mostly for outside mid-careerists who are senior and have specific expertise which the company immediately required. However, internal personnel who have sufficient capabilities, and worked with the company for long periods, on average 11 years, can be internally promoted. There are 26 personnel working at L4 and above, accounting for 6.2 percent of total personnel in the company. All personnel in these ranks and positions are high-ranking seniors who have to hold specialized expertise suiting the core tasks of the company, for example, telecommunications, IT, architecture and are also responsible for the tasks of leadership and management. As discussed earlier, the problems of shortage and stagnation have occurred in the specialist track (engineering), and the business unit of focus in this chapter is CTCO. The following Figure 5-9 shows task-based service by the ranks and positions system of CTCO at CSS.

Figure 5-9:Task-based Service by Ranks and Positions in Telecommunications Division at CSS

CTCO (L1)

Functions and Positions

Ranks	Sales	Technical	Installation	Admin.
L2		Deputy MD Telecoms (1)	Deputy MD Telecoms (1)	
L4		Telecoms Project Manager (1)	Telecoms Project Manager (1)	
L6		Asst. Telecoms Project Manager (5)	Asst. Telecoms Project Manager (5)	
L7	Sales and Project Support Officer (18)	Operations Manager /Asst. Operation Manager/Senior Auto CAD (10)	Operations Manager /Asst. Operation Manager/Senior Auto CAD (10)	Admin Officer/Operation Support Officer (5)
L8				Admin Staff/Operation Support Staff (8)

Source: Author's arrangement using micro-personnel data of CSS as of 2014.
Note: Number in parentheses is the number of personnel in each rank and position.

The number of personnel in CTCO is 66 persons, which accounts for 15.7 percent of the total personnel in the company. As shown in Figure 5-9, the task-based services at CTCO can be divided into four functions: sales, technical, installation and administration. The core task of the sales function is to derive telecoms projects from the principle-tier telecoms operators or vendor-tier MNCs (hereafter referred to as "the customers"). Specifically, they have to communicate and connect with the customers, and promote the CSS products and services. After acquiring the projects, it is the responsibility of technical functions to design telecoms antenna (auto CAD/CAM), and coordinate with both the customers and the installation function. The personnel in the installation function develop and build the telecoms network sites according to the technical architecture design, and deliver the projects to the customers with quality assurance and in a timely manner. Also, all these tasks in the three core functions of sales, technical and installation are supported and facilitated by the administrative function. At the top of this business unit, there is one CTCO in the telecommunications division, ranked at L1 (MD). There are two deputy MDs. One deputy MD supervises the technical function and the other supervises the installation function. Both are ranked at L2. The characteristics of the CTCO are as follows: male, 49 years old, 15 years of service, and an education background in electrical engineering and an MBA. The characteristics of the two deputy MDs at L2 are relatively the same as that of the CTCO. That is, they are also male, 46 years old, with 14 years of service, and have an education background in electrical engineering and an MBA. Moving downward, there are two project managers, ranked at L4, who directly get supervision and direction from the L2 deputy MD in a vertical chain of command. The characteristics of these two project managers at L4 can be summarized as follows: both are 40 years old and have education background in non S&T, particularly in management. One is a female who has worked for CSS for 17 years. The other

is male who entered CSS through the third port of entry (mid-career) and has worked for CSS only 4 years.

After the rank at L4, there are ten assistant project managers ranked at L6. Of these, five assist telecoms projects managers work in the technical function and the other five assist telecoms projects managers in the installation function. The characteristics of the assist telecoms projects managers are as follows: only 1 has graduated in non S&T (a background in management), while the other 9 have education backgrounds in various fields of engineering including electrical, telecommunications, electronic and civil engineering. Their age range is broad, from 39 – 53 years, and their years of service are around 12 – 14 years. All assistant telecoms project managers at L6 are internal personnel who have been promoted within.

Then, at the rank L7, there are approximately twenty persons working in various positions including operations manager, assistant operations manager, senior auto CAD, and auto CAD, and main task-based services are in operate and design. Their characteristics are as follows: male-oriented since two are female and eighteen are male, in the specialist track (engineering). They have education backgrounds in a variety of engineering and technical fields of including electronic, electrical, telecommunications, IT, industrial, mechanics, civil, construction and so on. There is mix of tenure ranging between new entry (1-3 years of service) and senior (more than 10 years of service), and also a wide age range between 21–50 years old. However, all personnel in this job function are recruited at entry level either from the second port of entry (bachelor's degree) or from the first port of entry (vocational and high vocational degree), and have been promoted from within.

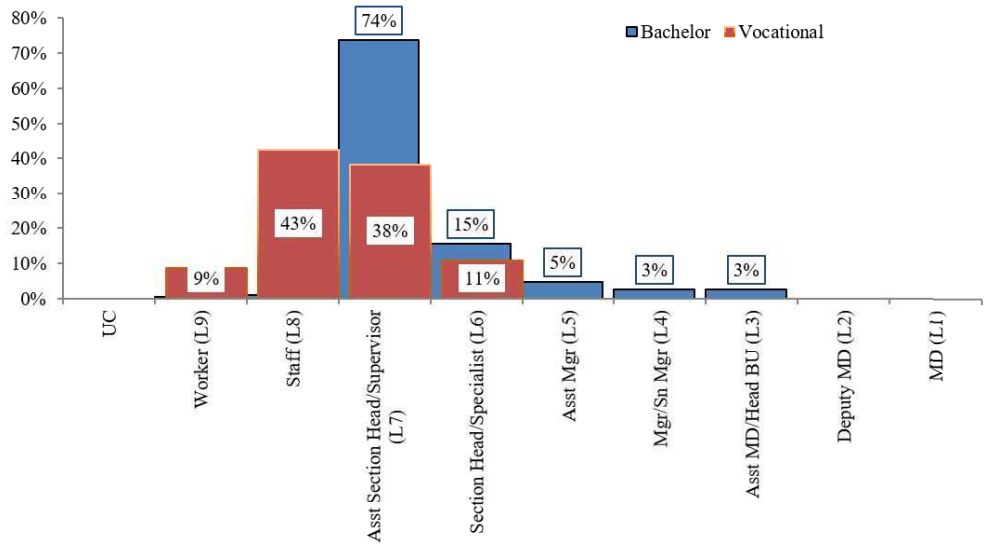
All the above thirty-five persons, ranking from L1-L7 in the two functions of technical and installation, are the core personnel in CTCO. Most are in the specialist track (engineer) while the other thirty-one responsible for sales and other administrative functions are in the generalist track. Based on the interview[55], the shortages of personnel have occurred at the job function of auto CAD/CAM in the technical function and also specialist track (engineer) as discussed in Table 5-3. In other words, the company has faced difficulties in recruiting a sufficient number of personnel in these job functions in time. Therefore, it has adopted the strategy of subcontracting for designing telecoms towers (auto CAD/CAM), and applied a fast-track and super fast-track promotion for engineering jobs in order to move the internal personnel into the higher ranks of unfilled-vacancies, for example assistant to telecoms project manager (L6) and project supervisor (L7). In other words, the company tapped the potential of the personnel in the vocational group (L8) by providing OJT (project-based site preparation and site construction) in order for them to gain expertise. Then the company promoted them to be supervisors of the telecoms projects.

CSS used fast-track and super-fast track promotion by moving their internal personnel into the higher ranks in response to the shortage of ICT professionals and technicians in the external labour market. In particular, the company promoted personnel who graduated in vocational or high vocational institutes into the higher rank of L7 and even L6 in the company's ranks and positions system. In this fast-track and super fast-track promotion practice, the company based the promotion criteria on actual expertise and performance rather than education background[56].

[55] Interviewed with HR manager of CSS on September 2015.
[56] Interviewed with the CEO of CSS on 28 July 2015 at CSS Headquarter.

Figure 5-10 shows the education background of personnel in each rank. It can be seen that the personnel who held vocational background of education can be promoted to work at the ranks L7 and L6. In other words, even though their port of entry is at L9 or L8, the personnel who have vocational backgrounds of education can be promoted up until L6 (section head or specialist). Based on promotion criteria on actual expertise, approximately 11 percent of the total number of vocational graduates have been promoted to work at L6 compared to 15 percent of the total number of bachelor graduates working at L6. Like the situation at L6, approximately 38 percent of the total number of vocational graduates have been promoted to work at L7, compared to 74 percent of the total number of bachelor graduates working at L7. In brief, the company have utilized the existing personnel (in this case, personnel who graduated from vocational level and who have long years of working experience within the company) by internally promoting them into the higher ranks in a response to fill the hard-to-fill vacancies.

Figure 5-10: CSS Ranking by Education: Bachelor VS Vocational (Share of Personnel in Education Group)

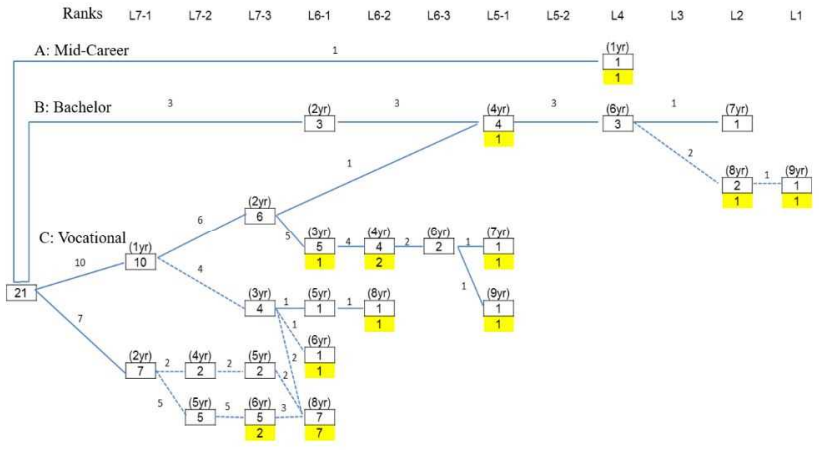


Source: Author's arrangement using micro-personnel data of CSS as of 2014.
Note: The word "vocational" here includes "high vocational" degree as well.

However, the fast-track and super-fast track promotion of internal personnel graduating from vocational and high vocational levels to work in higher ranks occurs until L5 due to the certificate of authorization. This is because personnel working at L5 have to sign the certificate of authorization for particular telecoms projects. Therefore, education background, once again, becomes an important aspect of internal promotion at L5 and above.

Figure 5-11 shows the practice of the fast-track and super fast-track promotion of the core twenty-one personnel in CTCO, whom the company internally promoted to fill some hard-to-fill vacancies in the higher ranks. This dataset comprises seventeen personnel who have education background in a vocational level and four who have education backgrounds at bachelor's level. As mentioned earlier, the company has been established for twenty-three years (founded in 1994). However, it developed the ranks and positions systems as well as the promotion practices just eleven years ago (in 2006). Therefore, the career tree model of the core twenty-one personnel in CTCO reflected the fast-track promotion practice within a period of nine years (2006-2015).

Figure 5-11: CSS Career Tree Model for 21 Job Positions



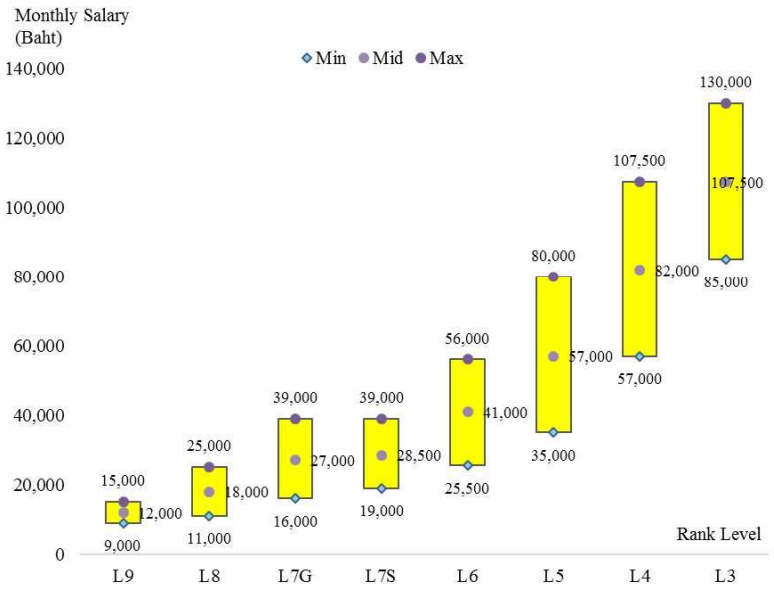
Source: Author`s arrangement using interview and promotion database as of 2015.
Note: This diagram shows how 21 personnel were promoted over the nine-year period (2006-2015). The boxed figures represent the number of personnel who have reached a particular job level. The figures enclosed in parentheses represent the number of years it took for the personnel to reach a particular job level. The figures on the lines connecting two boxes represent the number of those who had successfully moved up from one level to the next. The figures in shaded boxes show the number of personnel staying in that particular level.

The number of years in parentheses, thus, indicates the number of years it took for each round of promotion, rather than, the years of working experience of each person. This career tree was constructed using the promotion database of 21 personnel (male 80.9 per cent, female 19.1 per cent, average age of 44.6 years old, and average tenure of 12.8 years of service). As shown in Figure 5-11, there are three routes to promotions: A: mid-career, B: bachelor and C: vocational. The focus of analysis will be on C: vocational, comprising seventeen persons. The boxed figures represent the number of personnel who have reached a particular job level. The figures enclosed in parentheses represent the number of years it took for the personnel to reach particular job level. The figures on the lines connecting two boxes represent the number of those who successfully moved up from one level to the next. The figures in shaded boxes show the number of personnel staying in that particular job level. Although all seventeen personnel in the vocational route were selected into the fast-track and super fast-track promotion in 2006, and accorded the same job level at L8, they were heterogeneous in age, field of education and experience. Of this seventeen personnel, the ratio of male is 82.4 per cent and female 17.6 per cent. Their average age is 46.8 years old and average tenure is 12.8 years of service. The fields of education are various including construction, electronic, electrical and architect. As mentioned earlier, personnel who graduated from the vocational level can be promoted up until L6 due to the certificate of authorization. However, there are three persons exempted from this rule, as shown at rank level L5-1. These three are male and have vocational backgrounds of education in the areas of construction, electrical and electronic. They have been promoted to L5-1 within four years, seven years and nine years since the fast-track and super fast-track promotions have been adopted. Specifically, one person who has been quickly promoted within four years and flowed into bachelor due to his later attainment of a bachelor's degree in civil engineering.

Their capabilities in alignment with promotion have been cultivated through training courses, both in-house (CSS group) and outside training courses. These training courses are divided into two types: technical skills and managerial skills. The title of the training courses for the technical skills include Service Excellence for Operation, Basic Firefighting and Emergency Evacuation (Telecoms Sites), Fire Prevention, Emergency Preparedness and Rescue Plan, The Five Keys to Total Quality Environment, and Safety. The title of the training courses for managerial skills include KPIs Setting, Advanced Microsoft Excel, Techniques for Modern Supervisors, Budget and Finance Management, Strategic at Work, CSS: Road to Success, Teamwork for Success, Crisis Creation and Chance.

Typically, the salary structure is designed in accordance with the ranks and positions system, and also salary increase is applied couple with the promotion practice with the aim to increase the performance, motivation and morale of the personnel in the company. Figure 5-12 shows the company's structure by each rank level.

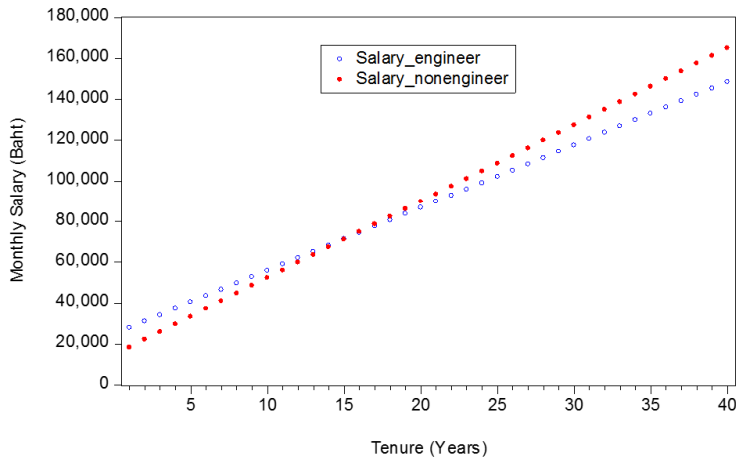
Figure 5-12: CSS Monthly Salary Range, by Rank Level



Source: Author's arrangement using salary structure of the company.
Note: G: Generalist track and S: Specialist track.

The company has designed the salary structure in salary range, from minimum, middle to maximum levels. The initial salary level is progressively higher in accordance with the higher rank levels. Also, the salary range is narrow at L9, and L8, and wider at L7 (general), L7 (specialist) and L6, and becomes the widest at L5, and above. Such a width of salary range reflects the greater flexibility in the pay increase policy at the relatively higher rank levels. As mentioned earlier, the company used actual expertise and performance years as the main criteria of promotion rather than educational attainment. Figure 5-13 shows the salary differentials by tenure (years of experience) between engineer and non-engineer groups, which are initially sorted out by educational attainment. The starting salary level of the engineer group is approximately 24,982 baht per month, while that of the non-engineer group is relatively lower at 14,687 baht per month. However, the average salary increase for the engineer group is 3,086 baht per year, while that of the non-engineer group is higher at 3,757 baht per year. This leads to a turning point at fifteen years of experience with the salary levels of the non-engineer group higher than those of the engineer group, as shown in Figure 5-13.

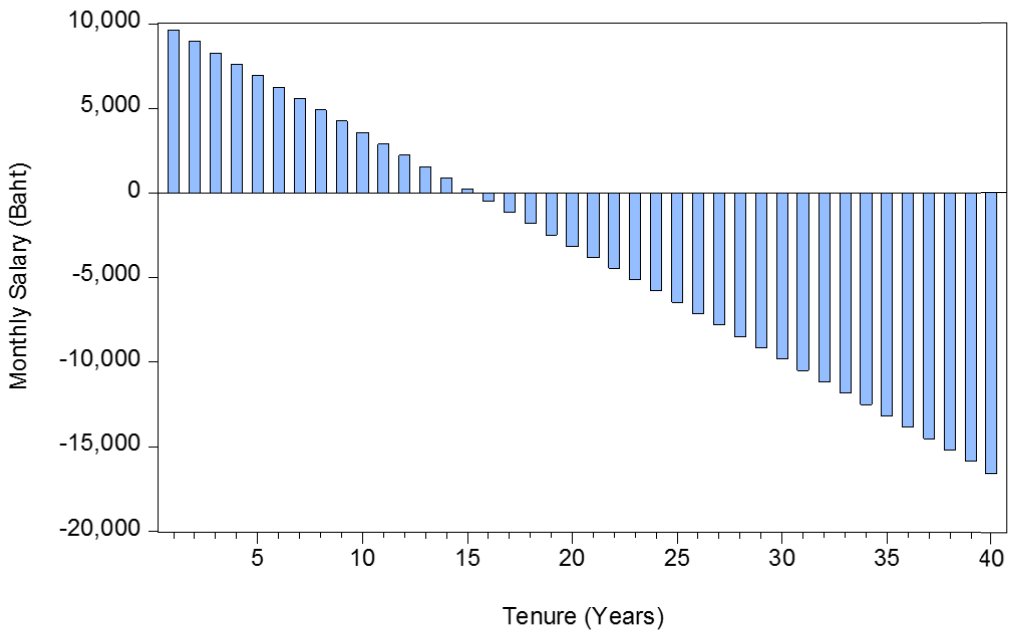
Figure 5-13: Salary Differentials by Tenure (Engineer VS Non Engineer) at CSS



Source: Author's calculation using micro-personnel data of CSS as of 2014.

Figure 5-14, then, shows the width of the salary gap by tenure (years of experience) between engineers and non-engineers. The width of the salary gap between engineers and non-engineers is high in the first year of experience, with the salary level of engineers higher than that of the non-engineer group. However, the longer the years of experience, the narrower the width of the salary gap between these two groups. In other words, the width of the salary gap between engineer and non-engineer becomes narrower. Also, this reached a turning point at fifteen years of experience, where the salary level of the non-engineer group becomes higher than the salary level of the engineer group, and the width of the salary gap becomes wider along with the longer years of experience. In accordance with the promotion practice, the salary increase follows the CSS-based performance and also expertise through years of experience as opposed to educational attainment.

Figure 5-14: Width of Salary Differentials by Tenure (Engineer VS Non-Engineer)



Source: Author's calculation using micro-personnel data of CSS as of 2014.

In short, the company has applied the fast-track and super fast-track promotion practice to broaden the typical pool of their talent. It has utilized the existing personnel, particularly vocational graduates as well as extending training strategies through intensive OJT, a wide range of OFF-JT (both for technical and managerial skills) and also internal report system. Coupled with the promotion practice, salary level and salary increase is an important aspect of HRM to maintain and motivate the performance of personnel. Also, the results of the salary differentials and the width of the salary gap by tenure between engineers and non-engineers shown in Figures 5-13, and 5-14 can confirm the fact that the company based the criteria on actual expertise and performance (through internal experience with the company) rather than educational attainment.

The company not only broadens the typical pool of internal talent, it also broadens it through an increase in the number of new hires. In other words, while the existing personnel who have longer years of services within the company have been promoted (through the fast-track promotion practice) to the higher rank of telecoms project supervisor (L7) and assistant telecoms project managers (L6), the new hires have been recruited through a variety of channels for example, online advertisement on Job Thai.com, a network of CSS colleagues, and subcontractors. The company also headhunts experienced personnel from dissolved companies, such as Alcatel and Nokia through the connections built during telecoms projects in the past.

At the same time, the company prioritizes training investment of the core personnel. The company has sent a small number of core personnel (10 persons at L6) to attend training with the vendor-tier MNCs, both domestic and foreign sessions, and also received reverse-back training from the second-tier subcontracting companies as mentioned in Chapter 2.

These core personnel are a crucial group sharing and transferring knowledge and expertise to the lower ranking personnel through onsite training or the role of supervisor as mentor. Another important component is the formal certificates to perform the tasks of the first-tier main contractor including those for safety and service excellence for operations (ISO9001-2008; ISO27001-2013 ISMS) and also the principle-tier standards (such as C-FBOQ, C-PAT, C-PAC, C-FAT, C-FAC) as discussed in Chapter 2. HRM in the first-tier company has been conducted through the fast-track promotion practice by broadening the typical pool of personnel and utilizing the potential of the existing personnel who have vocational backgrounds in education. However, this practice has its own limitations due to the aspect of the certificate of authorization. There is a very small number of personnel who have an authorization of the standards, such as C-FBOQ, C-PAT, C-PAC, C-FAC and they have to graduate from at least bachelor degree level.

5.3 Different Aspects of HRM between the Principle-tier and the First-tier Companies in the Thai Telecommunications Industry

In order to cope with the hard-to-fill vacancies of particular job positions, both the principle-tier DTAC and the first-tier CSS have adopted the following three key HRM practices: (1) review recruitment practices, (2) extend training strategies, and (3) broaden the typical pool of talent. However, there is difference in the requirements of expertise level and composition of job positions, the degree of utilization of the above-mentioned three HRM practices varies. The principle-tier DTAC mostly applied the extension of its training strategies as well as the review of its recruitment practice, while the first-tier CSS mostly relied on broadening its internal pool of talent and also extending its OJT strategies through on-going onsite telecoms projects and the role of supervisor as mentors.

Since the expertise level of most ICT personnel at the principle-tier DTAC, and also True Move is ICT professionals, which is inevitably connected with trends of technological development, these two companies have extended their training strategies by using external industry-based training courses, particularly IMC institutes to always upgrade the capabilities of their core personnel. Also, they have established their internal corporate academies, including DTAC Academy and True Academy. In particular, the DTAC 3E talent development model intensively exercises OJTs also does the True Star program. In terms of reviewing the recruitment practices, these two companies widen the channels and methods of recruitment beyond the typical recruitment practices, for example, by using a head-hunting agency, posting job vacancies on JobDB, motivating the use of personal referrals through the network of DTAC colleagues. Additionally, the companies have applied a more proactive approach to recruit the best performing students from the leading universities in Thailand by giving internship opportunities to these students on a project-based basis, for example the two-month project-based apprenticeship for junior and sophomore students under the True Next Generation program. Notably, True Move collaborated with Mahidol University to develop the engineering curriculum in telecommunications enterprise and architecture. This HRM practice not only reviews the recruitment practice, but it also functions to broaden the external pool of talent.

On the other hands, the expertise level of most ICT personnel at the first-tier CSS are ICT technicians. Since the size of the first-tier CSS is small and medium with a total number of personnel of approximately 440 persons, the number of core personnel especially engineers are few, accounting for 10 percent of the total personnel at the company. The key HRM which the company has applied to counteract hard-to-fill vacancies is broadening the typical pool of its internal talents and extending the training strategies through both OJT and

OFF-JT. In other words, the company unleashed the potential of personnel who have education backgrounds at vocational and high vocational level by giving them lots of OJT (through onsite telecoms projects and the role of supervisor as mentors), OFF-JT both for technical skills and managerial skills (for example, Service Excellence for Operation, The Five Keys to Total Quality Environment, and Safety and also KPIs Setting, Techniques for Modern Supervisors, Teamwork for Success, Crisis Creation and Chance, to name a few courses). Also, reverse-back training from the second-tier subcontractors and also the attendance of the vendor-tier MNCs has also been exercised. In addition, the company extended its training strategies through strategic partnership with other first-tier contractors, in this case NWC, in order to gain expertise in integrated commissioning and in-building coverage (IBC).

Coupled with extending training strategies through OJT and OFF-JT, the company internally promoted these personnel through the fast-track and super fast-track promotion practice as to broaden its internal pool of talent. Also, the salary increase has been linked to actual expertise and performance as criteria rather than educational attainment. However, the internal promotion of personnel with vocational and high vocational backgrounds of education can only be done up until the specific rank level (L6) due to the authorization of telecoms projects, which required ICT professionals with the minimum of bachelor's degrees to sign and authorize the projects.

5.4 Conclusion

This chapter detailed the hard-to-fill vacancies and human resource management practices which the principle-tier telecoms operators and the first-tier contractors in the Thai telecommunications industry have applied to counteract the shortage of ICT personnel in the

external labour market. Due to the differences in requirements of expertise levels and compositions of job positions, most ICT personnel at the principle-tier DTAC are ICT professional while those at the first-tier CSS are ICT technicians. At DTAC, there are three levels of expertise: architect, implement and operate, and also three areas of functions: network and system, platform and VAS (Value-Added Services), with also software and application at the principle-tier DTAC. Hard-to-fill vacancies have occurred in all three expertise levels and functional areas. However, the most serious and the vacancies that take the longest time to fill are those at architect level. This results from a small number of ICT graduates being supplied by the Thai education system (approximately ten percent of the total number of graduates in Thailand) and also the decreasing number of graduates choosing to study in ICT-related fields of education. Additionally, the demand for ICT personnel is required not only in the telecommunications industry, but also in other industries, for example the financial, insurance, banking, hospital, software, data warehouse and other industries as well. To solve the problem of the hard-to-fill vacancies, DTAC has applied three HRM practices: review the recruitment practices, extend the training strategies and broaden the typical pool of talent in its internal labour market. In particular, the company established a corporate academy, extended the use of industry-based training courses, widened recruitment channels and methods, and collaborated with educational institutes to develop specific curriculum to suite to the company's needs.

On the other hands, most ICT personnel at the first-tier CSS are ICT technicians. There are two expertise levels of engineers (ICT professionals who earned bachelor's degrees in engineering) and technicians (ICT technicians who earned vocational or high vocational degrees), and also the two functional areas of technical (design: auto CAD/CAM), and installation (develop: operate and supervise telecoms projects). Hard-to-fill vacancies have

occurred in one expertise level (engineer level) and in both functional areas. Since the company is small and medium sized, HRM practices are relatively more flexible. CSS has also applied the three HRM practices of reviewing the recruitment practices, extending the training strategies and broadening the typical pool of its internal talent. However, the focused HRM practice is that of broadening the typical pool of internal talent and intensively utilizing OJT (onsite telecoms projects, the role of supervisor as mentor). ICT technicians who have vocational and high vocational backgrounds of education were internally promoted through fast-track and super-fast track promotion coupled with salary increases based on actual expertise and performance as the main criteria, rather than educational attainment. Training investment (OFF-JT) is prioritized particularly for the core personnel (engineers) by sending them to attend the trainings provided by the vendor-tier MNCs, and also the reverse-back training from the second-tier subcontracting companies. Then, these core personnel will transfer their knowledge and expertise to the internal personnel through onsite project-based OJT and the role of supervisor as mentors. In addition, the company extended its training strategies through strategic partnership with other first-tier contractors, in this case NWC, in order to gain expertise in integrated commissioning and in-building coverage (IBC). In terms of reviewing the recruitment practice, CSS has also used various channels and methods, for example, online advertisements on Job Thai, networks of CSS personnel and subcontractors, head-hunting from dissolved companies like Alcatel and Nokia through a previous project-based relationship.

In short, the three underlying factors indicating the existence of internal labour markets (ILMs) comprise skill specificity, OJT and customary rules. HRM practices of case study companies, both the principle-tier DTAC and the first-tier CSS clarified that there has been the existence of ILMs in the Thai telecommunications industry. In particular, the internal

promotion of ICT technicians to fill the hard-to-fill vacancies of engineers at the first-tier CSS and the functional flexibility of ICT professionals in horizontal moves at the principle-tier DTAC coupled with the extension of training strategies especially OJT (onsite telecoms projects, the role of supervisors as mentors, and also corporate academy). However, the ratio of internal promotion is still relatively small. Also internal promotion and intensive OJT has been applied as a result of the shortage of ICT personnel or the inabilities to recruit able ICT personnel in the Thai ICT external labour market as an intrinsic motivation.

The characteristic of ILMs of the Thai telecommunications industry shows the same pattern of occupation ILMs (OILMs) as that of managerial ILMs in Thailand as discussed by Natenapha (2005). This is because the career formation of the ICT professional and ICT technician in the Thai telecommunications industry is based on each particular occupation with a single broad functional career path or broad specialism[57]. Their occupations are divided in accordance with functional areas and then vertically move up an expertise-based hierarchy.

[57] There are four patterns of career formation: (1) single functional career path, (2) single broad functional career path, (3) one-way two functional career path, and (4) multi-functional career path (Natenapha 2005).

Conclusion

Since 2000, the ICT and telecommunications industry has played an increasingly important role in the knowledge-based economy in Thailand. This industry has been viewed as a main foundation of the current digital economy and information society through its network linkages and connections. As indispensable infrastructure, telecommunications equipment and services are the important inputs of every kind of goods and services for all economic sectors of agriculture, manufacture and service. Still its market value and employment share have been relatively small, accounting for 6.20 per cent of total value added and for 0.60 per cent of total employment, revenue and investment growth rates has profoundly increased thanks to an increase in demand for both telecommunications equipment and services from all types of users: government, companies and households.

Although the Thai telecommunications industry exhibited competitive performance and potential growth, it is inevitably facing various challenging issues including volatile regulatory structure, capability to catch-up with global technological development, and shortage of the able-ICT personnel in the Thai ICT labour market in particular. The characteristic of the Thai telecommunications industry is complex due to a mix between government-linked and private companies operating under a wide variety of corporate interfaces and a volatile regulatory structure. Also, the historical developments of this industry involves with both changing technology and changing politics relating to regulatory bottlenecks and holding back overall development. Nevertheless, the Thai telecommunications industry has exhibited the constant growth in regional competitiveness, which mobile segment shows the strongest growth, followed by Internet segment and broadband segment respectively.

As the findings of Chapter 2 revealed, the Thai telecommunications industry has operated in the context of pyramid-shaped industrial organization and hierarchical governance structure, in which each-tier actors perform specific tasks and create specific value according to their functional specialization. Also, the industrial actors in the Thai telecommunications industry are demarcated into seven tiers: the regulator-tier NBTC, the vendor-tier MNCs, the principle-tier telecoms operators, the first-tier contractors, the second-tier subcontractors, the third-tier subcontracting teams and the supplier tier. The vendor-tier MNCs' positions are at the core of innovation in a global telecoms technology. The regulator-tier NBTC sits atop in the Thai telecommunications industry as a regulator on one hand and as a RF spectrum grantor on the other. The principle-tier telecoms operators, the first-tier contractors, the second and the third-tier subcontractors carry out complementary functions in the roll-out telecoms projects and also the telecoms service operations. The supplier tier actors carry out supplementary functions geared towards the supply of materials including equipment related to telecoms.

This pyramid-shaped organization and hierarchical governance structure has probably been the sources of substantial growth and competitiveness of the Thai telecommunications industry since each tier comprises a number of actors that perform specific tasks and create particular value according to each tier's functional specialization. Also, the industry's inter-corporate relationships function as a vertical integration system showing a dominant managerial control over the telecoms roll-out projects and also the high degree of explicit coordination. Such an industry's coordination-rich organizational capability ensures a system of checks and balances in place along the chain of command and a striking balance between cooperation and competition according to each-tier's fields of specialization.

At the company level, various tiers actors have to set the strategies by selecting choices of core capabilities in order to strengthen and sustain their competitiveness. As clarified in Chapter 3, the corporate strategy adopted in the Thai telecoms industry can be summarized as the strategy of choose and focus on the core, leverage and management of the long term relationship. All the three tier case studies' companies including the principle-tier telecoms operators, the first-tier contractors and the second-tier subcontractors gravitated on the core capabilities of operational excellence and quality assurance. The principle-tier telecoms operators focused on areas of network expansion and network quality by broadening coverage and deepening capacity of their networks. On the other hands, the first-tier contractors and the second-tier subcontractors focused on areas of telecoms engineering, particularly operational and quality excellence of the roll-out telecoms projects in accordance with the principle-tier standards. Leverage, by accumulating, allocating and multiplying companies' resources effectiveness, brings about companies' competitive advantage. Competitive advantages of the principle-tier include network excellency and customer loyalty through customer relationship management. Competitive advantages of the first-tier include all-in-one service and solution excellency (one-time big deal or turnkey project) and quality assurance, whereas competitive advantages of the second-tier include specialization and also coordination capabilities. The last strategy which the three-tier case studies' companies have adopted is the strategy of managing long term relationships with various tiers actors in order to create, maintain and strengthen long-run value in the Thai telecommunications industry.

Core capabilities, which each-tier companies in the Thai telecoms industry chose to strengthen and sustain their competitiveness, are intangible assets which beset in the companies' internal human resources, including knowledge, expertise, experience and skill. However, the results in Chapter 4 showed that the shortages of ICT professionals and ICT

technicians has been occurred in the Thai ICT external labour market, particularly computer network professionals, computer network and system technicians, and also programmers. At the same time, some ICT-related occupations including software developer, web and multimedia developer, database designer and administrator, telecommunications engineering technician, ICT user support and also web technician have shown substantial growth in demand.

ICT personnel in the Thai ICT labour market can be divided into three levels of expertise: manager, professional and technician. Approximately 74 per cent of total number of ICT personnel in the Thai ICT labour market work at technician level, followed by 21 per cent at professional level and 5 per cent at manager level. Each expertise level reflects different aspects in terms of various types of occupations and various routes of education backgrounds. Almost all ICT personnel at professional level have earned bachelor degree and have majored in engineering field of education, while half of ICT personnel at technician level have earned bachelor degree and another half have earned high vocational and vocational degrees with a mixture between engineering and non-engineering fields of education.

The shortages of ICT personnel in the Thai ICT external labour market are serious both at professional and technician levels and result from three reasons. The first reason is an insufficient number of ICT graduates produced from the Thai education system due to the system's lag of adjustment. The second is that the number of ICT graduates has been decreased while that of non ICT graduates has been increasing (2008-2015). In particular, the third reason is that the demand for ICT graduates has not only been in ICT sector, but also in non-ICT sector such as financial, banking, hospital, and insurance as well. Particularly, a

number of ICT graduates in the fields of computer science and also computer engineering has been substantially decreased while a number of graduates in the fields of telecoms, ICT, software, network and internet has shown an increasing trend.

The effects of the shortages of ICT personnel in the Thai ICT external labour market also result in the problems of hard-to-fill vacancies of particular job positions at each-tier companies in the Thai telecommunications industry. Due to different requirement in expertise levels, the principle-tier companies faced the recruitment difficulty for ICT professional, especially the architect level, followed by the implement and the operate levels. In particular, the vacancies of core network architect, infrastructure or platform architect and application architect require the longest time to fill. On the other hand, the first-tier companies faced the recruitment difficulty for ICT technicians, especially for engineers (including civil, electrical and telecoms) and also auto CAD/CAM (telecoms antenna design).

Therefore, case studies' companies in this industry have applied three practices of human resource management (HRM) to cope with these shortage problems: (1) review recruitment practices, (2) extend training strategies (OFF-JT and OJT), and (3) broaden typical pools of talent. However, there is different degree of utilization. The principle-tier telecoms operators pay much more important on the extension of its training strategies and the review of its recruitment practices. These companies extend the training strategies both through external industry-based trainings and establishment of internal corporate academy. Also, they widen the recruitment channels and methods in order to further reach to the targeted students by granting project-based internship opportunities and also collaborating with specific universities to develop telecoms-related courses and curriculums. On the contrary, the first-tier contractors much rested on broadening its internal pool of talent and

extending its training strategies. They have broadened typical pool of talent by utilizing the expertise and experience of high vocational graduates who hold relatively long years of services with the companies, and motivating them with fast-track and super fast-track promotion. Also, they have intensively extended training strategies through role of supervisors as mentors especially at onsite telecoms projects, the reversing back training from the second-tier subcontractors and also knowledge and technology transfer from the vendor-tier MNCs.

In short, internal labour market (ILM) has been existed in the Thai telecommunications industry. And the strength of this assertion is indicated by the high degree of internal promotion, intensive OJT and skill specificity that have been utilized at case studies' companies. Even though initial aims of these HRM practices are set to counteract the shortage problems of ICT personnel in the Thai ICT labour market, the existence of ILM also helps strengthen the competitiveness and sustain the value-creation opportunities of each-tier companies in the Thai telecommunications industry over the long-run.

The way forward related to this study concerns with the specific characteristics of the internal labour markets of each tier companies in the Thai telecommunications industry. In particular, the functions of training and development (OFF-JT and OJT) for the ICT personnel, and the mobility of their career paths through external and internal ICT labour markets in order to acquire and develop up-to-date knowledge and skills should be further studied and discussed.

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Appendix 3-A: Project-Based Contracts on Telecommunications Engineering Services (The year 2002-2015)

The Company was founded in 1994, then move into telecommunications period in 1999 as "incubation period"; getting a small-scale of project-based contracts as a small-sized subcontractor. In 2002, being a strategic partnership by joint venture with Downer Australia as Downer CSS; getting technology transfer and learning process from Downer. In 2010, "independent period", Downer Australia decided to depart the business from Thailand due to 2008 Global Financial Crisis, CSS then start to get the projected-based contracts with a certified standard ISO 9001:2008 for telecommunications business.

Projects	Clients	Developed by	Characteristics of Services/Regional	Value of Projects (Million Baht)	Process Time	Scope of Work
UTEL/DTAC	DTAC	JV with Downer CSS	New Sites/ Northeast, South, Central Thailand	130	2002-2006	Site preparation, equipment installation for GSM base: 120 BTS* Sites
Alcatel	Alcatel (Thailand) Co.,Ltd	JV with Downer CSS	New Sites/Central, West, North-East & South Thailand	102	Jun 2001-Apr 2004	Turnkey site preparation work for GSM based stations:110 BTS Sites
AIS Phase 11	AIS	JV with Downer CSS	New Sites/Southern Thailand	14	Sep 2002-Mar2003	Design and construct GSM base stations: 5 BTS Sites
TA Orange	TA Orange (TRUE)	JV with Downer CSS	New Sites/Throughout Thailand	980	Apr2002-Oct 2006	Design, supply and construct GSM 1800 base stations: 940 BTS Sites
Alcatel Thailand	Alcatel (Thailand) Co.,Ltd	JV with Downer CSS	New Sites/Southern Thailand 24 km	4	May 2003-Mar2004	Installation and jointing of aerial an buried optic fibre: 120 fibre optic
Lucent Technologies	Lucent	JV with Downer CSS	New Sites/Hanoi Vietnam	2.5	Jan 2004-Jun 2004	Design and install CDMA BTS sites and one MSC**
TA Orange	TA Orange (TRUE)	JV with Downer CSS	New Sites/Throughout Thailand 160 km	28	Nov 2003-Jun 2004	Installation and jointing of aerial optic fibre cable: 12&24 fibre optic cable
Chiva Som International Health Resorts	Chiva Som International Health Resorts	JV with Downer CSS	New Sites/Hua-Hin Thailand	0.7	Nov 2003	Design, supply and install paging system with 22 pagers
Huawei Technologies (Thailand)	Huawei Technologies (Thailand)	JV with Downer CSS	New Sites/Throughout Thailand	235	Mar 2005-Oct 2006	Engineering and construction permits for 370 BTS Sites
Huawei Technologies (Thailand)	Huawei Technologies (Thailand)	JV with Downer CSS	New Sites/North-East 580 km Fibre Optic	15	Mar 2005-Oct 2006	Approximately 580 km OSP (Fibre Optic Cable) Installation

Projects	Clients	Developed by	Characteristics of Services/Regional	Value of Projects (Million Baht)	Process Time	Scope of Work
TOT	TOT	JV with Downer CSS	New Sites/Throughout Thailand	280	Mar2003-Oct 2006	Pit, Pipe & Conduit (Design, Installation Copper and Fibre) and Optic cab (Survey & Installation) Supply & Installation of MSAN
True Move	True Move	JV with Downer CSS	Upgrade Sites/500 Upgrade Sites	28	Mar 2005-Oct 2006	Engineering and construction permits for 500 BTS Sites
UTEL/DTAC 2007	DTAC	JV with Downer CSS	New Sites/Throughout Thailand	33.721	Apr 2007-Dec 2007	Engineering and construction permits for 58 BTS Sites
DTAC (South Area)	United Telecom Sales & Services Co.,Ltd	JV with Downer CSS	New Sites/South area	41.38	Feb 2008-Dec 2008	Engineering and construction permits for 51 BTS sites
AIS Project 2008	Advanced Info Services Plc (AIS)	JV with Downer CSS	New Sites/South area	35.04	May 2008-Apr 2009	Engineering and construction for BTS Sites
TRUE Move Phase 5.1 B	True Move Co.,Ltd	JV with Downer CSS	New Sites/South area	75.47	Feb 2009-Nov 2009	Engineering and construction for 113 BTS Sites
TRUE Move Phase 6	True Move Co.,Ltd	JV with Downer CSS	New Sites/South area	82.85	Nov 2009-Oct 2010	Engineering and construction for 255 BTS Sites
TRUE Move Phase 7.2 & 8 GSM	True Move Co.,Ltd	JV with Downer CSS	New Sites/South area	80	Jan 2010-Oct 2010	Engineering and construction for BTS Sites
TRUE Move Phase 7.2/HSPA	Huawei Technologies (Thailand) Co,Ltd	Company	New Sites/Bangkok North, South, East Thailand	100	Jan 2010-Jun 2010	Engineering and construction for 200 BTS Sites

Projects	Clients	Developed by	Characteristics of Services/Regional	Value of Projects (Million Baht)	Process Time	Scope of Work
TMW CALL OFF 7&8 DCJV	Huawei Technologies (Thailand) Co,Ltd	Company	New Sites	180.46	Oct 2010-Oct 2011	Design, engineering and construction for BTS Sites
TMV Self Build	TRUE Move Co.,Ltd.	Company	New Sites	94.97	Oct 2010-Feb 2011	Design, engineering and construction for BTS Sites
TOT 3G Nationwide	Nokia Siemens Networks (Thailand) Co.,Ltd	Company	New Sites and Upgrades/Throughout Thailand	118.89	Jul 2011-Jun 2012	Design, engineering and construction for BTS Sites
Thailand BFKT 3G	ZTE (Thailand) Co.,Ltd.	Company	Upgrades	73.79	Sep 2011-Jun 2012	Design, engineering and construction for BTS Sites
Thailand BFKT 3G HSPA (East) Phase 4	Huawei Technologies (Thailand) Co,Ltd	Company	New Sites/East	32.95	Jan 2012-Jun 2013	Design, engineering and construction for BTS Sites
Thailand BFKT 3G HSPA (South) Phase 5	Asia Wireless Communications Co.,Ltd.	Company	New Sites/South	331.63	Mar 2012-Dec 2013	Design, engineering and construction for BTS Sites
Thailand BFKT 3G HSPA (East) Phase 5	Asia Wireless Communications Co.,Ltd.	Company	New Sites	620.6	Mar 2012-Dec 2013	Design, engineering and construction for BTS Sites
Real Future 2.1 GHz New Sites & Existing LTE Phase 1 (East/Bangkok/South)	True Corporation Plc.	Company	New Sites/ East, Bangkok, South	83.3	Jan 2014-Dec 2015	Design, engineering and construction for BTS Sites
TRUE Infrastructure Fund Project (Site Acquisition Work)	True Corporation Plc.	Company	New Sites	3.5	Jan 2014-Dec 2015	Sites Acquisition for Sites construction for TRUE

Projects	Clients	Developed by	Characteristics of Services/Regional	Value of Projects (Million Baht)	Process Time	Scope of Work
TRUE Infrastructure Fund Project (East)	True Corporation Plc.	Company	New Sites/East	543.6	Jan 2014-Dec 2015	Delivery of 6,000 Mobile Phone Stations for TRUE Communications Growth Infrastructure Fund (TRUEGIF)
TRUE Infrastructure Fund Project (Bangkok)	True Corporation Plc.	Company	New Sites/Bangkok	378.8	Jan 2014-Dec 2015	Delivery of 6,000 Mobile Phone Stations for TRUEGIF
TRUE Infrastructure Fund Project (South)	True Corporation Plc.	Company	New Sites/South	245.3	Jan 2014 Dec 2015	Delivery of 6,000 Mobile Phone Stations for TRUEGIF
Real Future 2.1 GHz UMTS LTE Phase 2.2 (South)	Ericsson (Thailand) Co.,Ltd.	Company	New Sites/South	2.6	Nov 2014-Dec 2015	Design, engineering and construction for UMTS LTE base sites
Real Future 2.1 GHz UMTS LTE Phase 3 (South)	Ericsson (Thailand) Co.,Ltd.	Company	New Sites/South	33.5	Dec 2014-Dec 2015	Design, engineering and construction for UMTS LTE base sites
Real Future 2.1 GHz UMTS LTE Phase 3 (East)	Huawei Technologies (Thailand) Co,Ltd	Company	New Sites/East	22.5	Dec 2014-Dec 2015	Design, engineering and construction for UMTS LTE base sites

Source: CSS Plc.

Note: *BTS: Base-Transceiver Station, **MSC: Microwave System Construction

Appendix 3-B: J-Siri Project-Based Contracts: Business Diversification Strategy												
Year	Scope of Work											
	New Site/Relocate Site		Upgrade Site		Site Acquisition		Building & Construction		Real Estate		Others	
	Project	Volume	Project	Volume	Project	Volume	Project	Volume	Project	Volume	Project	Volume
2009 - 2010	True Move Phase9, South	17 sites			True Move SP 18-19 South	15 sites					True Move House & Land Tax, South	250 sites
											True Move BTS Installation Phase 9 South	10 sites
2011	True Move Phase SPO-01,South	3 sites	True Move 3G BFKT/ZTE Phase 2 South	50 sites							True Move Node B Installation 3G BFKT/ZTE Phase2 South	13 sites
			True Move 3G BFKT/ZTE Phase 3 South	83 sites							True Move Submit PEA Power Meter Agent 3G BFKT South	350 sites
2012 - 2013	Relocate Site Suratthani True Move, South	2 sites	True Move 3G BFKT/ZTE Phase 4 South	82 sites	True Move Phase 4-5 South	140 sites	True Move Retaining Wall for Site Improvement BSC Nakorn Sri Thammarat &Hat Yai	2 sites	Shop House, Susiri@Lansaka Nakorn Sri Thammarat	8 Units	True Move Remove Site Repeater South	3 sites
	True Move Phase 4-5 South	115 sites	Real Future, 3G LTE/ Ericson Phase 1 South	68 sites	True Move Build Permit Agent Phase4-5 South	149 sites					True Move Outsource Support BFKT & Field Engineering	8 Positions

Year	Scope of Work											
	New Site/Relocate Site		Upgrade Site		Site Acquisition		Building & Construction		Real Estate		Others	
	Project	Volume	Project	Volume	Project	Volume	Project	Volume	Project	Volume	Project	Volume
	TRUEGIF (True Growth Infrastructure Fund) Real Future Phase 1	64 sites			TRUEGIF Real Future Phase 1 Build Permit Agent South	79 sites	AIS Regional Office Main Door & Fence South	1 site	House, Susiri@PatoompornII Suratthani	14 Units		
	TRUEGIF Real Future Phase 2	35 sites	Real Future 3G LTE/ Ericson Phase 3 South	102 sites	TRUEGIF Real Future Phase 2 Build Permit Agent South	65 sites					Transport Tower & Pole	85 sets
	DTAC 250 BMA, BBTEC	16 sites	TRUEGIF (Share) DTAC, BBTEC	41 sites								
	DTAC 430 BMA, BBTEC	6 sites	DTAC, BBTEC (Host)	45 sites								
	Relocate, DTAC BBTEC	1 site	AIS, BBTEC (Host)	6 sites								

Source: J-Siri Co., Ltd.

Appendix 4-A: The 2013 Labor Demand of Establishment Survey

Economic Activity	Whole Kingdom			Bangkok			Vicinity		
	Total number of labour demand	Total number of labor shortage	Ability to fill	Total number of labour demand	Total number of labor shortage	Ability to fill	Total number of labour demand	Total number of labor shortage	Ability to fill
	Number (%)	Number (%)	%	Number (%)	Number (%)	%	Number (%)	Number (%)	%
Business trade and service	154,820 (50.6)	91,619 (50.4)	40.8	72,928 (60.5)	43,963 (59.4)	39.7	11,252 (23.6)	7,144 (24.7)	36.5
1. Wholesale and retail trade; repair of motor vehicles and motorcycles	21,694 (7.1)	13,335 (7.3)	38.5	6,782 (5.6)	4,167 (5.6)	38.6	3,115 (6.5)	2,116 (7.3)	32.1
2. Wholesale trade	29,484 (9.6)	17,509 (9.6)	40.6	15,788 (13.1)	8,398 (11.4)	46.8	3,133 (6.6)	2,340 (8.1)	25.3
3. Retail trade	39,459 (12.9)	17,957 (9.9)	54.5	13,474 (11.2)	6,276 (8.5)	53.4	2,361 (5.0)	1,214 (4.2)	48.6
4. Accommodation Food and Beverage service activities	27,157 (8.9)	17,009 (9.4)	37.4	9,521 (7.9)	5,618 (7.6)	41.0	766 (1.6)	273 (0.9)	64.4
5. Information computer and communication	4,703 (1.5)	4,001 (2.2)	14.9	4,229 (3.5)	3,646 (4.9)	13.8	214 (0.4)	143 (0.5)	33.2
6. Real estate activities	4,336 (1.4)	2,404 (1.3)	44.6	3,840 (3.2)	1,996 (2.7)	48.0	259 (0.5)	259 (0.9)	0.0
7. Professional, scientific and Technical activities	5,458 (1.8)	3,270 (1.8)	40.1	4,626 (3.8)	2,917 (3.9)	36.9	211 (0.4)	92 (0.3)	56.4
8. Rental travel service and support service activity	17,892 (5.8)	13,457 (7.4)	24.8	12,208 (10.1)	9,795 (13.2)	19.8	847 (1.8)	429 (1.5)	49.4
9. Arts, entertainment and Recreation	1,353 (0.4)	528 (0.3)	61.0	870 (0.7)	185 (0.3)	78.7	43 (0.1)	43 (0.1)	0.0
10. Other service activities	3,283 (1.1)	2,150 (1.2)	34.5	1,590 (1.3)	964 (1.3)	39.4	304 (0.6)	235 (0.8)	22.7
Manufacturing Industrial	133,114 (43.5)	77,284 (42.5)	41.9	38,274 (31.8)	23,393 (31.6)	38.9	34,418 (72.3)	20,759 (71.8)	39.7
Construction	13,255	9,510	28.3	7,247	5,368	25.9	1,208	976	19.2
	(4.3)	(5.2)		(6.0)	(7.3)		(2.5)	(3.4)	
Land transport and storage	3,486	2,500	28.3	1,041	704	32.4	396	369	6.8
	(1.1)	(1.4)		(0.9)	(1.0)		(0.8)	(1.3)	
Hospital activities	1,473	915	37.9	961	540	43.8	131	91	30.5
	(0.5)	(0.5)		(0.8)	(0.7)		(0.3)	(0.3)	
Total	**306,148**	**181,827**	**40.6**	**120,455**	**73,968**	**38.6**	**47,600**	**28,926**	**39.2**
	100.0	100.0		100.0	100.0		100.0	100.0	

Source: NSO (2013)

Appendix 4-B: The Employment Characteristics of the Thai ICT Labor Market

Variables	Workforce in ICT-related occupations and also in ICT sector		Workforce in ICT-related occupations but notin ICT sector		Workforce in non ICT-related occupations but in ICT sector		All Workforce	
	Number (Persons)	Percentage	Number (Persons)	Percentage	Number (Persons)	Percentage	Number (Persons)	Percentage
Gender								
Male	14,580	62.6	181,517	83.9	44,738	48.0	21,186,795	53.8
Female	8,705	37.4	34,801	16.1	48,466	52.0	18,158,112	46.2
Total	23,284	100.0	216,317	100.0	93,204	100.0	39,344,908	100.0
Region								
Municipal	17,072	73.3	131,265	60.7	64,249	68.9	13,227,302	33.6
Non-Municipal	6,212	26.7	85,052	39.3	28,955	31.1	26,117,606	66.4
Total	23,284	100.0	216,317	100.0	93,204	100.0	39,344,908	100.0
Age Group								
21-25	4,156	17.8	32,039	14.8	12,322	13.2	3,813,568	9.7
26-30	5,019	21.6	56,555	26.1	22,052	23.7	4,772,936	12.1
31-35	6,097	26.2	42,999	19.9	11,986	12.9	4,701,439	11.9
36-40	3,815	16.4	31,712	14.7	12,184	13.1	5,129,063	13.0
41-45	1,640	7.0	17,413	8.0	17,334	18.6	4,877,104	12.4
46-50	239	1.0	20,911	9.7	5,845	6.3	4,631,379	11.8
51-55	1,531	6.6	8,833	4.1	8,721	9.4	3,850,973	9.8
56-60	697	3.0	3,848	1.8	1,018	1.1	2,904,063	7.4
More than 60	91	0.4	2,008	0.9	1,742	1.9	4,664,384	11.9
Total	23,284	100.0	216,317	100.0	93,204	100.0	39,344,908	100.0
Employment Status								
Employers	0	0.0	125	0.1	85	0.1	1,013,757	2.6
Own accout workers	9,427	40.5	16,154	7.5	8,099	8.7	12,259,016	31.2
Contributing family workers	804	3.5	2,273	1.1	5,514	5.9	9,220,165	23.4
Salaried workers (public sector)	0	0.0	68,705	31.8	0	0.0	3,268,661	8.3
Salaried workers (state own enterprises)	2,237	9.6	11,301	5.2	20,721	22.2	281,998	0.7
Salaried workers (private sector)	10,816	46.5	117,759	54.4	58,784	63.1	13,266,894	33.7
Colloboration	0	0.0	0	0.0	0	0.0	34,416	0.1
Total	23,284	100.0	216,317	100.0	93,204	100.0	39,344,908	100.0
Size of Establishments (Numbers of Workers)								
Small (1-20)	1,645	7.1	22,565	10.5	14,681	15.8	8,045,315	20.4
Lower Medium (21-100)	1,427	6.2	26,750	12.3	11,104	11.9	2,123,699	5.4
Upper Medium (101-200)	2,257	9.7	14,284	6.6	3,142	3.4	989,817	2.5
Large (more than 200)	5,488	23.6	54,284	25.1	29,726	31.9	3,089,264	7.9
N/A	12,468	53.5	98,434	45.5	34,550	37.0	32,555	0.1
Blank	0	0.0	0	0.0	0	0.0	25,064,257	36.3
Total	23,284	100.0	216,317	100.0	93,204	100.0	39,344,908	100.0
Monthly Wage (Baht)								
Less than 10,000	418	1.8	37,775	17.5	27,693	29.7	11,683,625	29.7
10,001-20,000	6,055	26.0	87,895	40.6	14,882	16.0	3,235,281	8.2
20,001-30,000	840	3.6	45,530	21.0	13,221	14.2	944,330	2.4
30,001-40,000	1,720	7.4	13,241	6.1	8,772	9.4	485,203	1.2
40,001-50,000	1,766	7.6	6,878	3.2	11,102	11.9	249,163	0.6
50,001-60,000	802	3.4	2,926	1.4	1,897	2.0	59,346	0.2
More than 60,000	1,452	6.2	3,520	1.6	1,938	2.1	160,605	0.4
N/A	0	0.0	18,552	8.6	13,699	14.7	0	0.0
Blank	0	0.0	0	0.0	0	0.0	22,527,354	57.3
Total	**23,284**	**100.0**	**216,317**	**100.0**	**93,204**	**100.0**	**39,344,908**	**100.0**

Source: Author`s tabulation using LFS 2012/Q4.

Appendix 4-C:

The Occupational Level, Education Background and Monthly Wage of the Thai ICT Personnel

Variables	Workers in ICT-related occupations and also in ICT sector			Workers in ICT-related occupations but not in ICT sector			Workers in non ICT-related occupations but in ICT sector			All Workers		
	Engineer	Non-Engineer	Total	Engineer	Non-Engineer	Total	Engineer	Non-Engineer	Total	Engineer	Non-Engineer	Total
Occupational Group												
1. Managers	1,680	3,231	4,911	3,980	2,349	6,329	376	7,544	7,920	89,918	1,074,911	1,164,829
	34.2%	65.8%	100%	62.9%	37.1%	100%	4.7%	95.3%	100%	7.7%	92.3%	100%
Monthly Wage (Baht)	51,432	52,536	52,518	52,389	35,174	46,001	NA	46,956	46,956	44,706	37,534	38,103
2. Professionals	3,234	306	3,540	36,012	15,069	51,081	2,071	8,798	10,869	215,973	1,682,953	1,898,926
	91.4%	8.6%	100%	70.5%	29.5%	100%	19.1%	80.9%	100%	11.4%	88.6%	100%
Monthly Wage (Baht)	23,115	15,000	22,413	27,324	31,021	28,238	44,585	26,962	30,320	26,115	26,608	26,552
3. Technicians and	5,893	8,938	14,834	76,262	82,646	158,908	495	13,428	13,923	215,201	1,222,798	1,437,999
Associate Professional	39.7%	60.3%	100%	48%	52%	100%	3.6%	96.4%	100%	15%	85%	100%
Monthly Wage (Baht)	22,333	29,654	24,740	18,610	17,221	17,910	13,858	40,740	39,784	19,311	26,050	24,997
4. Clerical Support							4,412	19,861	24,273	132,692	1,201,613	1,334,305
Workers							18.2%	81.8%	100%	9.9%	90.1%	100%
Monthly Wage (Baht)							10,150	21403	19,358	11,554	16,709	16,184
5. Services and							945	15,693	16,638	312,231	6,917,002	7,229,233
Sales Workers							5.7%	94.3%	100%	4.3%	95.7%	100
Monthly Wage (Baht)							7,617	7,667	7,664	15,200	11,364	11,563
6. Skilled Agriculture,							190	0	190	275,785	14,589,358	14,865,143
Forestry, Fishery W.							100%	0%	100%	1.9%	98.1%	100%
Monthly Wage (Baht)										7,052	11,258	11,204
7. Craft and Related							7,628	9,505	17,133	483,283	3,649,693	4,132,976
Trades							44.5%	55.5%	100%	11.7%	88.3%	100%
Monthly Wage (Baht)							14,628	21,327	18,344	12,999	11,154	11,397
8. Plant and Machine							420	248	668	199,691	2,891,548	3,091,239
Operator, Assembler							62.9%	37.1%	100%	6.5%	93.5%	100%
Monthly Wage (Baht)							7,800		7,800	11,691	9,942	10,053
9. Elementary Occupation							0	1,592	1,592	51,436	4,138,822	4,190,258
							0%	100%	100%	1.2%	98.8%	100%
Monthly Wage (Baht)								6,618	6,618	6,900	10,501	10,462
Total	10,810	12,475	23,285	116,254	100,064	216,318	16,537	76,669	93,206	1,976,210	37,368,698	39,344,908
	46.4%	53.6%	100%	53.7%	46.3%	100%	17.7%	82.3%	100%	5%	95%	100%
Monthly Wage (Baht)	28,759	43,404	34,425	22,634	19,591	21,303	15,386	26,195	24,416	17,233	15,005	15,172

Source: Author`s tabulation using LFS 2012/Q4.