

Adaptive Innovation in the Evolution of a Latecomer Firm: The Case of AsiaInfo, China

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Abstract: *This paper is based on a case study of AsiaInfo, a latecomer telecommunications software and service firm in China. It examines whether and how adaptive innovation can enable the latecomer firms in developing countries to accumulate technological advantages and gain competitiveness to emerge as multinational enterprises (MNEs) Data for this study is obtained from a series of interviews with managers in AsiaInfo and China Mobile. This study applied an evolutionary approach to analyse complex and dynamic developments within AsiaInfo and found that the firm (AsiaInfo) has: (i) Gradually obtained its competitive advantages through continuous accumulations of adaptive innovations over 20 years; (ii) Accumulated adaptive innovations and its competitive advantage co-evolved with the rapidly growing demands of the Chinese telecommunication industry; and (iii) The ability to continuously generate adaptive innovations depended not only on its ability to accumulate technological innovations, but also social and organisational innovations. These factors were instrumental in enabling AsiaInfo to eventually emerge as a multinational enterprise and catch-up with other multinationals. This case study makes a significant contribution to the growing body of literature on latecomer firms' characteristics and strategies, particularly in East Asia. It makes a theoretical contribution by modifying Michael Porter's diamond model and integrating it with latecomer strategies that treat adaptive innovation as central for achieving competitive advantages.*

Keywords: Adaptive innovation, competitive advantages, Diamond Model, latecomer firm, telecom industry, China

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1. Introduction

It is widely acknowledged that technological innovation is one of the main drivers of economic growth as it plays an important role in improving competitive advantages of a country. A question raised often is how latecomer firms in developing countries and regions could promote industrial competitive advantages through innovation. In this context, we set out to examine whether and how adaptive innovation could enable a latecomer firm from a developing country to accumulate technological advantages and gain competitiveness to enter the global market.

In developing countries, it is possible a big market demand could help promote and stimulate enterprises to innovate and create new technologies. Special factor conditions in these countries can help improve their industrial competitiveness. In this context, the developments in telecommunications industry in China since 1990s make it an interesting case study. It (the telecommunication industry in China) has experienced rapid growth since late 1990s and witnessed the emergence of large multinational enterprises, such as Huawei, ZTE and AsiaInfo.

In the context of how latecomer firms in China's telecommunications industry emerged as MNEs, we posed the following research questions: (i) What were the driving factors behind the rapid growth of leading firms in China's telecommunications industry? (ii) What was the role of adaptive innovation activities and how did that help some of these firms to emerge as multinationals?

In attempting to answer these questions, this paper examined the emergence of AsiaInfo Linkage Inc. (AsiaInfo), one of the largest Chinese IT firms and telecommunication software providers, from an adaptive innovation perspective. Although there are other studies that focused on innovation capabilities of telecommunications firms in China (e.g. Fan, 2006), they have not specifically focused on the role of adaptive innovation towards accumulation of competitive advantages.

For over a decade, AsiaInfo has grown rapidly and emerged as one of the leading MNEs in the global telecommunications software industry. It has successfully expanded its business globally from Southeast Asia to Europe and has become one of the largest and fastest growing Business Support Systems & Operational Support Systems (BSS/OSS) MNEs in the world. In 2012, it opened its European regional headquarters. In 2013 it signed a major contract with Telenor (an European operating group) and emerged as a global player (AsiaInfo, 2013; Wikisperience, n.d.). Therefore, this is an interesting case study.

Although latecomer firms' characteristics and strategies have been discussed by many scholars with a particular focus on East Asia, studies on latecomer MNEs from China are still scarce. This paper aims to fill this gap.

This present study of AsiaInfo identifies the reasons for giving a high degree of importance to the role of adaptive innovation in gaining international technological and competitive advantages. Furthermore, it makes a theoretical contribution by modifying Michael Porter's diamond model and by conceptualising and integrating it with latecomer strategies. The modified diamond model treats adaptive innovation as a vital factor for achieving competitive advantages, and shows how adaptive innovation is linked to and influenced by other factors of the diamond model (firm strategy, market demand, supporting industries and factor conditions).

This paper is organised into seven sections. Section 2 discusses the theoretical framework and presents the 'Modified Diamond Model' analytical framework. Section 3 discusses the research methodology. Section 4 provides an overview of the case study (AsiaInfo). Section 5 discusses and analyses the case study and presents the findings. The final section, Section 6, concludes the paper by providing some policy recommendations.

2. Literature Review: Latecomer Strategy, Adaptive Innovation & Competitive Advantage

2.1 Latecomer strategy

The concept of adaptations and incremental engineering as components of innovation was first articulated by Schumpeter (1961, p.6). Schumpeter (1943) distinguished the adaptive and incremental innovation, from R&D-intensive activities that requires lumpy investments to support large laboratories. He considered firms with large scale laboratories as the shapers of cycles of innovation while acknowledging the benefits latecomers enjoy by creatively imitating them through adaptive and incremental innovation. Gerschenkron (1952) recognised how latecomers strategise to adopt foreign technology and in so doing expedite the catch-up process. Others used this logic to explain how firms in developing countries acquire technology and grow.

Hobday (1998, p.50) defined 'latecomer firms' as "an individual enterprise (existing or potential) that confronts at least two major barriers to entry in attempting to compete in advanced (usually export) markets: (a) technological disadvantages; and (b) market disadvantages". It is through learning from existing technologies that latecomer firms gain benefits, including skipping and leaping sequential steps in the technology trajectory (Gerschenkron, 1952). Amsden (1989), Ernst (1990) and Kim (1997) praised the ability of Korean and Taiwanese firms to adapt foreign technology, which is a major route for progress. Freeman (1987) and Lall (1987) noted how firms in Japan and India respectively learned from foreign technology. Freeman (1992) identified four technology strategies – dependent, imitative,

defensive and offensive. Amsden (1991) emphasised the importance of learning from foreign technology which enabled firms in the developing countries to develop their own technologies. Studies have also highlighted the innovative activities of latecomer firms, mainly their incremental and minor innovations through the assimilation and adaptation of imported technology (Enos & Park, 1988; Bell & Pavitt, 1993; Hobday, 1994). Mathews and Cho (1999) argued that it is the single-loop (capability to make imported foreign equipment to perform more efficiently in terms of productivity, yield and quality among others) and double-loop organisational learning (moving rapidly from one product generation to another, and moving into mass production at higher and higher levels of performance with each generation) that enabled latecomer firms in Korea to become successful and enter the global market. Lee (2013) concluded that successful catch-up involves targeting of specific sectors based on short-cycle technologies and by building up broad capabilities during earlier phases.

Studies have also focused on strategies adopted by latecomer firms in China to gain competitive advantages. For example, Shan and Jolly (2011) examined four latecomer telecommunications equipment manufacturers in China (Huawei, ZTE, Datang and Great Dragon) and concluded that the innovation capability and self-developed technologies are key to enabling domestic firms catch-up with the foreign MNCs and the latecomer domestic firms mainly depended on in-house R&D development, supplemented with external alliance to build their innovation capability. Xiao, Tylecote and Liu (2013) presented a theoretical framework for understanding how 'late-comer firms' (LCFs) in developing economies manage their technological capability, and within it their IP, strategically, in order to become fully competitive internationally. They applied it to three cases of Chinese firms at different levels of technological intensity. Their research highlighted China's very limited catch-up in high technology sectors. Zhilong et al. (2010) examined the management strategy of late entrants in China's automobile sector by analysing five firms, and they found that these firms followed the strategies of the early comers. They gained advantages through innovations (non-product innovation at the initial survival stage, and innovation in products, customer value and brands in later stages).

Uppsala internationalisation model or internationalisation process model (IPM) by Johanson and Vahlne (1977), and product, operational mode and market (POM) model by Luostarinen (1979) stress that firms first gain experience from the domestic market before they attempt to access foreign markets; they begin their foreign operations in neighbouring countries before venturing into distant countries. These firms rely on traditional exports and gradually use more intensive and demanding operation modes both at the company and host country levels. Subsequently, many related theories or variations of existing theories emerged based on empirical studies of

developed countries' MNEs. In the last decade when MNEs from developing countries like China and India began expanding their operations into developed countries via outward foreign direct investment (OFDI), 'latecomer catch-up' and 'internationalisation' models were used to explain their dynamics and evolution.

For example, Meyer and Thaijongrak (2012) presented an extended internationalisation process model (IPM) to explain the evolution of MNEs in developing countries, specifically focusing on the role of acquisitions of strategic assets in foreign countries in the internationalisation process. Mathews' (2006) 'linkage, leverage and learning' (LLL) model highlighted the important role of global value chains in creating opportunities for latecomer firms in emerging economies to forge linkages and leverage to acquire technology, knowledge and market access and accumulate competitive advantages through sustained and repeated learning process. Child and Rodrigues (2005) observed the patterns of internationalisation by Chinese firms and suggested that they seek technological and brand assets to create a competitive position in international markets and overcome competitive disadvantages, in contrast to the general assumption that firms internationalise to exploit their competitive advantages. Lee, Cho and Jin (2009) studied catch-up by latecomer firms in the automobile and mobile phone sectors in China using the sectoral systems of innovation (SSI) framework that focuses on the regime of technologies and knowledge, such as modularity, degree of embodied technical change, tacit knowledge, knowledge access, and frequency of innovations.

Few studies have focused on how adaptive innovation can play a major role as 'latecomer strategy' or 'internationalisation strategy' in the evolution of some MNEs. For example, Yu et al. (2006) highlighted the role of 'adaptive entrepreneurship' to explain economic dynamism of Asian latecomer economies in general and Taiwan in particular. Zhang, Shi and Wu (2010) used one company as a case study and secondary industrial sector data to examine latecomer strategies and factors that enabled the rapid growth and emergence of Taiwanese TFT and LCD panel manufacturers. They found that an incremental approach rather than radical innovation provides latecomers with opportunity to utilise their learning curve. To sum up, although there are studies on latecomer strategies based on adaptive innovation, there is hardly any research that has focused on China.

This study aims to fill this gap in the literature by analysing the evolution of China's AsiaInfo (a latecomer firm in the telecommunications industry). It aims to understand whether and how adaptive innovation can be the main driver for some latecomer firms to gain competitive advantage, enabling them to catch-up and emerge as a multinational enterprise.

In the following sub-sections, we discuss the context and the meaning of 'adaptive innovation' and 'competitive advantage'.

2.2 *Adaptive innovation*

This paper uses the term ‘innovation’ to refer to both physical innovation (technological innovation) and social innovation (institutional innovation) (Nelson, 2002). The term ‘adaptive innovation’ on the hand is used in this paper instead of ‘innovation’ because the former is considered a key driver for the processes of catching-up.

Kirton (1976) introduced the Adaption-Innovation theory to describe cognitive styles and differences in creativity. That is, while adaptors aim to do things better using existing solutions, techniques, or products in new scenarios or changed conditions, innovators on the other hand seek to do things differently by coming up with new innovative solutions. However, in innovation literature, the terms ‘adaptive’ and ‘innovation’ are not treated separately; rather, they are referred to ‘adaptive innovation’. Although there is no authoritative and concrete definition for ‘adaptive innovation’, it is identified as a firm’s ability to understand the reasons and implications of market changes and adapt to them by creating an infrastructure and culture for sustained innovation (Shankar & Spanjol, 2005). To be sure, many scholars have recognised the significance of adaptive innovation for enterprises. For example, Von Hippel (1982, 2005) has examined user-centred innovations while Eisenhardt and Tabrizi (1995) analysed rapid adaptive processes in the global computer industry by focusing on product innovation as a crucial adaptive process. Yu, Yan and Yu (2006, p.59) called it ‘adaptive entrepreneurship’ which included “putting new ideas in use, modifying and perfecting original innovations, adding some product attributes and fitting a slightly different market, supplying something which is still lacking in the market, and serving the markets which pioneers have created but have not yet adequately serviced”.

To sum up, adaptive innovation means innovation adapted to various institutions, changes in technology, related industries, market and market structure and factor conditions. The adaptive innovation is seen as an evolutionary selection process. The effort to promote technology development is a continuous adaptive selection process, as a latecomer firm selects different paths of technological development including adaptive innovation that suit its particular circumstances. Therefore, adaptive innovation perspective can help explain how and why latecomer firms such as Huawei, ZTE, and AsiaInfo were able to gain competitive advantages and evolve into multinational enterprises.

2.3 *Competitive advantage*

White and Bruton (2010) argued that competitive advantage is something that the firm does better than any of its competitors; however, the ability to perform better than its competitors will lead to a sustainable competitive advantage only if the activity is something that the customer's value or want, and other firms cannot easily duplicate.

There are many studies on competitive advantage and innovation (e.g. Solleiro & Castanon, 2005; Uchida and Cook, 2005). It is widely acknowledged that market size, growth, and domestic demand for the firm's product could affect competitive advantage. Sophisticated customers or unique local conditions stimulate firms to enhance the quality of their products and to innovate. Home demand conditions can have an impact on the pace and direction of innovation and product development. Porter (1990) stated that a country can achieve national advantage in an industry or market segment if home demand provides clear signals of demand trends to domestic suppliers than foreign competitors. The World Bank research report (1993) on East-Asian catch-up emphasised the advantages of the countries' so-called 'market friendly' approach and downplayed the role of their interventionist policies (Cappelen & Fagerberg, 1995; MacDonald et al., 1993). Fagerberg, Mowery and Nelson (2004) pointed out that although Japanese innovation in the catch-up phase also included a large number of product innovations, especially of the minor types (adaptations to demand), the main emphasis was on process innovations, particularly of the organisational type, that allowed for simultaneous exploitation of scale economies and flexibility, leading to high through-put, efficient inventory management, high quality products, reliability and a proven ability to adjust to needs of the end-user. Some scholars studied competitive advantage from the resource based view (e.g. Peteraf, 1993).

2.4 *Framework of analysis: modified diamond model*

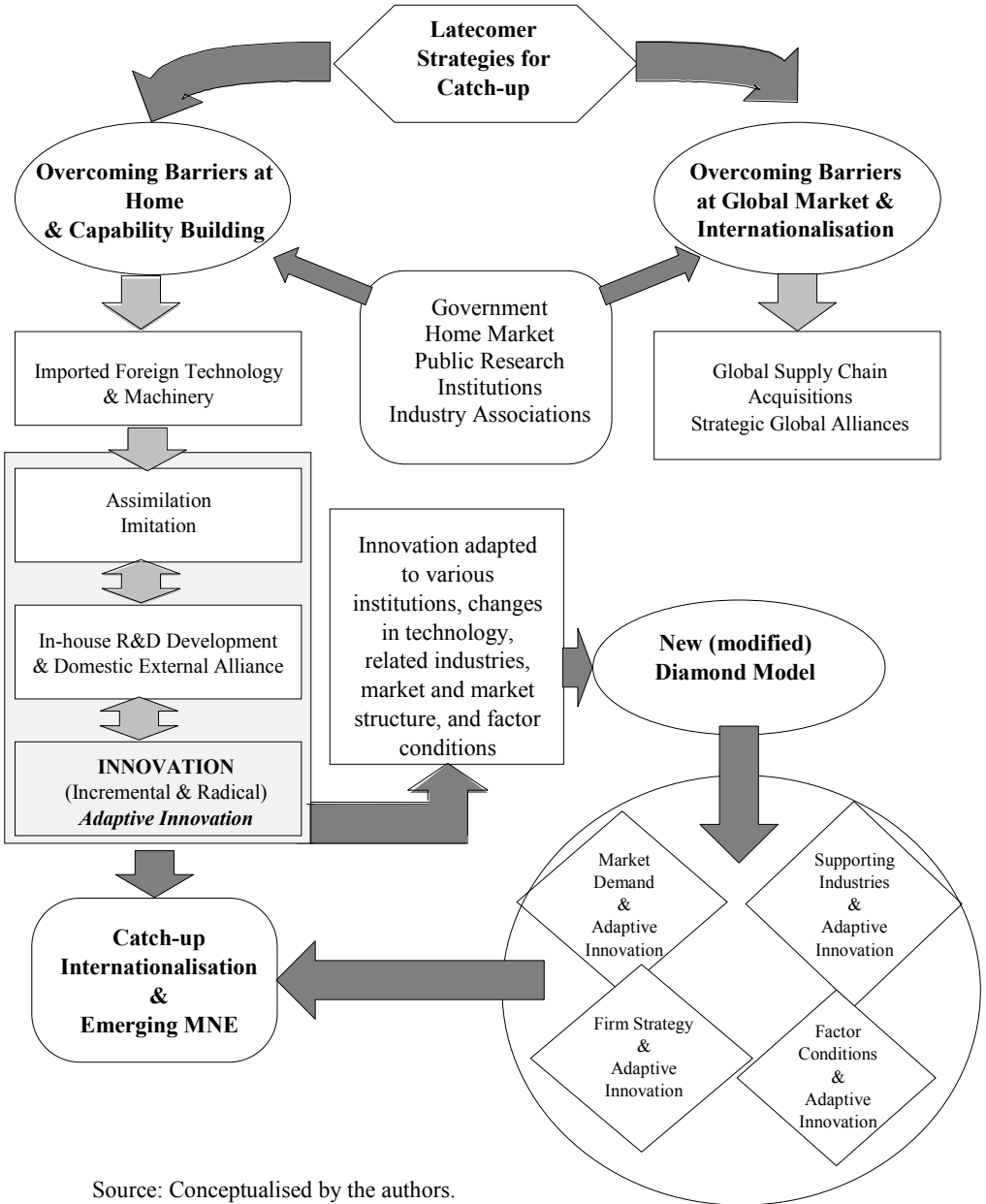
Porter (1985, 1990) presented the 'diamond model' to understand how various forces in an industry impact on each other in the process of acquiring competitive advantages. The four factors in his diamond model are: Factor conditions, Demand conditions, Related and supporting industries, and Firm strategy, structure and rivalry. In his book 'Competitive Advantage of Nations', Porter (1990) argued that innovation is the core of the formation of competitive advantage; however, the core position of innovation was not reflected in the diamond model and the latecomer competitive advantages were not systematically studied by him. For example, innovation was not listed as an individual factor in the diamond model and instead, technological innovation was internalised in the 'factor conditions'. Furthermore, Porter's

theory is based mostly on an analysis of the leading industries in the developed countries and therefore, how the latecomer could gain competitive advantages was not systematically analysed. There have been attempts to fill this gap in the literature by modifying Porter's model to study the dynamics of emerging MNEs in developing countries. Carayannis and Wang (2012, p.280), employed a 'Competitiveness Model – A Double Diamond' that 'extends Porter's Competitiveness Diamond, in which a firm's capacity in identifying, negotiating, networking with and improving its existing technological capacity is at the core of competitiveness'.

For the latecomer firms, adaptive innovation on its own would not result in acquiring competitive advantages. The latter can be achieved mainly through co-evolution of adaptive innovation with other main factors such as market demand and factor conditions. This paper adapts Porter's model to study how latecomer firms in developing countries gain competitive advantage. It proposes a 'Modified Diamond Model' as an analytical framework. Figure 1 illustrates the latecomer strategies for catch-up which includes adaptive innovation strategy. The main challenge is to build capabilities to overcome barriers in home and global markets. Capability building involves acquiring imported technology, assimilation and imitation, strengthening in-house R&D and forging domestic R&D alliance, incremental and radical innovations. Figure 1 shows how adaptive innovation is instrumental in the process of catch up and internationalisation. Adaptive innovation is influenced and shaped by different factors such as institutions and market conditions.

Figure 2 illustrates how adaptive innovation, central to the Modified Diamond Model, drives acquisition and accumulation of competitive advantages by latecomer firms in the catch-up process. It shows how adaptive innovation is linked to and is influenced by other factors of the diamond model: firm strategy, market demand, supporting industries and factor conditions. The modified diamond model helps to explain how adaptive innovation interacts with other key factors of Porter's diamond model in building competitive advantages. Table 1 shows the interaction between adaptive innovation and these key factors. Figure 2 and Table 1 are used as analytical frameworks to study the AsiaInfo's (latecomer) catch up process to emerge as a multinational enterprise.

Figure 1: Evolution of a latecomer firm into an emerging MNE through adaptive innovation and competitive advantages: a conceptual framework

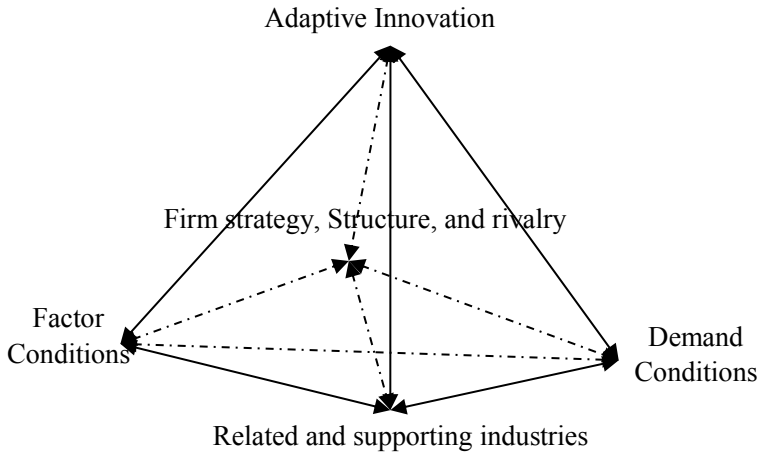


Source: Conceptualised by the authors.

Table 1: Modified diamond model analytical framework: links between adaptive innovation and other key factors

<i>Adaptive Innovation & Other Key Factors</i>	<i>Characteristics</i>
<i>Market Demand Conditions</i>	<ol style="list-style-type: none"> 1. Large and diverse market demands can push latecomer countries and regions to create new technologies which would be more appropriate for their own national circumstances. 2. During the process of rapid growth of market, emerging countries are likely to generate some special demands which are different from that of other countries. 3. These demands could stimulate the latecomer enterprises to produce new products and develop new technologies which might be more adaptive to their own cultures and organisations.
<i>Firm Strategy</i>	<ol style="list-style-type: none"> 1. Catching-up patterns of innovation of latecomer enterprises tend to be different from those of existing companies. 2. During initial catching-up phase, latecomer enterprises may focus mainly on solution-based process innovation and incremental innovation due to weak capabilities (relatively speaking). 3. When the industries continue to grow, latecomer enterprises will gradually improve their innovation capabilities through adaptive learning and innovation. Then, they will acquire endogenous innovation capabilities to pursue product innovation.
<i>Related and Supporting Industries</i>	<ol style="list-style-type: none"> 1. Industrial development of latecomer countries and region could drive the technology development of related and supporting industries. 2. Rapid industrial development of a latecomer country could stimulate related and supporting industries to carry out development of new technologies and technological innovations that are more adaptive, which gradually enable them to accumulate global competitive advantages.
<i>Factor Conditions</i>	<ol style="list-style-type: none"> 1. Gaining industrial competitive advantages depends critically on the effective use and management of natural resources, labour and capital, routing and the process of choice. 2. Factor conditions play an important role for latecomer industry to gain competitive advantage. 3. Under different circumstances, the same factor conditions can either promote or hinder gaining of competitive advantages. 4. Different factor conditions drive people to develop new technologies and solutions in different ways.

Source: Drawn from Porter (1990)

Figure 2: Modified diamond model

Source: Adapted from Porter (1985, 1990).

3. Research Methodology

There is no single method to study the complicated dynamics of adaptive innovation where knowledge and learning are central (Arrow, 1994). This paper employed qualitative (phenomenology) methodology, case study method and Modified Porter' Diamond Model as an analytical framework to examine how adaptive innovation enabled latecomer firms to accumulate competitive advantages to emerge as a MNE. Case studies are often used to examine an on-going social and economic phenomenon, its context and causes (Yin, 1981; 2014). In organisational research, the case study method is often used and its appropriateness is well documented (Eisenhardt, 1989; Pettigrew, 1990). Hence, this study examines how AsiaInfo had gradually accumulated competitive advantages through continuous adaptive innovation and coevolved with the fast-growing Chinese telecommunications industry, eventually emerging as a multinational enterprise and a global player.

The study employed multiple data sources and 'triangulation' technique to analyse the dynamics of adoptive innovation (Anand, Gardner & Morris, 2007; Cohen & Manion, 2000; Jick, 1979; O'Donoghue & Punch, 2003; Altrichter, Feldman, Posch & Somekh, 2008). Different techniques were utilised including interviews, direct observation, archives and descriptive statistics. The 'triangulation' technique was particularly useful as the study used only one case, and it is important to ensure a high degree of accuracy of data to produce robust results.

Acquisition of technological capabilities and competitive advantages of AsiaInfo over the years was analysed using primary data obtained from interviews with managers and other senior employees from various departments of AsiaInfo and China Mobile.

The interviews were conducted between 2009 and 2012. The first-round interviews were conducted in 2009 and subsequent interviews with the same respondents were conducted every three months. The second-round interviews were conducted using open questionnaires in 2010. The third-round interviews were conducted in 2012. Additional interviews were conducted in 2014 to get the latest updates on developments in the company (See Appendix 1 for details of interviews conducted for the study).

The following measures were taken to address potential bias: (i) Knowledgeable informants from different hierarchical levels were selected for interviews, including top management as well as middle management; (ii) 'Cross-examination' technique was used to gather factual accounts; and (iii) Business confidentiality and personal anonymity were assured to encourage openness.

Although it is well recognised that it is difficult to draw bold conclusions and generalisations from case studies, particularly from a single case study, this research makes significant contributions to the literature on 'latecomer catch-up' strategies by illustrating that adaptive innovation can be a core factor for achieving competitive advantages. Earlier studies did not consider adaptive innovation as a central factor for achieving competitive advantages. By addressing this gap in the literature, this study makes significant contribution towards understanding how adaptive innovation leads to accumulation of competitive advantages and help a latecomer establish itself in the global market.

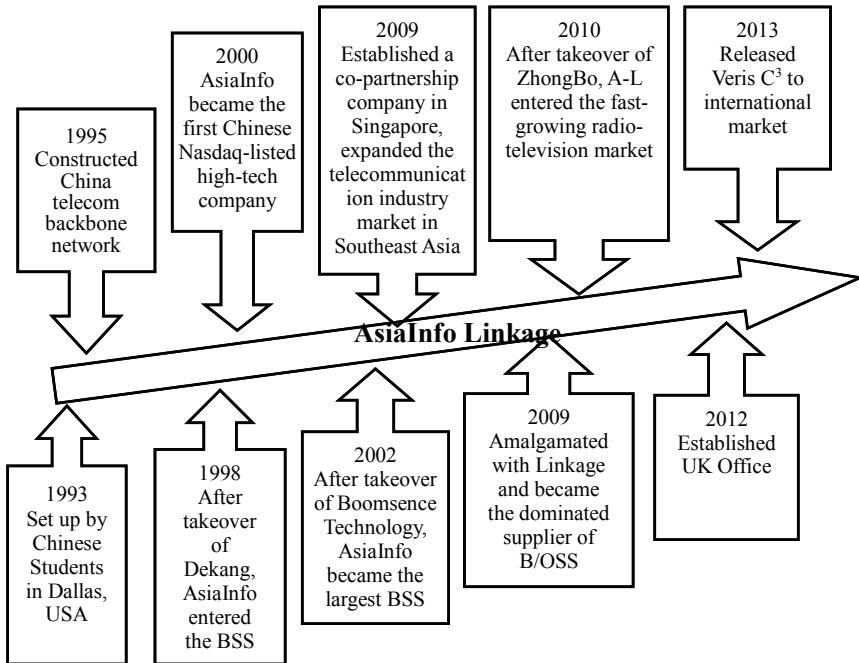
4. Overview of the Case Study: AsiaInfo

AsiaInfo was established in the United States in 1993 by a group of Chinese students. In 1995, its core founders returned to China and set up the AsiaInfo Technologies Ltd. By 1997, the company had successfully implemented hundreds of large Internet projects including the network construction for China Telecom. AsiaInfo became one of the first high-tech enterprises to gain venture capital backing in China from 1997 to 1999. In 2000, it became the first Chinese high-tech company to be listed on NASDAQ stock market. In 2010, AsiaInfo successfully completed its merger with Linkage, which was the second largest BSS/OSS provider for the Chinese telecommunications operators, forming the AsiaInfo-Linkage.

Over the years, AsiaInfo has become a dominant player throughout China. By 2011, ASIAINFO BI system had been introduced in 15 provincial companies and also within the group company of China Mobile with over

150 million users and supported more than 500TB data capacity; the ASIAINFO BOSS system was introduced in 9 provincial branches of China Mobile. At present, AsiaInfo Linkage is a leader in China with more than 50% share of the telecommunications billing, CRM, and business intelligence markets. Simultaneously, AsiaInfo expanded its global operations. It started its foreign operations in Southeast Asia with regional headquarters in Singapore. AsiaInfo rapidly expanded into Thailand, Malaysia, Nepal, Pakistan, Cambodia and other countries in the region. In 2012, it established the European regional headquarters and in 2013 it entered into a major contract with Telenor, one of the leading European operating groups. By 2014, AsiaInfo-Linkage has established its branches in the US, the UK, Hungary, Hong Kong and Singapore. It decided to delist from NASDAQ in 2014 for strategic reasons, and changed its name from AsiaInfo-Linkage to AsiaInfo and is now expanding into Europe, the Middle East and Africa. The company aims to be a global leader in the new era of ‘the Business Internet’. Figure 3 shows AsiaInfo’s journey since it began as a small firm in 1995, emerging as MNE in less than 20 years.

Figure 3: The development and growth process of AsiaInfo-Linkage Inc.



With the rapid development and expansion of China's telecommunications industry, operational support enterprises of this industry also experienced increasingly fierce market competition. In 1997, when China Mobile officially separated from China Telecom, the market share of telecommunications software and service providers in China was so low that none of them had more than 10% share. At that time, leading foreign multinational enterprises like AMDOCS and SIBEL provided telecommunications software and service to China Mobile. But after 10 years, both AMDOCS and SIBEL had to quit the Chinese market due to strong competition from other firms.

By 2009, AsiaInfo emerged as the second largest BSS/OSS telecommunications software solutions provider both in terms of global revenue and market capital. The merger of AsiaInfo and Linkage Technologies significantly enhanced the competitiveness of the new entity, transforming the latter into a multinational enterprise in the global telecommunications software industry. By 2013, the company had employed more than 11,000 people worldwide (84% of them were technicians) and established 10 R&D centres throughout China and one R&D centre in the UK (AsiaInfo, 2013; Wikisperience, n.d.).

5. Analysis of the Case Study

In this section, we employ the analytical framework presented in section 2 (See Figures 1 and 2, and Table 1) to trace how adaptive innovation process evolved within AsiaInfo and gradually transformed it into a MNE. In particular, this paper employs a modified Porter's (1990) diamond model for analysing this process.

5.1 AsiaInfo's adaptive innovation and firm strategy

AsiaInfo's main technologies can be divided into two types: (i) Platform software technology (or Structural software technology); and (ii) Operation software technology (or Functional software technology). Platform software innovations are mostly connected with product innovations or radical innovations while operation software technology can be viewed as process innovation or incremental innovation. AsiaInfo's innovation activities can be roughly divided into three stages:

5.1.1 Stage 1: Focusing on client-server database technology (1997-2001)

From the beginning, AsiaInfo accorded high priority to operation (functional) software and client-server database rather than platform (structural) software. At this stage, for platform software technologies,

AsiaInfo relied fully on procurement from leading foreign companies such as IBM and ORACLE, focusing its efforts on incremental operation software innovation. The operation software is not technically complex but requires greater labour input. This is in contrast with AsiaInfo's foreign competitors who focus on platform software.

According to Mr. Wang Jun, General Manager of South China AsiaInfo, in 1997, at the time only less than 10 technicians and engineers were involved in platform software development (most were involved in functional software development). AsiaInfo devoted its main effort towards providing prompt and efficient services to meet different needs of telecommunications operators. Through fast and efficient service and better understanding of players involved in the telecommunications sector, AsiaInfo rapidly gained access to provincial markets such as Guizhou, Guixi, Gansu and Tibet (mostly located in the less developed western part of China). During this stage, AsiaInfo's new products mainly were in the area of operation software. In the more developed regions such as Beijing and Tianjing leading multinational enterprises like AMDOCS and SIBEL provided supporting software during this period.

5.1.2 Stage 2: Focusing on Transaction Middleware technology (2002- 2009)

During Stage 2 China's telecommunications industry witnessed rapid development. The number of mobile phone users increased sharply, which formed technology bottlenecks. As a result, the demand for operation software increased (including the complexity of the telecommunications operators' demand) rapidly. AsiaInfo had to continuously improve its Transaction Middleware technology during this stage. The burden of huge user data, however, created a significant challenge to the billing system. During this stage, the NGBOSS system (Next Generation Business Operation Support System) was upgraded from version 1.0 to 3.0. According to Mr. Xu Li, the Co-manager of marketing department in Guizhou Mobile, the number of business halls increased from 3,000 in 2002 to 18,000 in 2009 in his company, showing that the number of concurrent users continued to rise. To be sure this demanded the improvement of Transaction Middleware technology to match the application programs (Such as Mobile Payment System) and meet the needs of concurrent users.¹ AsiaInfo continued optimising and modifying the source code to adapt to the requirements which gradually became their own proprietary technologies. These (proprietary technologies) have gradually improved AsiaInfo's competitive advantages. As a result, the market structure of telecommunications software and service provider industry in China changed significantly. The number of telecommunications software and service provider enterprises for China

Mobile have decreased from 23 in 1999 to just four in 2009, which were AsiaInfo, Huawei, Linkage and E-mobile. AsiaInfo had the highest market share compared with the others.

Platform software technologies in AsiaInfo were still dependent on foreign companies such as IBM and ORACLE. However, the company steadily increased its technology innovation capabilities to improve stability, security and scalability of its systems. Thus, while most of the new products were still in the area of operation software, AsiaInfo began to introduce new products in platform software. For example, a typical adaptive product innovation the company introduced was MDB (Memory Data Base) technology which could access and process data in memory. This technology was able to reduce reading steps, thereby led to enhancing operational efficiency of the entire NGBOSS system. The non-standard applications of MDB technology increased users' dependence on AsiaInfo's products, especially telecommunications operators.

5.1.3 Stage 3: Focusing on open source technology (2009-Present)

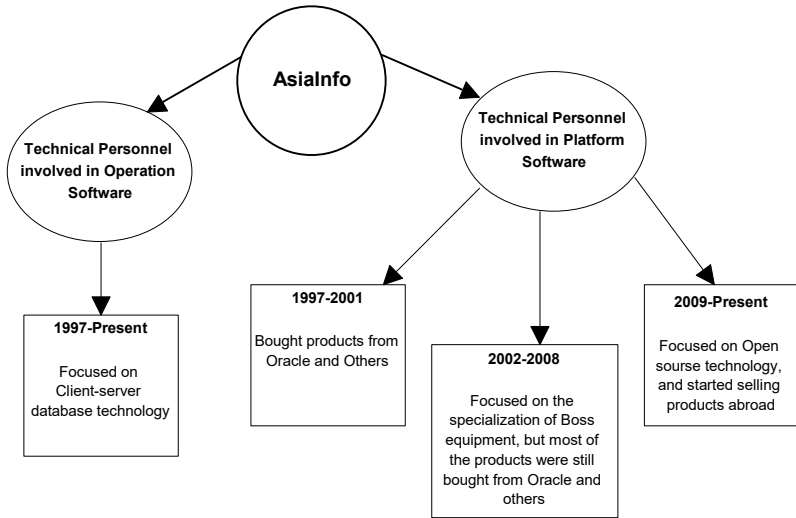
AsiaInfo gradually shifted its business focus from structure software development to platform software development. Also, open source technologies such as distributed database were gradually introduced and integrated step by step, which helped to replace the platform technology of IBM and ORACLE. The open source platform software development focused on Cloud based Platform and Dual Hot Backup Machine System. The Cloud based Platform implemented by AsiaInfo contributed to numerous researches on Cloud CRM, Cloud Business Intelligence, Cloud Billing, and so on, thus allowing different mobile companies to use data resource and service from this central Cloud based Platform. When Dual Hot Backup Machine System linked two servers through a database, they could perform the same task. Over the years, AsiaInfo has accumulated its platform technology innovation capability which is mainly driven by rapidly growing demands from China telecommunications operators. If AsiaInfo had continued to rely on technologies from foreign companies, it would not have been possible to satisfy the surge in demand from China telecommunications operators (the cost too would go up as a result of using foreign technology). Furthermore, open source technologies were more flexible to meet the demands of telecommunications operators. AsiaInfo also gradually increased its share of the international market, especially in Southeast Asia by meeting international norms, standards and demands of the international market. During this stage, the company's operation software products still accounted for a big share of its offering, although its platform software products had increased sharply as well. Since 2009, the number of R&D technical

personnel involved in the Nanjing product R&D centre, which focused on developing platform software, increased to 1,500 in 2012.

In the area of functional software, AsiaInfo began to use an upgraded version of NGBOSS (from version 3.0 to 4.5) which has many new functions based on user requirements, such as Real-time Self Service (RTSS) solution, variety payment methods, GPS data traffic alert, and so on. Table 2 highlights the growth of competitive advantages and adaptive process innovations while Table 3 highlights the growth of competitive advantages and adaptive product innovations in AsiaInfo in each of its three stages of development.

For the enterprises in developing countries and regions, the evolution of technological learning and innovation process may be different. According to Kim (1997), the dynamics of Korea's technological learning followed the path from imitation to innovation. AsiaInfo has demonstrated similar experience of technological learning. Through the above analysis of AsiaInfo's experience over the years, it showed that the evolution of its innovation process began from operation software technology, which could be viewed as process innovation, and gradually moved to platform software technology, which could be seen as product innovation. This is illustrated in Figure 4. In other words, AsiaInfo started its operations from simple application process development based on IBM platforms and gradually shifted to complex process development which led to proprietary technologies, such as AsiaInfo transaction Middleware technology and flexible adapting structure. Eventually AsiaInfo developed its own platform software, the AsiaInfo's Cloud-based Operation Platform, mainly based on indigenous technologies. This platform software was sold to telecommunications operators in other countries. It is evident that AsiaInfo's evolutionary path started from its capability to undertake simple process improvements gradually acquiring significant capabilities to undertake product development. According to Abernathy and Utterback (1978) who introduced the A_U model which AsiaInfo has followed, 'a productive unit's capacity for and methods of innovation depend critically on its stage of evolution from a small technology-based enterprise to a major high-volume producer' and the 'characteristics of innovative and innovation process correlate with such an historical analysis' (Abernathy & Utterback, 1978, p.41).

Figure 4: Evolution process of technological innovation in AsiaInfo: focus of technical personnel involved in operation software & platform software at different stages



Source: Based on interviews with respondents at AsiaInfo.

Table 2: Growth of competitive advantages and adaptive process innovations in AsiaInfo

Period	Examples of Process Innovation/ Projects
Stage 1: Focusing on Client-server database technology (1997-2001)	Billing system from version 1.0 to 3.0 <ul style="list-style-type: none"> • Billing data collection • Quasi-real-time Billing system • Payment Solution
Stage 2 Focusing on Transaction Middleware technology (2002-2009)	NGBOSS system from version 1.0 to 3.0 <ul style="list-style-type: none"> • Application system decoupling • Improving Function: Such Data Plan, SMS Plan, Data SP (Service Provider) Plan • NGBASS (Business Analysis System)
Stage 3 Focusing on open source technology (2009-Present)	NGBOSS from version 3.0 to 4.5 <ul style="list-style-type: none"> • Further Application system decoupling • SMS CRM, Web CRM, Customer-self CRM • Real-time Self Service (RTSS) solution

Note: Operation software technology could be viewed as process innovation or incremental innovation to some extent

Source: Interviews.

Table 3: Growth of competitive advantages and adaptive product innovations in AsiaInfo

Period	Examples of Product Innovations/ Projects
Stage 1: <i>Focusing on Client-server database technology (1997-2001)</i>	<ul style="list-style-type: none"> • Almost no product innovation.
Stage 2: <i>Focusing on Transaction Middleware technology (2002-2009)</i>	<ul style="list-style-type: none"> • MDB (Memory Data Base)
Stage 3: <i>Focusing on open source technology (2009-Present)</i>	<ul style="list-style-type: none"> • Cloud Based Platform • Dual Hot Backup Machine System

Note: Platform software innovations are more connected with product innovations or radical innovations

Source: Interviews.

5.2 AsiaInfo's adaptive innovation and special market demands in China

The Chinese telecommunications market has special characteristics. The growth pattern and culture of Chinese telecommunications operators and their counterparts in the developed economies are quite different. Current research shows Chinese telecommunications operators have to deal with large quantities of data, diversity, unpredictability, timeliness, and so on. Table 4 provides a comparison of telecommunications market demands in China and some developed countries.

China's telecommunications industry has grown rapidly since 1997. China Mobile for example, has expanded rapidly since 1999 and its mobile phone users have grown from 24.5 million in January 1999 to 633 million in September 2011. China Mobile has become the number one mobile operator in the world both in terms of network scale and customer size. During its expansion process, the requirements of high stability of service system posed a major challenge to China Mobile's operations support systems (OSS). The market scale and mass data have exceeded those of most other countries'. There was no operational software system in the world at the time which could be a reference or benchmark to address the challenges faced by AsiaInfo. The company had to actively invest in R&D to meet the demands from the rapidly growing and changing market. The focus was on adaptive innovation to meet local demands.

Table 4: Comparison of market demands in China and developed countries in the telecommunications sector

China	Some Developed Countries
Rapid development	Rapid development
Large Quantity	Comparatively small
Diversity	Similarity
Unpredictable	Predictable
Timeliness	Less mobility
Tens of thousands of secondary developments annually	Very few secondary developments

Source: Interviews

AsiaInfo's Cloud-based Operation Platform Container (COPC), a centralised BSS system with a multi-tenancy architecture that streamlines business operations across operator subsidiaries, helped to reduce the overall time to market new services and offers by 40 percent and also reduced average processing time of service orders by 30 percent (Clara, 2014). The COPC was shortlisted for the 'Best Use of Cloud Services' in the 2014 Telecoms.com Industry Awards which recognises innovation and excellence in the global communications industry.

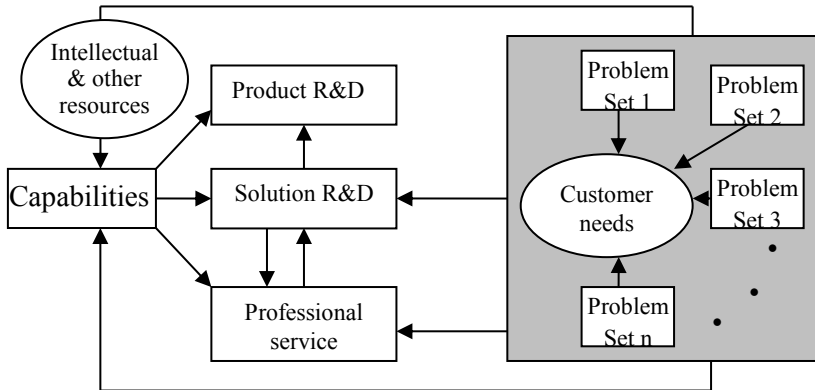
As each provincial branch of China Mobile has very diverse needs, AsiaInfo was required to respond quickly. China Mobile generated tens of thousands of new operational demands annually which had to be met by AsiaInfo. These demands required the company to update its business software constantly. For example, according to Mr. Cheng Zhenhong, Manager of Guizhou AsiaInfo, for adapting local demand of Guizhou Mobile, AsiaInfo invested 10,000 working days for the secondary development of products in 2013. European telecommunication software industries generally adopt 'product delivery' pattern and most rarely develop their software after delivery probably because of their high labour costs. However, AsiaInfo chose to conduct secondary development to meet local conditions.

Demands from telecommunications operators was generally unpredictable and diverse. Each provincial telecommunications operator has to come up with a specific response to meet demand. In addition, there is a huge gap of consumption demand between developed area and underdeveloped area, which shaped the operators' response. For example, promoting mobile phone usage varied greatly between developed areas and underdeveloped ones. In 2013, Guizhou Mobile (Underdeveloped area) offered 100 Yuan as bonus when a customer topped up his/her credit with 100 Yuan (\$1= about 6.5 Yuan). But in the developed area such as Zhejiang province, the bonus was 50 Yuan or less. When telecommunications operators generate new demands, AsiaInfo had to try its best to meet their

requirements. The diversity and complexity of customer demands has forced AsiaInfo to constantly upgrade its technical competence and to make its platform more open. It had developed personalised butler service to meet demands of the domestic market. Chinese markets are complex and posed a significant entry barrier for foreign competitors. As a result, leading foreign software providers such as AMDOCS and SIBEL had to quit the Chinese market in 2009.

AsiaInfo meets tens of thousands of new operational demands from China Mobile annually. For this, AsiaInfo had to update and modify its software constantly. For example, even during national holidays, AsiaInfo works hard to meet demands of China Mobile. The company has restructured its organisation, personalised its butler service to meet evolving demands. As mentioned above, the average R&D and implementation time for each new operational demand is between 15 and 20 days which is about 5 days less than the average time taken in the industry, according to Mr. Wang Jun, General Manager of South China AsiaInfo and Mr. Yang Ge, Technology Support Director of South China AsiaInfo.²

AsiaInfo has been continuously innovating not only in the area of technology but also on social and organisational areas. In the aspect of physical technological innovation, in its early stages, AsiaInfo has invested significant resources to develop functional software mainly on Billing System. The main functions of the Billing System included billing record collection, sorting, rating and generating bill. As AsiaInfo grew, it improved its R&D capability and gradually acquired the ability to develop platform software. For example, it developed its own MDB (AsiaInfo Memory Database System) which can access and process data in memory and reduce the speed of reading and writing data and improve access. In terms of social and organisational innovation, AsiaInfo has been restructuring its organisation since 2005. The main organisational structure changed from separate provincial projects teams into three centres: (i) R&D Centre (including Product R&D); (ii) Solution R&D; and (iii) PSO (Site team). Also, more suitable service patterns have been developed. For example, due to the extremely high altitude in Tibet, the R&D engineers could not adapt to the special highland environment. Therefore, AsiaInfo transferred all the billing and maintenance of Tibet Mobile into a southern base in Guangzhou city but retained a rudimentary business management unit in Tibet.

Figure 5: Adaptive innovation management in AsiaInfo

Source: Drawn from the interview data

Figure 5 illustrates the adaptive innovation pattern of AsiaInfo. As the company grew bigger, its intellectual assets became more distanced from its customer problem sets. The company successively set up three kinds of R&D departments to meet these problem sets: Product R&D, Solution R&D and Product Service Operation. The platform software was developed in the Product R&D department, Nanjing (founded in 2002). Most of the business software was developed in the Solution R&D departments, located in Nanjing, Guangzhou, Beijing and Hangzhou. These were set up according to the needs of AsiaInfo's fast growing market demands. Almost every province of China now has a Product Service Operation department to meet the specialised demands of the local market. AsiaInfo also developed a more personalised service to understand the problem sets of domestic telecommunications operators. This personalized service was referred to as 'none distance customer service' by AsiaInfo, characterised by quick responses and adjusting the system immediately according to customer demand. It moved the functional R&D and localised R&D forward to meet the needs of telecommunications operators. The 'none distance customer service' has distinguished AsiaInfo from AMDOCS (according to Jin Xisheng (Vice President of AsiaInfo -Linkage), Zhao Dingxi (Sales manager of AsiaInfo-Linkage), and Zhao Dingxi and Mr Xu Li (Co-managers of marketing department in Guizhou Mobile)).³

Generally, the solution and supporting R&D staff of AsiaInfo were posted to work on-site at customers' plants to forge close cooperation with their staff. For example, the staff of solution and supporting R&D of Guizhou AsiaInfo occupied half of the offices of technical supporting department of Guizhou Mobile. AsiaInfo also expanded with the growth of China Mobile.

For example, permanent staff working in Guizhou AsiaInfo have been growing gradually, from 10 in 1999 to 60 in 2013. The technical support division in Guizhou Mobile has also grown from 17 in 1999 to 70 staff in 2013. Guizhou AsiaInfo had really no distance with its customer. They could understand the mobile operators' needs instantly when they arose and were able to develop their products quickly. This 'none distance with customer' service enabled AsiaInfo technical personnel to understand the problem sets and work on them to meet the daily and diverse needs of domestic telecommunications operations.

However, AsiaInfo would send other professionals or refer to its R&D centre if its technicians are unable to resolve the problems. For example, China Mobile had wanted to upgrade its telecommunications billing and CRM System from big platform to cloud platform in July 2012. This upgrade version of billing and CRM System had been implemented in Zhejiang Mobile. From July to October 2012, 20 to 30 additional technicians were sent to Guizhou AsiaInfo to analyse local demands. Subsequently, 200 more technicians were sent to Guizhou AsiaInfo. When the system went online in February 2013, more than 300 technicians were working on software development in Guizhou AsiaInfo.

AsiaInfo has been focusing downstream in understanding the problems faced by telecommunications operators and the firm's own capabilities to address problem sets and provide solutions. It has emphasized the importance of establishing a deep link between capabilities and their telecommunications operators' problem sets. When customers' problem sets could not be met by AsiaInfo's technological capabilities, it would attempt to find other resources to solve the problems. In other words, AsiaInfo has been continuously undertaking the following adaptive innovation activities to meet the rapidly increasing demands from China's telecommunications market.

In order to meet the requirements of the changing Chinese market, AsiaInfo has engaged in adaptive innovations which has the following characteristics:

(i) Solution-based innovation

AsiaInfo's Solution-Based innovation identifies the demands of its customers and puts forward new customer solutions at a strategic level. Its goal is to be the leading provider of telecommunications software solutions, and IT security products and services. AsiaInfo introduced personalised butler service to customers to understand their needs better. The billing system is monitored by humans. In order to reduce difficulty of maintenance and transferring it into platform work, AsiaInfo developed BOMC (Business

Operation Management Centre) in 2007, which can gather and detect a system's operation status and raise alarm when problem arises.

(ii) Service innovation

AsiaInfo's competitive advantage is in its services whereby it constantly innovates to meet the evolving service demands of Chinese telecommunications operators. For example, it provided solutions for China Mobile via its 'best-of-class services'. The most typical service innovation is 'none distance with customer service', which largely contributed to expanding the technical service to consulting service. The R&D team of AsiaInfo joined the market department of China Mobile to analyse customer demand, and worked on a joint marketing campaign.

Over the years, AsiaInfo has accumulated strong capabilities to support telecommunications operators with comparatively low cost. It has also developed IT services to help the telecommunications operators to provide better services. This has enhanced customer satisfaction, which in turn boosted AsiaInfo's own operational competence.

(iii) Rapid innovation

AsiaInfo's core competence lies in its ability to innovate rapidly. For example, China Mobile generated tens of thousands of new demands annually. In order to meet the service demands of China Mobile, AsiaInfo as its solution provider, had to provide quick technical solutions. Compared with its competitors, the average time taken by AsiaInfo to implement demands was about 30 percent faster and more efficient. The average R&D and implementation time for each new operational demand is significantly lower (only around 15-20 days) for AsiaInfo compared with its competitors (usually more than 25 days).

5.3 AsiaInfo's adaptive innovation & related and supporting industries

By 2001, China Telecom monopolised the Chinese telecommunications industry. It had designed and developed the telecommunications software with the assistance of its affiliate research institute. Consequently, the quality of software technology of China Telecom remained at very low level meeting the basic needs of telecommunications operators and seriously lagged behind its competitors (from the developed countries).

In 1999, telecommunications industrial restructuring split China Telecom's business into three parts - China Telecom, China Mobile and China Unicom - resulting in an oligopoly. From then on, these three telecommunications operators had to compete with each other, gradually

generating higher technical requirements and demands leading to the emergence of many new enterprises in IT software and telecommunications solutions.

China Mobile has grown so rapidly since 1999 and it became the world's number one mobile operator both in terms of network scale and customer base. In 1999, 23 IT software companies signed software services contracts with the provincial branches of China Mobile. This fast expansion of China Mobile required a high stability of system operation. The development of service software posed a great challenge to the software operations system. The market scale and mass data have exceeded that of most countries. There was no existing operation software system in the world at the time which could be used as a reference or bench mark. China Mobile had to meet the fast-growing market demand through its own efforts and also by involving its partners like AsiaInfo. Additionally, China Mobile established its own R&D facilities, such as the Research Institute of China Mobile; it also entered into research collaboration with its partners like AsiaInfo and co-developed most of the operational software. In other words, rapid expansion of China Mobile determined its R&D trajectory.

China's telecommunications industry also promoted the development of the related and supporting industries and improved their innovation capabilities and international competitiveness. The development of related and supporting industries was mainly based on adaptive innovation. For example, the rapid development of China's telecommunication industry and fast growth of mobile phone users posed a great challenge to China Mobile, AsiaInfo, as well as other related supportive enterprises (e.g. Huawei and ZTE). Continuous investment in R&D is essential to meet the rapidly growing needs of the users and the changing markets. China Mobile worked closely with its related and supporting enterprises on R&D and thereby gave birth to a number of supportive enterprises and improved their endogenous R&D capabilities and international competitiveness. AsiaInfo experienced rapid development and expansion through adaptive innovation.

After AsiaInfo gradually improved its technological capabilities, it entered the international market and evolved into an influential global player. In 2009, it established a co-partnership company in Singapore and gained access into the telecommunications market in the Southeast Asia. For example, it established a significant presence in the Asian market (e.g. Pakistan, Thailand, Vietnam and Cambodia), by supplying software and services to the national telecommunications operators. In May 2012, AsiaInfo announced its plan to open its European headquarters in Cambridge, UK as part of an ongoing initiative to expand its global operations.

5.4 *AsiaInfo's adaptive innovation and factor conditions*

Factor conditions refer to human resources, physical resources, knowledge resources, capital resources and infrastructure. Specialised resources are often specific for an industry and important for its competitiveness and specific resources can be created to compensate for factor disadvantages (Porter, 1990).

The adaptive innovation in social and organizational areas, such as 'none distance with customer service' of the AsiaInfo was established on the basis of a large number of relatively inexpensive highly-qualified scientists and technicians. They could understand the demands of the domestic market better and came up with solutions based on mainly adaptive innovation. In turn, the company's excellent performance in the Chinese telecommunication industry attracted many highly-qualified professionals to work for the company. They have enabled the company to provide customers with the most suitable products and services.

To sum up, it is clearly evident that the key factors identified by Porter (1990): market demand, firm strategy, related supporting industries and factor conditions have played a major role in shaping the development of adaptive innovation process within AsiaInfo.

6. Conclusions

This paper analysed the role of adaptive innovation in enabling latecomer firms to catch-up and emerge as MNEs. The case of AsiaInfo, a latecomer firm from China's telecommunications industry, was used as a case study. AsiaInfo started as a very small company and over the years, it emerged as one of the leading players in the global telecommunications software industry. The study found that AsiaInfo has gradually obtained its industrial competitive advantages through continuous accumulation of adaptive innovations over a long period of time (about 20 years). AsiaInfo's growth was mainly driven by the rapid growth of China's telecommunications industry and expanding demands. For example, specific features of China's telecommunication market such as mass data, large quantity and diversity have driven AsiaInfo to innovate continuously both in the areas of process innovation and product innovation. At the initial phase, due to inadequate technical capabilities, AsiaInfo mainly focused on less complex operational software innovation. Gradually with the improvement of its technological capabilities (accumulated through adaptive innovations over the years), AsiaInfo was able to carry out more complex product innovation in the area of platform software. Its adaptive innovation system was driven by its strategies to improve competitiveness on solution-based innovation, fast innovation and service innovation. AsiaInfo's experience demonstrated that

its growth was not only dependent on its ability to accumulate technological innovations, but also on social and organisational innovations. Through incremental adaptive innovation, the company became very efficient over the years which helped it to meet fast growing market demands and factor conditions. In turn, the organisational mechanism and institutional structure that were built gradually helped AsiaInfo to continuously generate adaptive innovations.

In conclusion, the experience of China's telecommunications industry in general and the case of AsiaInfo in particular, showed that in latecomer countries (especially in developing countries) with significant domestic market demand and technological opportunities for local enterprises, they could exploit opportunities through adaptive innovations and acquire significant technological and competitive advantages (conditioned by their national circumstances). Once they acquire such technological and innovation capabilities, they are likely to gain international competitive advantages and transition towards catching-up with MNEs in developed countries.

Latecomer firms' characteristics and strategies have been discussed by many scholars. Studies have focused on East Asian countries such as Taiwan and Korea but not on latecomer MNEs in China. Therefore, the present case study of AsiaInfo makes an important contribution to literature by identifying the reasons for giving importance to the role of adaptive innovation in gaining international technological and competitive advantages, and why latecomer firms with ambition to catch up their counterparts in developed economies should not ignore it. Furthermore, this study makes a theoretical contribution by conceptualising and integrating latecomer strategies with a modified Michael Porter's diamond model, which treats adaptive innovation as a core factor for achieving competitive advantages, and shows how adaptive innovation interacts with other factors of the diamond model (firm strategy, market demand, supporting industries and factor conditions).

It is widely recognised that to draw stronger generalisations and offer more robust policy recommendations, it is important to use multiple case studies. Therefore we acknowledge the limitation of this study. The findings could not be generalised to other sectors as we have used a single case study (AsiaInfo), and suggest that multiple case studies should be undertaken in future. However, the in-depth analysis of a single case study of AsiaInfo, using an evolutionary stages approach, has demonstrated how latecomer firms could evolve into large MNEs by pursuing adaptive innovation strategies to gain global competitive advantage and catch-up with developed MNEs. This, we consider, is a major contribution to the body of literature on this topic. In addition, the case study also helped to generate significant policy lessons for emerging economies in particular.

6.1 Policy Implications and Lessons

- (a) Latecomer firms should not ignore the role of adaptive innovation in gaining international competitive advantages. They could obtain domestic and global competitive advantages through continuous accumulation of adaptive innovations over a long period of time (about 15 to 20 years).
- (b) In the initial phase, latecomer firms are likely to focus more on less complex innovations (e.g. process innovation), but consistent and gradual accumulate adaptive innovations would enable them to gain capabilities to undertake more complex innovations (e.g. product innovation) in the later phase which can contribute to its global competitive advantages.
- (c) Strong and large domestic market demands likely play a strong role in the growth of latecomer firms to accumulate domestic and global competitive advantages and emerge as MNEs.
- (d) A latecomer firm's ability to continuously generate adaptive innovations depends not only on its ability to accumulate technological innovations, but also on social and organisational innovations.

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Notes

- 1. Personal communications with Mr. Xu Li, the Co-manager of marketing department in Guizhou Mobile.
- 2. Personal communication with Mr. Wang Jun, General Manager, and Mr. Yang Ge, Technology Support Director, South China AsiaInfo.
- 3. Personal communications with Mr Jin Xisheng, Vice President of AsiaInfo-Linkage; Mr Zhao Dingxi, Sales manager of AsiaInfo-Linkage; Mr. Zhao Dingxi and Mr Xu Li, Co-managers of marketing department in Guizhou Mobile.

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Appendices

Appendix 1: Details of Interviews Conducted for the Study

Company Name	Details of Interviews Conducted
AsiaInfo	<p><i>First round interviews (2009):</i></p> <ol style="list-style-type: none"> 1. Informal discussions with the sales team of AsiaInfo. 2. Mr. Zhao Dingxi, The sales Manager (three face-to-face interviews) 3. Three engineers working on Solution R&D <p><i>Second round interviews (2010):</i></p> <ol style="list-style-type: none"> 1. Regular face-to-face interviews with sales team and solution R&D team (every three months between 2010 and until 2012). 2. Mr. Wang Jun, General Manager of South China AsiaInfo (two face-to-face interviews in 2010, in addition to telephone calls and email correspondences) 3. Mr. Xiao Yongjiang, Director of Guangzhou R&D centre of AsiaInfo 4. Mr. Yang Ge, Technology Support Director of South China AsiaInfo <p><i>Third round interviews (2012):</i></p> <ol style="list-style-type: none"> 1. Mr Jin Xisheng Vice President of AsiaInfo 2. Pre-sales team and R&D team of AsiaInfo in Southwest China and Guang Dong Province 3. Platform R&D centre in Nanjing. <p><i>Fourth round interviews (2014):</i></p> <p>Related sales team, R&D technicians and pre-sales team were revisited once again.</p>
China Mobile (Strategic partner of AsiaInfo)	<p><i>Period: 2012 to 2014</i></p> <p>Managers in provincial branches were interviewed three times.</p> <ol style="list-style-type: none"> 1. Guizhou Mobile (in less developed province): six people were interviewed (two from the marketing department, one from general management, two engineers from technical supporting department, and one from personnel department). 2. Guangdong Mobile (in one of the most developed regions): four people were interviewed (two from marketing department and two engineers from technical supporting department).