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CLOUD COMPUTING IN CHINA

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Abstract

Selecting appropriate technology strategy is crucial to those designing ICT-based offering for specific geographical market. The antecedents of adopting particular technology can be used to identify opportunities and barriers of entry, but further information is needed for technology management on how adoption would take place. In this paper, it is argued that deploying a scenario method facilitates identification of future developments and setting a technology strategy, which matches the emerging needs and requirements of a specific market. Specifically, this paper examines the trends and developments affecting state of Cloud Computing business in China and creating incentives for stakeholders to adopt Cloud Computing. Based on expert interviews and scenario analysis, four alternative and possibly co-existing scenarios are derived. The macro-level scenarios serve as inputs and tools for company-specific examinations on technology strategy. Also, the scenarios facilitate identifying indicators on whether standard or flexible technology architecture is needed for this particular market.

Keywords: Cloud Computing, China, Scenarios, Technology Management.

1   Introduction

The centre of gravity in world economy, with regards to aspiration and capabilities of growth, is moving increasingly towards East Asia. Especially the economy in China has developed with substantial pace. The current account surplus and investment flows in China have increased notably, also in information and communication technology. Consequently, several Western world companies and researchers have focused their interest on the developments and future of the Chinese markets.

A phenomenon getting wide attention in the ICT industry is Cloud Computing. *Cloud Computing* refers to pooled and elastic computational resources that are provided as metered service over the communication networks at different granularities (Mell and Grance, 2009). Cloud Computing manifests in three types of services, in which the key component of the business model is either an application provided to the end-users, platform and development tools provided to the application developers, or processing and storage capacity shared among multiple applications using virtualization techniques (Vaquero et al., 2008). The current academic literature around the phenomenon has focused on the economical and technical drivers and obstacles for adopting Cloud Computing (Lin et al. 2009; Armbrust et al., 2010). Based on conceptual and case studies the authors attempt to shed a light on the antecedents of adopting Cloud Computing in different user archetypes. Simultaneously, the contemporary trade literature provides predictions on adoption rates and spending using surveys among executives to derive point estimates. In addition to predictions on the worldwide market (IDC, 2009; Gartner 2009), there are studies focusing on specific geographical markets (Alter et al., 2010).

The current studies can consequently be summarized to focus around the questions *why* adoption of Cloud Computing would occur or *how much* adoption would take place. Instead, the interest of this paper is in *how* Cloud Computing would be adopted in certain geographical area, and how such information can be obtained. The latter two are particularly critical for those designing and managing the system requirements for a specific geographical market. This paper specifically reports a scenario elaboration item on the trends and developments affecting state of Cloud Computing business in China, as well as the outcomes of the anticipated developments. Contrary to the typical scenario work, where examination concentrates on the operating environment of a single company (Schoemaker, 1993), the objective of this study was to produce information for a large group of companies and researchers. To pursue this aim, several scenario techniques were applied, including interviews, PEST analysis, GBN method and morphological analysis. As a result, during the process it was recognized that these scenario elaboration tools might aid in technology management analysis, especially in cases where the target domain differs from the domestic market of a company.

This article will proceed as follows. In the next section, the definition and appliance of Cloud Computing is discussed. The section three gives an overview to the scenario method and techniques applied in this study. The following three sections deal with the trends and uncertainties of the Chinese ICT industry as well as introduce scenarios on the adoption of Cloud Computing in China. Before the conclusions, the implications of the scenarios in technology management and the advantages of the scenario approach are considered.

2   Cloud Computing Adoption

Taking a technological perspective, Cloud Computing can be considered as an evolutionary development. The virtualization techniques enable providing these resources as multi-tenant, scalable and on-demand services (Mell and Grance, 2009), but Cloud Computing is primarily a business innovation. The most significant change has occurred in the variables of the business model; in how the offering is created, how it is delivered to customers and in revenue logic. The three types of Cloud Computing services are IaaS, PaaS and SaaS (Vaquero et al., 2008; Mell and Grance, 2009):

- *Software-as-a-Service (SaaS):* in SaaS, a software vendor or a service provided provides the same software version over the Internet to several end-users, on top of multi-tenant infrastructure. With

regards to software business, in SaaS both the application development, deployment and operating is outsourced to the provider.

- *Platform-as-a-Service (PaaS):* PaaS refers to a computing platform and/or solution stack as a service, often consuming cloud infrastructure and sustaining cloud applications. Developers utilize the PaaS provisioning to implement their applications for and deploying them on the cloud. The PaaS providers supply the developers with a set of APIs to facilitate the interaction between the infrastructure and the applications, as well as to accelerate the deployment and support the scalability needed of those cloud applications.
- *Infrastructure-as-a-Service (IaaS):* IaaS delivers computer infrastructure, typically a platform virtualization environment as a service. Cloud services offered in this layer can be categorized into: computational resources, data storage, and communications. Capacity can be produced either in private cloud, which refers to a proprietary network or datacenter that is used exclusively by one organisation, in public cloud that is accessible for general public, or in hybrids representing combination of the former models.

Cloud Computing is expected to constitute a substantial business for the key stakeholders on the supply-side: service providers, software vendors, hardware manufacturers and system integrators. By provisioning Cloud Computing services, service providers may exhibit economies of scale and scope, which may manifest in different types of services. First, Cloud Computing bring into use technologies, which enable efficiency in processing and storing data. Cloud technologies increase the offering in data-intensive service, which features the management of complexity, volume and rate of data. Secondly, the improvements in processing, storage and network capacity are also needed in content-based services. The companies offering these services benefit from virtualized infrastructure, non-SQL databases and terminals supporting Cloud Computing. Further, the adoption of SaaS appears to becoming reality particularly in horizontal business applications (Benlian et al., 2009), e.g. in generic CRM and financial management applications are already available and in use. Finally, the economies of scope is probably most visible in PaaS services. By releasing the developers from the burden of building their own platforms, one enables them to focus on creating innovative services.

IDC (2009) forecasts that the worldwide market will increase to USD 44 billion by the year 2013 and Gartner (2009) predicts that the companies will spend on IaaS, PaaS ja SaaS a total of USD 112 billion in within the next five years. For service consumers, Cloud Computing is expected to bring both financial, flexibility and strategic benefits (Armbrust et al., 2010). Even so, a survey by Accenture (Alter et al. 2010), including input from 103 IT executives in China, found that only 43 percent of businesses and government organizations are testing or using cloud computing in at least a limited way. Further, the report suggests that very few will move beyond testing, investigating and private clouds. This contradicts with the general trend in adoption of Cloud Computing and suggests that incentives and facilitating conditions of adopting Cloud Computing offering are somehow different for Chinese organizations.

The following exploratory study on how Cloud Computing adoption would increase in China is guided by the concepts defined by Venkatesh et al. (2003). They combine and revise various technology acceptance models and explain adoption intentions and behavior through four determinants: performance expectancy, effort expectancy, social influence and facilitating conditions. *Performance expectancy* captures constructs of perceived usefulness and relative advantage. Likewise, *effort expectancy* and *social influence* capture constructs of ease of use and subjective norm, respectively. *Facilitating conditions* refer to organizational and infrastructural readiness for adopting new technology. In assessing future demand (i.e. *how* adoption might happen?), we find that usefulness, subjective norm and advantages are related to stakeholders' incentives to adopt particular technology. Therefore, we examine macro-level trends in the geographical context that may reveal the incentives for the various stakeholders. We also focus on the facilitating conditions in the target domain, since these exhibit whether adoption is conceivable from infrastructural perspective. Accordingly, emerging needs and requirements of the specific market are in this study captured through examining the interplay of developments in the stakeholders environment and their reasons to take action.

3   Scenario approach

In studying the future adoption of Cloud Computing in China, an exploratory approach was chosen, in which future scenarios were elaborated based on expert interviews and scenario analysis. Scenarios are defined by Ogilvy and Schwartz (2004) as "a tool for ordering one's perceptions about alternative future environments in which one's decisions might be played out". Accordingly, the aim was not to forecast one future state, but several alternative and possibly co-existing developments.

Scenarios are also specified as tool "to examine fundamental uncertainties and expand people's thinking" (Schoemaker, 1993). The adoption of new technology such as Cloud Computing is a complex phenomenon with high ambiguity. Further, cultural differences (Hofstede, 1991) increase the uncertainties in building up suitable offering to match the market needs. Under such circumstances, assessment of different options through scenarios makes available a tool for anticipate the developing needs and, thus, aid technology forecasting and roadmapping.

On a generic level, the process of scenario elaboration includes a number of identifiable tasks of the generation of ideas and gathering of data, integrating the ideas, and checking the consistency of scenarios (Börjeson et al., 2005). The main steps included in the method by Schoemaker (1993) were adapted for the current scenario elaboration. Table 1 below introduces the tasks in this study.

Tasks (Schoemaker, 1993)	Current study
1. Define scope	"How would Cloud Computing be adopted in China?"
2. Identify major stakeholders	Identified in previous studies (see section 2).
3. Identify current trends	Political, economical, societal and technological trends affecting the ICT industry and Cloud Computing adoption in China were examined through first round of expert interviews and literature.
4. Identify key uncertainties	From PEST analysis, authors identified two dimensions for uncertainties. GBN method was used to prioritize uncertainties.
5. Construct initial scenarios	Initial learning scenarios were constructed. Alternative development paths for four scenarios were elaborated utilizing GBN method.
6. Assess internal consistency and plausibility	Morphological analysis was employed to check the consistency of scenario logics.
7. Define how stakeholders behave in scenarios	Learning scenarios were iterated.
8. Eliminate impossible combinations	Plausibility of conclusions checked through second round of interviews.
9. Assess learning scenarios through quantitative models	Not applied in this study so far.
10. Reassess scenarios, arrive at decision scenarios	Not applied in this study so far. Learning scenarios were introduced to a set of companies as a tool for further work.

Table 1.   Scenario method in the current study.

To facilitate the scenario elaboration, we conducted empirical data gathering through a set of interviews among the representatives of the stakeholders and scholars. In the first round, the interviewees represented a mix of Chinese mobile operators (3 interviews), Chinese content providers (1), foreign infrastructure software providers (2), and foreign system integrators (4). In semi-structured interviews, these industry experts were asked to describe the special features and current trends of the ICT industry in China and the developments in the taking up of Cloud Computing. The initial findings from the interviews were documented and organized using PEST analysis to outline the political, economic, societal and technological trends. In the first iteration, searching literature on the trends complemented interview data.

To elaborate scenarios from identified trends, we had multiple means and methods available. Bishop et al. (2007) reviewed and evaluated the elaboration techniques that vary in complexity and rigor; from judgmental techniques rely solely on the individual describing the future to cross-impact analyses for

calculating relative probabilities for future events. Among the techniques are forecasting techniques, the GBN matrix and morphological analysis, which attempt to identify sources of uncertainty as the basis for alternative futures. In GBN method, a matrix of two dimensions of polarities is created and the four combinations of the dimensions incorporate the scenario logic (Ogilvy and Schwartz, 2004). Morphological analysis uses a "future table" in which the columns represent the dimensions of uncertainty and each dimension may include several alternative future states (Godet, 2000).

To elicit the scenarios, we applied a deductive GBN approach, in which the trends and uncertainties were prioritized to form scenarios, each combining the extremes of the uncertainties. Comparing and contrasting the identified trends in the Chinese ICT environment reduced the forces causing uncertainties reduced into two dimensions. First, the Eastern Asian cultures tend to be high in collectivism, but through introduction of the market economy also the Chinese society is subject to individualistic tendencies. This contradiction formed our social identity dimension. Secondly, Chinese have previously sourced high-end technology from abroad, but recent advances in the innovation landscape may increase domestic sourcing. This uncertainty affects both ICT service consumers and companies serving them, and forms our technology sourcing dimension.

Any scenario consists of three elements (Burt and Chermack, 2008): interpretation of current events and their propagation into the future, internally consistent description of future developments and description of future end state. In our approach, interviews and literature provided insight on the current state and on the likely developments in ICT industry in China. Further, the identified dimensions facilitated elaboration of alternative potential developments, based on combination of the extremes of the dimensions. Accordingly, after the dimensions were identified, we focused on creating descriptions of the future developments and arriving at prospective end state based on causal logic from the present to the future. Combining the extremes resulted in four consequences, which were written into a form of learning scenarios (Schoemaker, 1993). After this first iteration, morphological analysis was used to verify the consistency of scenario logics, and learning scenarios were iterated based on conflicts in the logic.

Later, another set of interviews was conducted in China among Chinese academics and representatives of a standardization body developing Cloud Computing specifications (seven in total), to verify the results of first round of analysis. We introduced the elaborated scenarios to the interviewees and discussed the plausibility of our conclusions. It was found that the identified trends and alternative developments were applicable and relevant for the Chinese environment. Finally, the second learning scenarios were introduced to a set of companies as a tool for company-specific analyzes.

4   Trends in Chinese ICT industry

In the following, the political, societal, economical and technological trends that emerged in the expert interviews and in the literature are drawn out.

4.1   Political and societal trends

Li (2007) presents three possible political scenarios for China in 2020. The most commonly perceived forecast is a combination of a market economy and an authoritarian political system, also observable today. For all the three scenarios, there are also some common trends influencing the political environment: the information and technology revolutions, urbanization followed by potential demographic challenges, pluralism in society, and the continued growth of nationalistic sentiment. Although China remains authoritarian, the central government is likely to continue being responsive to the increasingly diverse demands of Chinese society. Li argues that many of the potential problems in the society have already been identified by the central administration, now promoting more balanced regional development, domestic demand-driven growth, and technological research and innovation.

Country's policy making in turn affects technology and innovation landscape. The course of action set by the latest long-term plan for science and technology seems to stress supply-side for research and education and on a technology-driven view of innovation, but also raise concerns over the emergence of "techno-nationalism" and implications for China's future economic openness.

While the conducted interviews focused on the economic and technological trends, also the following political and societal factors and developments were discussed. The role of the Chinese government was seen important in form of launching and supporting major research and development programs, of promoting the birth of Chinese innovation system and of coordinating in building up the nations ICT infrastructure. The interviewees suggested that even though there are large investments on information and communication technology, the officials tend to pose control over the ICT market affecting the nature of competition. It was also brought out that unclear or missing regulation may hold up decision making on larger investments among Chinese executives or that regulation may prohibit offering certain ICT services dealing with sensitive or otherwise critical data.

On the societal level, the interviewees commended the huge talent pool for ICT industry, with indefinitely low costs and relatively good competences. However, probably owing to the characteristics of the education system or the absence of innovation system so far, among the Chinese employees there is a shortage of high-end research and development capabilities. This deficiency is however substituted with other traits. Chinese were said to possess adaptability and being capable of localizing western innovations, such as technologies and business models. The interviewees also concurred that both the level of employee skills and of scientific research will advance in the future, on account of investments and reform in the education system as well as resettlement of Chinese intellectuals returning to China from foreign universities.

4.2   Economical and technological trends

According to Whalley and Xin (2010), the inflows of foreign direct investments (FDI) play an important role in China's economic growth. The foreign enterprises, which have typically entered the market through joint venture arrangements, answer for over 50 percent of the export and 60 percent of the import activities. On the other hand, these companies employ only around three percent of the population, while the rest work in state-owned enterprises or in service industry. The statistics of OECD (2010) reveal that in the year 2008 the inflow FDI were over USD 161 billion, which is by way of illustration four times than the FDI for India on the same year. The amount is twofold compared to the year 2005 investments and quadruple compared to the year 2000.

However, the factual development of Chinese economy is open to debate. Prasad (2008) claims that the booming investments and cheap credit may have resulted in overoptimistic expectations of the future growth. However, Prasad also views the developments in economy and export activity as catalyst for technological and productivity advantages which enable increase in competitiveness. One may therefore assume that the competition between Chinese and foreign companies will increase, both inside and outside China's borders.

As a growing market with low cost of labor, China has for the last decades been a popular place to outsource and export technology. However, the development in the domestic market in China can be assumed to have an emerging role in the following years. The recently published 12th five-year stresses balanced economic development, which means an attempt to distribute the profits from growth more equally and focusing the investments to develop the inner parts of China. This policy may have several implications. The local market will grow, its importance will increase and the Chinese companies increase their market share. The other consequence would be raising labor costs, which are driven by increasing level of education and specializing, increasing standard of living and consumerism, to which the younger generation wants to partake.

The interviewees highlighted some further trends in the ICT business landscape in China. First, they see investments in logistic infrastructure and relaxation of regulations encouraging offshoring to

China. Regardless of this, competition against Chinese vendors is extremely hard and the environment may appear overly complicated due to discrepant bureaucracy. The foreign vendors typically compete with more advanced technology, whereas Chinese were said to use lower prices and proximity for their advantage. The respondent found that state-owned telecommunication service providers, large foreign technology vendors, their Chinese rivals and mostly Chinese content and value-added service providers drive the ICT market. It is typical that the Chinese acquire high-end technology from foreigners as products and contract the supporting services to local vendors.

In struggling against the growing costs of labor and real estate, the foreign companies have already started to move R&D and production from major cities to Western and Central China. The Western interviewees had also noticed the increase in consumption by the individuals, especially in tier-2 or tier-3 cities like Chengdu. In the interviews with the Chinese representatives, it was brought out that the both the policies and business environment supports entrepreneurship. As an example, the ecosystem created by e-commerce provider Alibaba was seen as major opportunity for SMEs to sustain and thrive, both locally and internationally.

The interviewees also identified several technological trends in the ICT industry in China. First, the development of standards has substantial impact on adoption of technologies in China. In turn, Chinese increasingly aim at influencing the definition of standard and even create national standards. For instance, in mobile networks all three large operators are, steered by the government, supporting different 3G standards, one of them being the homegrown TD-SCDMA standard. Secondly, the adoption of mobile technologies was seen considerably affecting the demand of ICT services. Currently, 3G networks are being ramped-up and the penetration of terminals is persuasive 40 percent. Saturation may occur surprisingly fast, but the enormous volume and very developed market of Mobile Internet create opportunities for payload providers. The growth of Mobile Internet is supported through flat-rate pricing, making the services accessible for regular people in China. Finally, in addition to mobile networks, large investments are made also to other parts of the ICT infrastructure. Chinese were said to utilize both proprietary commercial technology and open innovations.

Cloud Computing is hoped to be major driver for growth across industries in China, through efficiency gains. Telecom operators see opportunities in utilizing their existing assets, such as large customer base and network assets. Telecom operators are piloting technologies, and platforms are being developed for application and mobile application developers. Chinese companies are involved in many open source Cloud Computing projects. In general, however, compared to foreign companies, Chinese organizations are slower to adopt Cloud Computing technologies (Alter et. al. 2010). The main reasons for slower adoption are security concerns, missing regulation, and limited in-depth knowledge of cloud computing among Chinese executives. Chinese are expecting government to set the rules for the business, especially regards to cloud security and reliability. Further, the fundamental technical requirements for effective cloud computing are not fully in place in China (Alter et. al. 2010). While broadband technology is widespread in China, speeds remain low compared to other nations. And compared to foreign companies, Chinese organizations are slower to adopt server virtualization. Chinese organizations that are interested in cloud services have fewer choices than in other countries. Mainstream adoption of Cloud Computing in China is expected to happen in three to five years, while some Internet service providers may adopt Cloud technologies earlier.

5 Scenarios for the adoption of Cloud Computing in China

In the interviews with the domain experts as well as from the literary sources, a number of opposite forces in the environment could be identified that can be seen as affecting the adoption of Cloud Computing in China. Below, theory is used to define the identified dimensions: social identity and technology sourcing. Social identity is argued here to drive China from collectivism to individualism, whereas technology sourcing could be moving from global arms-length sourcing to increased vertical integration and national sourcing. These two dimensions create basis for developing the scenarios.

5.1   Social identity

Individuals define themselves and others to multiple social categories. The classification serves two purposes: in defining the social environment and in enabling individuals and organizations to identify themselves in this environment. Social identity as a concept is applicable also on an organizational level reflecting the values and culture of the organization (Hogg and Terry, 2000) and respectively on national and international level (Hofstede, 1991). One of the dimensions of social identity and two of its extremes are individualism and collectivism. Triandis and Gelfand (1998) have suggested four defining attributes to individualism and collectivism: 1) The definition of the self, which can emphasize personal or collective aspects. 2) Personal goals that can have priority over in-group goals or vice versa. 3) The emphasis on exchange rather than communal relationships or the emphasis on rationality rather than relatedness 4) The importance of attitudes and norms as determinants of social behavior. The definition signifies that in the collectivistic cultures the norms are more important than the attitudes.

Intuitively, the culture and other institutional environments in which they operate, in terms of both formal and informal decisions and behavior influence the history and organizational culture of firms. Adapting this to technological choices of organizations and to consumer behavior, in collectivistic environment the central administration has prominent impact on organizations and individuals, whereas in individualistic environment markets resolve the decisions. According to Hofstede (1991), the collectivism in East Asia is characterized by its long-term orientation. With this long-term orientation, people in China are more likely to emphasize education and training, and practice persistence and the delay of immediate gratification. Chinese are therefore more willing to spend time in building long-term business relationships and invest in long-term strategies.

However, through introduction of the market economy, the Chinese society is exposed to individualistic tendencies. The interviewees report on significant increase in consumerism on individual level. This may be seen as result entailment of Western influence, but assuming that the individualism is increasing in China, its implications are more interesting than the causes. Namely, as the levels of social identity affect each other hierarchically, the values of individuals also affect the organizational decision-making. In the context of this scenario work, based on the interviews and literature, we found forces pulling the Chinese society into collectivistic and individualistic directions.

5.2   Technology sourcing

Dibbern et al. (2004) define technology sourcing under the IS discipline as "the organizational arrangement instituted for obtaining IS services and the management of resources and activities required for producing these services". By organizational arrangement, the authors refer to fact that the organizations have the possibility to produce the ICT services themselves or outsource the services partly or totally to external providers (Hirschheim and Lacity, 2000). In the context of global technology sourcing, organizations may produce the services in its home country by engaging in standard vertical integration, by producing the service themselves abroad by engaging in foreign direct investment, outsource to a local vendor or engage in arm's-length service contract with foreign vendor (Antras and Helpman, 2004). Previous studies have found several reasons to outsource IS. In addition to the cost advantages, reason applicable in Chinese environment may be vendors' special capabilities and flexibility required under volatile demand (Dibbern et al., 2004). Comparably, Quitens et al. (2006) examines the antecedents for global sourcing based on a set of academic literature. The authors identify multiple product-related drivers, which we find applicable in explaining ICT outsourcing by Chinese organizations: achieve better delivery performance, acquire higher-quality products, acquire unique or differential products and obtain better technology.

Quitens et al. also review stage models for global sourcing, where companies move from domestic purchasing to foreign purchasing stage. The authors criticize the explanatory power of the previous models in that these rather describe the internationalization of companies. The models in which the

foreign sourcing increases over time do not apply well for China, where most of the high-end technology has primarily been sourced from abroad. Based on the interviews, this would also be the case with Cloud Computing. However, the identified trends suggest that in the future ICT services would be increasingly sourced by Chinese organization from domestic markets. Similarly as with the social identity, in China there are forces driving the sourcing decisions into opposite directions: domestic sourcing and global sourcing.

5.3   Four Scenarios

In the following, the two dimensions are used to develop future scenarios. The scenarios illustrate how the adoption of Cloud Computing might occur in the future. As described above, the GBN approach was applied to prioritize the trends and uncertainties to form four scenarios. In the scenarios elaborated below, the progress, the outcomes and the implications to different ICT industry stakeholder are considered. Table 2 presents the results of morphological analysis, which summarizes the four scenarios. The scenarios are not mutually exclusive; in the future we might see alternative and coexisting development, which all have potential to increase adoption of Cloud Computing in the domain.

	Scenario A	Scenario B	Scenario C	Scenario D
Political trends		Tight regulation Nationalism		
	Balanced regional development	Balanced regional development		Balanced regional development
Societal trends	Low capacity for high-end R&D	Indigenous innovation system emerges	Low capacity for high-end R&D Consumerism	Indigenous innovation system emerges Consumerism
Economical trends	Outbound outsourcing Inflow investments	Inbound outsourcing	Outbound outsourcing Inflow investments Entrepreneurship	Inbound outsourcing Outflow investments Entrepreneurship
Technical trends	Infrastructure development Global standards	Infrastructure development National standards	Content development	Content development
Process	Fast consolidation Telecom operator driven Data-intensive development	Fast consolidation Telecom operator driven Innovation-driven development	Divergence VAS and content provider driven Services driven development	Divergence VAS and content provider driven Services driven development
Outcomes	Investments in infrastructure	Investments in infrastructure Chinese high-tech SMEs flourish	Investments in services and content	Investments in services and content Mergers and acquisitions
	Outsourcing	Insourcing		
	Foreign SW vendors gain position	Foreign vendors fail to embark	Foreign SW vendors gain position	Foreign vendors fail to embark

Table 2.   Key factors in the morphological analysis summarizing the scenario analysis.

Scenario A combining global sourcing and collectivism: This scenario is based on the prevailing trends, collectivistic values and global sourcing with regards to high-end technology. This means that the markets would steer the adoption of cloud technologies, but the investments are primarily made to support Chinese ICT infrastructure with the aim of developing national competitiveness. The global standards dominate in cloud technologies or there are several competing proprietary technologies, mainly developed in abroad. In the scenario, the Cloud Computing market will consolidate fast and the drivers of the adoption and developments in China are the three national telecommunication operators, supported by the central administration. Both actors find Cloud Computing as an opportunity to collect data on companies' activities and developments in provinces. Most of the new technology is sourced from foreign vendors. Hardware manufacturers, vendors of infrastructure software and system

integrators are the beneficiaries of the developments, as large Chinese companies favor them as cloud technology providers.

Scenario B combining domestic sourcing and collectivism: this scenario differs from the previous business-as-usual developments in that it assumes trend of prolonged nationalism, combined with collectivistic values. In ICT industry this would mean that Chinese customer favor domestic providers for several reasons. In this scenario, the central administration supports developments with tightened regulation in Cloud Computing. The attempt to create an indigenous innovation system succeeds and several Chinese high technology enterprises, which outperform the Western rivals, emerge. In the scenario, telecommunication operators are in strong position and they manage to create a national standard for implementing Cloud Computing infrastructure. This makes operations in the market unappealing for the Western service providers. Chinese software vendors skillfully use available open source software and increase their contribution to the communities. The education system produces masses of skilled engineers and Chinese operators and other service providers increase their internal system development activities. The few foreign vendors being able to succeed are the system integrators, which fulfill the knowledge gap in the beginning of the developments. To support the growth and internationalization of SMEs, Chinese focus their efforts around creating Cloud platforms. As the larger providers are offering full-fledged infrastructure and platform, smaller software vendors may achieve leapfrog development in competitiveness in global markets.

Scenario C: this scenario is characterized by increase in individualistic values and global sourcing in Cloud Computing technologies. Westernization phenomenon appears as increased consumerism and motivation for entrepreneurship. As further consequence of the former, the penetration of mobile terminals and amount of available mobile applications accumulates rapidly. Chinese high-tech start-ups find their opportunities in Cloud Computing and the market in China becomes fragmented. The domestic and foreign providers for value-added services and content providers drive the development. State-owned enterprises, domestic entrepreneur-led providers and global service providers provide infrastructure services. However, the focus of business is in SaaS services for SMEs and in content-based services for the consumers. Trust is the key factor affecting the decision-making in delivering SaaS services. Chinese buyers seek for long-term co-operation with the vendor and, thus, service provider needs to have strong local presence.

Scenario D: in the fourth scenario the individualism and national sourcing are combined. Like in the previous scenario, increased consumption is a central trend; however, owing to developments in indigenous innovation system and emergence of numerous new start-ups, the Chinese vendors fulfill the demand. SMEs produce heaps of payload on top of infrastructure provided by the Chinese service providers. In this scenario, the development of the Chinese ICT cluster is considerably rapid and the level of technology and services is equal compared to Western rivals. Development is supported through strategic mergers and acquisitions. Conversely, most of the foreign software vendors fail to achieve reasonable market share. Chinese software vendors utilize open source software efficiently and make contributions to several communities.

6 Discussion and conclusions

Burt and Chermack (2008) argue that although scenario literature is full of different scenario methods, literature on best practices of utilizing scenario approach is missing. Therefore, it is valuable to highlight the attributes of current scenario elaboration, its benefits and problems. First, the approach has been exploratory. The aim was to produce relevant information for larger group of companies and researchers. The outcome of the elaboration may therefore be treated as learning scenarios (Schoemaker, 1993), which serve as inputs for company-specific examinations. Secondly, the scenario approach does not forecast the future; rather it can be seen as a tool for elaborating plausible future circumstances. In the current study, the focus was on stakeholders' incentives and possibilities to adopt Cloud Computing, induced or hindered by developments in their environment. In assessing the scenarios it should also be remembered that the scenarios are based more on the researchers' views

and interpretation than on the experts' views. In order to avoid misjudgments, we employed morphological analysis to test the consistency of scenario logics and a second round of interviews to verify our conclusions. Lastly, it is noteworthy that the analysis may have revealed possible development paths, but authors' conclusions on outcomes may not materialize.

The scenario elaboration reported in this paper focused on macro-level phenomenon. Keeping this focus enabled identification of several developments, some of which might turn out co-existing. This suggests that scenario studies are able to produce information complementing the analysis on the current state. In addition, the approach produces information, which the technology vendors may utilize to anticipate the development paths, focus their R&D efforts and even aim at influencing the development towards desired direction. For the managers responsible of technology management, information produced in scenario elaboration is applicable in defining requirements for the offering targeted to specific geographical market. Taking into account that the operational deployment of information systems may today take place in global context, scenarios will also indirectly enable identification of additional requirements, which developments in specific geographical area may cause. For instance, in this paper a possibility for a national ICT infrastructure and architecture, differing from the global standard, was identified.

Given that there may be co-existing developments combining multiple factors identified for the scenarios, making decisions on technology management issues, such as defining attributes of the offering, may turn out difficult. Anticipated developments and their outcomes however bring about some important indicators that assist in setting direction. In the first two scenarios, the Cloud Computing market consolidates rapidly. This may also be interpreted as leading to technological convergence, which would manifest in advances towards standard infrastructures for Cloud Computing services. This will eventually help end-user organizations in contracting ICT service through decreasing switching costs. Opportunities under such circumstances include fulfilling the demand for innovative solutions and the providers should therefore differentiate themselves in services to be built on top of standard cloud infrastructure. In the collectivistic environment of the first two scenarios, one must also invest in high quality support services and long-term contracts to achieve trust among the customers. In the latter two scenarios, the substantial volume of different services and technological divergence will lead to incompatible technologies and standards. In such case where there are multiple different infrastructures and platforms for services, there will be demand for flexible technological architectures. In the battle between incompatible standard, use of alliances to compete and facilitate building technological knowledge is advisable (Hagedoorn, 1993). It is further noteworthy that when moving in scenarios from global sourcing to national standards, foreign companies are required to take into account the China-specific adjustments in their offerings.

This paper has introduced alternative future developments for Cloud Computing in China. The future on this domain is not univocal and the adoption of Cloud Computing cannot be explained only through analysis on drivers and barriers of adoption. The stakeholders' operating environment is influenced by several trends and forces, some of which produce incentives or create barriers for adoption. These directions were examined in this paper through adapted scenario method. The approach is needed to facilitate studies aiming at answering how Cloud Computing would be adopted. In contrary to existing practice, our scenarios remain at macro-level and therefore introduce broad spectrum of alternative developments and outcomes. Alternative developments include adoption of data-intensive services, innovation-driven developments or divergence on the market and focus on value-adding services.

The presented approach is relevant particularly for technology managers as a tool to examine uncertainties and expand thinking on the requirements of entering Chinese Cloud Computing market and sustaining position there. The scenario elaboration is also useful in examining the interplay of multiple factors affecting the environment and developments. It is therefore viable tool for researchers in conducting exploratory research on the domain. The set of scenario techniques will in later studies be used in examining future directions other geographical markets such as the Indian, Korean and Indonesian markets. The influence of Chinese vendors to developments in Western markets was also left for further studies.

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