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Sustainability of rural informatization programs in developing countries: A case study of China's Sichuan province

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ABSTRACT

Traditionally, the role of telecommunications carriers is often limited to providing connections in rural informatization programs. This paper illustrates the case of Sichuan's government-carrier cooperative rural informatization model, where the carriers serve as both the information aggregator and distributor. A close historical analysis reveals that this seemingly unprofitable rural informatization service was originally conceived by competing carriers as a marketing strategy to gain a competitive advantage in less lucrative markets. However, when the government decided to promulgate such an informatization program nationwide, the business practice turned into one of the carrier's *de facto* obligations. Thus, Sichuan's model is a mixture of the passive fulfillment of political duty and the proactive pursuit of business interests. A sustainability failure analytical framework is applied to test the sustainability of Sichuan's model, which is found to be at risk of financial, social and institutional sustainability failures.

1. Introduction

Considered one of the strategies to solve China's high level of urban–rural economic inequality, the Chinese government has initiated various national and provincial programs to connect rural communities to the information highway. The current rural informatization[1] activities are usually composed of relatively independent, but fundamentally interrelated, "projects" sponsored by different government institutions (Xia, 2010). Several statistics have indicated that some significant achievements have been made so far. In terms of connectivity, telephone service was nearly ubiquitous in rural areas and broadband connections were available in 84.7% of all administrative villages by the end of 2012 (MIIT, 2013b). China Internet Network Information Center (CNNIC) estimated that 136 million rural residents had used the Internet in 2011, a nearly 9% increase from the previous year (CNNIC, 2012). In addition, there were over 31,000 agriculture-related websites, approximately 1 million village information

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[1] There seems to be no consensus on the definition of the term informatization (or informatisation) in the academic literature. Analogically speaking, informatization is to the information age what industrialization was to the industrial age. The term gained increasing popularity in China when the Chinese Communist Party included it as one of the major strategic impetuses in the socialist countryside campaign starting in 2007 and later expanded it to other sectors. Despite its wide usage, previous research has found that the term has not been officially defined in China's policy documents. Informed by Rogers (2000) and situated in the Chinese context, we define rural informatization in this paper as a process through which information technologies were used as a means for furthering socioeconomic development in rural areas. (See Liu (2012) for a more detailed discussion on the evolution of this term.)

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service stations and 700 thousand supporting staff members across the country (MOA, 2011)[2]. The unique feature of the Chinese model is the attempt to integrate connectivity and content together both in its strategic planning and national programs, which is arguably the first of its type in the world (Xia, 2010).

As the largest emerging economy, China's strategy in rural informatization is of significant interest to both ICT4D scholars and practitioners of other developing countries. There have been a few studies focusing on the institutional design of China's informatization programs (Hanna, Qiang, Bhavnani, Kimura, & Sudan, 2009; Liu, 2012; Ting & Yi, 2012; Xia, 2010). However, due to the relatively short history and the general lack of familiarity with operational details of China's rural informatization programs, research on this subject is still very limited and, particularly, the existing studies seem to have limited strength in assessing the sustainability of those programs. This paper serves the purpose of filling this important gap by providing a detailed account of the historical evolution of China's informatization program, based on firsthand evidence from the field, and analysis of its sustainability challenges. By looking at Sichuan's unique government-carrier cooperative model, this paper argues that, while Sichuan's model provides a low-cost solution to deliver information to mass recipients in rural areas, it is at risk of financial, institutional and cultural/social sustainability failures.

This article has six sections. The second section briefly reviews the research on China's rural informatization and various theoretical models to study sustainability of ICT4D projects. The research methodology is outlined in the third section. The fourth section presents the case study of Sichuan's rural informatization program, with the emphasis on the historical development. Next, the fifth section summarizes the case and discusses its sustainability issues. The last section derives important implications for rural informatization development in developing countries.

2. Related works

Existing research on China's rural informatization is limited. Most previous studies have been primarily concerned with connectivity, particularly universal telephone service (Harwit, 2004; Jayakar & Liu, 2014b; Shi, 2008; Xia & Lv, 2008; Zhao, 2007). A few studies have assessed China's recent "Information to the Countryside" program initiated in 2009, which required state-owned telecommunications carriers to integrate traditional "*access*" and value-added "*applications*" into a single package in rural areas, and found that although certain noticeable achievements have been made in terms of the increased numbers of rural government websites, rural information stations, and agriculture-related websites, this nationwide informatization program was fragmented under a powerful ideological influence that has led to unclear institutional arrangements and regulatory confusion (Hanna et al., 2009; Xia, 2010). Two separate case studies conducted at the provincial level revealed similar problematic issues, such as a lack of vision, coherent strategy, accountability, and a sustainable business model (Liu, 2012; Ting & Yi, 2012).

Through the lens of institutional theory, most of the above mentioned studies emphasize the institutional factors that influence the way informatization programs operate. These studies aptly describe the status quo, reveal the dynamic relationships among the institutions involved in the informatization program, and identify problems and successes. However, existing studies seem to be more descriptive than predictive, and have limited strength in predicting the sustainability of those programs.

Although most rural informatization research has addressed the issue of sustainability to some extent and identified some influencing factors, researchers have only recently proposed a number of theoretical frameworks and conceptual explanations to understand the long-term sustainability of such projects. The primary focus of early sustainability investigations has been on financial sustainability (Colle, 2005; Harris, Kumar, & Balaji, 2003), and researchers have often evaluated sustainability by analyzing and comparing the business models (Hosman & Fife, 2008; Proenza, 2001; Wellenius, 2003). Heeks and Bhatnagar (1999) proposed the critical success factor (CSF) and the critical failure factor (CFF) models. The ten critical factors that Heeks and Bhatnagar identified were: information, technical, people, management, process, culture, structure, strategy, politics, and environment. Built upon the CSF and CFF models, Kumar and Best (2006) presented a Sustainability Failure Model and argued that the sustainability failure of an ICT4D project usually took five principal forms: financial/economic sustainability failure, cultural/social sustainability failure, technological sustainability failure, political/institutional sustainability failure, and environmental sustainability failure. Similarly, Stoll argued that social, political, cultural and technical sustainability were vital elements to achieve financial sustainability (2005). Other theoretical models include "design-actuality" gaps, the match or mismatch between information system designs and local user actuality, based on the contingency theory (Gerhan & Mutula, 2007; Heeks, 2002) and the stakeholder theory, which presumes the necessity of a well-balanced partnership between players, particularly between informatization actors and the beneficiary (Bailur, 2006).

This paper is informed by Kumar and Best's Sustainability Failure Model. The model provides a succinct analytical framework to cover the major factors that imperil the long-term sustainability of an informatization program. If a program (or project) adequately addresses the five areas of weaknesses outlined by the model, it is likely to be sustainable. This model has been used to analyze Internet kiosks in India (Best & Kumar, 2008; Kumar & Best, 2006). However, to the best of our knowledge, this model and other models summarized above have not been utilized to study a nationwide informatization program, such as the one studied in this paper.

[2] These statistics should be read with caution because different institutions might have different definitions for "rural informatization".

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3. Research design

Since there are no established theories to explain the sustainability issues of rural informatization, a case study is appropriate because it is a commonly used methodology to incrementally refine middle-range contingent generalizations, either by broadening or narrowing their scope or introducing new types and subtypes through the inclusion of additional variables (George & Bennett, 2005). Yin (1993) has identified three types of case studies: exploratory, explanatory, and descriptive. Because one of our primary objectives is testing the sustainability of the Chinese informatization model, it appears that a single explanatory case study is justified (George & Bennett, 2005; Yin, 1993).

The choice of Sichuan was not only guided by the author's expertise and previous working experience, which were the keys to the feasibility of the study[3], but also based on Sichuan's unique geographic and economic features in rural informatization. On the one hand, Sichuan's geographic conditions make it extremely difficult to extend the information infrastructure to rural areas. On the other hand, surprisingly, Sichuan is the pioneer in China's rural informatization. As will be revealed later in this paper, the prototype of China's current nationwide informatization program first emerged in Sichuan. Sichuan is thus considered as the "pilot" or "model" rural informatization site in China. To this end, Sichuan provides a typical and exemplary case for the study of China's rural informatization program.

Yin (1993) suggested using multiple sources of evidence to ensure construct validity. The current study used multiple sources of evidence. The majority of the information was drawn from secondary resources, including scholarly articles, statistics, trade magazines, consulting papers, newspaper reports, company annual reports, and official speeches. Primary data were collected through informal interviews with people from telecommunications carriers, who were in charge of the rural informatization program, and other stakeholders, such as local government officials and farmers (See Appendix A for the list of the interviewees and their positions). The purpose of the interviews was to solicit information from stakeholders who had insight and real-world experience regarding the operational details of Sichuan's rural informatization program. All interviews were conducted between 2011 and 2012 by the author. Most interviews were conducted by phone, and the rest were conducted on-site during field study trips. Audio recording was rarely used because of the general reluctance and resistance of the interviewees.

4. Case description

The Sichuan rural informatization program can be traced back to 2001, when the provincial People's Congress passed the "Outline of the tenth five-year plan for Sichuan's economic and social development (2001–2005)," in which several objectives were set for rural informatization (Sichuan Provincial People's Congress, 2001). Since then, various projects have been initiated, among which two programs are available province-wide: the Rural Economic Information Network (REIN) operated by the Sichuan Weather Service Bureau, and the Telephone to Every Village project, undertaken by telecommunications carriers (Liu, 2012).

4.1. The historical separation of connectivity and content provision

Conventionally, connectivity and content have been treated separately in China. Providing connectivity was the responsibility of telecommunications carriers, whereas content was primarily controlled and handled by the government.

In terms of connectivity, the improvement of the rural communications infrastructure was considered one of the indicators of the Party's "socialist new countryside" campaign and was viewed as an important engine for rural economic growth (Shi, 2008; Xia & Lv, 2008). Nationally, China has chosen to follow an incremental approach to address digital inequality (Shi, 2008). The Ministry of Industry and Information Technology (MIIT, China's telecommunications regulator) distributed universal service tasks among the country's state-owned carriers based on their respective revenues, profits, and the geographical locations of their networks. In the first stage, the focus was to connect administrative villages[4] with two lines of telephone service, at least one of which must be a public pay phone. The first stage ended in 2008, by connecting 99.7% of administrative villages to the telephone network, and the new goal was then to extend the network to natural villages. In addition to plain old telephone service, the MIIT also planned to connect 95% of town centers[5] with broadband connections. In April 2011, the MIIT declared the complete accomplishment of all the targets set in the Eleventh Five-Year Plan. Also in 2011, China began to implement its Twelfth Five-Year Plan. Reportedly, the main goals of the MIIT's universal service plan included increasing the administrative village broadband penetration to 95%, connecting all natural villages with basic telephone service and establishing the universal service compensation mechanism. The latest statistics from the

[3] The author worked for China Telecom Sichuan's Department of Corporate Strategy in charge of strategic planning, including the rural market, for 3 years before this study was started in 2011. The working experience in China Telecom not only acquainted the author with operational details of Sichuan's rural informatization project but also made it feasible to arrange interviews with telecom operator's staff and government partners in 2011 and 2012 for the purpose of this research. However, the author is fully aware of difficulty in achieving an ideal research design and a complete avoidance of bias in this study. Efforts have been made to manage the challenge. For example, interviewees were carefully selected from a wide variety of organizations involved in rural informatization.

[4] "Natural village" is a demographic and sociological concept. A natural village is a clustered human settlement or community in rural areas. "Administrative village" is a political concept. Each administrative village has a Villagers' Committee and a Village Party Committee. Usually, an administrative village has jurisdiction over several natural villages.

[5] Towns are usually larger than villages. A town is organized as the lowest unit in China's government hierarchy.

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MIIT show that despite the absence of a universal service-funding mechanism, 100% of administrative villages and 95.2% of natural villages had been connected to the telephone network and that 100% of townships and 95.2% of administrative villages had internet access by the end of 2012 (MIIT, 2013a). In Sichuan, telecommunications carriers had connected all the administrative villages and 91.8% of natural villages to the telephone network by the end of 2012. In addition, broadband service was available in over 68% of administrative villages[6]. The remaining unconnected villages were primarily located in the remote and mountainous areas, 90% of which had no reliable electrical service.

Generally speaking, as a program endowed with political significance, tremendous success was made in connecting the rural villages. However, the future of China's universal service program was found to be uncertain due to the ambiguous roles of government and business and government–business relations, in terms of both regulatory incentives and regulatory governance (Harwit, 2004; Xia & Lv, 2008). By creating a critical contradiction between the commercial interest (profitability) of state-owned carriers and their political obligations of supporting state ideology, the close dependency between universal service policies and state legitimation strategies prevents the further development and full utilization of the telecommunications infrastructure (Liu & Jayakar, 2012). Because China's top-down universal service program allows little, if any, participation of the urban and rural lower social classes, the rural telephone system was at risk of being subordinated to the interests and policy priorities of the more powerful political and economic elites (Zhao, 2007). A recent example in Sichuan is China Telecom's discharge of its Department of Rural Market in May 2009 when it received the long-awaited cellular license and mobilized most of its resources to build and market the CDMA2000 3 G network in urban areas (Hongjian Liu, personal communication, May 2, 2011).

Focusing on the content side, the Sichuan provincial government also had its own rural informatization program called the Rural Economic Information Network (REIN)[7] since 2001. The REIN has a hierarchical organizational structure that includes both provincial and local government agriculture-related agencies. Horizontally, at the provincial level, all agriculture-related government agencies are members of the REIN. The 20 members include the Bureau of Information Industry, the Committee of Development and Planning, the Bureau of Finance, the Bureau of Agriculture, and the Research Institute of Agricultural Science. Vertically, the REIN consists of one provincial information center, 21 municipal centers, 174 county centers and 4,500 service stations in villages and towns[8]. Every township is required to appoint at least one information collector for the REIN who is responsible for collecting and uploading local news and other information to the REIN. Thus, the REIN is carefully equipped with a comprehensive information-collecting system that enables it to provide both authoritative government and relevant local information (Liu, 2012). However, the REIN is not involved in any connectivity issue. The major, if not only, information distribution channel of the REIN is its portal website. In some circumstances, local REIN staff have to print and post the REIN's information on the blackboard located in the local free market so that rural residents can read it during the weekly gathering (Zuo, 2006).

Overall, the government and carriers seem to focus on content and connectivity respectively. This is not surprising because the government, which maintains a huge amount of rural information and has the administrative authority to mobilize the bureaucratic system, lacks the experience and funding to build and maintain the physical network, whereas the state-owned carriers, which are naturally assigned the task of extending the physical network, generally have no expertise in collecting and distributing high-quality, locally relevant information (Liu, 2012).

4.2. *Convergence of connectivity and content: a government-carrier model*

In 2003, China Unicom Sichuan initiated a project called “Tianfu Agricultural Information Network” (TAIN; *Tian Fu Nong Ye Xin Xi Wang in Chinese*), which was the prototype of China's government-carrier informatization program. In the same year, the TAIN was officially endorsed by the provincial government. In its directive order, titled “Regarding the Promotion of the TAIN in Order to Further Develop Sichuan's Rural Informatization”, the provincial government stated that the primary objective was to utilize China Unicom's network to collect and deliver information to rural residents and thus solve the “last-mile” problem (General Office of the Sichuan Provincial Government, 2003)[9]. Several principles were also outlined in the above mentioned policy document:

- Institutionally, the TAIN was recognized as one of the government official rural informatization programs and local governments should coordinate with China Unicom to promote the TAIN;
- Operationally, the REIN and local governments should supply rural information to the TAIN and China Unicom was in charge of the routine operation;
- Financially, the TAIN was expected to be self-sustainable.

[6] Data was retrieved from the annual report of the Sichuan Communications Administration (in Chinese), see http://www.scca.gov.cn/weboa/xxfb.nsf/ncxxView/D469EC3CC5DDFFA248257903000887l6?opendocument.

[7] Although other government agencies have set up their own agricultural informatization services, the REIN has been considered the most authoritative one because it is directly organized by the Sichuan provincial government.

[8] See the REIN's “About Us” page at http://www.scnjw.gov.cn/export/sites/szx/wblj/20121224055010240.html.

[9] The one-page Order did not state any specific goal. Rather, it is a descriptive general statement.

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The model was not complicated. Unicom reached a strategic partnership with the REIN to deliver the REIN's information to Unicom's rural subscribers, primarily through the short messaging service (SMS)[10]. The TAIN system also enabled the institutional subscribers, primarily local governments, to upload and distribute information to their designated subscribers. In addition to depending on the REIN's information resources, Unicom attempted to collect locally relevant information itself by hiring part-time information collectors at the township or village levels. Commercially speaking, by providing useful content to its rural subscribers through the TAIN, Unicom expected to attract more rural customers and to gain extra revenue from existing rural subscribers because the TAIN service was charged as a value-added service.

Traditionally, telecommunications carriers served only as the distributor in delivering information to rural communities. In the TAIN model, Unicom also positioned itself as the information aggregator. To some extent, this model streamlined the information flow from information resources to recipients, and the government-carrier cooperation helped to overcome the government and carriers' respective limitations.

As the pioneer of providing informatization service in rural areas, the TAIN has won many awards for China Unicom Sichuan. In 2005, the TAIN was awarded the first prize by the China Association of Communications Enterprises for managerial innovation. It was recognized internationally by being selected as one of the five winners of the World Summit Reward in the category of E-business and Commerce[11]. The National Development and Reform Commission (NDRC) also awarded a 7.5 million RMB subsidy to Unicom to support the TAIN's second-phase system expansion in 2005 (Xie, 2005).

The TAIN was selected by the MIIT as the rural informatization demonstration project, and its operating model has been borrowed by other state-owned carriers in their rural informatization offerings. In 2009, the MIIT designated China Telecom to carry out the rural informatization project in Sichuan called “Information Countryside” (IC; *Xin Xi Tian Yuan*). In addition to receiving information via SMS service, China Telecom's rural subscribers could access information by visiting the IC's websites through television sets with a pre-programmed set-top box. Similar to the Unicom's TAIN, China Telecom depends primarily on the REIN to provide content. In 2011, the dominant wireless carrier, China Mobile, started a similar program called “New Agricultural Communications”. Instead of the REIN, China Mobile chose Xinhua News Agency as the main content partner. Similar to the TAIN, China Telecom and China Mobile have also established their local information collecting networks. The information collectors could be government employees, community leaders, or young college graduates recruited by the government to work in the countryside temporarily[12].

Regardless of branding, all of the abovementioned government-carrier programs seem to follow the same model, as depicted by Fig. 1, similar to the TAIN. In this model, telecommunications carriers are positioned at the center of information flow, connecting the otherwise disconnected information owners and rural recipients. Given the financial and technical constraints, information owners usually do not have the necessary resources or expertise to distribute their information to the targeted recipients. The widely dispersed rural population and the low computer subscribership in such areas have made it a daunting, if not impossible, task for the content owners to build their own distribution networks. On the other hand, a decade of effort to extend the telephone network to rural areas has readily covered most of the nation's vast remote regions. The strategic partnership between the content owners and the carriers has enabled the information to ride on the existing networks and thus overcome the limitations of both sides.

5. Sustainability analysis of Sichuan's government-carrier informatization program

Kumar and Best (2006) described a simple sustainability failure model to assess the ongoing survivability of a rural ICT4D project. They argued that the long-term survivability of a project could take five principal forms: financial/economic sustainability failure, cultural/social sustainability failure, technological sustainability failure, political/institutional sustainability failure, and environmental sustainability failure. In this section, drawing upon Kumar and Best's theoretical framework, we move from the case description to a critical analysis of Sichuan's informatization project.

5.1. Financial sustainability

Although the informatization project described in the previous section has become a national initiative, the funding mechanism has been largely missing in both the central and provincial plans.

Since the principle of universal service was written into the Telecommunications Regulation in 1996, China's telecommunications regulator has been attempting to put in place a Western-style universal service funding mechanism with explicit policies and regulations[13]. However, little progress has been made so far. Thus, the traditional universal telephone service programs, such as “Telephone to Every Village“, have been primarily funded by the carriers, as required by the regulator in forms of ministerial executive orders. However, the authority of China's telecommunications regulator was found to be relatively weak and has been circumscribed by other party-state institutions, particularly the State-owned

[10] Other low-cost information delivery systems were developed later, for example, China Telecom's TV Set-Top Box (Liu, 2012).

[11] The World Summit Award is a global initiative for selecting and promoting the best in e-content and creativity. The Award, which is coordinated by the International Center for New Media in Salzburg, Austria, is organized within the framework of the World Summit on the Information Society (WSIS).

[12] Volunteers would be given preference in graduate entrance and civil service examinations after their service in the countryside.

[13] Only in 2006, the MIIT appeared to secure budgetary support from the central government for subsidizing the carriers for some of the maintenance costs of rural telephone networks (MOF, 2006). However, the funding was provisional and subject to annual budgetary review.

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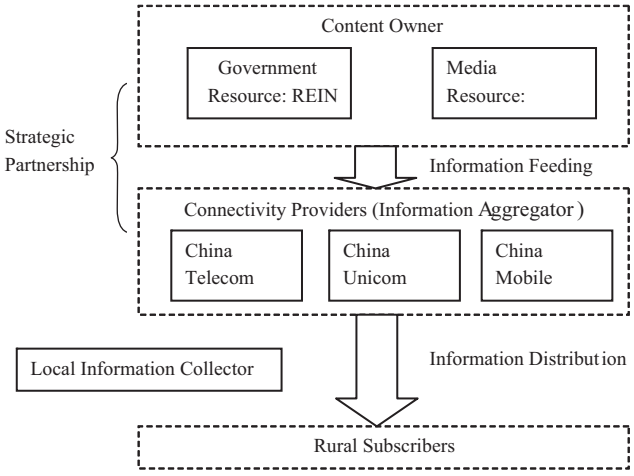

Fig. 1. The Government–Carrier Model.

Assets Supervision and Administration Commission (SASAC), whose primary interest was to maximize the value of these assets rather than to protect the consumers' interests (Pearson, 2005; Yeo, 2009). This, to some extent, explains the failure of the MIIT to gain support from other ministries, such as the SASAC and the Ministry of Finance (MOF), to establish a formal universal service funding mechanism. The conflicting interests of the SASAC, as the investor, to preserve and increase the value of the telecommunications carriers, with rate of return as one of the main Key Performance Indicators (KPI), and the MIIT, as the regulator, to mandate universal service obligations on those carriers, led to serious concern for the financial sustainability of China's universal service program (Harwit, 2004; Liu & Jayakar, 2012; Xia & Lv, 2008).

Like its predecessor, no formal funding mechanism is associated with rural informatization. Because most of the central government-initiated rural informatization projects are run on a trial basis in selected regions, fiscally speaking, rural informatization is largely a provincial endeavor under the ideological direction of the central government (Liu, 2012).

In Sichuan's case, the REIN is solely funded by the provincial government. The provincial government recommends local governments to allocate necessary funding to support the REIN's local operation. In the Chinese political language, this type of directive policy allows for flexible compliance. In practice, because the local governments have great autonomy to decide on their own budgetary spending, ironically, only those richer regions, that usually have higher levels of informatization, are able to invest in informatization programs, which arguably worsen the regional divide. For example, the village in the more developed Leshan County has a specified subsidy available from the county to maintain the daily operation of REIN's information station in that village (e.g., broadband access fee and awards for uploading information), whereas the poorer village in Dazhou County has no budget for that purpose (Duan & Wang, personal communication, July 5, 2012).

In practice, unsurprisingly, telecommunications carriers have to rely primarily on themselves to finance their rural informatization projects[14]. Occasionally, the provincial and local government might give spiritual awards, such as the title Rural Informatization Excellent Provider, for carriers investing in their areas. However, these awards are accompanied with nominal, if any, monetary value. Among the 21 China Telecom county branches in Sichuan, only 1 received a small subsidy from the county government in the fiscal year of 2012 (Deng, personal communication, December 20, 2012).

Because there has been essentially no government subsidy whatsoever to incentivize the carriers, it is intriguing that why the carriers have invested their own resources in rural informatization projects throughout the past several years.

First, it is worth noting that the origin of Sichuan's informatization project, Sichuan Unicom's TAIN, was driven by market competition instead of by a demand from the government, and, indeed, the TAIN was designed to be a value-added for-profit service rather than a charity project. Rural informatization has always been actively pushed forward by the competing, instead of the dominant, carriers. When China Unicom introduced the TAIN in rural areas, it was the weakest among the three carriers, with China Telecom dominating the wireline sector and China Mobile dominating the wireless sector in the more profitable urban market. The rural market, with a relatively low telephone penetration and less competition, was thus considered a new growth area for Unicom. As put by Shu Zhou (Director, Corporate Communications, China Unicom Sichuan Province), the rural market then presented a “blue sea” for China Unicom (Shu Zhou, personal communication, January 21, 2012). Similarly, when China Telecom first introduced its rural informatization project in 2008, although China Telecom was still the dominant wireline carrier, its rural wireline subscribers had been gradually, but substantially, switched to the cheaper and more convenient wireless service competitor, China Mobile[15]. Providing the content-rich rural informatization service was considered a strategy to stabilize the existing rural customer base and attract

[14] It is estimated that 96% of the 50 billion RMB investment in the rural infrastructure buildup was self-funded by carriers from2005–2010, according to a report by MII's research institute (Zhang, 2013). (See http://www.drpeng.com.cn/portal/xwzx/2013/0701/775.html in Chinese.)

[15] At that time, China Telecom had no wireless license.

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more subscribers to China Telecom's wireline service[16] (Li Li, personal communication, June 10, 2012). Businesswise, the expectation was that the fee charged to the informatization service subscribers should cover the cost. Providing advanced informatization services in rural areas became one of the competing carriers' strategies to gain larger market shares over the dominant carrier along with additional revenues. Thus, it is not surprising that China Mobile, which had the largest share in the rural wireless market, was the last of the three carriers to start a rural informatization service in 2011.

Another possible explanation is that the carriers have regarded providing rural informatization services as part of their corporate social responsibilities. Particularly because all of China's carriers are state-owned companies, their corporate responsibility fulfillments are often endowed with political significance (Hua Li & Ping Wang, personal communication, July 21, 2011). In addition, because the carriers' high-level executives are, in fact, government officials, the success or failure of the Party-led informatization projects has a significant effect on their future political careers. Thus, commercial interests might have a lower priority in carriers' informatization projects. As a matter of fact, informatization projects were often considered under carriers' overall rural market planning, and carriers have not carried out any formal study on the profitability of these projects and statistics on the subscribership and usage were not available (Yu Deng, Qiang Li & Shu Zhou, Personal communication, May, 2011).

As discussed, the carriers' informatization programs initially emerged as value-added services to compete in the less-developed rural market. The risk is that because the profit margin of the rural market is so low, it is rational for carriers to withdraw from this sector and shift resources to a more profitable sector. For example, China Telecom Sichuan discharged its Department of Rural Market in May 2009, when it received the long-awaited cellular license and decided to "concentrate most of our capital expenditure to build the CDMA2000 3 G network in urban areas"(Hongjian Liu, personal communication, May 2, 2011). Since there are no written formal regulations or rules, literally speaking, no penalties could be imposed on carriers, should they refuse to or withdraw from providing rural informatization services. However, because rural informatization has been turned into one of the national strategies to bridge the urban-rural divide, it is politically incorrect and also commercially infeasible to completely withdraw from rural informatization programs. Interviews with the senior executives of all the three carriers in Sichuan reveal a similar strategy in their informatization programs—that is, to maintain the status quo with no further investment. As it was put by one of China Telecom Sichuan's marketing managers, "We are happy to add more subscribers in rural informatization services, but the focus has definitely shifted to 3 G wireless now" (Li Li, personal communication, June 10, 2012). In fact, China Telecom Sichuan's rural informatization program was outsourced and is no longer considered a key business. Essentially, because these carriers are listed on the foreign and domestic stock markets, the mixed ownership requires them to be responsible not only to the government, but also to investors. Thus, the entrepreneurship and professionalism of the business culture are in conflict with responsibility to answer to the call of the Party. To that end, without a more explicit funding mechanism in place, the long-term financial sustainability of rural informatization is at risk.

5.2. Institutional sustainability

Previous studies have identified some important macro-level institutional flaws of China's rural informatization programs, such as interdepartmental rivalry, a lack of a coherent strategy, a lack of accountability and credible measurements, and central and local planning gaps (Liu, 2012; Ting & Yi, 2012; Xia, 2010).

The key to understanding China's institutional design in policy making is the so-called "Tiao-Kuai" concept. The term Tiao refers to the vertical lines of authority, and the term Kuai refers to the horizontal level of authority of the territorial government at the provincial or local level. Tiao and Kuai could not issue binding orders to each other, which created potential conflict between the Tiao vertical lines and the Kuai horizontal lines of authority (Lieberthal, 1997; Lieberthal & Lampton, 1992; Lieberthal & Oksenberg, 1988). For example, ministries of the central government could not issue a binding order to the provincial government, and vice-versa. Thus, China has become a highly negotiated political system, and flexible compliance is not rare (Lieberthal, 1997)[17].

In rural informatization, because the state-owned carriers belong to the Tiao system and report to the central ministries such as the SASAC and MIIT, the provincial government could not "order" or "demand" them to carry out tasks. In fact, the strategic partnership formed between the government and the carriers in Sichuan's model is loose. The Sichuan provincial government has later signed similar strategic cooperation agreements with all of the three dominant carriers, declaring its support to their respective rural informatization programs in 2009. However, no actionable follow-up plans have been announced since then. Essentially, the government-carrier cooperative rural informatization program is largely left only to the carriers to implement.

Because there is no revenue-sharing mechanism in place between the carriers and the government, the government's REIN has no incentive to feed the carriers with content, which, to some extent, explains why the carriers later have to seek other information resources, either on their own or through other organizations, such as the Xinhua News Agency. In practice, there is hardly any meaningful institutional support from the government to the carriers' rural informatization

[16] China Telecom's initial rural informatization service was delivered through its wireline (broadband) network (Liu, 2012).
[17] For a more detailed description, refer to Liu (2012).

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programs. Essentially, for both the government and the carriers, the current cooperative model is of more symbolic significance.

5.3. Cultural/social sustainability

One prominent feature of Sichuan's rural informatization program is its attempt to organize a local information collecting network (Liu, 2012). China's carriers have branch offices in nearly every township. Moreover, almost every administrative village is stationed with a sales representative who is usually a native person living in that area who has personal or business connections to local community leaders. In the informatization project, these branch offices serve as the information stations, where local residents are able to browse information online for free. Information collectors include carriers' sales representatives, government employees, community leaders, or young college graduates working in the countryside temporarily (see footnote [11]). Local government offices are able to post information to the system. For sales representatives, collecting and uploading local information is part of their job responsibilities. Other information collectors are usually given some free airtime minutes based on the amount of information uploaded. That information is then edited by the administrator and appears on the informatization portal sites.

In terms of information distribution, in addition to viewing the portal sites directly, informatization subscribers can receive information on cell phones through a short message service. Generally speaking, local sales representative and government officials are authorized to send messages to the designated subscribers. There seems to be no uniform criterion on the selection of messages. He, a China Telecom's sales representative in charge of Leshan County's Juxian Village, told us that she "will send the information that she thinks useful" to her customers in that village (Lili He, personal communication, May 20, 2011). In addition, as we learnt from China Telecom's Department of Marketing, local sales representatives are not required to distribute the information to the local community unless they themselves consider this extra effort helpful in promoting the informatization service because the primary interest of the corporation is increasing the subscribership rather than generating and distributing quality information (Li Li, personal communication, June 10, 2012). In reality, he also told us that she only occasionally selected and distributed the information because she would rather spend more time on other work that would bring in direct sales (Lili He, personal communication, May 20, 2011). However, without the active involvement of those local representatives, the quality of the locally relevant information might deteriorate in the long term.

In the current design, end-users are passive receivers of whatever information is delivered to them. Their actual needs are largely ignored. The relevance and immediacy of information is contingent on the individual skills and conscientiousness of the information collectors. Although we did not conduct a formal survey of information needs in this study, among the 7 rural residents interviewed, there was significant disparity in their evaluation of the usefulness of the informatization service. Five out of 7 said that most of the information was irrelevant; however, on the other end of the spectrum, Duan, the head of Juxian Villager's Committee, told us that they obtained extra orders for their teas from Guang Dong province with the help of marketing information delivered to them (Kun Duan, personal communication, May 21, 2011). The lack of input or feedback channels from the end users limits the usefulness of the current informatization program. Nevertheless, further research is needed to determine the actual usage of the information.

5.4. Technological sustainability

As was described in the previous sections, in Sichuan's government-carrier model, cheap solutions, such as SMS and TV set-top boxes, have been developed to enable rural subscribers to receive information. These technologies reduce the expense of equipment costs. In addition, compared to the tele-center solution, which is common in other developing countries, SMS-based service can reach a wider population base. Although statistics on the rural wireless market are not available, according to Sichuan Communications Administration's (SCA, provincial telecommunications regulator) most recent statistics, the number of wireless subscribers in Sichuan reached 65 million by the end of Oct 2014, with a penetration rate of 80.8%.

Admittedly, these solutions are constrained by their technological limitations. For example, they are based on one-way transmission technologies and have limited interactive capability. The recent significant uptake of 3 G wireless internet seems to bring in the opportunity for rural residents to take full advantage of the massive amount of information available online. In fact, CNNIC research shows that rural wireless subscribers were more likely to use a cell phone to access the Internet than urban residents (CNNIC, 2013). However, carriers seem not to be enthusiastic to keep their informatization programs up-to-date with the advancement of technologies. So far, China Telecom and China Mobile Sichuan have no plans to develop 3 G based rural informatization applications (Li Li & Hui Wang, personal communication, November 10, 2014). Li told us that, in the rural market, China Telecom must concentrate the limited resources to the broadband infrastructure network development (Li Li, personal communication, November 10, 2014).

5.5. Summary of the case analysis

Conventionally, the role of telecommunications carriers is limited to providing connections. The uniqueness of Sichuan's model is the positioning of the carrier as both the information aggregator and distributor. Essentially, requiring carriers to deliver information simply adds another layer of universal service obligation to their traditional role of connectivity. The

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primary strength of such a model lies in its ability to deliver information to mass recipients at a low cost. Riding on the existing wireless networks, relevant information can quickly spread to the large range of rural areas at nominal incremental cost. Thus, technologically speaking, it offers a simple, but yet effective, solution.

However, the model has failed to be financially sustainable as expected. While those carriers might be obligated to offer rural informatization services because they have to serve the public as state-owned enterprises, interestingly enough, the seemingly unprofitable rural informatization service was pushed forward by competing carriers, instead of the dominant ones, as a marketing strategy to gain competitive advantage in less lucrative markets. Thus, the program itself is designed, at least theoretically, to be business-oriented, instead of merely charitable. The expectation is that the cost of providing rural informatization service could be recovered by the fee charged to rural subscribers, which is hardly the reality, as reviewed in the previous section.

In Sichuan's model, in the original design, the role of the carrier was to deliver the information from the government to the rural resident. To that end, the carrier stayed within its traditional common carriage domain. As the program evolved, the carrier developed itself into an information aggregator, or a portal, combining content and conduit. Be that as it may, the motive behind this move is still the pursuit of business interests in the rural market. Thus, it is essentially a business practice. When the government decides to promulgate such an informatization program, it is then endowed with political significance. The informatization program has turned into one of the carrier's *de facto* obligations, and the carrier can no longer withdraw from it. Essentially, Sichuan's government-carrier cooperative informatization model is a mixture of the passive fulfillment of political duty and the proactive pursuit of business interests. The irony in Sichuan's case is that such an obligation has never been written into a formal regulatory policy. Therefore, the entire program is stagnant, awaiting further policy making.

6. Conclusions

Sustainability is most likely the most challenging issue for any rural informatization project. Guided by Kumar and Best's sustainability failure framework, our study found that Sichuan's government-carrier cooperative model was at risk of financial, institutional and cultural/social sustainability failures. Financially, because there is no formal universal service or related funding mechanism to support the rural informatization program, it primarily depends on the carrier to finance the project. Although rural informatization services could help the carrier to increase its market share in rural sector, it is a rational decision for the carrier to shift resources to a more profitable market should it emerge. Institutionally, because there are no binding political or commercial ties between the carriers and the government, the current cooperative model is of more symbolic significance. Socially, although there has been an effort to collect local information, the needs of the rural residents are largely ignored in the current design. However, those issues are not inextricable and some are China-specific. We do not intend to offer a comprehensive solution in this paper. However, the most important lesson other country or regional governments can learn from Sichuan's model is that a clear definition of responsibilities for each player in an informatization program is a vital prerequisite to its success because, essentially, involving telecommunications carriers in informatization implies adding another layer of obligation to the traditional universal service package. While this model involves minimal administrative adjustment, the regulatory contract between the government and carriers needs to be updated explicitly.

Despite these pitfalls, overall, involving telecommunications carriers in informatization provides a technologically simple and straightforward solution to achieve a large-scale delivery of informatization programs. Traditional solutions, such as a tele-center, could provide full-fledged informatization services, but with limited coverage. In addition, tele-centers require initial investment in equipment and continual maintenance funding. There are hardly any self-sustaining tele-centers in the world. On the contrary, with the world wireless market approaching saturation levels[18], wireless technology has enormous potential to facilitate informatization processes, particularly in rural areas. This feature is pertinent for developing countries, where computer ownership is low, but wireless subscribership is high. Particularly, with the quick diffusion of the 3 G (even 4 G) technology, advanced applications could be developed to take advantage of the high-speed wireless broadband. Thus, technological sustainability seems not to be a serious impediment in Sichuan's model.

As this paper developed, China announced the Broadband China Plan, aiming to build a ubiquitous, fast and advanced national broadband network before 2020 (State Council, 2013). The Broadband Countryside is listed as one of the seven major projects. However, it was found that this was largely a conventional supply-side infrastructural policy and common demand-side policies, such as subsidy to low-income and other disadvantaged populations and digital literacy training, were missing (Jayakar & Liu, 2014a). Granted, the continuing improvement of infrastructure will stimulate demand to some extent. However, previous research has found that although both supply-side and demand-side policies had a positive effect on broadband diffusion at the initial stage of broadband take-up, only demand-side policies appeared to generate an increasing effect when a certain degree of broadband penetration was reached (Belloc, Nicita, & Rossi, 2012). Our analysis of

[18] According to the ITU's recent estimate, the number of wireless subscriptions worldwide will reach 7 billion by the end of 2014, corresponding to a penetration rate of 96%. In developing countries, wireless-cellular penetration will reach 90% by the end of 2014. Particularly, wireless broadband penetration will reach 32% (84% in developed countries and 21% in developing countries) by the end of 2014. ITU also estimates that the wireless market is approaching saturation levels because the growth rates have reached their lowest-ever level (of 2.6% globally; see http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2014-e.pdf)

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Sichuan's informatization program also reveals that the lack of relevant content is one of the major limitations. Thus, it is recommended that China's policy makers consider adding content and applications to connectivity in future planning.

This study opens two lines of inquiry for further research. First, although Kumar and Best's sustainability failure model provides a useful analytical framework for our case, it serves best as an evaluation tool and provides somewhat limited guidance on the informatization project design. In addition, the model appears to treat failure factors equivalently. To apply it to large-scale ICT4D projects, failure factors should be weighted based on the size of the effect they have on the sustainability so that remedies could be prioritized in order of importance and urgency. For example, in our study, financial and institutional sustainability should be given higher priority, whereas environmental sustainability is largely irrelevant. Finally, another line of research that is beyond the scope of this paper, but worth further investigating is the demand of the rural resident. This paper is primarily from the carriers' point of view and only touches on the information needs of rural residents. What information do they need, and how can they be more proactive in the informatization program? Further investigation can help answer these questions.

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Appendix A. List of the interviewees

Name	Title, Organzation
Liu, Hongjian	CEO, China Telecom Sichuan Province
Deng, Yu	Deputy Director, Department of Corporate Strategy, China Telecom Sichuan Province
Li, Li	Director, Department of Rural Marketing, China Telecom Sichuan Province
Hu, Ping	Director, Department of Corporate Strategy, China Telecom Sichuan Province Leshan County Branch
Yu, Tao	Director, Department of Corporate Strategy, China Telecom Sichuan Province Dazhou County Branch
Li, Hua	Former CEO, China Mobile Sichuan Province
Hua, Bo	Senior Manager, Department of Marketing, China Mobile Sichuan Province Chengdu City Branch
Wang, Hui	Junior Manager, Department of Marketing, China Mobile Sichuan Province
Li, Qiang	Sales Manager, China Mobile Sichuan Province
Wang, Ping	Vice President for Marketing, China Unicom Sichuan Province
Zhou, Shu	Director, Corporate Communications, China Unicom Sichuan Province
Liu, Qing	Senior Manager, Department for Marketing, China Unicoom Sichuan Province
He, Lili	Sales Representative, China Telecom Sichuan Province Leshan County Ju Xian Village
Gou, Xiaoting	Resident, Leshan County, Juxian Village
Yuan, Lin	Resident, Leshan County, Juxian Village
Wang, Changchun	Resident, Leshan County, Juxian Village
Duan, Kun	Head of the Villager's Committee, Juxian Village
Pi, Renjie	Resident, Dazhou County, Chengbian Village
Huang, Chang	Resident, Dazhou County, Chengbian Village
Wang, Deping	Head of the Villager's Committee, Dazhou County, Chengbian Village

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