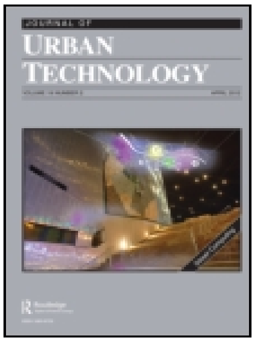

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ICT-Oriented Urban Planning Strategies: A Case Study of Taipei City, Taiwan

Wei-Ju Huang

ABSTRACT *With the development of wireless technology and its infrastructure networks, information and communication technologies have become widely and deeply embedded in our daily lives. Technological and socioeconomic trends are gradually changing the concept of ICT-oriented urban planning strategies from the virtual city to the ubiquitous city. Many studies have tried to map the relationship between urban planning and ICT strategies, but how the means of implementation influence the outcomes of such strategies is lacking discussion. This study aims to establish an analytical framework for exploring the relationship between the means of implementation and the outcomes of such strategies. The ICT-oriented urban planning experience of Taipei City is used to test the limitations and application of the framework. The study finds that technological trends, physical infrastructure, ICT content, interface design, and user characteristics are key factors that subtly interrelate with each other and should be considered integral when initiating such strategies.*

KEYWORDS *Urban Planning; ICT Strategies; Taipei City*

Introduction

Since the third industrial revolution in the mid-1970s, the rapid evolution of information and communication technologies (ICT) have allowed the dispersal and specialization of production, bolstered the hyper-mobility of capital on a global scale, and fostered the growth of central functions in cities (Castells, 1998; Graham and Marvin, 1996; 2001; Sassen, 2007). Thus, ICT not only supports and accelerates the process of globalization, making cities major players in the global economy, but also redefines “the way we conceive, use, plan, and control physical space in cities” (Firmino et al., 2008: 77).

The broad applications of ICT have posed two challenges to urban planners and policy makers. The first challenge is the shifting concept of place. The traditional understanding of places as “spaces of place” which considers places as “single, integrated, unitary, material objects” has been challenged by a new concept, namely “spaces of flows” or spaces of relations (Castells, 1998; Graham and Healey, 1999: 626). The new concept “sees spaces as an inherent spatiality in all relations . . . understands place as a social construct, generated as meanings

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are given in particular social contexts to particular sites, areas, and nodes of intersection" (Healey, 2004: 47).

The second challenge is the technological capacity of a city under intense global competition. The technological capacity of a city is understood as the ability of a local government to approach, evaluate, and select newly available technologies, and then to utilize, adopt, improve, and further develop such technologies to achieve their desirable governance goals (Kim and Bretschneider, 2004; Madanmohan et al., 2004). If the industrial economy cannot become informational and global, it will collapse, because technological capacity has become one of the major ways for countries and cities to link up with, and to compete in, the global and informational economy (Castells, 1998).

In order to cope with these two challenges, since the mid-1990s many cities in developed countries have started to integrate ICT strategies into urban and regional developments—such as the "TeleVillage" in the United States, the "Electronic Village Halls" in the United Kingdom, the "Telecities" network in the European Union, the "Technology Corridor" in Singapore, and "Kuala Lumpur and the Multimedia Super Corridor" in Malaysia (Graham and Marvin, 1999; Corey, 2000). Graham and Marvin (1999: 111) argued "new information technologies actually resonate with, and are bound up within, the active construction of urban places, rather than making them somehow redundant." They claimed that urban planning and ICT policy can no longer be considered as entirely separate disciplines.

Recently more studies try to map out the relationship between urban planning and ICT policy by investigating the perceptions and attitudes of urban policy makers and administrative officials toward ICT. They explain why and how ICT are integrated in urban planning from the perspective of government. They also argue that the main limit of ICT-oriented urban planning strategies results from the lack of knowledge, interest, and/or awareness of policy makers and administrative officials regarding the links between urban planning and ICT development and/or the potential impacts of such strategies on urban development (Cohen and Nijkamp, 2002; Cohen et al., 2004; Firminio et al., 2008).

However, there has been a lack of research evaluating how the means of implementation influence the outcomes of such strategies, while more and more cities view such strategies as a possible way to enhance urban competitiveness and solve existing urban issues. Based on the arguments of previous studies, this study aims to establish an analytical framework for exploring the relation between the means of implementation and the outcomes of such strategies and identifying the main factors and their interrelationships via a case study. The case study area is Taipei City which has been a pioneer in continuously putting forth ICT-oriented urban planning strategies since 1999. Several international institutes, including the Wireless Internet Institute, the Intelligent Community Forum, the JiWire and Asia Pacific Customer Service Consortium, have supported its efforts.[1]

The first part of this paper develops a theoretical approach by reviewing literature which helps to identify the typology of strategies and to demonstrate the interrelations between ICT infrastructure networks, users and their interfaces in terms of the concept of layering and networking. The second part is a case study of Taipei City. It is mainly a desk study based on second-hand data and Internet searching, including relevant literature, reports, official documents and statistics. In order to clarify some implementation details, key actors who have participated or are participating in the design and implementation process of Taipei City's ICT plans were interviewed.

The third part explores two ideological transitions—user focused design and synergy of physical and electronic developments—behind the series of Taipei City's ICT plans. According to the analytical framework, three issues are examined in the case study: deliberation on technological trends, role of public physical and electronic spaces, and demand-oriented design of ICT interfaces. The ideological transitions and the issues help to identify the key factors and their interrelations in the process of implementing ICT-oriented urban planning strategies. Finally, this paper suggests to urban planners and policy makers a possible way to promote better results and positive influences on cities while integrating ICT into urban planning practices and strategies.

Building an Analytical Framework

In this research we understand ICT-oriented urban planning strategies deal with issues related to ICT infrastructure development and/or electronic applications. Such strategies are often applied to enhance the efficacy of public service delivery and to manage the relationships between physical movement and mobility at the citywide level. Several types of ICT-oriented urban planning strategies have been identified. For example, Graham and Marvin (1999) classified three main types of strategies: integrated transport and telecommunications strategies, city-level new media strategies, and information districts. Cohen and Nijkamp (2002) divided such strategies into supply-side and demand-side. The former type focuses on the development of ICT infrastructure in order to enable ICT use. The latter type induces the use and adoption of ICT. Firmino et al. (2008) categorized such strategies into ICT initiatives, network infrastructure, and initiatives involving mobile and wireless technologies.

In the 1990s, building municipal websites and developing ICT infrastructures became the two most popular municipal ICT initiatives (Cohen et al., 2004). Such strategies are based on a concept of electronic cities, which is to transfer urban functions into virtual space (Komninos, 2002). With the development of wireless technology and its infrastructure networks, the applications of ICT have been widely and deeply embedded in our daily life. The conception and perception of the city have been changing as Mitchell (1996: 107) described that "the very idea of a city is challenged and must eventually be reconceived. Computer networks become as fundamental to urban life as street systems . . . Much of the economic, social, political, and cultural action shifts into cyberspace." These technological and socioeconomic trends are gradually changing the concept of ICT-oriented urban planning strategies to the ubiquitous city.

The ubiquitous city is based on a concept of "ubiquitous computing" proposed by Mark Weiser (1991: 94). He claimed that the most profound technologies were those that "weave themselves into the fabric of everyday life until they are indistinguishable from it." As shown in Figure 1, while the virtual city represents digitalized urban elements and data in a electronic space, the ubiquitous city

> is created by the computer chips or sensors inserted into those urban elements. . .. Effectiveness in urban planning and management can be improved by using real time data acquisition and information monitoring via those embedded computers in every part of cities (Lee et al., 2008: 150)

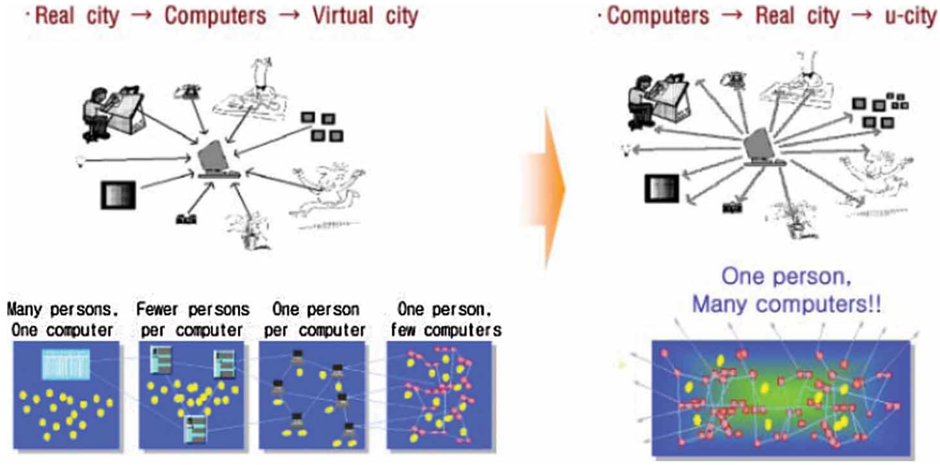


Figure 1: Difference between e-city and u-city
Source: Lee et al., 2008: 150

Both virtual cities and ubiquitous cities imply technology-oriented and linear concepts, although they may not be intentionally rolled out as technical "quick fix" solutions to complex urban problems as Graham and Marvin (1999) reminded us. In these two concepts, the relation between users and computers is considered as a one-directional rather than an interrelated networking process (See Figure 1). Technology availability and infrastructure-dependent hard networks are their main concerns, rather than citizens' needs and people-related networks. The demand, function, and effect of networking among users are often taken for granted in these two planning concepts.

According to the observed experience of wireless communication in the United States, Latin America, and Asia, Castells et al. (2007: 253) stated that

> people adopt the technology to their needs and interests. . .. People find uses and, when they are able to, invent new services and create new content (for example, mass image swapping, texting, and so on), and when they do not find the services and content they want, they vote with their thumbs by not using what is offered.

Users are not only consumers of technology; they are also producers of content and technological services. They are also the ones who determine if a particular technology can survive in the market. Thus, it is necessary to shift the technological determinist concept to a more comprehensive, network-oriented concept that considers infrastructure networks, user networks, and their interfaces to generate ICT-oriented urban strategies.

Dupuy (2008) proposed a scheme of network urbanism to explain how technical networks, functional networks, and social networks operate and interact in a city. In his scheme, the first level is the suppliers of technical networks, which are streets, highways, cables, broadband, and other urban infrastructure elements. The second level contains the operators of production, consumption, and distribution networks. The third level represents how people use the first two levels of networks to create their social networks. The scheme provides a basic understanding of the interrelations among different levels of urban networks.

Van der Meer and Van Winden (2003) identified ICT infrastructure, local electronic content, and access to ICT as three local manifestations of information society. They are interrelated and sometimes mutually reinforcing. Their dynamics can be understood as a local "digital flywheel" (See Figure 2). The success of the Korean broadband market has embodied this concept. In the case of the Korean broadband market, the government stimulates the competition of the telecommunication and Internet service market. As a result, more, better, and cheaper broadband technologies and electronic services are provided to attract more local ICT users. A "killer application" can apparently accelerate the adoption of a new technology, such as online games, online stock trading, and multimedia content in the Korean case. More local users and electronic services demand a better quality of ICT infrastructure, and better quality of ICT infrastructure also evokes the improvement of electronic services and again attracts more users (Kim et al., 2004; Lau et al., 2005; Lee et al., 2003). In fact, the concept of the digital flywheel actually implies two ideas, "network effects" and "system affordances," which will be explained later.

Based on the concepts of network urbanism and the digital flywheel, this study identified infrastructure networks, interfaces, and users as three key elements that together form ICT-oriented urban planning strategies (See Figure 3). The first two elements can be seen as the support systems of ICT-oriented urban planning strategies. This study defines the three elements as follows:

- Infrastructure networks include all physical networks—whether they are old or new communication technologies—that support the use of ICT. The physical networks can be wireless networks, copper wire-based networks, coaxial cable networks, and optic fiber networks that help to carry and deliver information.
- Interfaces are the interconnection between infrastructure networks and ICT users. Interfaces can be physical places, such as hotspots, where wireless Internet access are provided; virtual spaces, such as websites or electronic applications, where electronic services and information are provided; sets of mechanical devices, such as sensors and actuators, that are used to receive and process real-time data or to move or control a mechanism or system timely; or personal devices, such as PCs, smart phones, or laptops, which are used to receive information and electronic services.

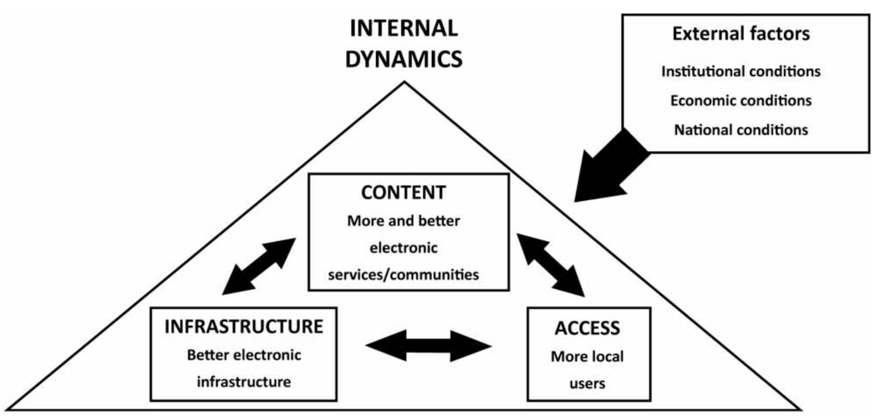


Figure 2: The digital flywheel
Source: Van der Meer and Van Winden, 2003: 411

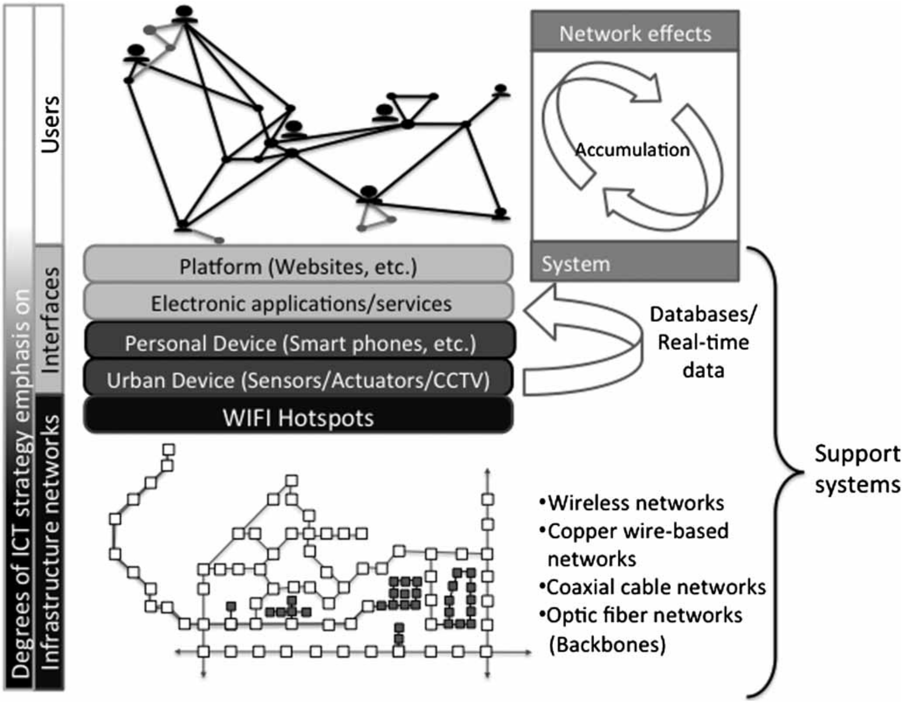


Figure 3: An analytical framework of ICT-oriented urban planning strategies

- Users consist of different groups of people who use and demand public electronic services, including long-stay citizens and short-stay tourists or foreign laborers in different ages and socioeconomic positions. By using the infrastructure networks and the interfaces, users can receive information and electronic services, develop personal networks, and create electronic content and services.

In this framework, two concepts are taken into account. These are, "network effects" and "system affordances." Together, they give us a basic understanding of the interrelationships between the interfaces and the user networks in ICT-oriented urban planning strategies. Network effects relate to a mutually beneficial effect—when, through more use of an ICT product by any user, the value of the product increases for other or all users (Occelli, 2008).

Affordance is a precondition for activity and "contributes to the possibility of that activity" (Greeno, 1994: 340). Gibson originally introduced the concept of affordances in ecological psychology. Occelli (2008) further used this concept as one of the constitutive layers of an ICT environment. In other words, when more varied devices and electronic applications can be used and accessed, the affordance of ICT infrastructure increases, so more users are generated to support the operation of ICT applications and infrastructures. This could be understood as a dynamic and accumulative process.

Most ICT-oriented urban planning strategies emphasize the significance of building ICT infrastructure and expanding electronic applications, because policy makers believe such strategies are more fundamental and visible in terms of promoting the use of ICT and making ICT applications accessible to all. The dynamic and accumulative process and the heterogeneity of users and their demands are relatively imperceptible for policy makers. The imperceptibility, on the other hand, further addresses the importance of considering the interrelations among the development of infrastructure networks, the design and applications of interfaces, and the networks and accessibility of different groups of users.

In the following section, the case study of Taipei City's ICT planning and implementation experience explores the key factors that should be considered in the process of design and implementation of ICT-oriented urban planning strategies, and how the factors interrelate to each other and together influence the outcomes. Furthermore, the limitations and application of the framework are tested.

From Taipei CyberCity to UI-Taipei (1999–2010)

Under the pressure of global urban competitiveness and the trend of informational city development, since 1999 the Taipei City Government (TCG) has been a pioneer in continuously putting forth ICT-oriented urban planning strategies. The rationale has been to complement the traditional geographical approach to urban policy with the innovative application of ICT in governing Taipei City and improving public services (RDEC, 2007). The first urban ICT plan, Taipei CyberCity, was initiated from 1999 to 2006. The main focus of Taipei CyberCity was to construct ICT infrastructures, including wired and wireless networks, to connect to global networks.

Since 2002, the TCG has devoted many resources to establishing a geographic information system of Taipei City, which integrates enormous amounts of geographic data and maps produced by different municipal departments (TCG, 2010b). In 2007 the TCG moved towards its next urban ICT plan, the Ubiquitous and Intelligent Taipei (UI-Taipei). On account of the successful construction of ICT infrastructures in the stage of Taipei CyberCity and the geographic database and information system, UI-Taipei is more focused on creating a "ubiquitous government" environment, where citizens can efficiently receive public services anytime, anywhere (TCG, 2008).

Since its first urban ICT plan, the TCG has designed and implemented more than 70 ICT-oriented projects across different sectors. Yet only a few of the projects have demonstrated identifiable achievements. The implementation of urban ICT plans is a long-term, trial-and-error process. Referring to the development procedure of the urban ICT plans in Taipei City, three strategies—wireless network development, digital divide improvement, and electronic public services—are selected to analyze the validity of the underlying assumptions of the strategies and to explore the interrelationships among physical networks of ICT infrastructures, users of public ICT services, and the interfaces between the infrastructures and the users. These three strategies are often announced as the major achievements of the TCG in implementing their ICT plans.

Wireless Network Development –WiFly Taipei

The WiFly Taipei wireless network infrastructure development project is one of the main strategies of the Taipei CyberCity Plan. Because of the uncertainty, in the beginning this project did not gain a lot of support inside the TCG until an idea of public-private partnership was raised. After reaching an internal consensus on the implementation of the project, the TCG proceeded to invite the private sector to invest in a nine-year build and operate (BO) franchise approach. Through this public-private partnership approach, the TCG did not invest any money directly but provided public facilities such as traffic signals, streetlamps, metro stations, civil hospital, civil library, and other cultural facilities—while the private sector was in charge to set up the wireless access points (APs). The TCG considers this project as an urban competitiveness plan and stated that "it was risky, but we would regret it if we never tried it" (RDEC, 2007: 20, translation by author).

In order to attract private-sector investment, the TCG promised the private sector that:

- would provide public resources and coordinate local administrations to help the private sector get the best places to set up the applications
- would not charge for the use of public facilities, including 1,800 traffic signals, 90,000 streetlamps, metro stations, and civil facilities
- would not allow any other wireless development projects during this nine-year period
- would offer the private sector the flexibility to adjust the fee ratio of the wireless network through establishing the Wireless Broadband Connection Commission to evaluate and set the fee's upper limit (RDEC, 2007).

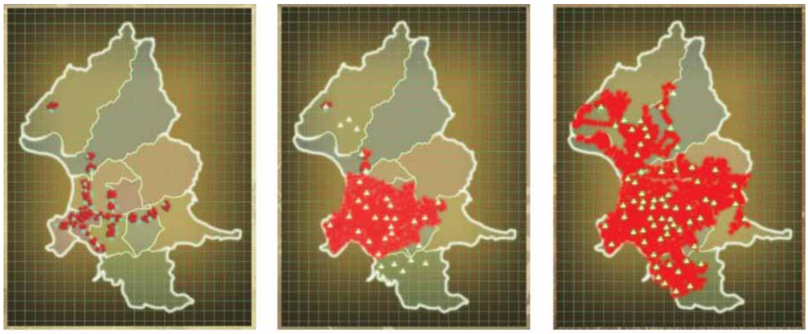
In May 2004, the TCG selected Hewlett-Packard Development Company, L.P. (HPDC) as the technical consultant for organizing the public tenders to help select the best applicant to execute the project, and then to supervise the construction process. In August 2004, Q-Ware Corporation (QWC) was selected as the best candidate to build and operate this wireless infrastructure. Since the QWC belongs to the Uni-President Enterprises Corporation (UPEC), which also owns 7-11[2] and Starbucks Coffee chain stores in Taiwan, the QWC proposed that the chain stores could be integrated into the project, a proposal that could maximize the coverage of the wireless sensor network in Taipei City. This proposal was a main reason for the TCG to choose the QWC as the best candidate.

In the very beginning, the TCG wanted universal coverage of the wireless sensing field in Taipei City, but they soon figured out that would need more than 12,000 access points (APs) to accomplish this ideal. The cost would be so extravagantly high that no private sector investor would be interested in the project. Thus, the TCG had to adjust its goal. According to an interview with Shih-Hsing Liang,[3] the former project manager of WiFly Taipei in the TCG, in order to serve the largest population in the most economical way the TCG finally decided to deploy Wi-Fi APs based on three factors:

- the distribution of registered population
- the distribution of road traffic volume
- the distribution of peak-hour population concentration.

Nearly 80 percent of the registered population in Taipei City was located in an area of 10 km by 13 km. As a result, the TCG chose 30 main streets to be the first areas for deploying the APs of the Wi-Fi sensor network, setting up two major conditions for the QWC: the wireless signal had to be received in all the open space of the 30 main streets, and the coverage had to be extended to reach 90 percent of the population within two years.

Following the suggestion of the HPDC, the construction of the Wi-Fi sensor network was divided into three stages (See Figure 4). Although the QWC offered to provide better services in more profitable commercial areas, in



Stage 1
(09/2004–01/2005)

Stage 2
(02/2005–12/2005)

Stage 3
(01/2006–07/2006)

Figure 4: The AP deployment of Taipei City in different stages
Source: http://www.tca.org.tw/taipei_gov/2005/taipeiwireless.htm

September 2006, the construction was completed and more than 4,000 APs had been set up in Taipei City, covering nearly 50 percent of the municipal area and reaching 90 percent of the 2.36 million inhabitants according to the conditions set by the TCG (RDEC, 2007).

From the start, there were tensions between the interests of the government and the private investors. In order to attract private investment successfully, the TCG had to compromise its goal of universal coverage towards 30 main streets to deploy the Wi-Fi APs. Although the private sector was more eager to provide access to profitable areas, the wireless network coverage still reached 90 percent of the population. This project demonstrates that if the local government ensures the benefit of most citizens from a spatial perspective, and concentrates on economic initiatives within its capacity, the polarization of ICT development in urban spaces might be mitigated and a better synergy between physical and electronic developments might be achieved.

However, another two issues have to be addressed. First, it remains a matter of public discussion that the TCG utilized valuable public facilities as an economic incentive to attract private investment. While the private sector can set up Wi-Fi APs in public places, such as libraries or other cultural facilities, without being charged and have a monopoly on wireless development for nine years, citizens still have to pay the wireless access even in those public places, a strategy that has increased the privatization of urban public space. This issue may result from a quantitative mode of thinking while the TCG initiated this project, as Kim (2006: 42) reminded us that when such thinking "is prioritized, the more fundamental and complex issues like the social and cultural values of informatization policy get marginalized."

Second, since the construction of the WiFly project, the TCG has proposed more than 60 public applications to increase the system affordances of WiFly, but most of the applications failed to proceed because they did not fit local needs. This outcome may originate from a myth that due to the overwhelming potential of ICT, urban planners and policy makers easily believe that "the articulations between urban spaces and new media technologies are open to innovative, local, and planned interventions which can bring benefits" (Graham and Marvin, 1999: 111).

Yet many ICT applications are a "technological push" that runs ahead of demand and may not fit the real social needs and demands of users, "a classic solution looking for a problem" (Graham and Marvin, 1996: 344). This outcome also shows that electronic development is as important as physical infrastructure development. When developing an ICT-oriented urban planning strategy, urban planners, and policymakers should not neglect either forms of development.

The concept of the digital flywheel theory and the experience of the Korean broadband market have demonstrated that the crucial element of a successful ICT strategy is to stimulate the competition of the market rather than to give the right to a single company to monopolize the market as the TCG did in the WiFly project. A healthy, competitive market will increase the varieties of ICT applications and encourage ICT sectors to provide better and cheaper services to fit the demands of users. Thus, local governments do not need to take full responsibility to keep the sustainable provision of ICT infrastructure and services for profitable areas, but rather for lagging areas and disadvantage groups.

Improvement in the Digital Divide

One of the main objectives of the Taipei CyberCity plan was to bridge the digital divide in Taipei City, which proposed three actions to ensure the accessibility of disadvantaged citizens, including giving three hours of basic skills training in the use of the Internet, improving the accessibility of municipal websites, and providing computers to low-income households and disadvantaged students. From official statistics, the percentage of household Internet facilities in some disadvantaged districts of Taipei City has improved. For example, in 2003 and 2009 the percentage of household Internet facilities of Datong district and Wanhua district, which rank the lowest in Taipei City, have respectively increased from 49.79 percent and 56.21 percent to 70.82 percent and 65.41 percent when the general averages in Taipei City are from 63.94 percent to 76.16 percent (See Figure 5). But it is hard to confirm the relationship between the improvement and the actions of the TGC.

This uncertainty addresses the difficulty in evaluating the performance of such actions through existing statistics. Existing statistics are too general and lack the consideration of demographic segmentation and spatial conditions, so the development of a geo-demographics information system (GDIS) is important and urgent. The GDIS could help urban planners and policymakers to clarify and understand the invisible impacts of ICT accessibility on the digital divide from a spatial point of view, and thus more appropriate ICT planning and strategies could be created.

The essence of accessibility is the core issue of the digital divide. From the government's perspective, the level of ICT accessibility relates to at least five factors: distribution of ICT infrastructures, basic skill of using ICT, the relative cost of ICT use, the ownership of devices, and the content and design of public websites (Evans-Cowley and Conroy, 2006; Graham, 2004; Inkinen, 2006; Van der Meer and Van Winden, 2003; Wilson and Corey, 2011). The first four factors are often contained in ICT-oriented urban planning strategies. While the first four factors have improved enormously and most people can access the Internet, the importance of the last factor is more gradually being addressed. Usable interface design and functional content provision not only relate to the trend and

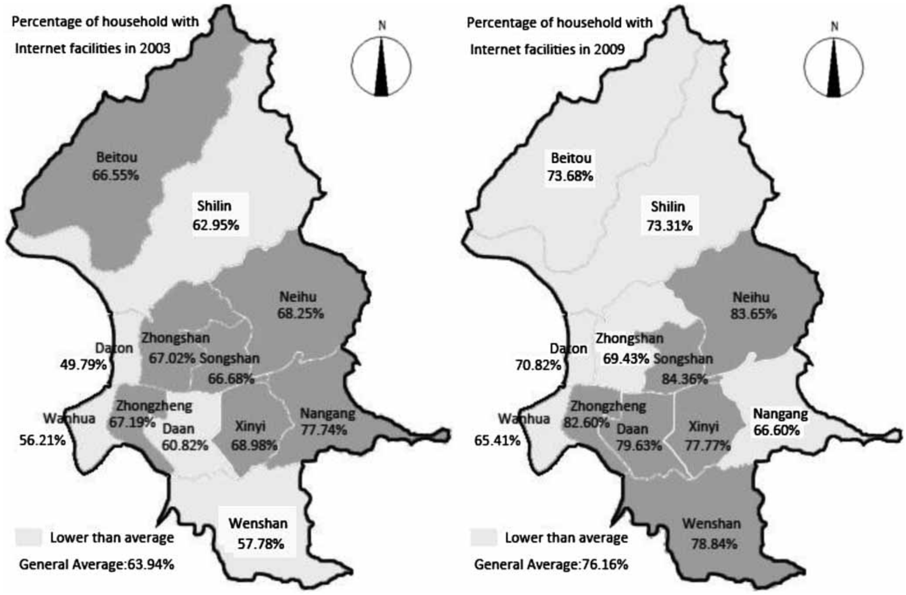


Figure 5: In 2003 and 2009 the percentage of household Internet facilities in Taipei City
Source: http://www.tca.org.tw/taipei_gov/2005/taipeiwireless.htm

convergence of ICT, but also the characteristics, behaviors, and demands of different groups of users, including disabled citizens, migrants, and foreign workers and tourists.

However, some groups of potential users are still not taken into account in the urban ICT plans of Taipei City, although the TCG has already put many efforts into improving accessibility of municipal websites for potential users who have visual, hearing, physical, cognitive, or neurological disabilities. For example, there are around 90,000 foreign workers from Southeast Asia in the Taipei Metropolitan area, but most government websites only offer Mandarin and English versions and the content of the English version is always poor and out of date.

Moreover, due to the trends of technological convergence and the mobile Internet, system requirements of different ICT devices, such as cell phone, Smartphone, PDA, or other text-based browsers, also need to be considered. For example, in 2007 only 29.5 percent of people in Taiwan chose PDA or Smartphone as one of their devices to link to the wireless Internet, but by 2009, the percentage had risen to 88.56 (TWNIC, 2007; 2009). Therefore, besides chasing universal access to ICT infrastructure and providing Internet facilities for disadvantaged groups, the TCG should be aware of the diversity of users who may access government websites, the devices and languages they may use, and the content and information they may need.

Electronic Public Services

One of the Taipei urban ICT plan's objectives is to make Internet service a public utility. Advanced Intelligent Transportation System (AITS) and the Taipei City citizen hotline are the most significant projects, not only because they integrate physical and electronic development but their services originate from the needs of the citizens.

Advanced Intelligent Transport System: Since 2005, the TCG has been devoted to the construction of the Advanced Intelligent Transport System (AITS). The AITS in Taipei City includes an E-parking system, an E-bus system, and the Taipei City Advanced Traveler Information Systems (ATIS) website. The E-parking system provides real-time parking information. The E-bus system offers the real-time location and arriving time of buses.

The ATIS website is an integration platform on the basis of WebGIS technology, which involves a process of designing, implementing, analyzing, generating and delivering maps on the World Wide Web. The maps contain not only all the information provided by the E-parking and E-bus systems, but also the image, speed, and service level of each road and public information on bike rentals in real-time. Travelers can receive all the real-time information from intelligent LED signs in each metro and bus station and via the traditional telephone system or the ATIS website that can be accessed by all devices. Since 2009 the ATIS website has tried to provide a more active function—an e-mail report system. Through this system, travelers can receive transport information at a specific time according to their personal set-up. This shows the possibility and the growing trend toward customized public services.

From 2005 to 2009, the passenger numbers of the Taipei metro and the Taipei City bus have risen by respectively 28.02 percent and 5.07 percent, and the growth rate of motor vehicles in each year has decreased from 1.72 percent to 0.88 percent (TCG, 2010a). This marked increase in metro passenger numbers and the concomitant decrease in the number of motor vehicles implies that telecommunications transport strategies could really help local government to offer better public transportation services and encourage citizens to use these services.

Despite the statistical outcomes, the effects of AITS on mobility and its impacts on spaces, places, the environment, the economy, and their interactions in Taipei City still require rigorous study. According to Rooij (2005: 109) there are six intertwined effects of ICT on mobility that need to be considered when studying urban mobility, including substitution of physical trips, complementation, generation, operational efficiency, long-term spatial planning, and supplementation.

The 1999 Citizen Hotline: The TCG initiated a citizen hotline in 2004 and has authorized its operation and management to the private sector since 2005. Originally, it operated as a 24-hour call center. Learning from the 311 hotline operation experience of New York City, in 2008 the TCG integrated 18 municipal telephone services into the "1999 Citizen Hotline" and extended the number of service agents from 31 to 92 in order to provide residents with twenty-four-hour service in multiple languages. Since 2010 the 1999 Citizen Hotline has provided sign language service through Skype (TCG, 2010b).

Residents can dial 1999 (toll-free) from any telephone or mobile phone within the city and use Skype or VoIP to reach the hotline for not only government information and enquiry services, but also to appeal and report municipal infrastructure issues. Residents can also track the process of each case they have reported through the hotline's website, a phone call, or SMS. After the system was upgraded in 2008, the number of cases reported by citizens through the hotline system has increased significantly. For example, from July 2008 to October 2009, the hotline received over 2.3 million calls, including 118,174 appealing cases and 237,718 dispatching cases (TCG, 2010b). Moreover, due to the use of data-mining tools, which can compare, extract and classify the data collected from the hotline system, the decision makers of TCG can easily understand what issues citizens are most concerned about and thus can improve the quality of their policy-making and administration.

One of the advantages of ICT applications is the ability to communicate with others anytime and anywhere through any device, so not only information receiving but also cyber-interactivity should be considered in ICT-oriented urban planning strategies. According to a four-part model of cyber-interactivity developed by McMillan (2002), there are four levels of interactivity—monologue, feedback, responsive dialogue, and mutual discourse. Monologue and feedback are one-way communications. The former only provides information for citizens. The latter allows citizens to have feedback but with no guarantee of extended communication, such as a reply from a government official. When a citizen's feedback has a guarantee of extended communication, responsive dialogue occurs. Mutual discourse is the highest level of cyber-interactivity and occurs when government officials and citizens act as participants in a conversation.

The application of the 1999 Citizen Hotline has reached the third and the fourth level of cyber-interactivity—responsive dialogue and mutual discourse. Learning from this experience, on the one hand, we understand that to reach mutual discourse implies not only great technological but also administrative challenges, because it requires an adequate number of qualified service agents to respond to messages from citizens actively and immediately. On the other hand, this application shows the possibility of promoting civic participation by applying ICT with strong understanding of the needs of residents and cross-discipline cooperation between technical and administrative teams, because ICT has enormous capacity for data management and communication in real-time.

Towards a Ubiquitous and Intelligent City

Taipei's ICT plans demonstrate that becoming a UI city depends on what residents want and the extent of the integration of physical and electronic development. However, integrating ICT into urban planning is a very new approach and has only emerged within the last decade in Taipei City, so it is certainly a process of learning-by-doing for the TCG. Through observing the series of ICT-oriented urban planning strategies, two positive trends can be identified. These are: user-focused design and synergy of physical and electronic developments.

Graham and Marvin (1999: 112) reminded us that "new technologies can somehow be rolled out as technical 'quick fix' solutions to complex urban problems," and thus can lead to careless one-directional predictions, such as "technological determinism" or "utopianism-futurism" (Graham and Marvin, 1996: 80). This situation more easily occurs when a completely new technology is just adopted and has a high degree of uncertainty. For example, the TCG (2010b: 10) in 1999 proposed that the core idea of its first ICT plan, Taipei CyberCity, was to "frequent the net and free up the roads" without considering the possible "generation effects" of ICT on traffic, because ICT generates the need for face-to-face contacts (Graham and Marvin, 1996; Rooij, 2005).

Later on, in 2004, the TCG proposed the WiFly Taipei project and believed that if they could provide universal digital access through wireless technology, citizens would spontaneously use these services. This would trigger a wave of experimentation in the field of ICT, and thus promote the innovation and development of ICT industries in Taipei City. But in reality, by the end of September 2008, the subscribers to WiFly were 435,624[4]—only around 16.61 percent of the population in Taipei City, much lower than the expectations of the TCG.[5]

Learning from these two experiences, the TCG started to rethink the role of ICT in relation to urban planning and governance, and thus to develop more sophisticated concepts of ICT-oriented urban planning strategies. The initiation of the Advanced Intelligent Transport System (AITS) in 2005 and the upgrading of the 1999 Citizen Hotline in 2008 have successfully demonstrated that the TCG has changed the underlying assumption and concept of its ICT plans from technological determinism to user-focused design.

The concept of user-focused design deeply relies on an understanding of users' heterogeneity and diversity. Different groups of users have their own demands, behaviors, characteristics, and technological capacity. The differences influence how users demand, receive, and use public ICT services, so the design and content of public ICT services and their interfaces have to correspond to the differences. For example, people would prefer to get real-time traffic information by intelligent station/parking signs or their own wireless devices, rather than through their personal computers or laptops, when they are traveling. Furthermore, their mode of traveling can be divided into cars, buses, metros, and bikes. These different modes should be reflected in the supply of content.

Synergy of physical and electronic developments is another lesson for the TCG through the implementation process of its ICT plans. Different from the WiFly Taipei project, which mainly considered the distribution of wireless access points, the AITS and the 1999 Citizen Hotline consider not only integrating all physical infrastructure networks, whether old or new communication technologies, but also applying new ICT electronic applications, such as WebGIS technology.

The structure of WebGIS is formed by a web server, database server, and real-time information receiving server. All the services not only depend on a closed-circuit television camera (CCTV) system across Taipei City, which provides real-time information, but also on the geographic information system of Taipei City, which was designed and developed in 2002. By developing the Taipei GIS website, the TCG has generated and integrated an enormous amount of geographic data and maps across municipal departments. Recently, the TCG has started to use this geographic database and information system as a foundation for multiple ICT applications and services. Moreover, the WebGIS technology helps the TCG set up a map-oriented interface that more effectively meets users' needs.

For cities designing and implementing their own ICT-oriented urban planning strategies, Taipei city can serve as a model. In addition to the issues already discussed, these cities would also have to take into account current technological trends, the role of public space in the life of the city, and the need for ICT interfaces to have demand-oriented designs. The emergence of these three issues also shows the subtle interrelations among infrastructure networks, user behavior, and interface design when designing and implementing ICT-oriented urban planning strategies.

Technological Trends

In February 2007, the WiFly was taken over by the Far East Tone Telecommunications Co., Ltd (FET), the second-largest mobile service provider in Taiwan (through purchasing 51 percent of the stock of the Q-Ware, which originally belonged to the Uni-President Enterprises Corporation [UPEC]). The UPEC believed this transaction and partnership could bring in new technology and advanced knowledge in managing a wireless business. On the other hand, the FET thought this transaction and partnership could fulfill their fixed-mobile convergence service, a seamless connectivity between fixed and wireless telecommunications networks, and thus enhance their competitiveness.

In fact, this transaction and partnership demonstrates two global technological trends—mobile communication and digital convergence—that deeply influence user behavior. If the TCG had understood the technological trends from the onset of the WiFly project, they may not have selected the Q-ware, a system integration provider, and instead have chosen a telecommunication company with broadband backbone network support that would have been capable of building and operating the wireless infrastructure. Thus, the WiFly project would not always struggle with an increase in subscribers. In short, the WiFly project clearly demonstrates how those technological trends directly influence the feasibility of an urban ICT strategy, so the ICT trends and their influences on user behavior have to be considered from the very beginning.

The failure of the WiFly Taipei and the success of the ATIS and the 1999 Citizen Hotline clearly show that before initiating such strategies, it is important to understand the trend of technological convergence and to consider existing infrastructures and services whether provided by the public or private sector. ICT can offer substitutes for certain urban activities, such as e-mail and e-shopping, but it is also true that ICT cannot replace all the functions provided by existing infrastructures, such as physical flows of goods and people. It is necessary to consider the complementarities between new ICT infrastructures and applications and existing infrastructures and services. The consideration not only increases the enhancement effect of ICT, but also leads to a more efficient management and employment of public resources.

The Role of Physical and Electronic Public Space

Castells (2004: 87) argued that in the network society "a redefinition of the notion of public sphere moving from institutions to the public space" is required, because public space is the "communicative device of our society" that can facilitate urban interactions and reinforce social cohesion and social exchange. Graham and Marvin (1999: 99) also stated that "rich, dense and interdependent combinations of meeting places and public spaces" support increasing face-to-face contact in informational networks. Thus, the role of public space is now becoming more and more important. Because of the broad applications of ICT, public space includes not only physical place but electronic space.

However, the boundaries between public and private space are getting blurred, because private-public spaces—such as shopping malls, tourist areas, and new housing estates—are proliferating and eventually producing fragmented spaces around cities. Graham and Marvin (1996: 186) argued that electronic space might have a similar tendency towards privatization as "telecommunication corporations attempt to 'package' electronic spaces for the purpose of electronic consumption." This tendency could be seen in the WiFly Taipei project as well. After the FET took over the WiFly in 2007, the homepage of WiFly showed a commercially oriented interface design. Not only did the FET enlarge the advertisement space, but also added e-commerce space by combining with other ICT service companies that are part of the same parent corporation. Moreover, the FET even removed the links of public services from the home page of WiFly (Liao, 2007).

According to Lynch's (1972) definition of a public space as an area or place that is freely accessible and available to all, two issues emerge in the WiFly Taipei project. First, while the TCG released public resources to private investors for the deployment of Wi-Fi APs without charging for nine years, citizens still have to pay for wireless access, even in public places such as libraries or other cultural facilities. Second, more than 80 percent of wireless network users in Taiwan still choose laptops as one of their main devices to access the Internet (TWNIC, 2009). Hence, while the TCG expected that QWC could use their chain stores to maximize the Wi-Fi coverage, citizens not only need to pay for the wireless access but also to consume in the chain stores in order to put their laptops on the table to access the Internet in the stores. This conflict also points out that public-private partnerships create concerns about whether these spaces belong to the private or public sector (Francis, 2003).

The role and importance of urban public places, whether physical or electronic, have to be considered when governments are constantly directing efforts towards urban ICT planning and development. The trends of public and private partnership in promoting ICT infrastructures and adoptions may lead to the privatization of physical and electronic public spaces. Thus, governments may lose the opportunity to reinforce social cohesion and in fact increase social disparity and the digital divide. The physical and electronic public spaces, which are the key interfaces between infrastructure networks and ICT users, need to be carefully planned, designed, constructed, and monitored when authorized to private sectors.

Demand-Oriented Design of ICT Interfaces

Because of the applications of ICT which offer the capacity of time-sharing social practices, traditional understanding of Euclidean space has been challenged by a new concept of "spaces of flows." The new concept of space is "the material organization of time-sharing social practices that work through flows" (Castells, 1998: 412). This concept implies that our perception of space now contains physical and electronic forms.

Thus, two correlated concepts of spatial design are emerging. First, the design of public ICT applications has now become part of public space design. Second, physical space, electronic space, and their interface have to be simultaneously considered in the design of public space. Therefore, in considering the broad dimensions of successful public spaces as stated by Francis (2003: 1), successful ICT public applications are supposed to be "ones that are responsive to the needs of their users; are democratic in their accessibility; and are meaningful for the larger community and society." However, through reviewing the outcomes of the WiFly project, it is obvious that the TCG neglected the underlying design concept of public ICT applications: demand-oriented design of ICT interfaces.

In terms of the design of physical space in the WiFly project, the metro station in Taipei City is one of the major public spaces in which a Wi-Fi AP has been deployed, yet the TCG merely provided two tables in an inconspicuous corner as the wireless service zone in each station without considering user behaviors and users' technical needs (See Figure 6). For example, when people are traveling, they may prefer to use their smart phones rather than their laptops to maintain their mobility, so they may need a charging station instead of a stand table. In addition to considering the needs of users, urban designers must recognize that the design of the physical interfaces of public ICT applications is becoming an increasingly important element of urban design that cannot be separated from the development or redevelopment of public space and its design.

In short, it is fundamental that urban ICT planning and its spatial design, either physical or electronic, have to be based on a clear understanding and careful consideration of different user groups—whether classified by age, gender, occupation, or other social condition. These applications and their spatial design "need to begin with social, geographical and institutional issues and policy needs and move onto how new technologies might meet these needs—rather than the other way round" (Graham and Marvin, 1999: 108).

Conclusions and Recommendations

ICT-oriented urban planning strategies have only emerged within the last decade. It is a process of learning by doing for urban planners and policymakers, so uncertainty of results and lack of knowledge are commonly faced when implementing such strategies. It is necessary to establish a way to evaluate the outcomes of such strategies on urban development. This study has formulated an analytical framework that can provide a general overview for planners and policymakers to understand how the way of design and implementation of such strategies

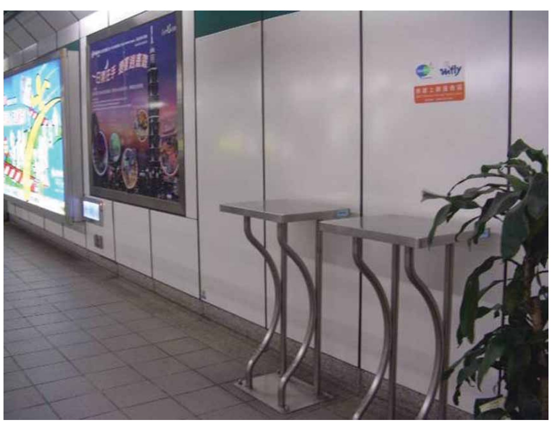


Figure 6: The WiFly wireless service zone in Metro station

influence their outcomes. Based on the framework, five key factors are also identified in the case study of Taipei City. These are technological trends, physical infrastructure, ICT content, interface design, and users' characteristics.

The five factors are deeply interrelated and thus cannot be discussed and considered separately. For example, the WiFly Taipei project shows how the TCG strategically constructed the Wi-Fi sensor network to serve 90 percent of the 2.36 million inhabitants of Taipei City within two years, but failed to proceed with the wireless public applications, which were proposed to increase the use of WiFly, because they hardly fit user needs. However, to "fit user needs" is not an easy job, because users are heterogeneous. They consist of long-stay citizens and short-stay tourists or foreign laborers of different ages and socioeconomic positions. Their capacities to use and behaviors in using ICT are also diverse and may be influenced by technological trends. These diverse characteristics determine the nature of local content and electronic services that should be provided and how the physical and electronic interfaces should be designed while local governments attempt to "fit user needs."

Referring to local content of public electronic services, the role of a geographic database and information system needs to be addressed as well. The TCG put a lot of effort into establishing a geographical information system. Its database contains topographic maps, cadastral maps, and satellite images as basic maps, and a large amount of static information and thematic maps across municipal departments. The thematic maps include environmental geological maps, public pipeline maps, disaster prevention maps, public construction maps, land management maps, urban planning maps, land use maps, and so on. Establishing a geographical information system is a massive undertaking, but its outcome provides a strong support for the public ICT applications and services and helps governments monitor the influence of ICT-oriented urban planning strategies.

However, governments should not see themselves as the only supplier of local content for the public domain. Through designing proper electronic platforms and using new web-mapping technology, such as WebGIS, users can also produce local ICT content to a certain degree and this interactive design concept may generate network effects as Google Maps already does. Moreover, in the case of Advanced Intelligent Transport System of Taipei, ICT has shown its enormous capacity for data management and communication in real-time. This provides the possibility of increasing civic participation as well.

While more cities try to integrate ICT into urban planning strategies, their impacts on urban society, economy, culture, and spaces certainly require constant evaluation and monitoring in order to make appropriate revisions. In the implementation process, four actions have to be made: specifying objectives, considering complementarities, maintaining monitoring, revising and integrating, and establishing on the public agenda. Hence, "strategic frameworks" and clear objectives are needed when designing and implementing such strategies. Specific objectives are not only the foundation but also the evaluation standard of the implementation, especially when governments lack professional knowledge and need to outsource. The case of Taipei City also demonstrates the benefits of tracking and evaluating the results after implementation and of continuously revising, upgrading, expanding, and integrating its public ICT infrastructures and services. This series of actions will eventually enhance the system affordances of public ICT support systems and guide governments towards more efficient and user focused ICT-oriented urban planning strategies and applications.

Finally, there are two constraints in this study. First, the analytical framework this study provides has only been tested based on the experience of Taipei City from 1999 to 2010, but the development of ICT and its influence on human behavior are rapid and often unpredictable in different contexts. Second, ICT has been and will be continuously applied in many disciplines, including transport, logistics, telemedicine, education, tourism, disaster management, and so on, of which most of the applications are cross-disciplinary. It is hard to formulate conclusions regarding the extent and means by which the five factors subtly interact with each other by relying solely on this single case study. Further, previous spatial planning studies—such as Scott (2001), and Corey and Wilson (2006)—have reminded us that in order to achieve effective practical planning in the contemporary global knowledge economy and network society, the importance of city-regional scale has to be addressed. Hence, more detailed investigations into each specific kind of ICT application as well as international case studies either on urban or city-regional levels are needed.

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Notes

1. In 2006, Taipei City won both the e-Government Applications of Wireless Communities Best Practices Awards from W2i and the most Intelligent Community from the ICF. The Wi-Fi hotspot authority, JiWire, also announced Taipei City is the largest municipal Wi-Fi network in the world. In 2009, the ICT public service application of Taipei City Government, 1999 citizen hotline, won "2009 Customer Relationship Excellence Awards: Public Service of the Year" from the Asia Pacific Customer Service Consortium.
2. The 7-11 chain is the biggest retailer in Taiwan. In 2006, there were 826 franchise stores in Taipei City, nearly one 7-11 store for every 300m2 built area.
3. On 11 March 2009, the author interviewed Shih-Hsing Liang to clarify the principle of Wi-Fi AP deployment.
4. This data is according to a press release from the Department of Information Technology of Taipei City Government on October 24, 2008. Available from: http://www.doit.taipei.gov.tw/cgi-bin/Message/MM_msg_control?mode=viewnews&ts=4901c0f9:12c7
5. According to Taipei City Council Communiqué Vol. 75(18), this project planned to have 1,100,000 subscribers by the end of 2006. Available from: tcckm.tcc.gov.tw/tccgazFront/gazatte/readByGaz.jsp?vol=075&no=18&startPage=3845&endPage=3912

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