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## Life Cycle of Municipal Wi-Fi

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# **Life Cycle of Municipal Wi-Fi**

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## **Abstract**

The popularity and growth of Internet usage and Internet enabled devices have changed the people life style and ways of communications. Mobile Internet usage increases year by year and have created prosperous Internet access market by myriad Internet service providers (ISPs). Mobile Internet operators and Wi-Fi service providers form complement and substitution relationships to offer Internet access options to enable anytime and anywhere services in many cities. From economics aspect, substitutes are often accompanied by market competition. In this scenario, municipal whether Wi-Fi would be treated as complement or substitute is an interesting question and incurs further consideration about what is the relationship between private ISPs and public ISPlife. To deal with this question, we take three steps to analyze municipal Wi-Fi projects around the world to compare their development process and outcomes. To find a clear definition of municipal Wi-Fi is the initial step through gathering information from various municipal projects. Then, the study depicts the value chain of municipal Wi-Fi and adopts Porter's five forces analysis to discuss current municipal Wi-Fi development and illustrate its external competition picture. In five force analysis, municipality is treated as one of suppliers and local residents/tourists are users to analyze their bargain power of these Wi-Fi projects. Threats come from mobile Internet operators (MISPs) and other Wi-Fi service providers would challenge original goals of municipal projects. The interaction of bargain power and threats among these stakeholders affect the attitude and willingness about how do municipalities affect or manipulate their Wi-Fi projects. We adopt real option analysis (ROA) to discuss what kind of options that municipalities can select to evaluate Wi-Fi projects with flexibility as the last step. Through three steps study, we can offer a clear evolution picture of municipal Wi-Fi for its life cycle and address when are the transition points of municipal Wi-Fi projects.

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This paper extends previous studies about feasibility, goals and outcomes of municipal Wi-Fi projects to reveal the evolution path of municipal Wi-Fi projects and rethink whether these projects can be treated as public utility or just provisional services. Aside from its academia value, we expect this paper to be valuable to policy makers of municipal projects, Wi-Fi service providers and mobile Internet operators to assess value of Wi-Fi projects.

**Keywords:** Municipal Wi-Fi project, Municipalities, Real options, Five-forces analysis, Development life cycle

## 1. Introduction

According to Cisco IoE smart city report about municipality development, it estimates the number of urban residents is growing by nearly 60 million from 2105. Besides, more than 60 percent of the world's population will be living in cities by 2050. As a result, people occupying just 2 percent of the world's land will consume about three-quarters of its resources. Moreover, more than 100 cities of 1 million people will be built in the next 10 years. If that so, more challenges for municipality. How to manage a modern city to cope with different kinds of needs, balance demand and supply, technology is the core solution to deal with. In the section of technology progress and adoption, backup information infrastructure is the key issue and Wi-Fi would be an suitable option to enable municipality for confronting job creation, economic growth, environmental sustainability, and social resilience. Given these trends, understanding where we are in the evolution of municipal Wi-Fi is critical to future city-planning processes.”

Besides, the development of municipal Wi-Fi issues has been proposed more than a decade since 2003. From the beginning of paying for renting it and then adopting free for using in most of the cities and region nowadays. There are a big change in development of municipal Wi-Fi. One of the most significant examples is measure index which was focused on coverage (Citywide Wi-Fi) from the initial stage but more Wi-Fi project are emphasized their using rates. With the development of information communication technology rapidly, the 4G long term evolution (LTE) has become an alternative relationship of municipal Wi-Fi in Taiwan and other countries. As a result, it is necessary to rethink the issues of development of municipal Wi-Fi. The municipalities get involved in or not and evolving process are the main research issues of this study. It is different of the two goods of the substitute and complementary relationship in municipal Wi-Fi for

users with the progress of mobile network. Municipal Wi-Fi and low speed of mobile network (2G / 3G) are substitute relationship in the past. They are complementary relationship when the municipal Wi-Fi speed better than mobile network. However, the speed of them has a notable promotion after the new generation of 4G. In the high speed of municipal Wi-Fi, it has a substitute relationship between 4G; opposite, it has a complementary relationship between 4G in low speed.

Through the following table of substitute and complementary relationship, we can find that the speed and service quality will influence the whole mobile network markets when local government provide the municipal Wi-Fi services. On the one hand, government involvement could affect the free competition of the market and in order to reduce whole social welfare. On the other hand, it has also keep an expectation for the government to provide municipal Wi-Fi services. Therefore, the research motivation of this study is to evaluate municipalities how did they get involved and then how to do is beneficial for cities.

**Table 1-1 Relationship between Mobile communication technology and Municipal Wi-Fi**

<b>Municipal Wi-Fi</b>	<b>Mobile communication technology</b>	
	<b>2G/3G</b>	<b>4G</b>
High speed	Complementary	Substitute
Low speed	Substitute	Complementary

In Taiwan, the municipal Wi-Fi potential customers are huge (e.g., laptop, smart phones, and tablet PC). Compared to 2014, it is not noticeable growth in 12 years of age and above the people which holdings of laptop and tablet PC are about 40% now. However, the holding rate of smartphones increased from 16.6% to 71.5% in 99 year, it has become the highest mobile carrier in Taiwan. With a large customers, and another aspect to think is the consumer behavior. According to Taiwan Network Information Center (TWNIC) in December 2015, the survey of Taiwan wireless network using has indicated the using of mobile network rate increased from 55.0% in 2014 to 64.0% in 2015.

Above the results, it is not a problem to compare the potential customers and the consumer behavior of municipal Wi-Fi. The problems may be in business management. The municipal Wi-Fi is the urban infrastructure of public department originally, because of facing of financial crisis and transiting to neoliberal approach and privatization. The development model transit to privatization or public-private partnership (e.g., Taipei

wireless network alliance). Beside, government also utilize the main function of municipal Wi-Fi to reduce digital divide (e.g., government built municipal Wi-Fi in 100 campus which were applied for from urban to rural, concentrated in the country, primary school campus, and the average 2 of each school). The popularity and growth of internet and mobile devices have changed the habit of people of using mobile communication. The using rate of mobile network increased year by year, leading to telecommunications industry market much more competitive. As mentioned above, 4G LTE has become an alternative relationship of municipal Wi-Fi and substitute is often accompanied by a competitive relationship in economics. It is worth issues to analyze if government become a mobile network competitors in markets when they built municipal Wi-Fi. Because the position of local government, whether it should be to subsidize the municipal Wi-Fi or simply participate.

Above the mention, in this study aims to understand the municipalities get involved in or not. As the historical changes or the progress of information communication technology to answer the following three points: With the progress of mobile network rapidly, government has faced the pressure of advancing to the municipal Wi-Fi. As a result, adopted the theory of real option and combined with the experience of foreign countries to evaluate the local government should not be involved in or not? When should be involved in and how is the degree of involvement? As well as external conditions or factors. On the contrary, the reason should not be involved in is also the problem we discussed. The local government has played a basic role (e.g., cannot ignore the problem of digital divide, provide the modern city services basically). Thus, in this study aims to evaluate the social impacts when the local government not be involved in. In the end, we can discuss the possible development of the municipal Wi-Fi with the status of the measurement methods and indicators in the future.

## **2. Literature review**

Before the study of this paper, the relevant literature will be discussed, compiled into the following three sections, the first section describes the municipality and municipal Wi-Fi; the second section introduces the municipal Wi-Fi management; third the section refers to the relationship between the theory of Real option and the thesis.

### **2.1 The relationship between municipality and municipal Wi-Fi**

#### **Basic functions of the municipality**

For Europe and the United States and other advanced industrialized and democratic countries, the role of local government over the past two decades has been a considerable change, resulting in this change in the drive from the following three levels to observe: First, in the decentralization (Central-local relations) has been transformed into a broader network of intergovernmental relations (network of inter-governmental relations); Second, due to accelerated changes in social structure, resulting in urbanization or urban population aggregation In order to respond to the increasing public demand, in addition to the need to enhance their professional capacity, but also must be combined with the power of civil society to provide public services; Third, the local government not only to deal with the problems brought about by urbanization, But also to face the challenges of globalization, for which the local government must often cross the national boundaries, and other countries or cities to develop a variety of competing relations.

### **From Wireless Local Area Network to Municipal Wi-Fi**

The so-called wireless local area network, refers to the use of wireless means to provide network users, anytime, anywhere can use the network environment, different from the wired area network, through the cable to send information (Huang Xiang-qi, 2002). Compared to the current wired network, the advantages of wireless networks can be said to be immediately visible, the main advantages are as follows: 1. No construction wiring and network planning, you can save costs and time. 2. Easy to use with special personnel (such as large warehouses, and business people). In the wireless area network, it is pointed out that the wireless network can be divided into wireless personal area network (WPAN), wireless local area network (WLAN), wireless metropolitan area network (WMAN) And wireless wide area network (WWAN) four categories. (Wireless Internet Service Provider, WISP) built by the service base (also known as hotspot, hotspot), to provide WLAN wireless Internet access services. WISP industry provides the action IP, the use of laptop computers equipped with wireless network card or 3G, 4G mobile wireless broadband in the acceptance range with the bridge connected.

It is a wireless service network that provides wireless broadband Internet access, municipal services and mobile business services for the public, business, campus and community, foreign tourists or foreign business people. In July 2004, Philadelphia first proposed the construction of WLAN-based wireless broadband metro network, also known as "wireless Philadelphia plan." The goal is to provide free outdoor WiFi Internet access within the urban area. Since then, the wave of wireless city construction has begun to sweep the world, thousands of cities under construction or planning to build a wireless city to meet the public access, public safety and public service needs.

## **The evolution of municipal Wi-Fi**

From a historical perspective, municipal Wi-Fi may be treated as a successor to municipal fiber. According to Balhoff and Rowe's survey from the late 1990's to 2005 "approximately 23 municipally-sponsored fiber networks providing commercial telecommunication services in the US". Even though a fiber optics network can offer high transmission capacity and is regarded as a future-proof technology, its high construction cost makes municipal fiber network risky and thus deters its proliferation. On the other hand, Wi-Fi has low deployment cost and uses unlicensed spectrum along with widely adopted Wi-Fi enabled devices. Muniwireless.com's 2004 report identified only 58 municipal wireless deployments in the US as of mid-2004; this number doubled in its 2005 report. Fleishman estimated that almost 200 municipalities have announced plans for a citywide wireless network in 2006 and the Wireless Internet Institute reported "about 300 early adopters have formulated municipal broadband projects in 2007".

## **Related research of Municipal Wi-Fi**

Wireless City Network Of the properties are divided into two categories, one for the use of the public as the core of the wireless network, this type of private investment to build the government to public resources with its operation; the other for the business application of the main wireless network, the main funds The source for the government budget for the construction, by the private company responsible for transport. Municipal Wi-Fi failure or can be imagined as a business model is not profitable due to two reasons, 1. Technical: Wi-Fi band high frequency low wavelength physical characteristics of Wi-Fi with high interference and transmission distance and other fundamental issues, 2. The market: the competition for the Internet competition alternative to the public wireless regional network in the high-speed and low-speed and mobile communication technology 2G / 3G, 4G alternative complementary relationship to the public wireless regional network positioning development is not clear.

## **2.2 Discussion on Municipal Wi-Fi Operation**

### **Operating types of municipal Wi-Fi**

For the public to participate in public construction of the most well-known a model, and more used in large-scale national traffic construction, including the famous Taiwan high-speed railway and the Chiang Kai-shek Expressway system construction case belong to this model. In recent years, due to the growing importance of information policy and construction, some countries have also started to integrate infrastructure such as

information networks into BOT. Hong Kong's "Public Service Electronicization Program" is one example. After the completion of the construction of the private sector, the government shall obtain the ownership free of charge, or the paid (may be paid once or in installments) to obtain the ownership and entrust the civil institution to operate. After the expiry of the operation period, the operation right shall be returned to the government. The difference between unpaid and paid is mainly due to the difference in the proportion of operating profit distribution.

### **Target audience of municipal Wi-Fi**

In Taiwan, for example, according to the National Development Council (NDC) statistics, the central administrative organs of indoor public areas to provide free wireless Internet to promote the status report, accumulated to August 31, 2005 registered, the national mobile phone account 3.95 million passengers, foreign visitors Account number 434,671 people. We can find that Taiwan's iTaiwan use ethnic groups are mostly nationals. Foreign user's majority is tourists, take Japan as an example: Japan has been developing tourism-oriented public wireless regional networks in the past few years, with the goal of making the public wireless area network system capable of creating friendly sightseeing during the 2020 Tokyo Olympic Games.

## **2.3 Real option theory**

### **Timing of the use of real options**

In general, the Net Present Value (NPV) evaluation method is the primary evaluation method used by the general corporate decision-making to assess whether an investment or R & D manufacturing program has an implementation value. The decision maker usually assumes that the investment or R & D manufacturing plan that it wants to evaluate will continue for a desired length of time and estimates the expected cash inflow due to the execution of the program, and then the decision maker uses the "risk-adjusted interest rate Weighted Average Capital Cost (WACC) "will be the expected cash flow into the discount (discount) to the beginning of the implementation of the plan and be summed, and then deduct the implementation of the plan, the period must be invested in cash outflow The sum of the discount, and finally the result is the NPV of the program. If the resulting NPV is positive, the plan will be accepted and considered for execution.

But the decision-making process does not take into account any decision-making flexibility that may be available at the time of the implementation of the program, and often underestimates the true value of the program. In fact, a plan may be faced with a lot



of opportunities and risks, decision-makers must consider the feasibility of the program, the market environment changes, potential profit and other decision-making factors, we must also consider when a plan is executed, it may have to respond if it encounters an opportunity or risk. For example, if a policymaker begins to implement the plan, if the plan is favorable, it can decide to increase the investment. If the prospect is unfavorable, the investment will be stopped. If the prospect is unknown, the investment will be suspended. If the prospect is clear, the decision will be made. The flexibility of these decisions is based on NPV evaluation method to do the decision-making process is not calculated part. Over the past few years, financial theory and computer computing capabilities have evolved, allowing decision makers to apply financial pricing pricing techniques to decision making on investment or R & D manufacturing plans. This method of assessing the value of the plan by the concept of the option is the substantive selection method. Because of the value of the decision-making flexibility when the value of the plan is assessed by the substantive selection method, it is more accurate to predict the value of the plan than the NPV method, so it is more suitable for the decision-making of the decision-making. In fact, not every plan requires the use of substantive selection method to assess its implementation value. If the absolute value of a NPV plan is very large, it is worthwhile for the project to be implemented at a glance. There will not be much difficulty in making decisions. However, if the NPV value falls near the gray area near zero, and investment decisions also need more strategic considerations, making the decision maker is not easy to judge, then the real option can come in handy.

### **Practical application of real option**

Previously referred to the use of substantive options analysis, mainly for the company managers to implement the strategy, the project plan analysis. However, the use of substantive option analysis methods is actually all-encompassing in real life, and the most common example is the assessment of the value of natural resources (land development, mining exploration); Is used in capital-intensive industries (flight and train); and most importantly, high-tech industries and R & D-intensive industries (electronics, biochemical engineering) and other industries face high uncertainty characteristics, but also makes the right to choose the right Applications are more valued; even the financial services industry in the uncertainty of the market in the issue of new products, plans, but also the use of real option framework for strategic assessment. Moreover, the recent venture capital (venture capital) is also often referred to the analysis of the substantive options.

### **3. Research Method**

This chapter aims to illustrate the research design, research method and research limitation. In the first section aims to illustrate the research design, second section illustrate the method adopted by literature review and real option, and the third illustrate research scope and limitation of this study.

#### **Research problem**

1. The government should get involved in the municipalities Wi-Fi or not?
2. When and what conditions of involving in or not?
3. Compared to different countries, we use the theory of real option and literature review of this study to evaluate government should get involved in the municipalities Wi-Fi or not?

#### **Research Method**

There are lots of thesis which used the municipalities Wi-Fi as an academic theory; however, it has adopted in many cities after the evolution of time. In this study, we adopt empirical analysis and the management of decision making analysis to make a combination of practice and theory of this research. As a result, the research adopted the literature review to collect and analyze each country. The government can choose one of the nine most appropriate real options in different conditions and combine with the theory of real options from the case of the municipalities Wi-Fi in each country.

#### **Literature review**

Literature analysis is an indirect research method which was used in social research widely. It can help us understand the past, rebuild the past, explain now, and speculate on the future. In addition, Cooper (1988) also indicated the literature review may has many different types (e.g., focus, purpose, viewpoint, covering strategies). It can focus on research results, research methods, theory, application, and also integrate with other hypothesis of other studies, criticize academic studies previously, build related theory, and identify critical issues in a particular fields. Besides, the review of the theory, it also contains a description of the important experiments that have been made or suggested. It may reorganize or integrate the concepts of different theories in sometimes. In this study, not only review the related fields of the theory, academic discourse, works, but also the communication agencies, annual reports, related records, job specifications and government agencies of the inspection report. Finally, expect to give the future thinking

of the municipalities Wi-Fi.

### **Types of real options**

There are many limitations on the municipalities Wi-Fi. For example: driving force: technical feasibility, market opportunities, past precedent and policy necessity, assets reused, regulatory permission, potential development of socio-economic. Limitations: technical risks, government roles, regulatory environment, different stand of government, and the different opinions of telecom operators.

## **4. Municipal Wi-Fi development decision and real options**

This chapter aims to illustrate the research design, research method and research limitation. In the first section aims to illustrate the research design, second section illustrate the method adopted by literature review and real option, and the third illustrate research scope and limitation of this study.

### **Decision reference matrix for Lint & Penning model**

Two variables of the decision reference matrix: the value of the real option and the volatility, Area A: low volatility, high predictability of the project, can be carried out in the R & D, and in the development phase immediately after the completion of marketing stage. Because the volatility is very low, the traditional NPV approach can also be used as a basis for investment decisions. But also because of the low volatility, the substantive decision to calculate the investment decision-making threshold ( $V^*$ ), very close to the actual investment costs must be. Area B: Just as Zone A, but at this time the project value is negative, for a failed project, the manager's decision to give up the project. Area C: high volatility, while the project value is positive. Because the volatility is high, the investment decision threshold ( $V^*$ ) calculated by the substantive option is relatively low, and it is judged by the way  $PV [E (V (TL)) - V^*] - C$  is the substantive choice. Project option value  $PV [E (V (TL)) - V^*]$  will be greater than the R & D cost  $C$ , and can get the real potential value of the project, can correct the net present value (NPV) method easily missed with high risk but high potential Lack of value project. Area D: As in area C, but the value of the project is negative at this time, but because the project value volatility is high, this time managers often use the "delay" strategy, to suspend investment, wait for the situation to change or change product strategy, Wait for the project value to fall into zone C, and then restart the R & D project.

## Cases study

According to the Lint & Penning model proposed 2x2 quadratic decision reference matrix we can find the corresponding case in each region, the following case data collection:

Area A (positive option value with low volatility = investment)

iTaiwn, in October 2011, the Executive Yuan launched the "iTaiwan Project" to provide free Wi-Fi hotspots at public and private hospitals throughout the country's central authorities, important attractions and transportation nodes. The free wireless network of the Executive Yuan is "dotted" and is attached to the building of the executive or important sightseeing spots. It is mainly used by the public or visitors at a specific point. Since the beginning of October 2011, China Development Association has launched iTaiwan from Taiwan, which has been co-advertised by the central and local governments. As of April 17, 2017, the data show that there are 9,959 hot spots and the estimated annual central budget Nearly NT \$ 200 million. But because the rate is only 1M, the utilization rate is not high. Increase the hot spots and improve the broadband, involving the construction and leasing lines and other costs, the cost shared by the central and local, it must be the first local inventory of the current hot situation, as well as budget costs and other issues. Because it is from the central government's budget and the continuation of the policy over the years, it is expected to iTaiwn's continued investment.

Area B (negative option value with low volatility = terminated)

Wifly, because the program is outdated (2005) and it is charged as compared to other public wireless LAN programs. Wifly's commercial operations were not as effective as expected, with a significant difference between actual users and expected amounts. In 2007, the original plan was sold to Far EasTone, and in 2011, the new public wireless area network Road plan to replace.

Area C (positive option value with high volatility = investment)

Taipei Free, 2011, Taipei City Government announced that it will provide free public wireless network services, Taipei Public District free wireless Internet service (Taipei Free) the results of public tender by the WiMAX industry, the world's success \$ 58 million). Since July 2011, a free wireless network called "TPE-Free" has been launched. The service area includes the main traffic arteries, public spaces, crowded areas and administrative facilities. After the re-tender, the service provider from the original global move, changed to Anyuan information, Anyuan standard amount of more than 100 million . It can be seen that the local government's own public wireless area network

program has a high degree of uncertainty (political policy of the rotation of the political parties, the tender business plan, the parliamentary public opinion and budget checks).

Area D (negative option value with high volatility = delay, hold)

(1) i-Changhua, "iTaiwan" wireless Internet hot spots around the country about eight or nine thousand, by the Changhua county government at their own expense to build the hot spots of 606, mainly to the county organs, mostly in the library, The local public places, visitor centers, private passenger transport to take the pilot nature of each hot spot to pay 16,000 yuan per year, the county will have to pay more than nine million yuan a year. Because the annual budget was cut, will apply for additional budget, to continue to sign, so that "iTaiwan" wireless Internet can continue to do so.

(2) Keelung City Wi-Fi (2013 ~ 2016), Keelung wireless hotspot "Keelung" was disabled at the end of last year, although it was searched, but could not be used. Li Guoxiong, director of the Municipal Government Research Institute, said the city's hot spots in recent years have increased by a total of thirty, the annual maintenance costs of about eight or nine million, but last year's budget, this year's maintenance Fees are frozen and are disabled. Keelung city government seven years to promote the city's free WiFi wireless Internet access, annual maintenance costs to spend nearly one million yuan, but the use of very low, coupled with poor signal was criticized. The end of last year has been suspended, this year's maintenance costs have also been frozen. To celebrate the 130th anniversary of the year, Keelung City has built "Keelung City WiFi" wireless network at a faster rate than the iTaiwan, and is enabled on the 25th of this month. In addition, And the central area, will also be a new look with everyone meet. Because of the rotation of the party, Keelung resumed the public wireless regional network program after changing the new mayor.

A good business model is the need for sustainable development, in the case of limited resources to improve efficiency is a top priority. Taipei City government in addition to the elimination of low utilization of hot spots, the removal of hot spots laid in the potential use of high address is very effective.

The Intelligent Community Forum (ICF) was established by the World Teleport Association (WTA), a nonprofit organization in the United States, from Canada, the United States, France, the United Kingdom, Russia, Japan, and Singapore , Belgium and so on more than 40 advanced countries and regions. Headquartered in New York, the purpose of the study is to strengthen international cooperation, explore the broadband construction as the main body of the economic system, how to create job opportunities

and promote economic development (Lin Zi-xian, 2012), combined with real life applications, to find new business models and applications Type, to enhance the city's competitive advantage, belonging to the global wisdom of the city more representative of the institutions. ICF originated in the Smart Community Movement in 1985 and became an independent organization in 2004 to explain the impact of the development of the global broadband communications industry through research exchanges, seminars and publications, Research work sharing and exchange of cities in the wisdom of the city to promote the successful experience, but also over the years on the wisdom of the city's research into education services to help the city to find a sustainable development and growth model to solve the present and future society Challenge; since 1999, ICF nominated Singapore to become its first annual wisdom city, the world cities have joined the ranks of the ratings to obtain ICF awards for the promotion of wisdom to build the verification.

Whether the wisdom of the city's performance can be reflected in the future of political figures or an undecided future. Taiwan's major cities over the years are actively participating in the ICF wisdom city rating, for example, in 2006, Mayor Ma Ying-jeou in Taipei City won the first prize in one fell swoop, followed by the expiration of the Mayor of the Mayor also successfully boarded High presidency. In contrast, in Taichung City, Mayor of Hu Zhi-qiang in 2013, he was also awarded the first prize of the Smart City, but lost in the re-election of the mayor. However, it is worth mentioning that the Mayor of May after leaving May has received ICF's annual vision, perhaps the votes can not be given certainly can be recognized in the other stage. These mayors are trying to promote the wisdom of the process, no matter how thinking is beneficial and harmless, which can also explain why some of the rulers will be willing to invest in the construction of public Wi-Fi.

## **5. Conclusion and Suggestions**

This chapter summarizes the conclusions of this study and addresses the management implications which can be taken for reference.

### **Conclusion**

The outcome of our analysis indicates nearly all options for Taipei WiFi project are positive. If that so, it means Taipei can take and accept all kinds of budget cut or budget increase with adding project value. If we pay attention on the value of WiFi project measured by traffic volume and how many users per day, the management of WiFi project

is critical to justify whether municipality should get involve in and use tax money to support WiFi project. After WiFi network deployment, each WiFi access point has to be evaluated by how much traffic can be generated to decide whether this WiFi access point can be sustained or not. With this mechanism, it would be much easy to explain why most of the value of options for public wireless LAN projects are positive, so that the cities, especially those who have chance to obtain high-paid public wireless LAN projects (e.g., Tainan City), invest more. However, we can learn from the case that some local governments(e.g. : Changhua City) select a temporary postponement in public wireless LAN project due to the parliamentary review of the budget, policy continuation caused by political party rotation and other issues. Local governments and even the central government (iTaiwan) have realized the positive value of options bring by public wireless LAN projects. Hence, public wireless LAN construction is imperative in long term.

### **Management implications**

We discover a more important conclusion which is the consideration of the critical value through the calculation of real options. The effectiveness of a project worth investing is not only determined by the amount of capital invested, but more importantly, by the efficiency increased in the project. For instance, we can improve the connection quality or eliminate the hot spots with low usage rate rather than add numerous new hot spots.) The most important and easier way to improve the profitability of the business model is to improve the existing processes and services.

### **Limitations of the research**

In the course of this study, the research limitations encountered are about four points: First, this study considers only relatively simple decision scenarios. Second, this study only uses a relatively simple model of substantive selection. Thirdly, this study does not include the possible competitive situation in the calculation of the substantive option. Fourth, the information obtained in this study is a rough estimate.

### **Suggestions for future research**

Based on the study limits in the previous section, this section attempts to present some relevant recommendations as a reference for subsequent researchers: First, consider more complex decision-making situations and finer substantive options. Second, the competitive situation into the discussion. Third, to obtain more realistic research information. Fourth, expand the scope of the study. Fifth, the establishment of the local government and ISP industry can consider the substantive option model.

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