

# Relationship between Service-Related Activities, Service Capability and Market Diffusion: Case of WiBro

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Moon-Koo Kim, Jong-Hyun Park, and Jong-Hyun Paik

**The market performance of WiBro in Korea has not been as expected, and its rapid diffusion in the near future is unlikely owing to the existence of competing services. There has been little research on the factors affecting this low market diffusion. This study is based on an analytical framework in which a lack of service capability and the insufficiency of service-related activities have resulted in the current poor market performance. An expert survey was conducted on WiBro specialists and verified using the analytical hierarchy process method. The result of this analysis is as follows: underinvestment in network deployment and marketing, insufficient promotional policies, and a shortage of service capabilities are to be analyzed as the main causes of WiBro's low market diffusion.**

**Keywords:** Market diffusion, service-related activities, service capability, WiBro, Mobile WiMAX.

## I. Introduction

The Korean IT sector has achieved continual growth since the late 1990s. In Korea, broadband and mobile communications services are readily available; and the majority of Koreans actively utilize IT in their daily lives. Korea is also home to a number of global IT companies specializing in hardware; and ongoing technological innovation is being achieved by these companies. The Korean government is also actively supporting the development of the IT industry through various policies, while consumers with extensive knowledge and experience in IT are doing their part as early adopters. As such, the Korean IT industry has advanced continuously to reach the status of a digital test bed for the world [1].

Wireless Broadband (WiBro), also known as mobile worldwide interoperability for microwave access (Mobile WiMAX), was first developed as a wireless broadband technology in Korea. Its development was based on the nation's heightened industrial capability and triggered by a post catch-up strategy of Korean IT ecosystem players [2].

After WiBro technology was first developed in the early 2000s through open R&D by Korean global IT companies and a government-funded research institute, the commercialization of WiBro began in Korea in 2006. Despite such an achievement, the diffusion of WiBro services in the Korean market has been extremely disappointing. As of November 2012, there were 1,011,886 registered WiBro users, which is less than 11% of the figure speculated in 2004 [3], [4].

In spite of this market condition, there has been a lack of

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systematic research on the low market diffusion of WiBro in Korea.

This study systematically examines the factors affecting the low diffusion of WiBro in the Korean market. This study is based on an analytical framework in which the insufficiency of service-related activities has caused a lack of service capabilities, which in turn has resulted in low market diffusion.

## II. Deployment of WiBro and Literature Review

### 1. Mobile Communications Technology Evolution and WiBro

Mobile communications have rapidly developed since their first commercialization in 1978, benefiting from successive strides made in transmission speed throughout the years [3], [5].

First-generation (1G) mobile communications systems, mostly analog-centered, provided subscribers with only voice services. Digital technology was first introduced with second-generation (2G) mobile communications in the early 1990s. 2G mobile communications developed under two different standards: global system for mobile communication (GSM), which is mainly used in Europe; and code division multiple access (CDMA), which is mainly used in the US, Korea, and other non-European countries. Both provided high-quality voice calls and short messaging service (SMS).

Wideband code division multiple access (W-CDMA), the third-generation (3G) mobile communications technology that emerged in the early 2000s and that is also known as international mobile telecommunications-2000 (IMT-2000), evolved from GSM technology. The transmission speed provided by this technology was high enough to make the normal use of mobile Internet possible. To enable access to broadband mobile Internet services, W-CDMA is currently evolving into next-generation technologies such as high-speed downlink packet access (HSDPA) and long-term evolution (LTE).

Meanwhile, WiBro, also known as Mobile WiMAX, improves on fixed WiMAX by adding mobility. This technology was both developed and commercialized in Korea

for the first time in the world during the mid-2000s. By adopting next-generation mobile technologies, such as multiple-input and multiple-output (MIMO); and orthogonal frequency-division multiple access (OFDMA), WiBro has been able to deploy next-generation mobile telecommunications such as 4G and 5G.

Both LTE and WiBro are currently evolving into fourth-generation (4G) mobile communications technologies. 4G mobile communication, known as IMT-Advanced, is a technology capable of enabling not just voice and mobile internet services but also multimedia services such as high definition (HD) and 3D contents. LTE-Advanced (LTE-Adv) and WiBro-Advanced (WiBro-Adv) have been selected as candidate technologies to become 4G global standards. These two technologies are expected to become commercialized in earnest starting in 2013. The characteristics of mobile communications technology are listed in Table 1 [5]–[8].

WiBro is distinct from LTE in terms of its technological origin, having evolved from WiFi and W-CDMA. WiBro, which was first commercialized in 2006, adopts elements of next-generation technologies and provides a faster rate of transmission than LTE. WiBro also has an advantage over LTE in terms of support for fixed-mobile convergence, as it is an IP-based service. As these two services evolve into 4G mobile technologies, these characteristics are likely to become less salient, although some of them will remain, in a manner to erase their differences to a considerable degree [9].

### 2. WiBro Development and its Market Situation in Korea

The development of WiBro officially started in Korea when the Korea Ministry of Information and Communication designated the 2.3 GHz band, which was being used for a narrowband wireless local-loop (N-WLL), as a new wireless broadband service frequency. After 2003, Samsung and a number of venture businesses, along with the Electronics and Telecommunications Research Institute (ETRI), started a joint development of WiBro technology and eventually succeeded in 2005. Business rights were granted to KT and SK Telecom

Table 1. Characteristics of mobile communications technologies.

Generation	1G	2G	3G			4G
Technology standards	Analog technology	CDMA, GSM	W-CDMA	HSDPA	LTE, WiBro	LTE-Adv, WiBro-Adv
Transmission speed	Up to 10 Kbps	14.4 Kbps – 64 Kbps	144 Kbps – 2 Mbps	Up to 14.4 Mbps	Up to 100 Mbps	Up to 600 Mbps
Services supported	Voice		Voice, SMS	Voice, mobile internet		Broadband internet multimedia
Year of commercialization	1978	1992	2000	2007	LTE: 2010, WiBro: 2006	2013 or thereafter

\* Source: ETRI (2011), Kim and Jee (2006), Kim et al. (2013), KCC (2011).

in 2005, and domestic commercialization took place in 2006.

The background on the development and commercialization of WiBro in Korea is as follows: Instead of importing foreign mobile communications technology, WiBro was developed as a post-catch-up strategy by the Korean telecommunications industry as a source technology that could be continuously innovated to create markets both in and out of Korea. Increased consumer demand for advanced mobile communications services also came into play. Developed in the early 2000s, it was anticipated that W-CDMA would herald a new era of mobile communications based on video calling, global roaming, and wireless Internet. However, W-CDMA was unable to accommodate the rapidly increasing demand for mobile data communications. Rather, market demand was focused on a new service equipped with rapid transmission speed and a greater capacity required for wireless broadband Internet.

Despite the technological development of WiBro, the Korean market diffusion has fallen far short of the desired level. The number of users, service coverage, device types, and business models forecast for 2006, at the time of commercialization, has not yet been achieved.

Notably, the number of users as of 2012 was 1,009,827, which is a mere 10.7% of the 9,450,000 forecast in 2004. Service coverage is also limited to the capital region and some provincial cities, thus causing user inconvenience. While the number of smartphones is increasing in Korea, no smartphones specifically developed for WiBro have been released. At the time of commercialization in 2006, the contents specialized for WiBro were forecasted to be developed, but in reality WiBro is now only predominantly being used for general mobile Internet access [2]–[4].

### 3. Literature Review

The success or failure of a telecommunications service has a huge impact on not only the national economy but also on its users' welfare. It is significantly important to systematically define the determinants of service success and failure [10]–[15]. However, there are few domestic or overseas studies on this issue. The relevant studies are described as follows.

A case study by Funk [10] was referenced to identify the acquisition of unprecedented global standards as the requirements for a successful global diffusion of mobile communications. Oh and others [11] examined the success of Korea's CDMA technology in terms of policies, technology, and market through an expert survey. Ahn and others [12] conducted case studies and expert surveys to examine the failure of Korea's communications services in terms of business, technology, competition, and policies.

Tilson and Lyytinen [13] identified the policies and businesses responsible for a successful 3G conversion in the US through case studies, and Picot and Wernick [14] analyzed the successful diffusion of the Internet in key countries with a focus on policies for market promotion, increased competition, and regulations. Paik and others [15] examined the causes of WiBro's slowdown in the Korean market and analyzed the success factors of the 4G market.

Summarizing the above studies, the factors affecting success and failure in communication services include: lack of service capabilities and lack of service-related activities. For example, the second generation of cordless telephones, known as CT-2, failed in Korea due to a lack of service capabilities, such as its poor function and quality in terms of technology, whereas the personal handy-phone system in Japan failed owing to insufficient service-related activities, such as its unsuccessful global policy expansion [11], [12]. The rapid diffusion of Internet protocol television and terrestrial digital multimedia broadcasting in Korea, were largely determined by service-related activities, such as providing killer applications in terms of business and market.

## III. Analytical Framework and Methods

### 1. Analytical Framework

When consumers adopt an IT service that is newly available on the market, a shortage of service capability can raise a barrier to consumer-adoption intentions. To prevent such a negative effect, rigorous activities by service providers, ecosystem players, and the government are required [12], [15], [16]. If a shortage of service capability is a result of insufficient service-related activities, the consumer adoption of new IT services will be difficult and market diffusion is likely to fail.

Referring to the study by Paik et al. (2010), this paper—is suggested by the analytical framework shown in Fig. 1—is primarily aimed at explaining the causes of low WiBro diffusion in terms of the relationship between serviced-related activities, service activity, and market diffusion.

### 2. Research Methods

To verify this analytical framework, an expert survey was conducted. Before conducting the survey, the survey items were established based on prior research. The survey items

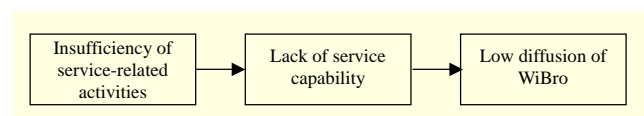


Fig. 1. Analytical framework.

Table 2. Characteristics of experts surveyed.

Organization	Proportion	Details
University	25%	<ul style="list-style-type: none"> <li>▪ Konkuk University, Korea University, Sogang University, Seoul National University, Sungkyunkwan University, Yonsei University, Inha University, Hanyang University, KAIST</li> </ul>
Government funded research institute	50%	<ul style="list-style-type: none"> <li>▪ Policy related institute: Korea Creative Content Agency, Korea Internet and Security Agency, Korea Institute for Industrial Economics and Trade, Science and Technology Policy Institute, Korea Radio Promotion Agency, Science and Technology Policy Institute, National IT Industry Promotion Agency, Korea Information Society Development Institute</li> <li>▪ Technology related institute: Korea Electronics Technology Institute, Telecommunications Technology Association, Electronic and Telecommunications Research Institute</li> </ul>
Company	25%	<ul style="list-style-type: none"> <li>▪ Manufacture: Samsung Electronics, LG</li> <li>▪ Provider: KT, SK telecom</li> <li>▪ IT consulting or research company: Samsung Economic Research Institute, LG Economic Research Institute, Samsung SDS, Technovation consulting, Knowledge works consulting</li> </ul>

were then adjusted or supplemented through a focus group discussion (FGD). The FGD was carried out by seven experts, each of whom had more than ten years of research experience in WiBro, a master's degree or higher, and a position within a government-funded research institute, university, or industry.

We considered the survey items for insufficiency of service-related activities, lack of service capability, and low diffusion of WiBro; based on [15], [12] and [11].

With these duly reflected, this study set the following variables:

- Policies: promotion policies, supervision of business plan execution, and competition-activating policies.
- Technological development: quality enhancement, convergence technology development, and next-generation technology leadership.
- Business activities: network investment, device supply, marketing activities, and specialized applications.
- Global expansions: open innovation with foreign companies, cooperation with foreign service providers, and efforts in overseas market development.

Survey items of service capability that can be directly experienced by WiBro consumers were then identified. To achieve such an end, an evaluation of customer loyalty and prior researches on high-speed Internet and mobile communications service proliferation were referenced [15], [17], [18].

The experts selected had a master's degree or higher in business administration, economics, or IT and at least three years of experience in research on WiBro. The experts were restricted to those working as academics, government workers, manufacturers, service providers, and IT-consulting company employees. The survey itself was conducted with research-specialized companies through face-to-face interviews during the second half of 2010. A total of 56 questionnaires were collected, of which 50 questionnaires—excluding inadequate

responses—were analysed.

The characteristics of the experts surveyed are shown in Table 2. Fifty-two percent have a master's degree, whereas forty-eight percent are PhD holders. Their average level of experience in IT research is 7.24 years, and their majors were either in business administration/economics (50%) or engineering (50%).

The analytical hierarchy process (AHP) was applied, a pairwise comparison of the 9-point Likert scale on the survey items was made, and Expert Choice 2000 was used for a statistical analysis.

## IV. Results

### 1. Causes of Low WiBro Diffusion

The causes of low WiBro diffusion in the Korean market as identified through the AHP are shown in Table 3. Insufficient coverage (0.393) and little distinguishing features (0.220) were shown to be more responsible than other factors. These were followed by insufficient applications (0.144) and poor function (0.109), while the least responsibility was ascribed to poor quality (0.086) and no global roaming (0.049).

These findings lead to the following: The main reasons behind the poor market performance of WiBro in Korea are that the service coverage is limited to the capital region and that WiBro offers little distinguishing features that set it apart from other services such as WiFi and W-CDMA (LTE). In addition, while a large population is concentrated in the capital region of Korea, the unavailability of WiBro services in provinces further afield has presented a great challenge to the successful diffusion of the WiBro market.

Mobile Internet has been provided through LTE in Korea since 2011, and WiFi service coverage has been expanding significantly since the advent of the smartphone in 2010. While

Table 3. Analytical results on causes of low diffusion.

Causes	Weight	Priority
Poor function	0.109	4
Poor quality	0.086	5
Insufficient coverage	0.393	1
Insufficient applications	0.144	3
Little distinguishing features	0.220	2
No global roaming	0.049	6

\* CI (Consistency Index) < 0.1.

WiBro is superior to LTE in terms of transmission speed/capacity and cost, it is inferior in terms of service coverage and mobility. And while WiBro provides greater mobility than WiFi, it is weaker in terms of transmission speed/capacity and cost. The nature of WiBro is akin to a cross between LTE and WiFi, and as there are few distinguishing features that set WiBro apart from other services, its successful market positioning is experiencing difficulty.

In particular, the difference of function, performance, and global expansion between W-CDMA (LTE) and WiBro had a decisive effect on the diffusion of WiBro. Mobile service providers in Korea selected W-CDMA and LTE strategically and made intensive investments in the network and in marketing. Therefore, the investment in WiBro was minimized, and WiBro became somewhat inferior with a poor market performance. At the end of 2012, the number of WiBro subscribers hadn't even reached 2% of W-CDMA and LTE service subscribers [4].

Other reasons behind the hindered diffusion of WiBro in Korea are an insufficiency of application services. At the time of its commercialization in 2006, WiBro was expected to service as an infrastructure that would promote fixed-mobile convergence, communications-broadcasting convergence, and inter-industrial convergence. Moreover, diverse application services tailored to suit the characteristics of other industries were expected to be developed. However, the current reality of WiBro is that it does nothing more than provide mobile Internet access, and few convergence services are available.

Among the causes of the low WiBro diffusion, poor service quality and a lack of global roaming were the least culpable. A study on the quality of WiBro service conducted by the Korea Communications Commission in 2010, showed that service quality, including connection quality and stability, was generally 'above average' in all areas. What this signifies is that service quality is not a determinant factor in the low diffusion of WiBro. As there are currently a limited number of countries and companies that provide WiBro, as well as there being limited service coverage, global roaming is almost out of the

question.

## 2. Causes of a Lack of Service Capability

The main causes of insufficient service capability in Korea, as analyzed through the AHP, are insufficient business activities (0.496) and insufficient policies (0.270), as shown in Table 4. These are followed by insufficient technological development (0.146) and insufficient global expansions (0.088).

A further analysis of each of these reasons showed that insufficient business activities are mainly caused by insufficient network investment (0.342), insufficient marketing activities (0.333), and insufficient device supply (0.234). Insufficient policies are mainly caused by insufficient promotion policies (0.457) and insufficient competition activating policies (0.375). Insufficient technological development is mainly caused by insufficient next-generation technology leadership (0.450). These findings have led to the following: The insufficient WiBro service capability in Korea is primarily caused by insufficient business activities and policy support. WiBro service providers are falling short with regard to the investment and strategies required to promote the use of WiBro, and the government's WiBro promotion policies are ineffective.

WiBro service in Korea is provided by KT and SK Telecom, which also provide almost all of the nation's fixed and mobile communications services. Naturally, these service providers are not investing heavily in WiBro networks, as WiBro is merely another mobile communications service. According to a business plan submitted to the Korean Ministry of Information and Communication in 2004, these service providers were planning to establish WiBro networks in 84 cities throughout Korea. However, networks have been established in 82 of those cities as of the end of 2012, and it is difficult to use WiBro in rural areas [3], [4]. Insufficient network investment has reduced the service coverage and has directly resulted in the non-adoption of WiBro by consumers.

In addition, the marketing activities of WiBro service providers in Korea have been extremely insufficient. While affordable fee plans with WiBro subscriptions are offered by certain service providers, there is a great insufficiency in mass media advertisements, and fee plans vary.

The limited range of devices required to use WiBro is limiting consumer options, and in turn, is causing low WiBro market diffusion. Users are unable to use WiBro on a variety of devices including smartphones and mobile phones.

The Korea Communications Commission is implementing a number of policies to diffuse the Korean WiBro market but without much effectiveness. There have also been times when policy support for service promotion has been inappropriate or too late. For example, WiBro service providers requested the

provisioning of a voice service to support the 010 identification numbers at the time of WiBro's commercialization in 2006, but the issue of 010 identification numbers has been delayed for various reasons. When the 010 identification numbers were finally issued at the end of 2008, the communications environment had changed, and WiBro service providers were subsequently unable to provide a voice service.

Insufficient competition-activating policies are also hindering WiBro market diffusion. In particular, the designation of new service providers to available WiBro frequency bands has been delayed. The formation of policies to create mobile virtual network operators (MVNOs) has also been delayed significantly. Such a significant delay in the establishment of new service providers and MVNOs has ultimately precluded competition between service providers.

Insufficient technological development has also contributed to the insufficiency of WiBro service capability. WiBro is continuously seeking advancement to become a leader of 4G technology, and while it has been selected as a 4G candidate, the technological gap between WiBro and LTE—its only competitor—is decreasing significantly. More extensive cooperation on the technological development of WiBro is required for it to secure technological leadership.

While the efficiency of technological development systems tailored for some prominent companies is high, there is a limit to how well the meritorious technology of smaller companies can be shared. This is linked to insufficient open innovation in collaboration with foreign companies in terms of global activities. Collaborative technological development with both Korean and foreign institutes is required to achieve open

innovation and enhance WiBro service capability.

## V. Conclusion

### 1. Summaries

WiBro was developed to capitalize on Korea's advanced IT industry and provide the market with convenient wireless Internet services. WiBro has been continuously upgraded to meet the 4G standards and is being used for mobile communications in a number of countries. However, the number of WiBro users in Korea is much lower than originally forecast. As such, this study examined the causes for the low market diffusion of WiBro in Korea. The summary of this study is as follows: First, the poor market performance of WiBro in Korea has been predominantly caused by its limited service coverage, a lack of distinguishing features setting it apart from other services, and insufficient applications. Rather than poor functionality or quality, low market diffusion has been hindered by insufficient service capabilities such as availability, differentiation, and usefulness.

Second, these insufficient capabilities are predominantly caused by insufficient business activities and policy support rather than by a lack of technological or overseas market development. More specifically, the insufficiency of these service capabilities is caused by insufficient network investment, marketing, device supply, and governmental policies for service promotion.

This study is different from prior studies. First, prior studies mainly identified ICT success and failure factors from a

Table 4. Analytical results on the causes of a lack of service capability.

Causes	Weight	Details	Local weight	Global weight	Global priority
Policies	0.270	Insufficient promotion policies	0.457	0.123	3
		Insufficient supervision of business plan execution	0.168	0.045	7
		Insufficient competition activating policies	0.375	0.101	5
Technological development	0.146	Insufficient quality enhancement	0.265	0.039	11
		Insufficient convergence technology development	0.286	0.042	10
		Insufficient next-generation technology leadership	0.450	0.066	6
Business activities	0.496	Insufficient network investment	0.342	0.170	1
		Insufficient device supply	0.234	0.116	4
		Insufficient marketing activities	0.333	0.165	2
		Insufficient specialized applications	0.091	0.045	8
Global expansions	0.088	Insufficient open innovation with foreign companies	0.481	0.042	9
		Insufficient cooperation with foreign service providers	0.357	0.031	12
		Insufficient efforts overseas market development	0.162	0.014	13

\* All CIs (consistency index) < 0.1.

technology perspective, whereas this study approached policy, technology, business, global, and service aspects; analyzing the influence of each factor upon market diffusion. Second, this study is different in that service diffusion was explained through the process relationship of service capabilities and related activities (or the research model of capability-activity-performance).

Further studies must endeavor to examine and compare the reasons for the failure or poor performance of WiBro, as well as of other IT technologies in Korea and overseas. This will identify the policies; service features and environments; business and global activities; and technologies that are responsible for the failure or success of this service.

## 2. Implications

Based on this study, considering that mobile communication technology is evolving quickly and that the market is becoming more competitive, we provide the survival and development strategy for WiBro as follows: The technological evolution and market diffusion of WiBro are quite unclear, as the next-generation mobile communication evolves through and beyond 4G and 5G. As clarified in this paper, the service capability of WiBro is likely to deteriorate in the future. As a result, the service should be re-positioned again. It would be reasonable to develop a niche market as a special-purpose network for national defense, disaster prevention, and safety [19].

In addition, the technological capabilities obtained from WiBro need to be utilized as a basic technological infrastructure through the mobile-oriented future of the Internet [20]. In particular, China and India are leading the development of the new mobile communication technology “LTE TDD (or TD-LTE)” and are trying to commercialize it after 2013. As LTE TDD is quite similar to WiBro in its basic foundation, technical capabilities accumulated from WiBro need to be invested in the development of core TDD technology and equipment; terminals; and application services in order to secure competitiveness in its early phases [19].

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