

Comparison of Mobile TV in Singapore and Taiwan: A Social-technical System Approach

Trisha, Tsui-Chuan Lin¹

Liu, Yu-Li²

“Mobile 2.0: Beyond Voice?”

Pre-conference workshop at the International Communication Association (ICA)

Conference

Chicago, Illinois

¹ Assistant Professor, Division of Broadcast and Cinema Studies
Wee Kim Wee School of Communication and Information
Nanyang Technological University
31 Nanyang Link, Singapore 637718
trishalin@ntu.edu.sg

² Professor, Department of Radio and Television
National Chengchi University
64, Sec 2, Chinan Rd., Taipei, Taiwan 11605
yuliliu@nccu.edu.tw

Abstract

As mobile TV is a fledging technology, only a few scholarly literatures use theoretical framework to analyze its development and compare it in different national contexts. With high digital advancement and mobile phone penetration, mobile TV players in Singapore and Taiwan are having broadcasting mobile TV market trials and some 3G services without decisive commercialized plans and policies. This study interviewed stakeholders, like industrial players (telcos, broadcasters, content/services aggregators) and regulators, and took a social-technical framework to examine mobile TV's technological, market, and policy subsystems in Singapore and Taiwan. The findings elaborated mobile TV ecology in two national contexts, and compared key issues in technologies, market trials and business models, and proposed regulatory frameworks.

KEYWORDS

Mobile TV, DVB-H, 3G, Mobile TV Business Model, Mobile TV Policy

1. Introduction

Mobile TV that fulfills customers' needs to view informative and entertaining audiovisual content anytime and anywhere is forecast to be the next hit in the near future. It has unique characteristics: mobility and bi-directional capability, convergence of broadcasting and communicating services, and personalized services. ABI Research estimates global mobile TV users will rise to 250 million in 2010 (Oh & Jablon, 2008) and its revenues will climb to more than \$10 billion in 2013 (BNET, 2008). Many reports regard Asia as a hotbed for mobile TV development, because of high cell phone penetration, Asian commuting lifestyles, and advanced mobile technology (Feuilherade, 2006; Gill, 2008; Informa Telecoms & Media, 2007; Oh & Jablon, 2008). South Korea first launched the free-to-air mobile TV in mid 2005, followed by Japan's commercial mobile broadcasting TV next year. At present, many Asia countries are undergoing market trials, including China, India, Indonesia, Malaysia, Australia, Hong Kong, Taiwan, and Singapore. In addition to test nebulous consumers' demand, they attempt to find out appropriate technological standards, business models, and regulatory frameworks for their specific national contexts.

To date, Singapore's and Taiwan's mobile TV is still in their infancy without decisive commercialized plans and finalized policies. According to 2007 International Telecommunication Union's Digital Opportunity Index, Singapore and Taiwan are ranked 5th and 7th most advanced in digital technology across the globe. Singapore has more than 131.3% mobile phone penetration and 2.5 million 3G subscribers in January 2009 (iDA Singapore, 2009), while Taiwan's is 110.3% with 11.29 million 3G

subscribers (FIND, 2009). Around 2005, they launched small-scaled 3G video services. Technological bottlenecks in bandwidth and compression inhibited their 3G mobile video services to take off.

Industrial actors in two countries shift the technological focus from 3G toward broadcasting mobile TV technology nearly at the same time. In mid 2007, a new media company, PGK, launched the first Singapore's broadcasting mobile TV trial, TV2GO. Later, a joint DVB-H mobile TV trial held by Singapore's local telcos (SingTel, Starhub, M1) and the only broadcaster (MediaCorp) inaugurated during 2008 Chinese Olympics Games. In 2007, Taiwan's National Communications Commission (NCC) allocated three channels for mobile TV trials to five groups: PTS team, CTV team, Qualcomm team, Chung-Hwa Wideband Best Network team and Dawn TV team. Among them, four applied DVB-H standard, one group adopted MediaFLO. As for mobile TV policy, Singapore's Media Development Authority (MDA) proposed its regulatory framework for publics' feedback in November 2007, while Taiwan's NCC proposed a regulatory framework and sought public consultation in February 2008.

Singapore and Taiwan are free-trade countries with 'pro-market' characteristics in their economic systems. Heavily relying on export and import businesses, these two 'Little Asian Tigers' deeply integrate with the global market. During the economic downturns, both countries faced similar pressures to sustain and revitalize economies by advancing their information and mobile technology development. The challenges posed by emerging but promising mobile TV industry were particularly relevant for investigation. However, these two countries represent different government-market relationships: Singapore that has an authoritarian regime with a tight control of information flow (Rodan, 2004) favors government involvement, whereas Taiwan that is market-led and enjoys free flow of information prefers minimal government intervention. It will be interesting to contrast their responses to deal with similar techno-economic-regulatory challenges brought by mobile TV. Two questions of mobile TV development in Singapore and Taiwan are worthy of exploration: firstly, how do the stakeholders (various industrial players, policy makers) in Singapore and Taiwan respond to the hype of mobile TV? Secondly, what are the similarities and differences between the two countries regarding mobile TV technology, markets/business models, and policy planning.

Since mobile TV is a fledging technology, there are few studies using theories to analyze its development, not to mention to compare it in different national contexts. Based on the theory of social construction of technologies (Bijker, 1995), Sawyer et al. (2003) investigated emerging broadband and mobile opportunities with a socio-technical perspective. Bauer (2004) who viewed technology, industry/market, and policy as a coevolving ensemble used a similar framework in forecasting the future mobile environment. Thus, this exploratory paper uses the social-technical framework (Dong, 2006) as the theoretical lens to tackle mobile TV's technological, market, and policy subsystems in Singapore and Taiwan. In this comparison analysis study, the researchers conduct in-depth interviews with major

stakeholders, like industrial players (telcos, broadcasters, content/services aggregators) and regulators in both countries. This study aims to elaborate mobile TV ecology in two national contexts, and further compare key issues in technology, market trials and business models, and regulatory frameworks. The findings of mobile TV in the two tech-savvy, mobile saturated Asia countries will provide insights for the future development of mobile TV in other nations.

2. Definition and Current Trend of Mobile TV

Mobile TV is “the transmission of TV programs or video for a range of wireless device ranging from mobile TV-capable phones to PDAs and wireless multimedia devices (Kumar, 2007, p.5).” It can be divided by modes of content delivery (Informa Telecoms & Media, 2007; Kumar, 2007): “mobile broadcasting TV” transmits content with a scheduled timetable over streamed cellular networks or broadcast networks (i.e. DVB-H or DMB-T); “unicasting mobile video” delivers user-selected audio/video services to handsets by downloading or streaming over the cellular networks. In 2009, it is projected global mobile entertainment revenues in broadcasting mobile TV will exceed mobile videos (Informa Telecoms & Media, 2007).

Mobile broadcast TV services started in 2005 in Korea via the terrestrial-based T-DMB system. Most agree mobile TV is technologically ready; however, successful business models are still ambiguous. TU Media Corp in South Korea that adopted a hybrid model first created a successful business model. It attracts one million subscribers in early 2007 (Shin, 2007) and has the biggest positive uptake of Mobile TV worldwide so far. Currently, the diffusion of mobile TV in most countries are in the trial stage. Italy has the only commercial DVB-H mobile TV industry in Europe. The European Commission (EU) announced its support for DVB-H (Digital Video Broadcasting-Handheld) over other delivery technology. This technology is based on the DVB-T Digital TV system (DTV) to receive TV-type services and multimedia content on handheld devices (Cho, 2008). DVB-H could be used to receive signals or services indoor, outdoor, or inside moving vehicles (Faria, et al., 2006). During 2006, a large number of DVB-H trials also took place in Asia, including Japan, Vietnam, Australia and Hong Kong (Curwen and Whalley, 2008). In April 2007, the adoption of DVB-H in Russia was hindered because its local broadcasters refused to lend towers to Russia’s largest mobile player, Sistema.

As for the MediaFLO technology, the dominant mobile TV standard in US, it finally achieved TIA (Telecommunications Industry Association) standards body for use over UHF Channel 55 at 716-722MHz and required to establish its overseas credibility. Some major network operators such as AT&T, T-Mobile USA and Sprint Nextel began to support Qualcomm through conducting market trials during 2007 (Curwen and Whalley, 2008). Taiwan’s national broadcaster Taiwan Television station (TTV) has announced its test of MediaFLO in conjunction with China Network Systems (Curwen and Whalley,

2008). There are also other possibilities – for example, China has opted for CMMB (China Multimedia Mobile Broadcasting).

2.1 Mobile TV Technology

The multitude of technologies is one main inhibitor of widespread mobile adoption (Gill, 2008). Mobile network operators used the 3G technology to provide video services to boost the sales of cell phones, and shift phone use from communicating to proactively searching for information or entertainment (Carlsson & Walden, 2007). However, bandwidth limitation caused unsatisfied viewing experiences of 3G videos. Later, broadcasting mobile technologies emerged. The broadcasting mobile TV technologies in trials or in use include three main open standards—Europe's digital video broadcasting-handheld (DVB-H), South Korea's digital multimedia broadcasting (DMB), Japan's integrated services digital broadcasting-terrestrial (ISDB-T)--and one proprietary standard, the United States' (Qualcomm) forward link only (MediaFLO) (Choi, et al., 2008; Gill, 2008; Kumar, 2007). China Mobile Multimedia Broadcasting standard (CMMB) is developed by the State Administration for Radio, Film, and TV in an early stage without commercial handsets. Additionally, satellite technologies, such as ISDB-S, S-DMB, and DVB-SH, can be used to deliver mobile TV services (MTVS).

In comparison, broadcast based Mobile TV has several advantages over cellular Mobile TV (Gill, 2008). First, it can transmit content to large areas simultaneously and carry high quality pictures with little additional cost. Second, broadcast mobile TV can allow many players to join in, not just broadcasters and telcos. Third, broadcasting mobile TV transmits content robustly that does not require telco infrastructure or spectrum availability. However, whether there is a reliable transmission of services in tunnels or indoor and unified frequency allocation for mobile TV are two critical technological issues to decide the feasibility of broadcasting mobile TV. The dilemma that network operators face is whether they should stick to streaming via 3G or adopt DVB-H, DMB or MediaFLO or, should choose any combination thereof. In the future, if the software challenge to integrate DVB-H and 3G technologies is overcome, the hybrid technological infrastructure will keep costs down (Carlsson & Walden, 2007).

2.2 Mobile TV Business Model

Although most agree mobile TV is technologically ready, few consider its business models are clear. The subscription model and the free-to-air (FTA) model are two dominant business models (Gill, 2008; Kumar; 2007). The subscription model is the mobile operator-led model where the carrier manages the end-to-end relationship with customers and provides the full service, including distribution, billing and CRM. In contrast, the free-to-air model is led by the broadcasters or a consortium comprising distributors, technology providers and other third parties to provide services and support and largely by-

passes the mobile operators. TU Media Corp in South Korea that adopted a hybrid model attracts one million subscribers in early 2007, the biggest positive uptake of Mobile TV worldwide (Shin, 2007). Both South Korea and Japan have licensed two platforms: a FTA advertising funded service broadcast over terrestrial networks and a satellite-based subscription service. The former grows faster in its customer base.

In Asia, the low willingness to pay for mobile TV services is attributed to unfamiliarity and confusion about charging models (Oh& Jablon, 2008).The broadcasters and satellite operators claim the FTA model that transmits TV channels to large-scaled viewers with less cost will migrate viewers easily. Comparatively, Qualcomm's research supports the subscription model is suitable in the Asia-Pacific region, because mobile TV service providers can gain revenue in return immediately and offer diverse content and services for Asia's heterogeneous peoples and cultures (Oh& Jablon, 2008). Even if the FTA model succeeds in several Asian countries, Oh and Jablon (2008) believed the subscription model that provided incentives of revenue generation to all stakeholders would become the mainstream.

2.3 Mobile TV Policy

To date, most countries have separated mobile telephony and broadcasting TV as separate industries that require separate regulators. The majority of global regulatory authorities apply fixed TV broadcast rules on mobile TV content, except USA treating MTVS as information services (MDA, 2007). The current practice of KBC (Korean Broadcasting Commission) is to define DMB as an extension of traditional broadcasting, based on its functionality (Dong, 2006). This placed DMB within the framework of traditional broadcasting TV that is more restrictive in content due to its mass coverage. The KBC requires DMB carriers to follow broadcasting content codes and universal services. However, whether it is appropriate to place the FTA content restrictions to MTVS is still debated within Korea as it contradicts the principles of diverse content and free speech. The similar scenarios occur to many other countries' evolving mobile TV policymaking. Besides, Dong (2006) argued that Korea had no solid framework to regulate DMB, but a provisional case by case approach. Its policy cannot reflect constant technological changes and complicated interactions within the mobile industry (Dong, 2006).

The FCC (Federal Communication Commission) in the USA and Ofcom (Office of Communication) in the UK recognized that the boundaries for conventional broadcasting are no longer relevant in the convergent age. As a result, they kept the control of broadcast channels in the hands of broadcasters, while mobile operators control the great majority of uplink capacity. Moreover, as noted from the current trends of mobile TV, many involved parties see this as opportunities to establish their preferred proprietary standards as the global standards. Driven by profit, it caused negative responses from the industry and created countervailing standards (Curwen and Whalley, 2008). So far, provisional

regulations set up by some countries, such as USA and Korea, fail to fully address the complex issues of mobile TV and require further refinements.

2.4 Mobile TV Content

Content is the key to drive the adoption of mobile TV. As mobile attention span is short, mobile TV, an attention-expensive medium, should create content and services with shorter, quick interaction. Groebel, et al. (2006) identified the two key characteristics of the mobile devices: anytime, anywhere and location-based services. International MTVS market trials showed 40% to 70% end users would be willing to pay S\$10 to S\$20 to subscribe 8 to 15 channels, a mix of FTA programming and made-for-mobile content (MDA, 2007). News, sports, soap operas, and music videos are found by many studies as the most popular genres for mobile TV customers (Carlsson & Walden, 2007; Gill, 2008; MDA, 2007; Shin, 2007; Wei & Huang, 2008). Different countries have various MTVS viewing times: from 15 minutes in the US trials to 50 minutes for commercial services in South Korea (MDA, 2007). People tend to watch MTVS whilst travelling, at home, or lunch hour at work. In Asia, consumers prefer local content (Gill, 2008). In addition to a new distribution platform, mobile TV acts as a secondary channel to add interactivity, mobility, and personalization into traditional TV content (Andersson et al, 2006). Results from pilots and successful rollouts reflect the 'surrogate TV effect' and show mobile TV to be popular in prime time (Gill, 2008; Radne, 2007). International content providers are developing mobile TV-specific channels, like Discovery mobile, HBO's mobile TV film, CNBC's mobile news, and ESPN, etc.

Past studies showed that consumers felt frustrated to discover videos on mobile services and wanted a personalized Electronic Program Guide (EPG) tailored to personal tastes and interests to find content (Oh& Jablon, 2008). Ease of use in interface design is another critical in successful diffusion of mobile TV. Handset manufacturers should make mobile TV a ubiquitous feature to create a seamless user experience and incorporate interactive features with mobile TV viewing.

2.5 Social-Technical Perspectives of Technologies

One prominent work on social-technical perspectives of technologies is Bijker's social-technical change. Derived from work in the sociology of technology, Bijker's (1995) four principles of socio-technical change provided a set of goals for theories that strived to take a socio-technical perspective: the seamless web principle, the principle of change and continuity, the symmetry principle and the principle of action and structure.

Despite Bijker's contribution toward the social-technical perspective, his work on theorizing social construction of technologies was rarely used to understand emerging technologies at macro levels. Criticizing that Bijker's principals caused tension in broadband research, Sawyer et al. (2003) pinpointed

four tensions to be managed when any researcher intended to use the social-technical perspective to analyze technologies (Table 1). Regarding the socio-technical approach as a good framework to investigate interrelationships of technical and social processes, their study showed how it could be used to provide useful insights in predicting emerging broadband technologies.

The objective of socio-technical system theory was to develop an optimal organizational design to enable the three subsystems-- social subsystem, technical subsystem, and the environment-- to work well together (Pasmore, 1988). The interdependent subsystems required a theoretical framework to untangle and account for the complicated interactions between them (de Sitter et al., 1997). Cherry and Bauer (2004) used Complex System Theory to understand the requirements for sustainable telecommunications policy and argued that the telecommunications sector was a complex adaptive system. Later, to predict the future mobile environment, Bauer (2004) used a similar framework that viewed technology, industry, market, and policy as a coevolving ensemble. His proposition resembled a social-technical approach toward emerging technologies. Han (2003) used the technology, policy, and culture model to analyze the adoption of broadband technologies in Korea and concluded that Korean government's ICT policy propelled demand and supply the rollouts. Shin (2007)'s study of Korean's DMB development used a similar approach and found an array of socio-cultural factors affecting the adoption of DMB. He claimed a social-technical perspective was a feasible theoretic framework to analyze emerging technologies, such as broadband and mobile TV.

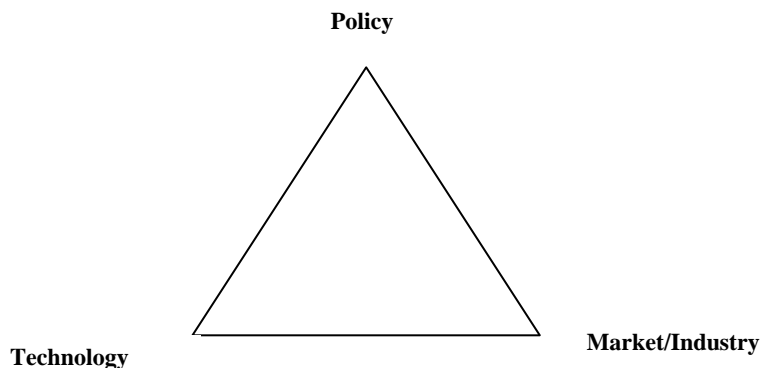


Fig. 1. Disjoint of DMB in socio-technical framework based on Dong (2006)

Moreover, Dong (2006) took a social technical approach to examine the trilateral relationship between policy, technology and the market regarding the DMB development in South Korea (Figure 1). Based on the triangle model, he explained that there were a weak relation between regulation and industry. Also, he argued that the development of DMB was due to a technology push to market rather than market pull and one obstacle of its adoption was the lack of demand from market and users. On policy and

industry, Dong implied divergent views between different industrial players: while broadcasting companies argued that content should not be commercialized in the name of public interests, telcos counter-argued that subscription-based content was the only way to operate DMB sustainably. Discrepant views implied the significant disjunction in the socio-technical perspectives (Dong, 2006).

As such, by viewing mobile TV as a socio-technical artifact, this paper adopted Dong (2006)'s model to examine how the three subsystems-- technology, market/industry, and policy-- shapes the development of mobile TV in Taiwan and Singapore.

3. Method

From November 2008 to March 2009, the researchers collected second-hand data and conducted in-depth interviews with major stakeholders, like industrial players (telcos, broadcasters, content/services aggregators) and regulators in Singapore and Taiwan. Following Miles and Huberman's (1994) thematic data analysis methods, the researchers coded and analyzed transcribed interviews second-hand documents in order to find out recurrent patterns. Taking a socio-technical system theoretical approach, this study investigated the technology subsystem, market/industry subsystem, and policy subsystem in two countries' mobile TV industries. It also examined the complex interrelationship among the three subsystems and compares the similarities and differences in two national contexts. This study aims to understand the interplay among mobile TV technology, its market, industry, and regulation regarding mobile TV in Taiwan and Singapore.

4. Analysis: Comparison of Mobile TV in Taiwan and Singapore

After introducing the background of mobile TV in both countries, this section will use a social-technical framework (Dong, 2006) to elaborate the comparisons of mobile TV in Singapore and Taiwan, including technology, market, and policy.

4.1 Background of Mobile TV Industries in Two Countries

4.1.1 Singapore

Singapore has a limited competitive telecommunication market with three mobile communication operators (Singtel, Starhub, M1) and a monopoly broadcasting industry (MediaCorp). In April 2001, Infocomm Development Authority of Singapore (IDA) sold the 3G licenses to the mobile incumbents. In February 2005, M1 offered the first commercialized 3G video service that allowed users to watch steamed TV content via a web portal on handsets. Besides, M1's *MeTV*, in January 2007 first displayed and exchanged user-generated content (UGC) on mobile phones. In May 2008, SingTel made its IPTV, *mio TV*, available on mobile phones. Viewers can watch *mio TV*'s live channels and video-on-demand with

an electronic program guide (EPG). 3G video services have not been successfully diffused in Singapore, because of expensive data charges in downloading content and unsatisfied viewing quality caused by bandwidth limitation.

Currently, all three telcos (SingTel, M1 and StarHub) are actively involved in the development of Singapore's mobile TV, while MediaCorp is the local content provider. Singapore Digital is a full service mobile TV provider and a joint-venture of Broadcast Australia and PGK Media. Its market trial, TV2GO, was the first broadcasting mobile TV test in Singapore during June 2007 to November 2008. Transmitting by DVB-H technology, it provided live TV programming and real-time interactive content on-the-move. This mobile platform was integrated with the Nokia DVB-H broadcast platform (Mobile Broadcast Solution) to support interactive functionalities.

In July 2008, SingTel, StarHub, M1 and MediaCorp rolled out a joint DVB-H mobile TV consumer trial in August 2008, to jump on Beijing Olympics 2008's bandwagon, (Mayer, 2008). The 300 trialists could view varieties of broadcasting mobile TV content encompassed sports, news (Channel News Asia, CNBC, Taiwanese cable news channel), Cantonese movie channel, local broadcasting channels, kids' programs, entertainment, and documentaries. Participants used the Samsung P-960 handsets to get access to the DVB-H platform supported by Alcatel-Lucent and Gemalto.

From November 2007, MDA, Singapore's policymaker for interactive digital media, conducted a 3-month public consultation on the proposed regulatory framework for mobile TV services (MTVS). After both sides submitted market trial reports to MDA last December, Singapore's industrial players are waiting for MDA to finalize the regulatory framework for licensing. When to launch mobile TV commercially and how to collaborate among key players remain uncertain.

Table 1. The Development of Mobile TV in Singapore

Time period	Event(s)
April, 2001	3G licenses awarded to MobileOne, SingTel and StarHub
December, 2004	StarHub launched 3G network
February, 2005	M1 started commercialized 3G video services
November 18, 2005	StarHub launched i-mode
January, 2007	M1 launched MeTV
June, 2007	PGK Media launched TV2GO Trial
November, 2007~ January, 2008	MDA sought public feedback on its proposed regulatory framework for mobile TV services in Singapore
May, 2008	SingTel had mio TV on Mobile

June, 2008	Joint venture between PGK Media and Broadcast Australia to set up Singapore Digital
August, 2008~ November, 2008	Joint DVB-H mobile TV consumer trial by SingTel, StarHub, M1, and Mediacorp
December, 2008	Both market trials submitted reports to MDA

4.1.2 Taiwan

There are five 3G operators in Taiwan. Adopting the WCDMA standard, Chunghwa Telecom, Taiwan Mobile, Far Eastone, and Vibo Telecom have provided mobile channels, VOD, and other services via streaming technology. Asia Pacific Broadband Wireless (APBW) only provided value-added services applying CDMA 2000 standard. In 2005, Formosa TV (FTV) and Taiwan Mobile Media Technology formed Taiwan Mobile Television Station in order to provide mobile TV content to all 3G operators. In Taiwan, the 3G operators are not the dominant players in the mobile TV trials, because they have spent around US \$1.5 billion in bidding for the 3G licenses. Before they recovered their invested money, they would be more conservative in investing other business plans.

At the nascent stage of the mobile TV development, several government agencies and broadcasters were involved in initiating the project related to “handheld TV” which was another term for mobile TV. In March 2005 “the Mobile TV Strategic Alliance” was formed under the guidance of the former broadcasting regulator the Government Information Office (GIO), the former telecommunication regulator the Directorate General of Telecommunications (DGT), and the Ministry of Economics. The Alliance composed of CMC Magnetics Corporation, Nokia, broadcasters and telecom operators. Its goals included evaluating related engineering technologies, finding business models, and promoting the development of domestic mobile TV services and related industries (Yang, 2007).

After two months, a terrestrial television station Chinese Television System (CTS) was also supported by the Ministry of Economics to do a project about DVB-H Platform and its Business Model. In August, 2005, “Taiwan Digital Television Association” and some telecom operators and broadcasters established “Mobile TV Industry Exchange Association” to promote the development of mobile TV in Taiwan. The Legislative Yuan also passed the DVB-H/IPDC proposal proposed by Public Television Service (PTS) in 2006 (Yang, 2007). With regard to the planning of the licensing scheme for mobile TV, it was passed to the newly established converged regulator the National Communications Commission (NCC) to decide.

The National Communications Commission (NCC) was established in February 2006. It decided to incorporate “Promoting Handheld TV Experimental Plan” as its annual plan of 2006, “Promoting Handheld TV Experimental Plan and the Following Licensing Scheme” as its annual plan of 2007 and

“Promoting Mobile TV Service” as its annual plan of 2008 (NCC, 2006; NCC, 2007; NCC, 2008). In order to implement its plan, the NCC held a hearing in July 2006 and proposed a handheld television trial project in the following month (www.ncc.gov.tw). Based on the “Table of Frequency Allocations of the Republic of China,” the test-trial frequencies are located on Ch35 (freq.596-602 MHz), Ch36 (freq.602-608 MHz), and Ch53 (freq.704-710 MHz). There are two regions for this project covering the western half of Taiwan. Northern region is from Keelung to Miaoli. Southern region is from Taichung to Pingdong.

The primary selection for trial project team was concluded and the outcome was approved at the 114th NCC Commissioners Meeting in October 2006. Four teams qualified for the project. They were Public Television Service Team, CTV Team, Qualcomm Team, and Chung-hwa Wideband Team. The first three teams conducted the trials in the North, the fourth one in the South. The secondary selection for handheld television trial project was announced in November. Dawn TV team qualified and was assigned channel 35 to do the trial (www.ncc.gov.tw).

Table 2. The Development of Mobile TV in Taiwan

Time period	Events
August 1, 2006	NCC passed the hand-held TV trial plans
August 4, 2006	NCC asked interested teams to apply for mobile TV trials
October 13, 2006	NCC announced four teams qualified for the project
November 30, 2006	In the secondary selection, NCC selected PTS team for the trial
January 1, 2007	PTS team started to launch the trial
June to October 2007	Other four teams launched mobile TV trials
December 2007- June 2008	Trials completed (Dawn TV team, FTV team, and CTV team had 6 month delay)
December 2007	NCC held internal meetings to review the results of the trials and to discuss the possible licensing scheme
January 31, 2008	NCC passed the drafted plan for soliciting public consultation for mobile TV licensing scheme
March 11, 2009	MOTC suggested discuss the mobile TV issues with the DTV issues about frequency allocation

The five teams conducted their trials from January 2007 to June 2008. Dawn TV team, FTV team, and CTV team had 6 month delay. From February 26, 2008, the NCC conducted a 3-week public consultation on the proposed regulatory framework for MTVS. In fact, before seeking the public consultation, the NCC Commissioners had different views about the regulatory framework and the schedule to open up MTVS. After the consultation, there has been no progress about MTVS policy (Ho, 2008). The licensing scheme was expected to be announced by the end of 2008, but it was put off. Thus, like Singapore, Taiwan's industrial players are also waiting for the NCC to finalize the regulatory framework for licensing. When to launch mobile TV commercially and how to open up MTVS also remain uncertain (Deng, 2009; Hong, 2009).

4.2 Mobile TV Technology

There are multiple technologies for mobile TV applications across the globe. The analyses (Informa Telecoms & Media, 2007) showed broadcasting mobile TV is more likely to win out 3G videos in the future. Most of the countries that either undergo commercialized mobile TV or market trials concurrently have the two technologies and various broadcasting mobile TV technological standards (i.e. Europe's DVB-H, South Korea's DMB, Japan's ISDB-T and the United States' MediaFLO (Choi, et al., 2008; Gill, 2008; Kumar, 2007).

4.2.1 Singapore

Without mandating a single standard, MDA's proposed regulatory framework suggested DVB-H, MediaFLO, and UHS three technologies for MTVS platforms, because it believed the market will be a better indicator for mobile TV technology. Later, the two Singapore's mobile TV trials show that Singapore's mobile TV industrial players tend to select DVB-H over other technologies. The results of interviews in March, 2009 with the MDA policy director and industrial players also back up this prediction. They stated several reasons why DVB-H became the chosen technology for Singapore's mobile TV. First, regardless of the limit of users, the DVB-H platform can support up to 20 channels, as with the same quality and speed of transmission, whilst 3G technology only support a few. Second, the DVB-H users need not pay extra data charges for watching broadcasting programs or using interactive services, which helps the affordability of DVB-H mobile TV services/content. However, interactive content or services on mobile TV platforms can only be provided by the 3G network that supports one-to-one transmission, because DVB-H mobile TV sends out the same content to mass audience. In the future, Singapore's industrial players predicted the co-existence of DVB-H and 3G technologies to complement each other's functionalities.

A sophisticated DVB-H broadcasting platform requires high investment in building transmission towers and set up the complicated network. However, if DVB-H broadcasting requires good quality of indoor and underground reception, the infrastructure investment will be costly. MediaCorp's TV mobile uses existing DVB-T signals, so it has enough transmitters to cover the whole island outdoor. Besides, Singapore digital's chairman indicated that they planned to invest in building DVB-H towers and then resold extra bandwidth to three telcos, Mediacorp or to whoever would be interested in broadcasting mobile TV. TV2GO's chairman found many trialists watched the third screen indoor at home or at work, which drastically changed their parameter for transmission and the investment needed to deploy the infrastructure to cover up HDB flats (Singapore's State-owned apartments).

In a bid to ensure that MTVS are offered nationwide, MDA plans to impose minimum network coverage requirements on multiplex licenses, which is to specify a 95% outdoor coverage level for multiplex licenses. In contrast, costly indoor coverage will not be made mandatory in the short run. Using the same DVB-H technology, all MTVS players in Singapore will face two major technological bottlenecks: indoor coverage and bad reception in tunnels. However, because Singaporeans spend most of their time indoor or commuting, there is an urgent need for upgrading mobile TV infrastructure and solving the two technical issues for successful diffusion of mobile TV in Singapore.

4.2.2 Taiwan

As mentioned above, the 3G operators are not as interested in broadcasting mobile TV as the broadcasters are. Among all Taiwan's broadcasters, PTS and CTV are more active than others. In the analogue age, the four commercial TV stations and one public TV station used to adopt the US NTSC standard. However, when they went digital, they decided to adopt the European DVB-T standard, because they believed DVB-T had better indoor reception and could provide single frequency network advantage. Since DVB-H evolved from DVB system, it would make sense for the broadcasters in most trial teams to adopt the DVB-H standard as the broadcasting mobile TV standards. Also, it is natural for the Qualcomm team to adopt its proprietary standard MediaFLO.

Article 10 of the Fundamental Communications Act stipulated that "the allocation and administration of scarce communications resources shall conform to the principles of fairness, efficiency, convenience, harmony and the neutrality of technology." The regulator NCC emphasized that its position toward MTVS standard was "technological neutral," so it would let the industry decide which standard they wanted to adopt for mobile TV. When the NCC allocated three channels for the mobile TV trials, it designated CH53 (704-710 MHz) as one of the trial channels (www.ncc.gov.tw). Although there were four groups adopting DVB-H in their trials and one group adopting MediaFLO standard, the regulator accepted both standards for the trials. However, in order to protect the consumers' interests, the regulator

required that different standards had to be compatible with another standard. MTVS operators have to guarantee there is no interoperability problem between different systems (www.ncc.gov.tw).

4.3 Mobile TV Industry/Market

4.3.1 Singapore

In Singapore's mobile TV industry, three local mobile operators, the broadcaster, and one new media company showed strong interests in operating this new mobile business and participated in two market trials on broadcasting mobile TV from 2007 to 2008.

Key Industrial Players

As the largest telco in Singapore, SingTel has not been keen in developing mobile TV until recently. In addition to some 3G video services, SingTel offered mio TV on Mobile in mid 2008 that was supported by Nokia Siemens Networks' Mobile TV streaming service on its MDS 3.5 platform. mio TV on Mobile allows viewers to watch SingTel's 3G users pay S\$6 flat monthly fee for watching six TV channels with an easy-to-use EPG, plus the fee for on-demand programs and pay per view (PPV). In 2008, SingTel also offered Apple's latest 3G iPhone exclusively in Singapore.

Launched in 2000, StarHub is the second largest mobile operator and the sole cable television operator in Singapore. It operates Singapore's fastest 3.5G mobile network to complement its nation-wide GSM network, and an island-wide HFC network to deliver digital cable TV and broadband services. Its 3G subscribers could view multimedia data on mobile phones in 2005. Collaborating with NTT DOCOMO, StarHub offered i-mode exclusively for Singaporean users in November, 2005 (Hardware Zone, 2005).

M1 is the third largest mobile operator with more than one million customers. It provides various mobile voice and data communications services over 2G/3G/3.5G network. It is active in experimenting with mobile video services. After January 2007, M1 users could upload videos through MMS to its mobile portal, MeTV site, for sharing self-generated content among mobile social network and obtain monetary rewards. This service attracted more than 50,000 users after half a year. Later, M1 signed a deal with StarHub to open the MeTV for its customers (TeleGeography, 2007). Besides, in 2008, M1 partnered MediaCorp to produce Asia's first 3G mandarin mobi-drama, "P.S I Luv U" which contained 30 episodes of 3-minute videos.

MediaCorp is Singapore's leading media company and content provider, spanning television, radio, newspapers, magazines, movies and digital media. To date, it has 8 television channels and 14 radio channels. Worldwide it is the first to use DVB technology to transmit outdoor DTV, TVMobile. In

October 2007, MediaCorp developed made-for-mobile TV content and offered M1 customers Asia's first 3G mobile drama.

Singapore's TV2GO mobile TV market trial (June 2007~ November 2008) was run by Singapore Digital, a joint venture between PGK Media and Broadcast Australia. Using an EPG, 100 trialists of TV2GO can watch 10 TV channels, like CNBC, ESPN, WOW!TV, and engage real-time interactive services on the move, including voting and mobile Internet. TV2GO's chairman expressed the ambition to use Singapore as the test bed to expand experiences to other countries by using standardized technology, a similar business model, content lineup, and mobile TV devices.

Comparison of Market Trials

Two DVB-H broadcasting mobile TV trials were completed in 2008: a joint local telco-broadcaster trial (SingTel, StarHub, M1, MediaCorp) and TV2GO (Table 2). Both of them targeted young adults and PMEBS (professionals, Managements, Executives, Businessmen) as the early adopters of mobile TV. Although the former has strong local experiences and the access to existing mobile phone users, the latter has collaborative relationships with international partners. With respect to content, the strength of the local telco-broadcaster consortium is the MediaCorp's local programming and Chinese channels; however, TV2GO adds interactivity to its content and provides premium foreign channels. Both sides encountered the same problems: accessibility, affordability, and maturity of MTVS hand phones. Only a couple of expensive Nokia and Samsung cell phones could receive signals of both mobile TV trials, but their functionalities and designs were immature. Besides, the usability test of mobile TV handsets showed that TV2GO's devices had a more user friendly interface with superior functionalities, but required long time for switching channels. MediaCorp's Business Development Director said the local joint trial did not offer interactive programming because the hand phones in the market trail could not support such applications.

Table 3. Comparisons of Broadcasting Mobile TV Trials in Singapore (Lin, 2009)

	Joint DVB-H Mobile TV trial	TV2GO
Trial Time	August 2008- November 2008	June 2007-November 2008
Technology	DVB-H	DVB-H
Trialists	300 (youth, professionals, parents & kids)	100 (mixed demographics)
Early Adopter	Youth & PMEBS	Youth & PMEBS, age 17-35
Content	15 channels (English and Chinese) News (Channel NewsAsia, CNBC, Cti,	10 foreign channels CNBC, ESPN, WOW!TV, ESPN,

	TVBS News); Sports (tvmobile's Olympics 2008, Football Channel); Entertainment (UKTV, Channel 8, Channel U, ETTV Asia); Kids & LifeStyle (MTV, Kids Central, Nickelodeon, World Fashion, The History Channel)	Bloomberg, Disney Channel and TV2GO's own channels
Interactive service	None	EPG, Interactive radio shows, digital text applications, interactive ads, voting on programs, content purchase, and access to micro-sites, weather applications
Trial Alliance	M1, StarHub, SingTel, MediaCorp Alcatel-Lucent and Gemalto (Technology partners)	PGK Media, Broadcast Australia Zentek Technology, NCS Communications Engineering, CNBC Asia Pacific, ESPN STAR Sports, Kamera
Usability Test	simple navigation and channel switch functions, minimalistic design	User friendly, easy to navigate, long pause for channel switch
Handset	Samsung P-960	Nokia N77, N92, Samsung SGH-P930

From the results of two market trials, Singapore's commercialized mobile TV will be likely to choose DVB-H technology, adopt a subscription model for early adopters, and form a consortium to run MTVS. In addition to live content, mobile TV users would like to have made-for-mobile content, interactivity, and even user-generated content. Besides, mobile TV handsets must upgrade their designs, interfaces, and software to impress Singapore's gadget lovers.

In comparison, the local players tend to take a more conservative, wait-and-see attitude toward the development of mobile TV, especially when they do well in core business and attempt to save investment on this unknown new area during the financial crisis; on the other hand, TV2GO is more keen in pushing the mobile TV business in order to enjoy the first mover advantages. As a new brand lacking of mobile customer bases and local experiences, Singapore Digital expects a tough battle ahead. However, some local competitors do not see TV2GO as a threat, because they think the small company, without network coverage and sufficient fund for investment, will not make it in the start-up.

Singapore's Mobile TV Content

During trials, there was no pricing involved, so the viewing was mostly driven by the content. For instance, the live Olympics games attracted many trialists' attention; however, after that, it fell back to incidental viewing. In addition to attractive content, MediaCorp's Business Development Director indicated it was critical to use marketing strategies to sustain continuous viewing of MTVS on the go. According to TV2GO's Chairman, the lineup of compelling contents is one big challenge in commercialized mobile TV. Singapore's market trials show sports, news, and local content are expected to be the top genres for MTVS.

Nokia's large study in late 2007 forecasts that by 2012, 25% of all entertainment will be created, remixed, and shared within one's peer circle (Zeman, 2007). These all clearly point out that mobile TV content cannot just simply be broadcasting programming. Instead, it must be a new genre to instantly engaging users on the move. If mobile TV eventually cannot provide original content and interactive services at affordable prices, it will be hard to switch users from existing substitutes. However, from the interviews, initial commercialized mobile TV content in Singapore concentrates on how to arrange a compelling lineup of content, rather than prioritizing interactivity.

Besides, user-generated content (UGC) is one salient trend that can be shown on mobile TV platform. MediaCorp that chose a broadcasting model of mobile TV expressed a carefully selective attitude toward using UGC, while TV2GO that emphasized on content innovativeness showed high enthusiasm in placing UGC channels so as to target on 17 to 20 year-old youth who are likely to drive the early adoption of mobile TV.

To push the deploying of interactive digital media, the MDA indicated if any industrial player could develop interactive features to improve commercial viability of Singapore's mobile TV industry, they show merits in their licensing process.

Singapore's Mobile TV Consumers

In January 2007, MDA's position paper revealed only 11% Singaporeans would be willing to pay between S\$5 and S\$15 per month for MTVS. During the economic downturn, mobile TV is a just "nice to have" service and the price that consumers are willing to pay is not very high. Unless mobile TV can demonstrates its unique content and flashy design, tech-savvy and gadget loving Singaporeans may not accept commercialized mobile TV soon. Yet, TV2GO's chairman still felt confident that the mobile TV in Singapore could be successful, because Singaporeans consume a lot of content out of home. The small size of HDB flats as well as long working hour and commuting time are the attributes for people to watch mobile TV on the go. He believed mobile TV could enter the market in the next couple of years and reach a substantial size.

So far, mobile TV now has not been aware by the majority in Singapore's society and people often mistake it for TVMobile, a DTV service shown on SBS buses. Mobile TV operators must make lots of efforts to educate customers and create awareness, when they launch commercialized services. In addition, Singapore's mobile consumers who live in a media saturated society have many portable entertaining substitutes, such as mobile Internet video downloads, iPods, blackberry, and portable video games. Commercialized mobile TV will face strong competition of substitute artifacts. Furthermore, it is critical for early MTVS adopters to have fancy mobile TV devices with affordable prices, sophisticated designs, and superior functionalities.

Singapore's Mobile TV Business Model

Singapore mobile TV players involved in the two market trials all prefer to have the subscription model in the early adopter markets, rather than the FTA model. For instance, TV2GO's chairman indicated, after its commercial launch, TV2GO would set an affordable monthly flat rate for viewing 8-10 broadcasting TV channels over hand phones and the payment would be charged into users' mobile phone bills under three local mobile operators. Initially, some early adopters will be willing to pay for unique services, even though the subscription model may encounter problems to drive volume for mobile TV handsets. From global experiences, when the MTVS aims to switch to mass market, the FTA model is useful to bundle free content and services to attract a bigger population. MediaCorp's Business Development Director stated the timing to transit from the initial paid model to the FTA one is tricky and complicated. If the introduction of the FTA model is premature, the established pay market will be undermined by advertising-supported free content operators.

Moreover, interviews show it is most likely that Singapore will have a collaborative consortium market structure, because of its small market size. To make commercialized mobile TV successful, telcos, content providers, and handset manufacturers should collaborate with each other and telcos, such as Singtel, with direct relationship with consumers should lead the development. For a market without scale, industrial players prefer to build one common network to cut costs, share wholesale content, and educate consumers. The three telcos realized that they should grow the nascent mobile TV market together (Ku, 2009). On the retail side, there will be enough room for the telcos to pick and choose content to make differentiation in marketing and pricing. Positioning itself as the neutral third party and the backbone of future MTVS, MediaCorp's primary role is to create and aggregate content for telcos that sell MTVS to end users directly.

Furthermore, whether broadcasting mobile TV can take off or not also depends on the availabilities and readiness of mobile TV handsets. Phone vendors, Nokia and Samsung, whose handsets were selected to be used in Singapore's mobile TV trials are the key players in the value chain.

MediaCorp's Business Development Director mentioned Singapore's small-sized market could not shape features of mobile TV devices but accepted what are available. Both sides of mobile TV players indicated they would have bundled commercial launch with major handset manufacturers to strengthen the publicity.

So far, Singapore's potential mobile TV players are waiting for the regulator to come up a licensing framework for the tender process and the spectrum allocation, etc.

4.3.2 Taiwan

The five trial alliances started their field trials separately from January 2007 to October 2007. Qualcomm team, Dawn TV team, and CHWBN team delayed for 6 months. They extended their trials for another six months in order to push the NCC to release its proposed regulatory framework as early as possible.

Key Industrial Players

The key players for mobile TV trials include terrestrial broadcasters, cable MSO (Multiple System Operator), satellite TV operators, 3G operators, ISP (Information Service Provider), equipment providers, value-added service providers, and hand-set manufacturers. Among the five teams, two are led by terrestrial TV stations (PTS and CTV), one is led by an ISP, one is led by a mobile TV standard proprietary company, and one is led by a DVD company's subsidiary. The role of mobile operators includes providing return path for interactive services, providing authentication and billing system, utilizing their customer base, providing subsidy of user terminal, and dealing with CRM (Shih, 2009). The role of terrestrial TV stations, cable MSO, and satellite TV channels is to provide content for the trials.

Taiwan's broadcasters, PTS and CTV, both are the major players leading two trial teams. PTS's MTVS budgets came from the government. It planned to test the handset's reception, interoperability among systems, mobile content, application services and outdoor reception to establish a platform for mobile TV and provide free content to the platform. CTV is a commercial TV, so its goal is to utilize this new platform to expand its media empire. Qualcomm wanted to introduce its MediaFLO standard to Taiwan, so it formed an alliance to conduct the trial. The state-owned ISP, Chung-Hwa Wideband Best Network, failed in its previous attempt to obtain wireless broadband access license from the NCC, and aims to expand its MTVS business as well. Dawn TV, a subsidiary of CMC Magnetic Corporation, was mainly established for the mobile TV trial. Since the NCC has not had a clear policy for MTVS, it was dismissed in 2008 (Lai, 2009).

Comparison of Market Trials

Among the five teams, four teams adopted DVB-H, while only Qualcomm team adopted its proprietary standard MediaFLO. PTS team, CTV team, and Qualcomm team conducted the trials in the North; the rest two teams conducted their trials in the South. PTS team had financial support from the government, while the other four teams had to spend their own budgets to do the trials. Qualcomm wanted to prove to Taiwan and other countries that Qualcomm' MediaFLO system is as good as DVB-H and it can be compatible with other broadcasting mobile TV systems, like DVB-H. Only Qualcomm used CH53 to conduct the trial, when other teams used CH35 and CH36. As an ISP, Chung-Hwa Wideband Best Network attempted to expand its wireless territory by conducting the broadcasting mobile TV trial. Dawn TV believed that participating in mobile TV trial might be a chance to enter the TV industry.

Table 4. Comparisons of Mobile TV Trials in Taiwan

Teams	PTS team	CTV team	Qualcomm team	Chung-Hwa Wideband Best Network (CHWBN)	Dawn TV team
Trial time	Jan 2007-Jan 2008	June 2007-June 2008	Oct 2007-Feb 2008	Aug 2007-March 2008	Sept 2007-March 2008
Technology	DVB-H	DVB-H	Media FLO	DVB-H	DVB-H
Trial Region	North	North	North	South (Kaohsiung, Tainan)	South (Taichung, Tainan, Kaohsiung)
Trial Content	CNBC, ESPN, PTS, TVBS-N SET (Metro) Phone TV	CTV News CTV Variety, Cti News, DaAi TV, iNTv, Momo, Star TV, Music Radio	5 channels	ETTV News, ETTV Variety, ETTV Shopping, FTV News, FTV, Traffic TV, Movie Channel, Video Content	CTS, CTS Leisure ETTV News, ETTV Shopping, CMC Mobile Entertainment, Beautiful Life TV, Skyhigh Entertainment

Trial Alliance	PTS, Chunghwa Telecom, Taiwan Mobile, Far Eastone, BenQ, Motorola, Cyberlink	CTV, Chunghwa Telecom, Taiwan Mobile, Far Eastone, CTV Infortech, Motorola, DaAi TV, Cti TV, Cyberlink	Qualcomm, Asia Pacific Broadband Wireless, China Network Systems, TTV	Chung-Hwa Wideband Best Network, Far Eastone, Eastern TV, Formosa TV, DaAi TV, Innoxious	Dawn TV, CTS, Nokia, Eastern TV, Vibo Telecom, Cyberlink, Far Eastone
Trial Survey and Interviews	250 samples interviewed on streets, 85 for handset placement test	1,000 random samples, 200 trial users	NA	NA	100 trial users, Focus group, In-depth interviews

Source: NCC website (www.ncc.gov.tw); Yang (2007); Ho (2008). Five trial teams' final report (2007).

As mentioned above, the 3G operators are only interested in participating in the trials, they are not the major players in the trials, because they are also concerned with their own 3G TV. Currently, the 3G operators all cooperate with Taiwan Mobile TV station (a mobile TV content aggregator) to provide TV channels and other value-added services to their customers. For instance, CHT provides 18 channels with NT\$168 (US\$5.1) per month. Taiwan Mobile provides 1,000 minutes program for NT\$199 (US\$6) per month. In order to maintain their leading positions in mobile industry, CHT and Taiwan Mobile joined two teams (PTS and CTV) by supporting the return path via their 3G/2.5G Networks and providing customer services and billing systems to the tests. Far Eastone even joined four teams to do the experiments.

Taiwan's Mobile TV Content

The five trial teams provided different contents for their test users. There were also overlapping channels such as ETTV News and ETTV Shopping channels in the trials. PTS team provided CNBC, ESPN, TVBS-N, SET (Metro), PTS, and Phone TV which was a tailored-made mobile channel by PTS.

The uniqueness of Phone TV was that it broadcast four-hour personalized content every day. In addition to the TV channels, PTS team also provided some short films and data services (Lai, 2009). CTV team provided CTV News, CTV Variety, Cti News, DaAi TV (religious channel), iNTv (interactive channel), Momo (shopping channel), Star TV, and Music Radio. CHWBN team provided ETTV News, ETTV Variety, ETTV Shopping, FTV News, FTV, Traffic TV, Movie Channel, and other video Content. Dawn TV team provided CTS, CTS Leisure, ETTV News, ETTV shopping, CMC Mobile Entertainment, Beautiful Life TV, and Skyhigh Entertainment. It also provided some interactive services and value-added services.

PTS team survey showed that 45% of the test users were willing to subscribe to specific pay channels, while 55% expressed no interest. As for the paid interactive services, the users' answers were very close. 51% said they were willing to use the paid interactive service, while 49% said they had no interest. When asked the same question, 37% of CTV team's test users were not interested in the interactive services, while only 27% were interested.

According to CTV's survey, the trialists said the mobile TV content should have more varieties and focus on the characteristics of mobile TV for targeting users' needs. The mobile TV operators should make their services easy to use and provide more functions, including mobile Internet, an EGP, and customized personal channels. CTV's and PTS's surveys (Lai, 2009) showed news, sports and drama were among the mostly watched and favored programs for mobile TV.

Taiwan's Mobile TV Consumers

The PTS team report showed that over 50% users were willing to buy mobile TV handsets in 6 to 12 months. Dawn TV survey also showed that half of the trial users said they wanted to have MTVS. After the trial, only 6% of the users expressed that they would adopt mobile TV immediately; 42% would wait six months and adopt; 16% would wait one year and adopt; 34% would wait; only 2% expressed that they had no interest at all.

Table5. User Attitudes Before & After Trial (CTV Report, 2007)

	Before the test (1,100 phone users) %	After the test (200 trial users)%
Appealing	18	55
Willing to use	11	33
Meet the needs	13	41

More than half of the test users in Taiwan's trials showed the needs to improve the broadcasting mobile TV content and service. According to PTS team report, 33% of the test users were satisfied with the overall test results, 25% were dissatisfied with the trial, while 42% expressed neutral attitude. The trialists were satisfied with MTVS' functionalities and picture quality, but dissatisfied with its poor reception and less channels. The CTV team report also showed that only about half of the users were satisfied with the trial's test results. The CTV team conducted a survey before the trial and after the trial test in the fourth quarter of 2007. After the trial, the users became more willing to use MTVS and thought it as a more appealing service that met users' needs.

Moreover, the results showed that the test users tended to use the MTVS 2-3times a day and spend about 10 minutes each time. They usually used the MTVS when they were waiting for the bus or waiting for people. As for the places to use the MTVS, they tended to use it more on the bus or on the way (CTV team report, 2007).

Taiwan's Mobile TV Business Model

The global experiences showed that most of the FTA model failed to bring revenues to the MTVS operators. Therefore, most of the Taiwanese trials teams focused on the subscription model rather than the FTA model. However, in order to attract more users to adopt MTVS, the trial teams proposed the hybrid model--an advertisement-sponsored FTA model and a subscription model. The MTVS can bundle some free content with some paid contents. The subscription model includes pay per month with a certain channels, pay per channel monthly, and pay per view model (Yang, 2009).

With regard to the monthly flat fee, the CTV team's test results showed that the consumers can accept 300 NTD (US\$9) per month for 20 channels. PTS team's survey also showed that the potential consumers are willing to pay 300 NTD per month no matter whether they are offered 10 channels or 20 channels. Comparing the three business models, 66 percent of the consumers prefer to pay monthly fee, 26 % prefer the "pay per channel" model, while only 7% prefer the "pay per view" model. With regard to the tested users, most of them were willing to pay 108-215 NTD (US\$3.5~9) for 20 channels, less than those who did not have the experiences of using MTVS. Dawn TV team's survey also showed that 90% of the tested users were willing to spend less than 200 NTD per month.

According to a NCC sponsored report conducted by Prof. Yang Chia-hwei in 2007, two trial teams suggested that NT\$200 (US\$6) per month will be widely accepted by the consumers, two teams suggested that NT\$150-200 per month should be a viable pricing strategy for MTVS. The report recommended that the MTVS operators can provide 1/4 free content and 3/4 paid content. The pricing strategy should be NT\$50 per month for the transmission fee and NT\$100-150 per month for the content

subscription fee. In this case, if the users do not subscribe to the paid content, they still pay NT\$50 for the transmission fee which can possibly cover the basic service charge.

4.4 Mobile TV Policy

4.4.1 Singapore

Formed in 2003, MDA aims to promote the growth of Singapore's digital media industry and manage media content to protect core values and safeguard consumer interests. In late November 2007, MDA has proposed a regulatory framework for Singapore's mobile TV services that was opened for public consultation. Technology, licensing framework, market structure, and content and advertising regulation are the four main issues addressed in this proposal. MDA defined MTVS as "personalized viewing TV, often with a choice of 10 to 15 channels on an anywhere anytime' basis," and unlike cellular mobile TV, the service is not charged by the length of viewing time.

First, MDA announced a "platform-neutral" approach to mobile TV services (MTVS) because there is no mainstream standard worldwide or no strong public interest consideration. DVB-H, MediaFLO, and UHS platforms are MDA's three technologies for broadcasting mobile TV. According to the MDA Policy Director, because the standard of mobile TV is still evolving, the government plans to give industry maximum room to find out the best technological match rather than mandate one technology that may turn out to be wrong or obsolete soon. Since the two trials used DVB-H standard, it is likely that industrial players will use this for the commercial deployment. Besides, the MDA also proposed a 95% outdoor coverage level for multiplex licenses in Singapore. Due to MTVS viability reasons (ex. flexibility of content providing), MDA proposed not to mandate any QoS (Quality of Service) on picture quality.

Second, uncertain of which frequency industry found suitable in deploying services, the MDA proposed to issue up to four multiplex licenses for MTVS: two 8 MHz UHF channels and two VHF 1.5 MHz channels. It allowed industry to decide its sensible deployment option. In comparison, using VHF, like South Korea's DMB, is slightly cheaper than UHF used by MediaFLO and DVB-H. However, VHF cannot provide as many channels as UHF because of the bandwidth limitation. The two trials in 2008 appear that the industry is more interested in the UHF spectrum. The MDA also indicated it would be possible to issue only one multiplex to a consortium that its partnered telcos share channels and differentiated services.

In the nascent stage, the mobile TV industry has high entry barriers in technology, content, business models, and even artifact and interface design. There will be a comparative approach to award licenses to applicants that meet consumer interests and show commercial viability. MTVS in Singapore are subject to the following licensing arrangements:

1. Under the Broadcasting Act, the MDA will issue a multiplex license to use and/or lease digital multiplex capacity for approved content and data, and a Broadcasting Service license to offer broadcasting services on the multiplex;
2. Under the Telecommunication Act, a license will be issued to any party running a telecommunication system for operating the multiplex broadcasting service;

To foster the growth of nascent mobile TV industry, MDA proposed to adapt IPTV services' two-tier framework to MTVS and cellular mobile TV service: niche license (<100,000 subscribers) and nationwide license (>100,000 subscribers). Both licensees have no must carry obligations, no cap on advertising revenue, but have advertising time limit and MDA's programming code restriction. Possible evaluation criteria for a comparative tender include technical measurements, financial and commercial measurements, and consumer interest requirements. 65% of the multiplex capacity for TV services is another license condition.

Lastly, as the mobile TV is likely to attract young users, to protect the vulnerable groups, the MDA proposed MTVS to follow Broadcasting TV Program Codes for FTA, subscribing TV, video on demand, etc. Yet, some telcos prefer a class license that was introduced in 1996 for Singapore's Internet services, because this light-touched approach has less content limitations and censorship. Apparently, Singapore's MTVS policy will be more content-centric and service-regulated, because broadcasting TV content will go through a mobile service.

Although the global financial crisis may hold back the growth of Singapore's commercialize mobile TV, the MDA still encourages advancing such interactive digital media to move one step closer to the vision of Asia Media Hub. The MDA holds an underlying market-driven principle that the industry should decide whether MTVS is commercially attractive services or which new media are best used for the frequencies. According to MDA's Policy Director, with concerns of commercial viability of mobile TV, the government actively discusses with the industry to get clarity before the policy framework can be finalized. One main issue is whether the government should establish the infrastructure to kick off the development of mobile TV. From the interview, the MDA emphasized they would not force MTVS to be commercialized when it was premature of industry's viable business plans and consumers' demand.

As mobile TV is an emerging industry, there is no policy model that can be directly implanted to the context of Singapore. The uncertainty of financial deployment of MTVS makes the MDA now consider to take a more consultative and collaborative approach for licensing, instead of a traditional tender process. The MDA will keep observing the international deployment in technological standards, business models, etc. Meanwhile, it welcomes companies, like TV2GO, to use Singapore as a test bed for new services of the interactive digital media.

4.4.2 Taiwan

Although the NCC considered promoting mobile TV services as its annual plans for 2006, 2007, and 2008, there were disagreements among the NCC Commissioners about when to open up the mobile TV services. Supporters argued that since there were at least five teams expressed their interests in the services, the regulator should respond to their needs. The opponent argued that there were no successful business models in the world, therefore, it was premature to open up the MTVS license. On January 31 2008, the proposed regulatory framework for public consultation was finally passed at the NCC Commission Meeting (www.ncc.gov.tw).

On February 26, 2008, the NCC sought for written public consultation. It only gave three weeks for the public to respond. To open up mobile TV services, the NCC will hold three principles: (1) encourage new technologies and services; (2) have careful planning for scarce resource; (3) open up the licenses in a fair, open, and efficient manner.

Like Singapore's MDA, the NCC also announced a "technology-neutral" approach for opening up mobile TV services. Unlike MDA which proposed to issue 4 multiplex licenses, the NCC proposed to issue 3 MTVS licenses. Each MTVS license will be allocated 6MHz which shall provide at least 8 channels. Fifty percent of the capacity has to be committed to TV content. The spectrum considered for mobile TV licenses include CH35 (596-602MHz), CH36 (602-608MHz), and CH49 (680-686MHz).

Considering the scales of economics, all the interested players proposed to have nationwide mobile TV service instead of regional service. Taiwan used to have regional cellular phone companies. However, they were merged with bigger companies because of the consideration of the economic scales. Therefore, the NCC proposed to have nationwide mobile TV service instead of regional service.

Although the NCC is a converged regulator, it still regulates telecommunications and broadcasting industries with separate Telecommunications Act and Broadcasting Act. As MTVS is a converged service, the NCC has to consider which law is more appropriate for opening up its license. Since the Broadcasting Act has some restrictions which might limit the development of mobile TV, like no foreign ownership and no lease for spectrum capacity, the NCC proposed to regulate the MTVS license based on the Telecommunications Act. With regard to the MTVS content, it will be subject to the Broadcasting Act (Ho, 2008).

Like Singapore's MDA, the NCC does not think must carry rule is applicable to MTVS. The proposed license term is 6 years. The licensing mechanism is a hybrid scheme including beauty contest and auction. In order to encourage competition and innovation, the NCC proposed to reserve one channel for non-WBA or non-3G operators. The financial qualification is more than 1 billion NT dollars (30 million US dollars). In addition to opening up new licenses for mobile TV services, the NCC also proposed to let the 3G operators and the DTV license holders to use their existing spectrum to provide the MTVS (www.ncc.gov.tw).

After the public consultation stage, the NCC has not taken any action for its mobile TV regulatory proposal, because one supported Commissioner left in February 2008 and the first-term Commissioners dissolved in July 2008. The second-term Commissioners do not consider it as an urgent issue to be dealt with. After the new Administration took the helm in May 2008, the KMT-led Executive Yuan considered discussing the mobile TV issues with DTV issues altogether (Deng, 2009; Hong, 2009; Wu, 2009). Namely, it is uncertain whether the NCC will open up new licenses for mobile TV services. Nevertheless, it is still an alternative to let the incumbent telco operators and broadcasters to provide MTVS with their assigned frequencies.

5. Discussion and Conclusion

The diffusion of mobile TV is contextualized in different national context. Singapore and Taiwan both have advantaged conditions to develop mobile TV successfully, including high mobile penetration, digital savvy customers, pro-innovation government, sophisticated media companies, and well-established telecommunication infrastructure. Mobile TV offers new business and investment opportunities to both telcos and media companies, whilst it presents a new platform for TV and content producers to showcase products and generate sales. Mobile TV industries in both countries have the potential to blossom if they can settle the issues, like MTVS licensing policies, business models, and customer awareness. Their success in mobile TV services will not only advance their visions of Asia's media hub, but also benefit consumer to enjoy varied content and interactive services on the move.

Both countries with less successful 3G video services take a technology-neutral approach toward the standard setting of broadcasting mobile TV. Singapore's market trials show its commercial MTVS will be on the DVB-H platform; most of Taiwan's key players tend to select this standard that go with their chosen DTV standard, except the MediaFLO team that uses Taiwan as a test bed for its interoperability with other broadcasting mobile TV technology. They both encounter the bottlenecks to improve the indoor and tunnel reception; however, Taiwan, a bigger island country, will have to invest more in infrastructure to achieve good outdoor coverage.

Lacking of economies of scale lets Singapore MTVS players tend to adopt a telco-led consortium market structure to share costs in investment and do R&D together with differentiation in pricing and marketing, with competing with one new entrant. Compared with Taiwan, Singapore's commercial mobile TV market is more collaborative and less competitive. Taiwan's five MTVS trial teams come from different background and form their alliances, including telcos, ISP, content providers, broadcasters, etc. From the market trials, Taiwan's commercial mobile TV market is more likely to be broadcast-led consortium. Additionally, Taiwan's 3G TV is a competitive substitute that attracts a certain amount of users and has more shaping power than Singapore's 3G video services.

Developing customized mobile TV content and interactive applications require huge investment in infrastructure installation and R&D in content creation and interactive services. The subscription model can ensure a clear revenue stream to stakeholders in the mobile TV value chain (Oh& Jablon, 2008) to keep ongoing development. The findings show Singapore's industrial players and the policy makers regard the subscription model as the viable business model for MTVS, while Taiwan's actors prefer a mix model of the FTA and the subscription. Besides, Singaporeans who have experienced pay TV's tiered packages, video on demand, pay per view and other 3G mobile Internet and video services, so that this market can use a subscription business model with tiered content/services. Unlike Singaporeans, Taiwan's users whose cable TV operators have not provided such pricing services are difficult to accept any complicated tiered pricing scheme. Therefore, a flat monthly MTVS fee with a set of channels might be a viable business model for Taiwan users, while Singapore's users can enjoy varieties in combinations of content and services at different rates.

When to start the commercialized MTVS in both countries is uncertain. Currently, the most important thing for the development of MTVS in Singapore and Taiwan is that the regulator has to set up a clear policy about its licensing scheme as soon as possible. Concerning about commercial viability, the MDA now take a more consultative, collaborative, and market-driven approach for licensing and will open four multiplexes for offering MTVS in Singapore. The MDA may involve in building broadcasting mobile TV infrastructure, after discovering the industrials' needs and evaluating mobile TV business potential. In comparison, Taiwan's NCC is less enthusiastic about MTVS and still indecisive to either open three new MTVS license for tender or auction, or let incumbent telcos or broadcasting to provide new services with their assigned frequencies. Taiwan's government is less involved in pushing this emerging business. With respect of the content, Singapore's MTVS is subject to the Broadcasting Act that applies strict content code, while Taiwan's MTVS will have more flexibility in their content, because MTVS is viewed more as a new convergent service.

Moreover, mobile TV that creates many changes in economy and society and introduces next generation networks can be viewed as a disruptive technology and a social-technical artifact. Adopting Dong (2006)'s model, this research has found the socio-technical theoretical approach is useful to investigate the technology subsystem, market/industry subsystem, and policy subsystem of the emerging and evolving new technology, MTVS, and even do a cross-country comparison. With multiple standards, broadcasting mobile TV technology is ready, while its business models and customer needs are still nebulous. The two countries' mobile TV industries are neither technology push, nor policy push. In Singapore's mobile TV industry, it shows that the new entrant triggered the initial market trials, the MDA's proposed regulatory framework, and the local joint DVB-H trial. In Taiwan, the broadcasters, the telcos, other new entrants are keen to seek for new business opportunities of wireless video services, in addition to the 3G videos. In general, the two countries' broadcasting mobile TV are more shaped by the industrial actors than the policy makers who follow behind the fast developing technological advancement and conservatively sketch the regulatory framework. So far, their policy makers both take market-driven and technology neutral approaches. The flexibility in their mobile TV policy may foster the development of the MTVS; however, the indecisiveness will miss the timing for nurturing its blossom. Overall, industrial players shape the trajectories of the two countries' mobile TV more than policy and technology.

Finally, this paper that elaborates the status quo of Singapore's and Taiwan's mobile TV industry and identifies their key stakeholders provides rich empirical data and insightful analysis. It can shed light for the future development of mobile TV in Singapore or other countries in Asia Pacific. Most importantly, the study shows the social-technical framework is useful to examine the complex interplay of technology, market, and policy that shape the trajectory of any emerging new technology in different national contexts.

References

- Andersson et al. (2006). *Mobile Media and Application: from Concept to Cash- Successful Service Creation and Launch*. John Wiley & Sons.
- Bijker, W. E. (1995). *Of Bicycles, Bakelites and Bulbs. Towards a Theory of Sociotechnical Change*. The MIT Press: Cambridge, MA.
- BNET Business Network. (2008 November). *Mobile TV revenue \$1.5b and rising fast*. Retrieved February 13, 2009 from http://findarticles.com/p/articles/mi_hb5932/is_200811/ai_n31250904?tag=content;coll
- Carlsson, C. & Walden, P. (2007). *Mobile TV - To Live or Die by Content*, Proceedings of the 40th Hawaii International Conference on System Sciences.
- Cho, H. (2008). *Acceptance of third generation (3G) mobile services in Singapore: Decomposing perceived critical mass and subjective norms*. Paper presented at the 2008 ICA Conference, Montreal.
- Choi, J.Y. et al. (2008). Ex-ante simulation of mobile TV market based on consumers' preference data, *Technological Forecasting & Social Change*, 1043-1053.
- CTV Team. (2007, December). *The Report of the Handheld TV Experimental Plan*. Submitted to the NCC.
- Dawn TV Team. (2007, December). *The Report of the Handheld TV Experimental Plan*. Submitted to the NCC.
- Deng, T. L. (2009). Director of the Department of Post and Telecommunications, MOTC. Personal interview.
- De Sitter, L., et al. (1997). From complex organizations with simple jobs to simple organizations with complex jobs. *Human Relations*, 50, 497-534.
- Dong, H. S. (2006). Prospectus of mobile TV: Another bubble or killer application?. *Telematics and Informatics*, 23(4), 253-270.

Dorrucci, G. (2008, October 16) Founder, Chairman & CEO of PGK & Singapore. Personal Interview.

Ericsson. (2008, February 12). *CNN and Ericsson Reveal Key Findings from Joint International Mobile TV Research Study*. Retrieved July 15, 2008, from <http://www.ericsson.com/ericsson/press/releases/20080212-1190582.shtml>

Faria, et al. (2006, January) DVB-H: Digital Broadcast Services to Handheld Devices, *Proceedings of the IEEE*, 94(1), 194-209.

Fierce Mobile Content. (2007, November 26). *Singapore legislators outline mobile TV rules*. Retrieved August 13, 2008, from <http://www.fiercemobilecontent.com/story/singapore-legislators-outline-mobile-tv-rules/2007-11-26>

Feuilherade, P. (2006, June 22). *Mobile TV scores in Asia*. Retrieved August 13, 2008, from BBC Monitoring, Singapore Web site: <http://news.bbc.co.uk/1/hi/technology/5105400.stm>

FIND (2009, March 16). "Taiwanese Mobile Internet Behavior in 2008-Q4." Retrieved April 6, 2009 from www.find.org.tw?find/home.aspx.

Gill, A. (2008). *The Business Model for Broadcast Mobile TV*. Paper presented at the BroadcastAsia2008, Singapore.

Groebel, et al. (2006). *Mobile Media: Content and Services for Wireless Communication*. Lawrence Erlbaum Associates.

Hardware Zone. (2005, November 18). StarHub launches i-mode in Singapore. Retrieved September 18, 2008 from <http://ph.hardwarezone.com/news/view.php?cid=23&id=3155>

Ho, H. J. (November, 2007). Swap of Telecommunications, TV, and Handset Industrial Players, *Business Next*.

Ho, J. Y. (January, 2008). Slow Pace of Taiwan's Mobile TV. *Communication Components Magazine*. No. 83.

Hong, J.K. (2009, March 20). Director of Department of Planning, NCC. Personal interview.

IBE News. (2008, July 2). *Singapore Digital extends mobile TV trial*. Retrieved August 13,

- 2008, from <http://www.ibeweb.com/ibe-news/singapore-digital-extends-mobile-tv-trial>
- iDA Singapore. (2009). *Statistics on Telecom Services for 2009 (Jan-Jun)*. Retrieved January 20, 2009, from <http://www.ida.gov.sg/Publications/20090304182010.aspx>
- Informa Telecoms & Media. (2007, November 23). Mobile TV and Video Revenues to Reach US\$8 billion by 2012. *TVinternational*, 15(21), p.2-3.
- International Telecommunication Union. (n.d.). *Digital Opportunity Index, Top 25 Economies, 2007*. Retrieved February 13, 2009 from <http://www.itu.int/ITU-D/ict/doi/index.html>
- Is Mobile TV's Biggest Market Asia. (2006, June 20). *Business Week*. Retrieved May 20, 2008, from http://www.businessweek.com/globalbiz/content/jun2006/gb20060620_115324.htm?chan=tc.
- Ku, K. M. (2009, March 4). Director of Business Development, Channel 5, MediaCorp TV. Personal Interview.
- Kumar, A. (2007). *Mobile TV: DVB-H, DMB, 3G Systems and Rich Media Applications*. Oxford: Focal Press.
- Lai, Francis (2009, March17). Manager of Strategic Planning and Development, PTS. Personal interview.
- Lin, T. C. (2008). Emerging Mobile TV Industry in Singapore: A Six Forces Model Analysis. Proceedings of 31th Pacific Telecommunications Council, Hawaii, Honolulu.
- Ling, P. L. (2009, March16). Director of Media Policy Division, Media Development Authority. Personal Interview.
- Mayer, R. (2008, July 27). *More join Singapore DVB-H trial*. Retrieved September 28, 2008 from Rapid TV News: <http://rapidtvnews.com/index.php/200807271770/more-join-singapore-dvb-h-trial.html>

Media Development Authority. (2007, December 28). *MDA extends public consultation on proposed mobile TV policies*. Retrieved April 20, 2008, from [http:// www.mda.gov.sg/wms. www/actualTransferrer.aspx?c=2.2.1.&sid=845&eid=-](http://www.mda.gov.sg/wms/www/actualTransferrer.aspx?c=2.2.1.&sid=845&eid=-)

Media Development Authority. (2007). *Policy and regulatory framework for mobile broadcasting services in Singapore*. Retrieved April 20, 2008, from [http://www.mda.gov.sg/wms.www/devnpolicies.aspx?sid=152](http://www.mda.gov.sg/wms/www/devnpolicies.aspx?sid=152)

Mobile TV Trial. (2008). Retrieved August 12, 2008, from <http://mobiletvtrial.sg/index.htm>.

NCC (2006). NCC Annual Plan 2006.

NCC (2007). NCC Annual Plan 2007.

NCC (2008). NCC Annual Plan 2008.

NTT DOCOMO. (2005, November 18). StarHub to launch i-mode Service in Singapore. Retrieved September 18, 2008 from <http://www.nttdocomo.com/pr/2005/000700.html>

Oh, M. Y., & Jablon, N. (2008). *Mobile TV Business Models in Asia-Pacific*. Paper presented at the BroadcastAsia2008, Singapore.

Pasmore, W.A. (1988). *Designing Effective Organizations: The Sociotechnical Systems Perspective*. Wiley, New York.

Radne, K. (2007). *Mobile TV: Lessons from TeliaSonera*. Presented at Mobile TV World Forum.

Rodan, Garry, 2004 *Transparency and Authoritarian Rule in Southeast Asia*. London and New York: RoutledgeCurzon.

PTS Team. (2007, December). *The Report of the Handheld TV Experimental Plan*. Submitted to the NCC.

Sawyer, S., Allen, J.P., Lee, H. (2003). *Broadband and mobile opportunities: a sociotechnical*

- perspective. *Journal of Information Technology*, 18, 121–136.
- Shin, D. T. (2007). *Mobile TV Broadcasting Development and Experiment in Korea*. Paper presented at Pacific Telecommunications Conference, Hawaii, USA.
- Ong, B. (2008, August 4). *Mobile TV pilot takes off in S'pore*. Retrieved August 10, 2008, from <http://www.mobiletvtrial.sg>
- Shih, M. P. (November 26, 2008). *Business Model of Mobile TV and Its Key Success Factors*. Presented at the 2008 HD and Mobile TV International Conference. Taipei.
- Tan, M. (2009, March 4). Manager of Business Development, Channel 5, MediaCorp TV. Personal Interview.
- TeleGeography. (2007, July 3). M1, StarHub ink joint MeTV deal. Retrieved October 21, 2008, from http://www.telegeography.com/cu/article.php?article_id=18547
- Wei, R., & Huang, J. (2008). *Profiling User Responses to Mobile TV: Effects of Individual Differences, Mobility and Technology Cluster on Critical Mass*. Paper presented at the Broadcast Education Association, Las Vegas, USA.
- Wu, C. H. (2009, March 6). Chief Secretary, NCC. Personal interview.
- Yang, C. H. (2007). *The Study of Hand-held TV Technological Application and Regulation*. NCC report.
- Zeman, E. (2007, December 3). *Where Will You Get Your Entertainment in Five Years? Nokia Says from Your Peers*. Retrieved August 10, 2008, from InformationWeek [HTTP://WWW.INFORMATIONWEEK.COM/BLOG/MAIN/ARCHIVES/2007/12/WHERE_WILL_YOU.HTML](http://www.informationweek.com/blog/main/archives/2007/12/where_will_you.html)

