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ORIGINAL ARTICLE

The development of mobile broadcasting TV: a socio-technical comparison of Singapore and Taiwan

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Among studies on emerging mobile broadcasting TV, theories for cross-country comparisons have seldom been applied. This paper investigates market trials of mobile broadcasting TV in Singapore and Taiwan. It uses a socio-technical perspective to examine complex relations between the co-evolving subsystems of industry/market, policy, and technology. This paper advances the understanding of how this mobile technology will evolve by interviewing key stakeholders in industry players and regulators. After Taiwan announced its mobile TV policy in December 2009, Singapore has remained indecisive. The findings show that Singapore is likely to choose the DVB-H standard and adopt the subscription model, while Taiwan will adopt DVB-H and MediaFLO and apply a hybrid model. Industry pull is found to be the driving force in developing mobile broadcasting TV, while policy delays this technology-ready mobile service. The cultural factor is considered as the underlying shaping power of the three subsystems and subtly affects technological development.

Keywords: mobile broadcasting TV; mobile TV business model; mobile TV policy; mobile TV technology; DVB-H; MediaFLO

Introduction

Mobile TV is the transmission of TV programs or videos on a range of wireless devices (Kumar, 2007, p. 5). Divided by modes of content delivery, mobile TV can be categorized into ‘mobile broadcasting TV’ that transmits content with a scheduled timetable over broadcast networks, and ‘unicasting mobile video’ that delivers user-selected audio/video services by downloading or streaming over cellular networks (Kumar, 2007). Due to the stagnant adoption of 3G mobile videos, many studies forecast mobile broadcasting TV to be the next hit, and regard Asia as a source for its development (Feuilherade, 2006; Informa Telecoms & Media, 2007) because of high cell phone penetration, advanced mobile technology, and Asian commuting lifestyles (Gill, 2008; Oh & Jablon, 2008). After South Korea and Japan launched their proprietary free-to-air and satellite mobile TV, other Asia countries also had market trials to explore mobile TV technological standards, business models, and regulatory frameworks for their national contexts. At present, mobile

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broadcasting TV in most parts of the world, like Singapore and Taiwan, is still in its infancy.

Singapore and Taiwan are ranked the fifth and seventh most advanced in digital technology across the globe (International Telecommunication Union, 2007). Singapore had more than 136% mobile phone penetration and 2.79 million 3G subscribers in July 2009 (IDA Singapore, 2009), while Taiwan had 110.3% mobile phone penetration with 11.29 million 3G subscribers (FiND, 2009). They represent different government-market relationships: Singapore's authoritarian regime favors government involvement in the economy (Rodan, 2004), whereas market-driven Taiwan prefers minimal government intervention. During the economic downturn, the two free-trade and pro-market 'little Asian Dragons' faced similar pressures to sustain and revitalize their economies by advancing information and mobile technology development.

After the sluggish roll-outs of 3G video services, the emerging mobile broadcasting TV technology reignited the hope for mobile TV in both countries. In 2007, PGK, a new media company, launched Singapore's first broadcasting mobile TV trial, TV2GO. Later, a joint digital video broadcasting-handheld (DVB-H) mobile TV trial by Singapore's local telcos and the sole broadcaster was inaugurated during the Beijing 2008 Olympic Games. In 2007, Taiwan's National Communications Commission (NCC) selected five groups to conduct mobile broadcasting TV trials: four applied the DVB-H standard and one adopted MediaFLO. To regulate this new platform, Singapore's Media Development Authority (MDA) sought for public feedback to the consultation paper for mobile TV service (MTVS) in November 2007, while Taiwan's NCC proposed its regulatory framework and solicited public opinions in February 2008.

Since mobile TV is a fledgling technology, prior studies have examined the factors affecting its adoption and its developmental issues related to policy, technology, or market (Bauer, Ha, & Saugstrup, 2007; Shim, 2005). Regarding mobile TV as a social-technical artifact, this exploratory study uses Shin's (2006) framework as a theoretical lens to examine mobile broadcasting TV's industry/market, technology, and policy subsystems and their interrelationships. Two questions concerning the emerging mobile TV industry are particularly relevant for investigations. First, how do stakeholders (various industry players, policy-makers) in Singapore and Taiwan respond to the hype of mobile broadcasting TV? Second, what are the similarities and differences between the two countries regarding mobile TV technology, markets/business models, and policy planning? The researchers conducted in-depth interviews with major stakeholders, including industry players (telcos, broadcasters, content/services aggregators) and regulators in Singapore and Taiwan. This paper aims to find out how the driving forces shape the development of mobile broadcasting TV in both countries and gain a better understanding of the future evolution of their mobile TV industries. The comparison study of mobile broadcasting TV in the two tech-savvy, mobile-saturated Asian countries not only provides insightful implication for adopting and managing the innovation of mobile TV, but also makes a theoretical contribution by testing the suitability of the social technical framework in examining the evolution of the new mobile TV technology at macro levels.

Literature review

Mobile broadcasting TV technology, market, policy

Mobile broadcasting TV which emerged in 2005 has only reached critical mass in South Korea, Japan, and Italy. The multitude of broadcasting mobile technologies is one factor that slows down widespread mobile adoption globally (Gill, 2008). So far, Europe's DVB-H technology has become prevalent in most countries. South Korea's digital multimedia broadcasting (DMB), Japan's integrated services digital broadcasting-terrestrial (ISDB-T), the United States' (Qualcomm) forward link only (MediaFLO) (Choi, Koh, & Lee, 2008), and China's Mobile Multimedia Broadcasting standard (CMMB) lead in some regions. Mobile broadcasting requires investment into a dedicated mobile broadcasting infrastructure and new mobile terminals to receive broadcast signals; however, it can transmit high-quality content without congesting the bandwidth of the mobile networks. Most agree mobile broadcasting TV is technologically ready, but the business models are still ambiguous.

Currently, the diffusion of mobile broadcasting TV in most countries is either in the initial commercialized or trial stage. There are two dominant business models: the subscription model and the free-to-air (FTA) model (Gill, 2008; Kumar, 2007). The former is the mobile operator-led model where the carrier manages the end-to-end relationship with customers and provides full services, including distribution, billing, and customer relationship management; the latter is led by the broadcasters or a consortium to provide services and largely bypasses the mobile operators. At present, both South Korea and Japan have licensed two platforms: an FTA advertising-funded service broadcast over terrestrial networks and a satellite-based subscription service. The broadcasters and satellite operators claim the FTA model that succeeds in several Asian countries will migrate viewers easily, as it transmits mobile TV channels to a large viewership with less cost. However, Qualcomm argues the subscription model will become the mainstream in the Asia-Pacific region, because mobile TV service providers (MTVS) can gain revenue quickly to develop diverse content and services for Asia's heterogeneous peoples and cultures (Oh & Jablon, 2008). Bauer, Ha, and Saugstrup (2007) found significant challenges in creating a financially sustainable mobile TV industry because the complex value network of mobile TV requires consistent technology and policy, firm strategies, and a higher degree of coordination and integration among participants.

International MTVS market trials showed 40% to 70% of end users would be willing to pay US\$7 to US\$14 to subscribe to eight to 15 channels, a mix of FTA programming and made-for-mobile content (MDA, 2007). In Asia, consumers prefer local content (Gill, 2008). 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; Shih, 2008; Wei & Huang, 2008). As mobile attention span is short, mobile TV, an attention-expensive medium, should create content and services with shorter, quicker interaction. The MTVS viewing times vary in different countries: 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 during lunch hour at work. Results from pilots and successful roll-outs reflect the 'surrogate TV effect' that mobile TV is popular in prime time for viewers to watch live TV content via handphones (Gill, 2008; Radne, 2007). Also, mobile

broadcasting TV not only provides an additional distribution platform, but also serves as a secondary channel to add interactivity, mobility, and personalization into traditional TV content (Andersson, Freeman, James, Johnston, & Ljung, 2006).

Regulators in some countries have imposed the Broadcasting Act on mobile broadcasting TV. The Korean Broadcasting Commission (KBC) viewed DMB as an extension of traditional broadcasting and amended its Broadcasting Act to include mobile broadcasting TV services (Shin, 2006). Italy's AGCOM amended its 2001 digital terrestrial television regulations in 2006 to cover mobile broadcasting TV (Infodev ITU, 2009). Hong Kong's jurisdiction proposed two alternative approaches: either deploying a self-regulatory approach or amending the Broadcasting Ordinance to treat mobile TV (3G TV and MTS) as a new service (Infodev ITU, 2009).

Although the majority of global regulatory authorities apply original or amended (digital) broadcast TV rules to mobile TV (MDA, 2007), some jurisdictions, like the United States, have opted for a light-handed approach, classifying mobile TV (2G, 3G, and live mobile TV channels) as an information service for accelerating its rollout. The FCC (Federal Communication Commission) in the USA and Ofcom (Office of Communication) in the UK recognized the blurry boundaries for convergent media, like mobile TV, and the inappropriateness to be regulated under traditional media laws. Canadian Radio-Television and Telecommunications Commission (CRTC) viewed imposing stringent broadcasting conditions on mobile broadcasting services as potentially detrimental to its development (Infodev ITU, 2009). The evolving global mobile TV policy cannot fully address the complex issues related to mobile TV's technology, market, and industry yet.

Social construction and social-technical approach of technologies

The development of technological artifacts is interwoven into a seamless web of technical, political, social, and economic forces. It is difficult to predict the future of a disruptive technology (Everett, 2003) because many complicated variables are involved. The prevalent diffusion model fails to address the key shaping forces of technological development such as societal context, market/industry, and politics/regulation while the social-technical system approach primarily examines the integration of technology, people, organization, and processes. The social constructivist approach sees technologies and technological practices as a result of the process of social construction and negotiation, often driven by various interests of heterogeneous social actors (Bijker & Law, 1992). On the one hand, the structure of social relations tremendously influences technological trajectories; on the other hand, the shaping of a technology is also the shaping of a society and a set of social and economic relations.

In the Social Construction of Technology (SCOT) theory, the development process of a technological artifact is described as an alternation of variation and selection (Bijker, Hughes, & Pinch, 1990). Hughes thinks that technological systems encompass messy, complicated, and problem-solving elements which are socially constructed and society-shaping (Bijker et al., 1990, p. 51). According to Pinch and Bijker (1984), using SCOT to analyze technological trajectories includes identifying relevant social groups of any technological artifact who may have conflicts of interests and clarifying the problems and solutions considered by each social group.

Social groups who perceive various meanings and problems of technologies cause flexibility in multiple interpretations and designs. Besides, Michel Callon's actor network theory examines the motivations and actions of clusters of actors linked by associations in heterogeneous networks of interests (Walsham, 1997, p. 467). The concept of actor network is useful to explain both the first stages of the invention and its gradual institutionalization dynamically.

Mobile broadcasting TV as a social-technical ensemble

Sawyer et al. (2003) use the socio-technical approach to investigate the emerging broadband technology and tackle its technical and social processes at macro levels. They encourage the linking of technological choices with social interaction and explain technological changes by considering social action and structure. Similarly, Han (2003) uses the technology, policy, and culture model to analyze the adoption of broadband technologies in Korea. He concludes that the culturally sensitive ICT policy propelled the roll-outs. Bauer et al.'s framework (2007) views technology, economics, and policy as a co-evolving ensemble and stresses the importance of identifying and differentiating the three realms.

Mobile broadcasting TV, like DMB, creates many radical changes and impacts on society and economy. Shim's (2005) social-technical study of Korean's DMB development identifies an array of socio-cultural factors affecting the adoption, including consumer behavior, culture, education focus, pervasive infrastructure, aggressive IT planning, and so on. Yet he does not tackle the interrelationship among the factors. According to Bauer et al. (2007), mobile TV would not take off unless the key players in the value net could coordinate and integrate closely with a constellation of technology, policy, and firm strategies. Shin (2006) takes a socio-technical ensemble perspective to investigate DMB's three subsystems (technology, market/industry, and policy) and further examine their interrelationships. His integrated analysis claims that the fast development of DMB has shifted from being technology-driven to being external factor-driven (market, user, and regulation).

Shin's social-technical approach (2006) not only looks at how the key forces (technology, market, policy) shape the technological development, but also at how the forces affect each other. It can serve as a holistic theoretic lens for investigating the emerging dynamics of mobile broadcasting TV. Hence, this study uses it to examine mobile broadcasting TV's technical subsystem, social subsystem, and policy subsystem in Singapore and Taiwan. It not only explores the identified key social actors' perspectives toward mobile broadcasting TV but also analyzes the influences and relations among the relevant subsystems (industry/market, technology, and policy).

Method

The development of mobile broadcasting TV in most countries is still in an initial stage. Singapore and Taiwan just finished the mobile broadcasting TV trials in late 2008 and not many changes have occurred till now (Mobile TV Trial, 2008).

To tackle the complex interrelationships among market, policy, and technology in two emerging industries, in-depth interviews with the major stakeholders is an adequate method to obtain the first-hand and insightful information from key social

actors that shape the technological development. From November 2008 to May 2009, the researchers conducted in-depth interviews with the policy-makers in MDA (Singapore), NCC and MOTC (Taiwan), as well as the industrial leaders who participated in the mobile broadcasting TV market trials in the two countries (Appendix 1). One key step to use the social construction of technology approach to analyze technological trajectories is to identify relevant social groups with conflicts of interests (Bijker & Law, 1992; Pinch & Bijker, 1984; Sawyer et al., 2003; Walsham, 1997). Before interviews, the researchers identified key persons in the mobile broadcasting TV trials, like mobile operators and broadcasters, as well as regulatory agents related to mobile TV policy. The semi-constructed questions for industrial players include their perceived market of mobile broadcasting TV, possible business models, content creation, perceived consumer needs, chosen technology, and preferred regulatory model. What we asked the policy-makers focused on the licensing scheme, content regulation, technological framework, and the expected government and industrial participation in developing mobile broadcasting TV.

In addition, the researchers managed to obtain the MTVS market trial reports, the proposed policy plans, and the second-hand data such as critics' comments on news reports, to complement and contrast the interview results in order to illustrate the macro-level development of mobile TV industries holistically. Hence, in-depth interviews with key stakeholders and second-hand data analysis are valid ways for this exploratory study pertaining to emerging mobile broadcasting TV industries in Singapore and Taiwan. Moreover, viewing mobile TV as a socio-technical ensemble, this study adopts Shin's (2006) model to examine how the three subsystems (technology, industry/market, and policy) shapes the development of mobile TV in Singapore and Taiwan. It also examines the complicated interrelationships among the three subsystems and compares the similarities and differences of mobile broadcasting TV in two national contexts. All the data collected were organized and analyzed under this socio-technical framework.

The development of mobile broadcasting TV

Singapore: controlled competition and two market trials

Singapore has a limited competitive telecommunication market with three mobile communication operators (Singtel, Starhub, and M1) and a monopoly broadcasting industry (MediaCorp). During June 2007 to November 2008, Singapore Digital, a joint-venture of Broadcast Australia and PGK Media, launched the first DVB-H mobile broadcasting TV trial in Singapore, named TV2GO. It provided live TV programming and interactive content on the DVB-H mobile platform. In November 2007, the MDA, Singapore's policy-maker for interactive digital media, conducted a three-month public consultation on the proposed regulatory framework for mobile TV services (MTVS). In August 2008, the three telcos (SingTel, M1, and StarHub) and MediaCorp rolled out a joint DVB-H mobile broadcasting TV trial and offered live broadcasting content on mobile, especially the Olympic Games in Beijing. After TV2GO and the local consortium submitted trial reports in late 2008, the MDA has not made any further move on MTVS policy yet. The launch of commercial mobile broadcasting TV in Singapore remains uncertain.

Taiwan: free competition and five mobile broadcasting TV trials

Mobile broadcasting TV initiatives started earlier in Taiwan's open and competitive telecommunication market than in Singapore. In 2005, the Mobile TV Strategic Alliance and the Mobile TV Industry Exchange Association were formed to evaluate technologies, search business models, and promote mobile TV services in Taiwan (Yang, 2007). In May 2005, Chinese Television System (CTS), a broadcaster, was supported by the Ministry of Economics to start a DVB-H project. In 2006, the government passed Public Television Services' (PTS) DVB-H/IPDC proposal (Yang, 2007). The mobile broadcasting TV licensing scheme was left to a newly established converged regulator, the NCC, to decide.

In 2006, the NCC proposed a handheld TV trial project in August and assigned three channels and two regions for trials. In October 2006, the NCC issued four licenses for mobile broadcasting TV trials (PTS Team, CTV Team, Qualcomm Team, and Chung Hwa Wideband Team) and chose Dawn TV in the second selection. The five trial alliances started their field trials separately from January 2007 to October 2007. Qualcomm, Dawn TV, and CHWBN delayed their starts and extended trials for another six months. 'Promoting Handheld TV/Mobile TV' was listed in NCC's annual plan from 2006 to 2008. Before the first-term Commissioners ended their duty in July 2008, no progress on MTVS policy was made due to disagreement among some NCC Commissioners (Ho, 2008). Because the licensing scheme was put off, Dawn TV was unfortunately dismissed in 2008 (F. Lai, personal communication, March 17, 2009).

After spending around US\$1.5 billion in bidding for the 3G licenses, the 3G mobile operators were not as keen to invest in mobile broadcasting TV and played a supporting role in the trials. For example, Chung Hwa Telecom and Taiwan Mobile joined PTS and CTV, supplying the return path via their 3G/2.5G networks and providing customer services and billing systems; Far Eastone joined four local teams (PTS, CTV, CHWBN, and Dawn TV) to do experiments.

Socio-technical system analysis of mobile broadcasting TV

After illustrating the background of mobile TV in both countries, the following sections take a social-technical framework (Shin, 2006) to analyze the subsystems (market/industry, technology, and policy) of mobile broadcasting TV in Singapore and Taiwan.

Industry/market subsystem

Singapore's MTVS trials

The two Singapore DVB-H broadcasting MTVS trials both targeted young adults and PMEBS (professionals, managers, executives, businessmen) as the early adopters of mobile TV (Lin, 2008) (Table 1). The former has local experience and access to existing mobile phone users, while the latter collaborates with ABC and other international partners. The strength of the local consortium lay in MediaCorp's local programming and Chinese channels. MediaCorp's Business Development Director said the local joint trial did not offer interactive content as their handheld devices could not support such applications (K.M. Ku, personal

Table 1. Comparisons of broadcasting mobile TV trials in Singapore.

| | 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, and kids) | 100 (mixed demographics) |
| Early adopter | Youth and PMEBs | Youth and PMEBs, age 17–35 |
| Content | 15 channels (English and Chinese) News (Channel NewsAsia, CNBC, Cti, 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) | 10 foreign channels CNBC, ESPN, WOW!TV, ESPN, Bloomberg, Disney Channel and TV2GO's own channels |
| Interactive service | n/a | 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 |
| Handset | Samsung P-960 | Nokia N77, N92, Samsung SGH-P930 |

Source: Lin (2008)

communication, March 4, 2009). However, TV2GO provided its 300 trial participants with premium foreign channels and interactive content, such as road-test interactive chat rooms, teletext-to-mobile, and interactive real-time financial services. Its chairman expressed the ambition to use Singapore as the test-bed to expand experiences to other countries (G. Dorrucchi, personal communication, October 16, 2008).

In comparison, the local players took a more conservative, wait-and-see attitude toward the development of the risky MTVS business during the economic downturn. However, Singapore Digital was keen in pushing MTVS to enjoy first-mover advantages, despite uncertainty and an expected turf war. Local industry players did see TV2GO as a threat, as this new entrant did not have local connection, network coverage, and finance for investment (K.M. Ku, personal communication, March 4, 2009; M. Tan, personal communication, March 4, 2009).

Singapore's predicted MTVS business model

Singapore mobile broadcasting TV players (G. Dorrucchi, personal communication, October 16, 2008; K.M. Ku, personal communication, March 4, 2009; M. Tan, personal communication, March 4, 2009) involved in the two market trials preferred the subscription model in the early adopter markets, even though global experiences show that the FTA model that bundles free mobile TV services is useful in reaching a critical mass. Industry players expected early adopters would pay for unique mobile content and services. For instance, TV2GO's chairman Dorrucchi indicated TV2GO would set an affordable monthly flat rate for viewing eight to 10 broadcasting TV channels over cell phones. MediaCorp's Business Development Director stated that at a later stage MTVS should switch from a subscription model to a FTA model, but the timing of introducing the latter model was tricky. K.M. Ku (personal communication, March 4, 2009) stressed if the introduction was premature, the established pay-MTVS market might be undermined as in the cases of South Korea and Japan.

Next, interviews with MTVS trial teams and the MDA policy director show that Singapore will be likely to have a collaborative consortium market structure and share a common infrastructure because of its small market size (G. Dorrucchi, personal communication, October 16, 2008; K.M. Ku, personal communication, March 4, 2009; P.L. Ling, personal communication, March 16, 2009; M. Tan, personal communication, March 4, 2009). To make commercialized MTVS successful, mobile operators, content providers, and handphone manufacturers must work closely together. Telcos with direct relationships with mobile phone users (such as SingTel) are expected to lead the development, while the broadcaster MediaCorp works as a supporting role to create and aggregate content for MTVS multiplex (K.M. Ku, personal communication, March 4, 2009). Industry players (K.M. Ku, personal communication, March 4, 2009; M. Tan, personal communication, March 4, 2009) believe there would be enough content for MTVS operators to differentiate marketing and pricing. Furthermore, only a few expensive Nokia and Samsung cell phones can receive signals of both MTVS trials, but their functionalities and designs are immature. The commercialized MTVS handsets must be improved in design, interface, and software to impress Singapore's gadget-lovers.

Singapore's MTVS demand

During the trials, as there was no pricing involved, the viewing patterns directly reflected viewers' content preference. The MTVS trial content still used existing local and foreign broadcasting programming primarily. Sports, news, and local content were found to be the most popular MTVS genres in trials, especially the Beijing Olympic Games (K.M. Ku, personal communication, March 4, 2009; Lin, 2008). Interviewees indicated initial commercialized mobile TV would concentrate on how to arrange a compelling line-up of broadcasting content, rather than prioritize interactivity or innovative content (e.g., user-generated videos) (G. Dorrucchi, personal communication, October 16, 2008; K.M. Ku, personal communication, March 4, 2009). Ultimately, it is necessary to develop made-for-mobile content to engage users on the move. Besides, MediaCorp expressed a careful and selective attitude toward using UGC, while TV2GO showed high enthusiasm in placing UGC channels to target youths, the potential early adopters of MTVS. MediaCorp's

Business Development Director Ku also stressed the significance of using marketing strategies to sustain continuous viewing of MTVS (K.M. Ku, personal communication, March 4, 2009).

There are challenges to boost the market demand foreseen before the commercialization of MTVS. According to K.M. Ku (personal communication, March 4, 2009), mobile TV is a 'nice to have' service, not a necessity. MDA's 2007 survey revealed that 11% of Singaporeans would pay US\$4–\$12 per month for MTVS (MDA, 2007). The majority of Singaporeans have not been aware of MTVS yet. Often, Singaporeans confuse mobile TV with TVMobile, the digital TV service provided on public buses. Also, MTVS faces strong competition from substitutes such as iPods, Blackberry devices, and portable video games. Yet, TV2GO's chairman Dorrucchi confidently thought the business would reach critical mass shortly after launch, as it fits the Singaporean lifestyle (G. Dorrucchi, personal communication, October 16, 2008); that is, many live in small flats, work long hours, and commute using public transportation.

Taiwan's MTVS trials

Two broadcasters, PTS and CTV, led two trial teams. PTS used government's fund to test handset reception and system interoperability, develop mobile TV content/services, as well as establish the platform. Qualcomm wanted to prove to Taiwan and other countries MediaFLO's functionality and compatibility with other MTVS systems. Chung Hwa Wideband Best Network, an ISP, hoped to expand its wireless territory by conducting a MTVS trial. Finally, newly-established Dawn TV, a subsidiary of CMC Magnetic Corporation, planned to enter the TV industry by participating in the trial.

The five mobile broadcasting TV trials cover the western half of Taiwan (Table 2). PTS, CTV, and Qualcomm conducted MTVS trials in the northern region (from Keelung to Miaoli) and the remaining two in the south (from Taichung to Pingdong). Only Qualcomm was assigned CH53 to conduct the trial, when other teams used CH35 and CH36. In the trial consortiums, broadcasters, cable MSOs, and satellite TV operators supplied MTVS content, while mobile operators provided the return path for interactive services, authentication/ billing systems, customer base, and CRM (Shih, 2008).

Compared with Singapore's MTVS content, Taiwan's trial teams provided more varieties of content for their trialists, ranging from traditional TV and radio channels to interactive, made-for-mobile content. In addition to existing audiovisual content, the four trial teams provided made-for-mobile content, including PTS's Phone TV (F. Lai, personal communication, March 17, 2009), CTV's iNTv (interactive channel), CHWBN's Traffic TV, and Dawn TV's Beautiful Life TV, Skyhigh Entertainment, as well as interactive and value-added services. Some channels, such as ETTV News and ETTV Shopping channels, were shown in different trials.

Taiwan's predicted MTVS business model

In Taiwan, the five MTVS trial teams proposed a hybrid model, an advertisement-sponsored FTA, and a subscription model (J.K. Hong, personal communication, March 20, 2009) because most foreign experiences revealed that the FTA model was difficult in making revenue. Three trial results (CTV, PTS, and Dawn TV) showed

Table 2. Comparisons of mobile broadcasting 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, Da Ai TV, iNTv, Momo, Star TV, Music Radio | 5 channels | ETTV News, ETTV Variety, ETTV Shopping, FTV, FTV News, 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, Da Ai TV, Cti TV, Cyberlink | Qualcomm, Asia Pacific Broadband Wireless, China Network Systems, TTV | Chung-Hwa Wideband Best Network, Far Eastone, Eastern TV, Formosa TV, Da Ai TV | Dawn TV, CTS, Nokia, Eastern TV, Vibo Telecom, Cyberlink, Far Eastone |
| Trial survey | 250 samples interviewed on streets, 85 for handset placement test | 1000 random samples, 200 trial users | n/a | n/a | 100 trial users, focus group, in- depth interviews |

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

that the majority (66%) preferred to pay a monthly fee US\$6–\$9 for 20 MTVS channels. The PTS survey showed that 51% of test users were willing to subscribe to pay channels (45%) or interactive services (PTS MTVS Trial Team, 2008). A total of 73% of CTV's users were interested in subscribing to MTVS interactive services. To attract MTVS users, Yang's NCC-sponsored report (2007) recommended that 25% free content and 75% paid content might be accepted by the interested users. It suggested MTVS users pay a modest monthly transmission fee (US\$1.5) for free content, but have the freedom to subscribe to *à la carte* channels and pay-per-view (US\$3–\$5 per month).

Taiwan's MTVS demand

CTV and PTS's surveys (F. Lai, personal communication, March 17, 2009) showed that news, sports, and drama were trialists' favorite content. They tended to use MTVS two to three times a day and about 10 minutes each time. CTV report (2007) stated trialists usually watched MTVS while waiting or commuting. Surveys revealed that mobile TV trials helped the acceptance of MTVS as the testers became more willing to use MTVS after the trial. Half of the trial users in the Dawn TV trial wanted to subscribe to MTVS (Dawn TV MTVS Trial Team, 2008), while over 50% of the PTS trial's users would buy MTVS devices in six to 12 months. In general, what the trial participants were dissatisfied with included poor reception and insufficient content. For example, CTV's trialists suggested improvement in content diversity, user-friendly services, and functionalities, like mobile Internet, an EGP, and personal services. The trial surveys showed that more than half of the trialists stressed the need to improve MTVS content and services.

Technology subsystem*Singapore: DVB-H standard*

According to the MDA's Policy Director (P.L. Ling, personal communication, March 16, 2009), the government gave maximum room to the industry to find a suitable technological match. With MDA's technology-neutrality principle, the two MTVS trials showed that Singapore industry players would choose DVB-H because of its compatibility to the existing digital terrestrial TV standard DVB-T and capacity to support 20 high-quality channels without paying data charges (G. Dorrucchi, personal communication, October 16, 2008; K.M. Ku, personal communication, March 4, 2009; P.L. Ling, personal communication, March 16, 2009). A sophisticated DVB-H broadcasting platform requires substantial investment in building transmission towers and infrastructure. MediaCorp has built DVB-T transmitters for digital terrestrial TV and TVmobile, the digital broadcasting service on buses, which could be used to broadcast DVB-H mobile TV broadcasting. Singapore Digital would also invest in building DVB-H towers and then rent extra bandwidth to its competitors.

Moreover, 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 the industry to choose from VHF, used by South Korea's DMB to save cost, and UHF, used by MediaFLO and DVB-H to offer more channels. The two 2008 market trials revealed the industry's preference for the UHF frequency.

Even though the MDA does not mandate indoor coverage in the short run, DVB-H mobile broadcasting services must overcome the technological bottlenecks of indoor coverage and tunnel reception before their massive roll-out, because Singaporeans spend most of their time indoors or commuting. For example, TV2GO's chairman found many trialists watched the mobile TV at home or in the office and decided to improve the indoor reception (G. Dorrucchi, personal communication, October 16, 2008). In the future, Singapore's industry players predict the co-existence of DVB-H and 3G/4G technologies as they complement each other's functionalities (G. Dorrucchi, personal communication, October 16, 2008; K.M. Ku, personal communication, March 4, 2009). Interactive content or services

on mobile TV platforms can be provided by the 3G cellular network, while DVB-H mobile TV sends out multi-casting content to a mass audience.

Taiwan: DVB-H and MediaFLO standard

Similar to Singapore, the regulator NCC emphasized its ‘technologically neutral’ approach to the MTVS standard, so it would let the industry decide their standards. Since Taiwan adopted the European DVB-T standard for digital terrestrial TV, due to compatibility issues, most trial teams selected the DVB-H standard. Only the Qualcomm team used its proprietary standard MediaFLO. In order to protect consumers’ interests, the regulator required MTVS operators to guarantee no system interoperability problems. Besides, Article 10 of the Fundamental Communications Act stipulates 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 test-trial frequencies are located on CH35 (freq. 596–602 MHz), CH36 (freq. 602–608 MHz), and CH53 (freq. 704–710 MHz). However, according to the proposal submitted by the MOTC to the Executive Yuan, CH53 would not be used by the MTVS at the initial stage.

Policy subsystem

Singapore: platform-neutral, market innovative, Broadcasting Act

MDA’s proposed regulatory framework defined MTVS as ‘personalized viewing TV, often with a choice of 10 to 15 channels on an anywhere anytime basis’, which is not charged by the length of viewing time. The MDA announced a ‘platform-neutral’ approach as there is neither any mainstream standard worldwide nor strong public interest consideration. 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, while under the Telecommunication Act, a license will be issued to any party running a telecommunication system for operating MTVS.

To foster the growth of nascent mobile TV industry, the MDA proposed to adapt IPTV services’ two-tier framework to MTVS and cellular mobile TV service: a niche license (< 100,000 subscribers) and a nationwide license (> 100,000 subscribers). All operators will apply for the niche license in the initial stage. Both licenses have no must-carry obligations and no cap on advertising revenue, but have programming code restrictions and advertising time limits. As mobile TV is likely to attract young users, the MDA proposed that MTVS follow Broadcasting TV Program Codes to protect the vulnerable groups.

The uncertainty of commercial viability of MTVS has led to the MDA considering a consultative and collaborative approach for licensing instead of its traditional tender process (P.L. Ling, personal communication, March 16, 2009). To push mobile TV content innovation, the MDA encouraged industry players to develop interactive features in their MTVS content/services, which would show merit in their licensing process (P.L. Ling, personal communication, March 16, 2009). It also welcomed companies like Singapore Digital to use Singapore as a test-bed for new services of the interactive digital media.

The MDA holds the underlying market-driven principle that the industry should decide whether MTVS is commercially attractive or not. According to the MDA's Policy Director (P.L. Ling, personal communication, March 16, 2009), the government had been in active discussions with industry players before finalizing the MTVS policy framework. The MDA would not force commercialized MTVS if the industry's business plans and consumer demand were premature. The general concern of telcos and the broadcaster was to what degree the government would be involved in building MTVS infrastructure.

Taiwan: technology neutral, uncertain licensing scheme

Although the NCC considered promoting mobile TV services in its annual plans from 2006 to 2008, there were disagreements among the NCC Commissioners about when to open up mobile TV services. Supporters indicated that the NCC should support the keen interests of the five industry trial teams and speed up the licensing process; opponents argued that it was premature for MTVS as there were no successful business models worldwide (225th NCC Commission Meeting Record; www.ncc.gov.tw).

On 31 January 2008, NCC's proposed regulatory framework for public consultation was finally passed and later sought for a three-week public consultation. To open up MTVS, the NCC followed three principles: (1) encourage new technologies and services; (2) plan carefully for scarce resource; (3) and issue licenses in a fair, open, and efficient manner. As a converged regulator, the NCC regulates telecommunications and broadcasting industries with a Telecommunications Act and a Radio and Television Act. As MTVS is a converged service, the NCC must consider which law is more appropriate for governing its license. Since the Radio and Television 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 open up the MTVS license based on the Telecommunications Act. With regard to MTVS content, it will be subject to the Broadcasting Act (Ho, 2008).

Like Singapore's MDA, the NCC proposed to take a 'technology-neutral' approach to issue three MTVS licenses, each of which will be allocated 6 MHz to provide at least eight channels and at least 50% of TV content. The proposed license term is six years. The licensing mechanism is a hybrid scheme including beauty contests and auctions. Considering economies of scale, all of the interested players proposed to have nationwide MTVS. In order to encourage competition and innovation, the NCC proposed to reserve one channel for non-WBA or non-3G operators. The NCC does not think a must-carry rule is applicable to MTVS.

However, after the public consultation, the NCC has not taken any further action until the first-term Commissioners dissolved in July 2008 and the second-term Commissioners did not regard mobile TV as an urgent issue. After the new administration took the helm in May 2008, the KMT-led Executive Yuan considered combining mobile TV and DTV issues together (T.L. Deng, personal communication, March 20, 2009; J.K. Hong, personal communication, March 20, 2009; C.H. Wu, personal communication, March 6, 2009). Almost 22 months after the NCC solicited public consultation for the MTVS policy, the Executive Yuan finally passed the MOTC's proposal on 29 December 2009. Thereafter, the MOTC announced that the government will open up two 6 MHz nationwide MTVS licenses broadcast on

CH35 and CH36. It is speculated that the NCC will take at least six to eight months to finalize the MTVS licensing scheme. Moreover, the NCC proposed to let 3G operators, WBA (wireless broadband access) operators, and DTV license holders use their existing spectrum to provide the MTVS. However, the NCC must revise relevant laws (such as content regulation and leasing restrictions) before the incumbent can provide the service.

Cross-country comparisons of mobile broadcasting TV

Singapore and Taiwan both have advantageous conditions to develop mobile TV, including high mobile penetration, digital-savvy customers, pro-innovation governments, sophisticated media companies, and well-established telecommunication infrastructure. Table 3 elaborates the comparisons of industry/market, technology, and policy subsystems of mobile broadcasting TV in Singapore and Taiwan. Compared with Taiwan, Singapore's commercial mobile TV market is more collaborative and less competitive. Lacking economies of scale leads Singapore MTVS players to adopt a telco-led consortium market structure to share costs in infrastructure investment and content development and compete with the new entrant. Taiwan's five MTVS trial teams formed their alliances from telcos, ISPs, content providers, broadcasters, etc. The market trials show Taiwan's commercial mobile TV

Table 3. Comparisons of mobile broadcasting TV in Singapore and Taiwan.

| | Singapore | Taiwan |
|-------------------------|--|---|
| Industrial players | Mobile operators, broadcaster, one new entrant (foreign) | Broadcasters, mobile operators, new entrants (1 foreign, 2 locals), 3G TV content providers |
| Proposed business model | Subscription model in early adoption stage, FTA model later | Hybrid model: an advertisement-sponsored FTA model and a subscription model |
| Regulators | MDA, IDA | NCC (regulator) MOTC (policy-maker) |
| Technology | DVB-H | DVB-H and MediaFLO |
| Standard setting | Technology-neutral | Technology-neutral |
| Licenses | 4 (proposed): 2 (1.5 MHz), 2 (8 MHz) | 2 (6 MHz) |
| Licensing scheme | comparative tender | Beauty contest and comparative tender (not decided yet) |
| License term | 10 years + 5-year extension 5 years (niche MTVS) | 6 years + 6-year extension |
| Laws applied | Multiplex: Broadcasting Act MTVS: Broadcasting Act Transmission: Telecommunications Act | MTVS license: Telecommunications Act |
| Content regulation | Broadcasting Act | Self-regulation (not decided) |
| Mobile TV content | >65% | >50% (not decided) |
| Obligation | No must-carry | No must-carry (not decided) |

market is more likely to be a broadcast-led consortium. However, if the NCC decides to use a Telecommunications Act to open up the MTVS licenses, and if the licensing scheme is 'beauty contest and auction,' the telco-led consortium will have more advantages over the broadcast-led consortium.

In addition, Taiwan's 3G TV that has attracted a certain amount of users with innovative content and services is a competitive substitute for its commercialized MTVS. In comparison, Singapore's sluggish 3G video services have less shaping power. Taiwan's broadcasters, mobile operators, and new entrants spent more in R&D and marketing of 3G TV services that provided the precious lessons for them to move forward to the mobile broadcasting TV business. Singapore's industrial players did relatively little in mobile video services which causes them more challenges to find the appropriate business model, pricing scheme, and consumer education.

The subscription model could ensure a clear revenue stream to stakeholders in the mobile TV value chain (Oh & Jablon, 2008) to sustain ongoing development. The findings show Singapore's industry players and policy-makers regard the subscription model as a viable business model for MTVS, while Taiwan's actors prefer a mixed model of FTA and subscription. Singaporeans have experienced pay-TV's tiered packages, video-on-demand, pay-per-view, and other 3G mobile Internet and video services, so this market can use a subscription business model for viewers to enjoy varieties of mobile video content and services at different rates. In contrast, Taiwan's users who lack experience of tiered pricing may prefer a flat monthly MTVS fee with a set of channels and pay-per-view additional personalized content and services. However, MTVS operators in these two media-saturated countries must make more effort to attract audience's eyeballs and facilitate the mobile video viewing culture.

Both countries took a technology-neutral approach toward the standard setting of mobile broadcasting TV. Singapore's market trials showed its commercial MTVS will be on the DVB-H platform; most of Taiwan's key players also tended to select this standard as their DTV standard, except the MediaFLO team that used Taiwan as a test-bed for its interoperability with other broadcasting mobile TV technology. They both encountered bottlenecks in improving indoor and tunnel reception. Nevertheless, Taiwan, a bigger island country compared to Singapore, ought to invest more in infrastructure to achieve good outdoor coverage.

The question of when to start the commercialized MTVS in Singapore and Taiwan is still uncertain. Concerned about commercial viability, the MDA takes a more consultative, collaborative, and market-driven approach for licensing and will open four multiplexes offering MTVS in Singapore. The MDA may involve itself in building infrastructure, after discovering the industry's needs and evaluating mobile TV business potential. Comparatively, Taiwan's government is less involved in pushing this emerging business and MTVS was not highly prioritized by the NCC. It is the industry, especially the MTVS trial teams, which pushed the government to move forward. As for content, Singapore's MTVS is subject to the Broadcasting Act that applies strict content code, while Taiwan's MTVS is regarded as a convergent service and will enjoy more flexibility in content. Currently, the most important issue for developing MTVS in Singapore is when to open up the license, but for Taiwan, the important issue is how to open up the license.

According to Bauer et al. (2007), the diffusion of mobile broadcasting TV require key players in the value chain to coordinate and integrate with a constellation of technology, policy, and market strategies. The analyses show Taiwan is more ready to commercialize mobile broadcasting TV as its finalized policy is technologically neutral and supportive in content innovation. The experiences of 3G TV operations in Taiwan also offer valuable lessons for its industrial players to collaborate with actors in the value net and run a similar mobile broadcasting TV business.

Social-technical mobile broadcasting TV and interrelated subsystems

The emergence of mobile broadcasting TV, a social-technical artifact, is a socially and technologically complex development that will create changes in economy and society (Bauer et al., 2007; Shin, 2006; Han, 2003; Shim, 2005). The socio-technical perspective shows various aspects of mobile broadcasting TV: technology, services, industry, market, regulation, and their dynamic interrelationships. Technological development, such as mobile broadcasting TV, is shaped by networks of social actors (Walsham, 1997) and their selection based on interests (Bijker & Law, 1992). Based on the interviews with key social groups of mobile broadcasting TV in the two countries, we found discrepant views and conflicts of interest with respect to developing mobile broadcasting TV. Singapore's telcos and broadcasters are more uncertain and conservative than the potential new entrant and its small-scale market has more obstacles in the development of mobile broadcasting TV (e.g., less made-for-mobile TV content or interactive services). In Taiwan, the broadcasters and new entrants were keener than the telcos to provide wireless video services.

Singapore's economic planning and highly efficient administration are likely to create a prosperous mobile broadcasting industry despite the initial lack of compelling content/services. However, even after the new entrant triggered the market trials and prompted the proposed regulatory framework, the regulator is still evaluating the commercial viability of the new technology. In comparison, although Taiwan's free and competitive telecommunications market and ineffective policy-making process cast uncertainty, the policy announced in December 2009 might propel the development of the MTVS.

Similarly, the initial stage of technologically-mature mobile broadcasting TV in Singapore and Taiwan was pushed forward by industry players but held back by policy-makers. Policy-makers in both countries have taken market-driven and technology-neutral approaches. They tend to choose DVB-H technology which is compatible to the previous DVB-T standard. Nevertheless, Taiwan may adopt both standards, since Qualcomm has been active in promoting MediaFLO there. The flexibility in selecting mobile TV standard may foster the development of MTVS; however, the indecisiveness in policy-making may result in them missing the early window for nurturing the blossoming of MTVS.

The analyses reveal that the initial development of mobile broadcasting TV in Singapore and Taiwan is more industry- and policy-driven than technology-driven. Their industry players and regulators shape the nascent mobile broadcasting TV industry more than technological forces. As for the interactions between the three

subsystems of mobile broadcasting TV, the industry pull is shown as the most significant driving force for the development of mobile broadcasting TV in Singapore and Taiwan, while the policy delays this technology-ready mobile service.

Similar to previous socio-technical studies of emerging technologies, this research also found the significance of social actors in shaping the technological trajectory and the determining driving forces of industry/market, policy, and technology. New mobile media technology in different national contexts may present different interrelationships of the three interrelated subsystems. In general, technological maturity and its compatibility to existing infrastructure are the first cornerstone of developing emerging technology and applications. Next, policy is critical to clarify the licensing scheme, content regulation, and other issues, before any interesting industrial players invest and launch any commercialized new media services.

The social technical models of Han (2003) and Shim (2005) include the culture dimension to analyze the adoption of emerging technology. However, unlike Korean's DMB development involving culturally sensitive ICT policy, this study does not find cultural influence in the technological standard setting, as both Singapore and Taiwan decided not to impose any single mandatory technological standard. This may be attributed to their small economies which can only choose their standards from the existing ones invented by the USA, EU, or other bigger countries. Other than national protectionism and interests, they are concerned more about functionality, compatibility with legacy infrastructure, and reliability in performance by carefully observing early adoption cases overseas.

However, content regulation is a fairly socio-cultural issue. Singapore's regulatory body intends to apply the Broadcasting TV Act to the mobile TV content, in order to protect the minors and maintain censorship, while the Taiwan counterpart that is known for speech freedom cares about whether the MTVS can aggregate compelling and original content to achieve commercial viability. Moreover, the two countries have distinctive cultures in their mobile industries and market. Singapore is a planned economy with a controlled telecommunication industry; Taiwan has a highly competitive market. Singapore's multilingual videos are primarily for the local market; Taiwan produces varieties of audiovisual cultural products in Mandarin for both the internal market and export. From these analyses, we argue that the cultural factor indeed plays an underlying role in shaping the three subsystems of emerging technologies and affect the technological development in a subtle but pervasive way. Therefore, we add the culture dimension into the socio-technical framework to analyze the mobile broadcast TV industry (Figure 1).

The socio-technical approach is found useful for investigating mobile broadcasting TV's interrelated, co-evolving subsystems (technology, economics, policy), predicting its possible evolution, and serving as a framework for cross-country comparisons. This paper provides rich empirical data and socio-technical insights which shed light on technological, economic, and regulatory issues related to evolution of mobile broadcasting TV in Singapore and Taiwan, and provide implications for high mobile penetration and digital-savvy countries to develop the emerging mobile technology.

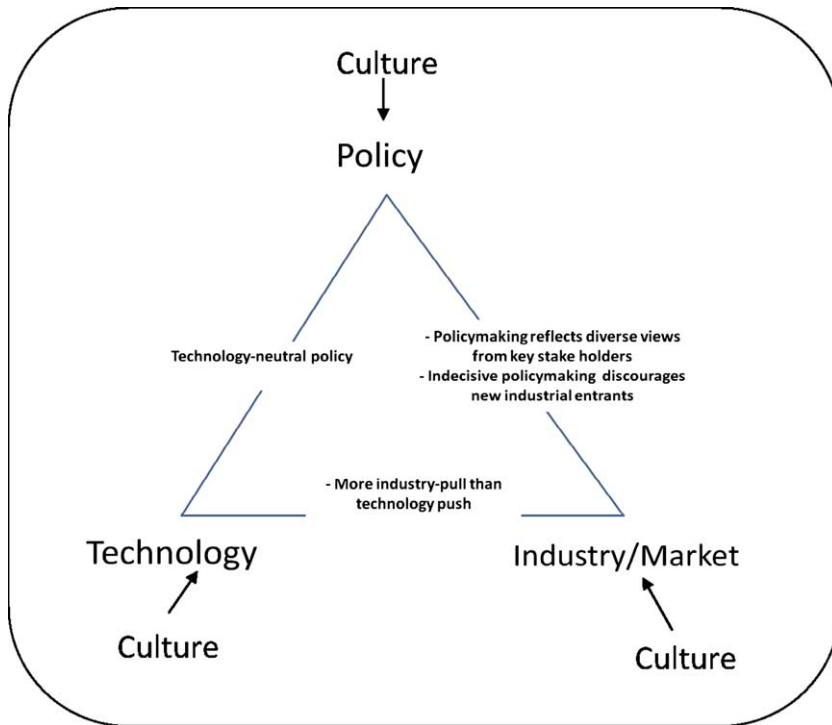


Figure 1. Mobile broadcasting TV in a socio-technical framework.

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Appendix 1: Interviewee list

| | Singapore | Taiwan |
|---|--|---|
| Mobile broadcasting TV policy-makers | Ling, P.L. (2009, March 16). Director of Media Policy Division, Media Development Authority. | Deng, T.L. (2009, March 20). Director of the Department of Post and Telecommunications, MOTC. Hong, J.K. (2009, March 20). Director of Department of Planning, NCC. Wu, C.H. (2009, March 6). Chief Secretary, NCC. |
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