ICT Convergence in Creative Economy for Policy Coordination:

A Case Study of Unmanned Vehicle Research for Developing Digital Platform and Ecosystem+

B. Joon Kim

Abstract

This study is to examine markets and policies of sectoral Information Communication & Technology (ICT) convergence, focusing on a case study of policy coordination with ICT convergence from the perspective of building a digital platform and ecosystem to enhance synergy effects in the industrial sector. Based on general, theoretical studies on digital platforms and ecosystems, unmanned vehicles (or ICT convergence of autonomous vehicles) were selected to design a model and draw practical implications. With AHP survey targeting experts and researchers (including graduate students) working in the field, the design of policy and systems, and the basic direction for policy coordination were investigated. This introductory study was conducted to verify whether digital platform and ecosystem are being realized as in developed countries. In particular, the present study's policy implications were suggested with respect to policy mediation through the case study. Core values of digital platform and ecosystem are 1) ICT convergence ecosystem (systems and policy establishment); 2) economic development and industry growth (economic and industrial support); 3) social entitlements (social contribution); and 4) technological development (cooperative research and technology development). Based on these factors, priorities were analyzed from each sub-factor. The finding shows that policy coordination should pursue ICT-based industries, concentrating on the artificial intelligence industry; and should develop intelligent cars that prevent accidents with a view to reducing social costs while realizing the creative economy in the future.

Keywords: Creative Economy, ICT convergence, autonomous vehicles, AHP, digital platform, ecosystem

1. Introduction

The need for policy-relevant research on new technology to provide a blueprint for future science and technology policy has been heightened due to growing uncertainty and unpredictability arising from technological development and social change. Since the mid-2000s, discussions have been ongoing across academic and industrial fields on reinforcing the positive cycle between policy and information and communication technology (ICT), as represented by a hyper-connected society[1], Internet of Things (IoT), and Big Data, to enable quality service for people and foster future industries. In particular,

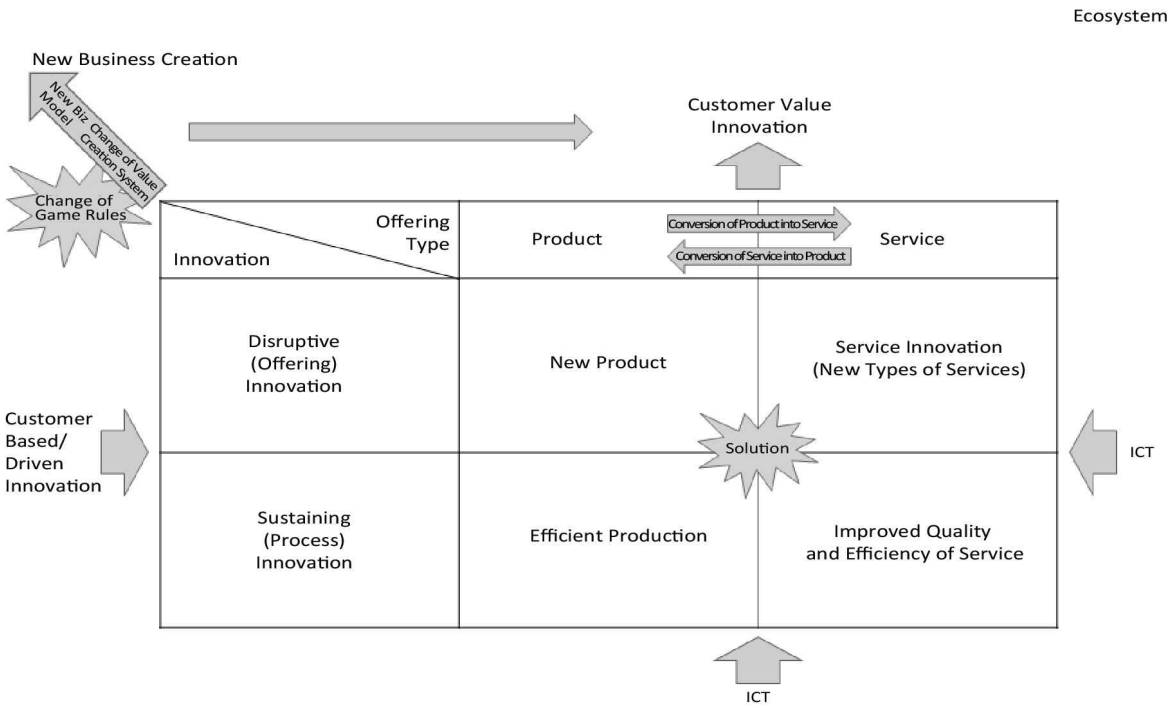
School of Public Administration and Public Policy, Kookmin University, 77 Jeongneung-ro, Seongbuk-gu, Seoul 02707, Korea

E-mail: kimbj@kookmin.ac.kr

+ This paper was funded by KISTEP through the 2016 Creative KISTEP Fellowship Program

1 ICT is emerging as a key means of realizing 'creative economy' to generate new businesses and jobs through convergence with other industries. The development of ICT includes machine to machine (M2M), IoT, and IoE, which is expected to enter the era of hyper-connected society (Ju and Kim, 2014).

Figure 1. Definition of ICT convergence



Source: Kim et al. (2013) The Korea Society of Management Information Systems.

ICT has dramatically developed, opening up a new era of Internet of Everything (IoE) which connects humans, processes, data, and things. In addition, the importance of ICT convergence in realizing a creative economy for policy coordination is being emphasized.

While the definition of ICT convergence technology varies, it mainly refers to blending technology in different fields with ICT, which causes essential changes in products and services to give rise to new ones. The keyword 'connection' that has come to define ICT refers to relations between humans, things, and the world. Convergence is an important concept in the sense of a hyper-connected society, which connects a variety of data, systems, and services. As indicated in Figure 1, ICT convergence can be defined as creating new business models and ecosystems.

As defined in Figure 1, ICT convergence leads to creation of products and services through new processes and a wide range of cooperation with manufacturing and service sectors to meet the needs of customers. Consequently, ICT convergence fundamentally reforms existing value creation systems and relations between actors in the market (such as cooperation and competition). As such, new business models or industries can be created, allowing a transfer to a different ecosystem of ICT.

To adapt to social changes at a national level, an innovation ecosystem as well as digital platform need to be established to foster new products and services, facilitating convergence among technologies, industries, and markets. The digital platform represents the era of convergence in the areas of ICT, science and technology, and industrial policy. Major countries are pushing ahead with plans to establish innovative digital platforms and ecosystems, including drastic reforms of regulations to increase the flexibility of the existing industrial ecosystems.

Therefore, this study is to examine market and policy trends, and case studies for policy coordination of ICT convergence from the perspective of digital

platform and ecosystem, and draw policy implications. To design a theoretical model and draw empirical implications on developing digital platform and ecosystem, unmanned vehicles in Korea have been analyzed. The AHP survey and interviews were conducted with ICT convergence experts in the area of unmanned vehicles and researchers (mostly graduate students) working in the field. The findings obtained through these methods may be used as basic data to promote and coordinate policy. In other words, this study analyzes the feasibility of digital platform and ecosystem for ICT convergence in Korea, and investigates its implications from the perspective of policy coordination.

2. Previous Studies

Growth of technology-based e-Government has reached its limit as the role of ICT has shifted from means to ends. In this regard, a new approach toward science and technology is necessary to meet future changes. In this study, previous studies are reviewed from a critical point of view. A study by Johnston et al. (2008) emphasizes that maximizing efficiency in public sectors helps to establish consumer-centered policy as digital platforms with ICT convergence technology are developed due to SNS-based networks. Another study by Huang and Benyoucef (2014) shows that usability[2] and credibility[3] are integral parts of public service. Accordingly, the present study also emphasizes the growing need for user-oriented research. As stated by McCarthy and Wright (2007), ICT is no longer something encountered in a specialized environment, but an essential tool in our daily lives. The present study also accepts the idea that future policy implications arise from the current state. Recent studies have stressed the importance of the qualitative growth focusing on the idea that the citizens "do not just use technology; we live with it." In this regard, the study examines policies, strategies, and the current state of market of ICT convergence from the perspective of creative development of ICT convergence technology. In addition, as an analytical framework and concept, digital platform, ecosystem, and policy coordination are also investigated.

2.1. ICT Convergence Policy and Strategy

ICT convergence policy is expected to transform the existing markets or contribute to the creation of new markets and jobs. As such, major countries have established strategies to boost convergence industries, and promote science and technology policy based on ICT convergence to widen opportunities to realize creative economy. ICT convergence industries are expected to have a great impact by merging ICT with various fields such as materials, electronics, optics, energy, space, and medicine. While enormous investment needs to be made for new technology R&D in the medium and long term, the probability for success remains low in the market. In this regard, major governments are actively supporting relevant industries. The US focuses on four categories such as IT, NT, BT, and CS (Cognitive Science), a relatively narrow range of convergence technology. However, R&D for e-healthcare, bio-chip, and bio-informatics is being made through the world's best IT industry and venture ecosystem (Ha and Lee, 2012).

The US strategy for convergence focuses on gaining a competitive edge of technology to improve individual, collective, societal, and security capacity. Main areas are 1) expanding personal perception and communication skills, 2) improving personal health and physical capabilities, 3) enhancing

2 A study of 'Changes of Policy Paradigm for future e-government and Tasks (2009)' emphasizes Easy Government, introducing a case of EU council which shows positive economic effects of e-government when marginalities (the elderly, the disabled) are able to access to it.

3 If credibility is discussed based on the truth, not trust, this concept can be expanded to We/Me on-offline projects, Life Event evaluation index, innovative team management to suggest new experiences, privacy protection and transparent monitoring system (Kim, 2015).

performance of group and society, 4) strengthening national security, and 5) integrating science and education (Kim et al., 2013). The characteristics of the US strategy for convergence technology development include 1) the leading role of federal government in technology development by promoting national projects, 2) federal government's independent contribution or multilateral cooperation with other agencies in technology development, and 3) active participation of enterprises and universities during the phase of R&D and commercialization to maximize impact and put outcomes to practical use (Ahn and Jeong, 2008).

EU started the discussion on convergence from "Converging Technologies-Shaping the Future of European Knowledge Societies (CTEKS)" in 2004. This plan aimed to promote social science approaches to "Knowledge NBIC" and convergence technology from 2006 to 2009, and introduce interdisciplinary research according to the 7th Framework Programme (FP7) from 2007 to 2013 as a means of expanding R&D for convergence technology (Kim, 2010). EU set the targets to utilize convergence technology in five areas: health, education, information and communications, environment, and energy. Based on this strategy, EU is pushing forward to develop technology, establish research environments, and strengthen social and ethical responsibilities.

The features of EU strategy for convergence technology development include 1) enhancing inter-disciplinary activities to include social science and humanities in the area of convergence, 2) considering review and regulations about ethical and social issues, 3) conducting systematic research to develop as well as utilize convergence technology, and 4) providing relevant education in middle schools, high schools and universities. In addition, major countries execute various policy in relation to Internet of Things (IoT). The US, EU, China, Japan are establishing R&D centers and industrial complexes to carry out government-led R&D for IoT and smart grids.

The US has few policies specialized for IoT, but recognizes its importance and focuses on technology and service development. In 2007, the Department of Defense applied M2M-based tracking systems to transport facilities. New York City has also made it mandatory for all taxis to adopt telematics since 2007. In April 2008, National Intelligence Council selected IoT as a key technology affecting national competitiveness. From 2009 to 2020, the US plans to implement IT New Deal policy to distribute smart grids, healthcare, and broadband networks. Efforts to lay the foundation are being made, such as through a public hearing on IoT regulations organized by the Federal Communications Commission in 2013 to assimilate the opinions of participants from various fields (Ju and Kim, 2014).

EU has actively carried out IoT policy compared to the US In 2006, EU made plans to prepare for the era of IoT by drawing up "i2020—A European Information Society for growth and employment." In 2008, research on IoE began through CASAGRAS project supported by the FP7 (2007-13). In July 2009, 14 action plans on IoT (Internet of Things: An Action Plan for Europe) were suggested in terms of R&D, service, infrastructures, privacy protection, information security, legal systems and evaluation systems. In 2010, CASAGRAS project II was implemented to support 40 projects that will lay the grounds for IoT. In August 2013, EU reported the outcome of "Europe's policy options for a dynamic and trustworthy development of the Internet of Things" which had been studied from 2005 (Ju and Kim, 2014).

South Korea has implemented various ICT convergence policies. They can be divided into phases of prior to Lee Myung-bak government, the first half term of Lee Myung-bak government, the second half term of Lee Myung-bak government, and Park Geun-hye government. Prior to Lee Myung-bak government, convergence of BT, CT, NT, ET, IT, and ST was discussed in association with Next

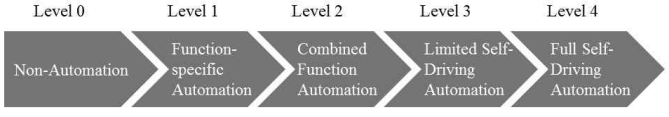
Generation Growth Engines or New Growth Engine Industries. The organizing ministries drew up strategies as follows: Development Strategies for Convergent Components for Industrial Products (Ministry of Commerce Industry and Energy, 2006), Strategies for Digital Convergence New Industry (Ministry of Commerce Industry and Energy, 2006), Basic Policy of Convergence Technology Development (cooperation between 7 ministries, 2007), and Basic Plans for National Convergence Technology (NSTC, 2008; Kim et al., 2013). During the first half term of Lee Myung-bak government (08-11), New IT policy (Ministry of Knowledge Economy, 2008) focusing on IT-based convergence in all industries, and Basic Plans for National Convergence & Technological Development (Ministry of Education, 2008) were established to promote convergence in the areas of automobile, ship building, construction, fabrics, machinery, medicine, national defense, energy, lighting, and robots.

During the second half term of Lee Myung-bak government, "Industrial Convergence Promotion Act (2011)" was established in accordance with global trends of convergence. As such, ministries set up implementation systems of industrial convergence and promoted basic plans for industrial convergence development, including humanities and social sciences. The convergence policy of Lee's administration aimed to create high value-added business through large scale ICT-based manufacturing in order to increase competitiveness in the world market, though it faced criticism for excessive support for conglomerates.

Park Geun-hye government has established the Ministry of Science, ICT and Future Planning to promote commercialization of ICT-based convergence industries for realization of creative economy. Besides online Creative Economy Town, Creative Economy Centers were established to support business in the area of convergence industry in 17 cities around the country through early 2015. In addition, Creative Vitamin Project was promoted to address current issues and support creation of new businesses. The 68 projects selected by March 2015 contributed to increasing industrial vitality through IoT related projects and cooperation, solving social issues utilizing ICT, and stimulating the economy. In January 2015, strategies for new IoT industry were established to lead development in 6 areas (home electronic appliances, automobiles, education, distribution, industrial safety, and energy) with a view to creating new convergence industry (Ministry of Science, ICT and Future Planning, 2015).

In particular, immediate support for unmanned vehicles among ICT convergence policy was brought up at the 3rd ministerial meeting on regulatory reform in May 2015. With a view to commercialize unmanned vehicle by 2020 (Level 3 of automated driving)[4], the administration planned to establish systems and infrastructure early to accelerate

4 Levels of driving automation can be categorized from Level 0 (non-automation) to Level 4 (full self-driving automation). Our goal is to reach Level 3 by 2020, which is limited self-driving automation. In this level, drivers must be available to take over controls in case of emergency (source: NHTSA).



Characteristics	Automation system has no vehicle control	Involves one or more specific control functions	Involves automation of at least two primary control functions working in unison	Limited self-driving automation	Safe self-driving automation
Examples		Cruise control, pre-charged brakes, lane keeping	Adaptive cruise control in combination with lane keeping	Enables all critical functions to be automated. Driver must be ready to take over control in case of emergency	Vehicle is designed to perform self-driving in all circumstances

commercialization of unmanned vehicles although development of technology has started later than in developing countries. In this regard, policy was to focus on 1) regulatory reform and system maintenance, 2) support for unmanned vehicles technological development, and 3) increasing infrastructures for unmanned vehicles. Detailed plans are as follows (MOLIT, 2015).

First, regulatory reform of test-runs on the road and commercialization systems were taken into consideration in regulatory reform and system maintenance. Second, development of core technology, establishment of experimental city for autonomous vehicles (K-City), support for technological development and training against hacking, and trial services for short distances were suggested in support for unmanned vehicles technological development. Lastly, developing global positioning systems, producing digital maps for lane markings, establishing road infrastructures for autonomous driving (V2I), providing frequencies for inter-vehicular communication, and forming a popular consensus were determined as detailed plans for increasing infrastructures for unmanned vehicles, which is the most important policy (MOLIT, 2015).

Based on these goals, visions, and detailed plans, Korean government has accelerated the establishment of infrastructures to conduct test-runs for the Pyeong Chang 2018 Winter Games Olympics. The government, in particular, focuses on technology development (such as guidelines to protect vehicles from hackers, test operation at university campuses) and infrastructures (digital maps for lane markings, GPS adjustment information transmission, test beds for expressways, frequencies for inter-vehicular communication) to take a step towards commercialization.

As shown with above-mentioned policies, unmanned vehicles can be an important example of ICT convergence sector. With new ITS technology and GPS technology, as well as digital maps for lane markings, autonomous driving can be tested from Seoul Tollgate to Hobeop JC through real-time road transport informatics.

Therefore, this study examines ICT convergence strategies and policy for unmanned vehicles as a case of policy coordination about ICT convergence in creative economy. It also draws core values and implications of digital platform and ecosystem. As mentioned before, the study analyzes future creative industry and markets to find strategies for building innovative ecosystems and platforms. The main purpose of this study is to look into implications for policy coordination.

2.2. The Size and the Trends of the Market

ICT convergence features networked ICT, intellectualization, and internalization. In the course of new convergence, it attains characteristics of continuity, additionality, extendibility, and multiplicity, which allows multi-dimensional value chain in the evolving ecosystem, instead of one-way value chain[5]. As such, the market of ICT convergence science and technology industry has drastically grown. The size of the market was 10,946 billion dollars in 2010, and 18,851 billion dollars in 2015. The market is expected to grow to 37,796 billion dollars in 2020 (Table 1).

Similar to the growth rate of the world market, the domestic market is expected to increase in size. The size of domestic market was USD 39 billion in 2010, USD 73.9 billion in 2015, and is expected to grow to USD 148.3 billion in 2020. Therefore, the need for appropriate policy and policy coordination is heightened with the development of ICT convergence industry (MKE, 2011).

5 Continuity refers to continually evolving features. Additionality means new technology, products, and services can be applied to existing convergence to create new convergence. Extendability means the existing convergence can expand horizontally or vertically. Multiplicity means a consumer can experience various platforms through a device, which in turn, interaction between a variety of actors enables to connect each other, leading to multi-dimensional interaction. More details are stated in: Ha and Lee (2012); KIET (2012)

This change arises from a shift in ICT paradigm. ICT used to be supplier-oriented, focusing on technology, while current ICT is consumer-oriented. In addition, ICT dissemination was emphasized through networks and mobile devices in the past, but the practical utilization of ICT is expected to be more important as applications such as IoT develops. ICT itself was a goal to achieve, while now it is considered as a means and a foundation. Based on ICT development, appropriate policies will enable enhancement of people's quality of lives and find new engines for growth.

2.3. Digital Platforms and Ecosystems

Recently, major international companies have launched a new product or service based on ICT. For example, Google, well-known for its search engine, has been developing convergence-based products for a long time. Google Car is one of them. It is equipped with sensors, processors, and software for autonomous driving, and utilizes video cameras, laser sensors, laser range finders, and GPS.

Many studies state that these changes have occurred due to digital platforms which enabled establishment of innovation ecosystems. In the case of Google, it has established its own innovation ecosystem to provide digital space, or a digital platform, to freely communicate and interact (play) with content providers, consumers, advertisers, and innovators (Fishenden & Thompson, 2012).

The importance of platform governance has been emphasized. According to a study by Fishenden and Thompson (2012), having its own innovation ecosystem was the reason behind Google's rise to international success, although it did not have tangible products. The platform which allowed content providers, consumers, advertisers, and innovators to communicate and interact each other was the key to success. In this regard, the role of the future government is to provide innovation ecosystem in administration in order to enable various actors to communicate with a creative mind. The new e-government is one method of establishing such a platform (Fishenden & Thompson, 2012).

In addition, global ICT companies are competing in the wearable device markets to lead the post-smartphone era. The market is already formed for Google Glass, Apple Watch, and mobile payment systems (Samsung Pay, Apple Pay, etc.). Notable changes in ICT companies can be found in the area of unmanned vehicles. This study conducted a case study focusing on ICT convergence in the area of unmanned vehicles among convergence industries in Korea and major countries[6].

Table 1. Markets and prospects of IT convergence industry (billion USD)

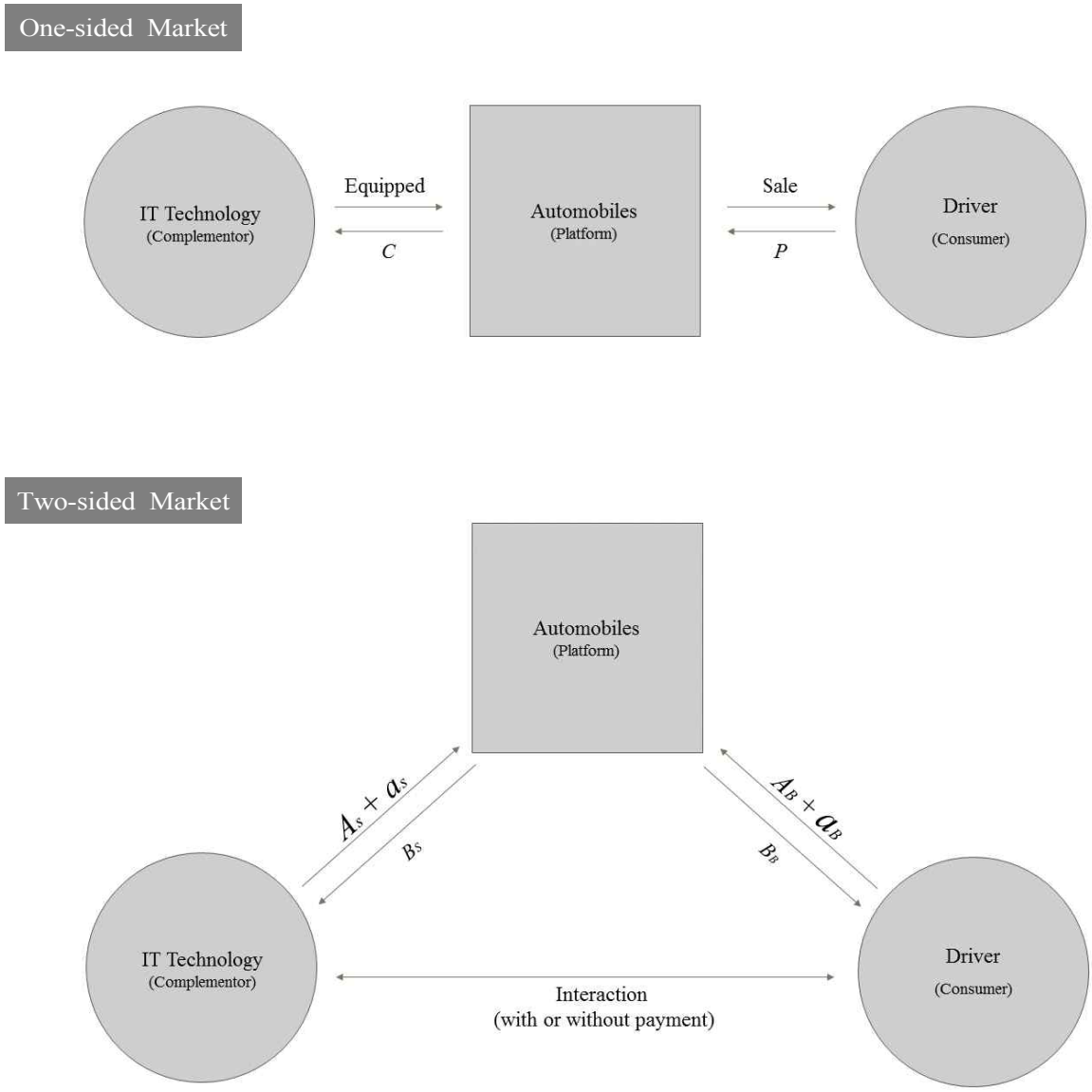
Year	Cars	Ship Building	Construction	Fabrics	Medicine	Machinery	Lighting	Energy	National Defense	Total
2010	146.6	20.8	264.0	173.7	120.0	160.0	35.6	1.3	172.6	1,094.6
2015	211.2	26.0	330.7	203.3	233.0	290.0	103.0	6.9	481.0	1,885.1
2020	266.2	35.1	414.1	247.3	500.0	521.3	300.0	12.7	1,482.9	3,779.6

Source: Korea Institute for Advancement of Technology (KIAT) National Technology Roadmap (2010), National IT Industry Promotion Agency (NIPA) Current Trends of IT Convergence (2010), and Ministry of Knowledge Economy (2011). As cited in Ha and Lee (2012), p 40.

6 Looking at launched cars, Tesla, Benz, Nissan, Google take the lead in the market. In 2013, Benz succeeded in 100 km self-driving in urban area, with a goal of commercialization by 2020. Nissan operated Leaf for a test drive, and is concentrating on research to enable commercialization by 2018. Google plans to launch complete autonomous vehicles (level 4) in 2-5 years (MOLIT, 2015).

Automobiles can be considered as a kind of platform, equipped with ICT technology (complementor), and provided to drivers (consumer). This is a linear process that constitutes a conventional transaction of a one-sided market (cost and profit are created through transaction), where chances of a new ecosystem are slim. However, interaction between IT technology and drivers based on automobiles (platform) enables formation of a structure from which both complementor and consumer benefit and double the creative value (two-sided market).

Figure 2. Value chain of cars as IT convergence platform: one-sided vs. two-sided markets



A: entry fees, a: usage charge, B: consumer, S: seller, and B: benefits.

Source: Ha and Lee (2012)

This study examines unmanned vehicles in the context of four core values: ICT convergence ecosystem (establishing systems and policy), economic development and industry promotion (economic and industrial support), social entitlements (social contribution), and technological development (focusing on cooperative research and technology development). In regards to ICT convergence policy, especially unmanned vehicles policy, the most important sectors and contents are examined with Analytic Hierarchy Process (AHP) technique. Before examining the outcomes, the methodology of AHP will be described in the following session.

2.4. Policy Mediation: Success and Failure in Policy

This study defines policy mediation as a process of finding mediation tools that help to integrate policy and to seek communication strategies, which derive collective intelligence in the nonlinear, interactive model of "cognition ↔ judgment (decision) ↔ act (acceptance)." As such, policy mediation is fundamentally analyzed with AHP technique and survey targeting experts and graduate students. This study is significant as a basic research for offering policy mediation. Another purpose is to verify whether ICT convergence policy in the area of unmanned vehicles follow a linear process that is stated in the rational model.

3. Methods

3.1. Background and Basis of Case Selection

This study focuses on autonomous vehicles (or unmanned vehicles) as they are an example of policy mediation that will be discussed in the present study. First of all, the area of cars and ICT convergence technology can be investigated from different perspectives in regards to platform and ecosystem. In terms of technology and service, AUTOSAR (AUTomotive Open System Architecture), a standard platform of software used for car electronic devices, ISO26262 certifications, an international standard of car safety function; GENIVI, a multimedia platform for automobiles; and AGL (Automotive Grade Linux) were discussed (Han and Lee, 2014). However, these discussions are limited to the concept of platform at a technological level. Therefore, this study intends to go beyond the conventional concept and to extend the concept to include establishing policy and systematic platforms and ecosystems based on policy mediation. Thus, the case of autonomous vehicles was selected to study the comprehensive concept of a policy platform that encompasses various perspectives, and a digital platform, to draw meaningful implications.

3.2. The Necessity and Introduction of AHP Analysis

The hierarchical analysis in this study is Analytic Hierarchy Process (AHP) which was developed by Thomas Saaty in 1980. AHP is a supporting tool for decision making processes through multi-dimensional evaluation when there are many alternative solutions. The process is important in AHP, which helps to make decisions in a more rational way through repetitive analyses. These repetitive analyses target experts, which is useful in looking at experts' opinions comprehensively. AHP helps to gain a better insight in complex decision-making problems. It classifies alternative solutions based on the goal, evaluation standards, and alternative choices, and allows comparison of results based on hierarchical surveys conducted by experts. AHP comprises three levels. At the highest level, decision-making is the goal. Factors that affect decision-making and make up the higher targets are determined at the middle level.

At the lowest level, evaluation factors are identified, and each factor can be compared to determine its priority and weighted value. The weighted value is not put forth as a question in the survey, but is determined in the process of

prioritization. Respondents' consistency is crucial in AHP. AHP questionnaires are designed to conduct a comparative analysis of evaluation factors (alternatives) to set priorities. When there are multiple evaluation factors (alternatives), a comparative analysis needs to be made in every case. The problem is that this process makes questionnaires complex, and respondents may lose consistency. Loss of consistency, which can be found even in straightforward questionnaires asking priorities, may intensify in a comparative analysis of multiple alternatives. Decision-makers' consistency is a key to AHP, and should be ensured when deciding influential issues like national policy.

To ensure respondents' consistency, AHP utilizes consistency index. Consistency index (CI) shows how consistent the alternatives are. In general, consistency index of 0 indicates the greatest consistency. Practically, however, it is highly unlikely to see 0 as the consistency index. Based on empirical data, analysis is considered to be consistent when consistency index is below 0.1. Unlike other surveys that require a varied set of respondents, AHP targets experts in a specific area to find priorities. AHP provides quantitative data for decision making, and is thus being used in various fields.

This study examines domestic (Korean) and foreign markets in the sense of ICT convergence policy and digital platform/ecosystem to find policy implications. Based on these findings, interviews and AHP are used to analyze the new paradigm of ICT convergent autonomous vehicle industry, and the impacts of innovation ecosystem and digital platform, which are the possible ways of realizing creative economy.

AHP questionnaires are prepared with a method of qualitative clustering that divides research results from literature research and interviews into factors/sub-factors/details based on similarity, importance, tendency, and directionality. To enhance applicability of clustered research in policy practice, AHP was conducted in each case to figure out priorities and importance. The comparative analysis of AHP helps to understand priorities of detailed factors in regard of digital platform and ecosystem because this method shows complex decision-making problems hierarchically.

The First AHP: The comparative analysis enabled evaluation of "relative importance," comparing two questionnaires based on the results of expert interview. The case study focused on ICT convergence in the area of domestic unmanned vehicles. The survey included open answer questions to gather other opinions. This enabled respondents to suggest different opinions, which ensured the opportunity to adopt better ideas. After contacting respondents, questionnaires were sent via email and then collected.

The Second AHP: Based on the first survey, modified online surveys were developed and redistributed to the experts who responded to the first survey. Through modified, improved questionnaires, the level of convergence and divergence among experts' opinions was analyzed with a qualitative method. For this analysis, unlike the first survey, the consensus ratio, average, standard deviation, and quartile deviation were used.

The Final Analysis: The degree of convergence or divergence over two rounds of AHP analyses was verified, and if needed, further survey was conducted. To find out the level of agreement and consent, CI was used to decide whether to accept or reject the priorities, and the most appropriate factors were finally chosen.

3.3. Targeting Group

For this study, AHP was targeted to researchers of Kookmin University and Intelligent Car Research Team. Kookmin University Research Team is currently performing research on autonomous vehicles equipped with PC and H/W. A total of 12 researchers participated in the survey, and their

responses were consistent according to the feedback. To ensure objectivity and minimize influence of personal preferences, the persons who gave the highest score and the lowest score were excluded from analysis. Therefore, 10 responses out of the total 12 were used for the final analysis.

3.4. AHP Structure and Analysis Items

The AHP structure is divided into 4 categories, which are based on previous studies and FGI interviews targeting experts. It can be largely understood in an aspect of technology, society, economy/industry, and ecosystem (ICT convergence ecosystem). Each aspect has four different factors. Detailed AHP analysis criteria are as shown in Table 2.

4. Findings

4.1. Foundation of Core Values

Based on the various issues stated in the previous studies, 4 aspects of core values were suggested: First, ICT convergence ecosystem (establishing systems and policy), second, economic development and industry promotion (economic, industrial support), third, social entitlements (social contribution), and lastly technological development (focusing on cooperative research and technology development). These 4 aspects show the importance of ecosystem which was emphasized in the case study of Google, a leading company of ICT convergence (Fishenden & Thompson, 2012). In addition, a case study of IT convergence in industrial areas (Kim and Kim, 2013) was reflected in economic development and industrial promotion. The idea that virtual goods in cyberspace evolve and provide solution and S/W in the real market to increase social benefits was also reflected (Min, 2013). As indicated in the study of ICT convergence policy in the field of domestic/foreign car industry (Kim, 2015), technological development was taken into account as well, and sub-factors were defined. This study intends to analyze priorities of core values with AHP technique to figure out positive direction for future policy, and to examine appropriate means of policy mediation. The sub-factors were first analyzed, following priorities of factors.

Table 2. AHP analysis criteria

Core Values	Contents
ICT Convergence Ecosystem[7] (Establishing systems and policy)	Car Industry (chassis module, automotive electric parts, terminals, V2V (vehicle to vehicle) communication security), ITS Industry (road-side equipment, operation agency, control center, Vto Communication Security), ICT Industry (mobile, cloud, LBS service, new generation communication security), Fundamental Industry (embedded SW, HMI device, smart sensor)
Economic Development and Industry Promotion (Economic, industrial support)	SW/Information Industry, Artificial Intelligence Industry, Communications/Security Industry, Sensor/Navigation Industry
Social Entitlements (Social contributions)	Based on the existing supply chain, expansion of new industry growth engine, Reducing the social cost due to decrease in car accidents (Best Safety) (insurance, medical expenses), low cost and high accessibility in transportation service (improving convenience for the disabled and the weak (Infinite Convenience)), Eco-friendly transportation system through efficient control of the volume of traffic
Technological Development (Focusing on cooperative research and technology development)	Intelligent Cars which prevent accidents, Communication-enabled Cars, Human-oriented Cars, Creating synergy effects through convergence

7 For ecosystem, various technologies in industries are integrated in a way of convergence. Subsidiary equipment of keeping a safe distance, keeping driving on the road, autonomous control, and steering for parking has been developed to the extent of level 3.

4.2. AHP Analysis Result: Sub-factors

As indicated in the methodology based on above-mentioned factors, the research on autonomous vehicles has core values in the aspect of 1) ICT convergence ecosystem (platform), 2) economic development and industry promotion, 3) social entitlements, and 4) technological development. With AHP surveys, opinions of experts were gathered. The results regarding final ranks and weighted values in each aspect are as follows.

Table 3. AHP analysis results: sub-factors

Areas	Sub-factors	Consistency Index* (Rank)
ICT Convergence Ecosystem (Establishing systems and policy)	Car Industry (chassis module, automotive electric parts, terminals, V2V communication security)	0.235 (3)
	ITS Industry (road-side equipment, operation agency, control center, Vto communication security)	0.265 (2)
	ICT Industry (mobile, cloud, LBS service, new generation communication security)	0.337 (1)
	Fundamental industry (embedded SW, HMI device, smart sensor)	0.164 (4)
Economic Development and Industry Promotion (Economic, industrial support)	SW/Information Industry	0.203 (4)
	Artificial Intelligence Industry	0.355 (1)
	Communications/Security Industry	0.229 (2)
	Sensor/Navigation Industry	0.212 (3)
Social Entitlements (Social contributions)	Based on the existing supply chain, expansion of new industry growth engine	0.168 (3)
	Reducing the social cost due to decrease in car accidents (Best Safety) (insurance, medical expenses)	0.500 (1)
	Low cost and high accessibility in transportation service (improving convenience for the disabled and the weak (Infinite Convenience))	0.085 (4)
	Eco-friendly transportation system through efficient control of the volume of traffic	0.247 (2)
Technological Development (Cooperative research and technology development)	Intelligent Cars which prevent accidents	0.582 (1)
	Communication-enabled Cars	0.187 (2)
	Human-oriented Cars	0.129 (3)
	Creating synergy effects through convergence	0.101 (4)

*CI (consistency index) <0.1. It is calculated by counting the weighted average in a dataset: n=10

The analysis showed that the first priority of ICT convergence ecosystem was ICT Industry (0.337), followed by ITS Industry (0.265), Car Industry (0.235), and Fundamental Industry (0.164). These findings indicated that ICT industry comes first when establishing an ICT convergence ecosystem. Although Korea is a latecomer to the market for autonomous vehicles, it is expected that ICT industry will enable Korea to take the lead in the future considering its importance.

The first priority of economic and industrial promotion was Artificial Intelligence Industry (0.355), followed by Communications/Security Industry (0.229), Sensor/Navigation Industry (0.212), and SW/Information Industry (0.203). Except Artificial Intelligence Industry, the differences between the rest of the industries are minor, which indicates that they require similar levels of interest and attention.

The first priority of social entitlements was reducing the social cost due to decrease in car accidents (0.500), followed by eco-friendly transportation system through efficient control of the volume of traffic (0.247), expansion of new industry growth engine based on the existing supply chain (0.168), and low cost and high accessibility in transportation service (improving convenience for the disabled and the weak) (0.085). As an overwhelming majority selected reducing the social cost as a priority, this part needs to be considered in establishing policy.

The first priority of technological development was Intelligent Cars which prevent accidents (0.582), followed by Communication-enabled Cars (0.187), Human-oriented Cars (0.129), and Creating Synergy Effects through Convergence (0.101). The differences between these factors suggest that policy makers pay attention to the results to mediate policy and solve problems.

4.3. AHP Analysis Result: Factors

The first priority of the comparative analysis about factors was technological development (focusing on cooperative research and technology development) (0.3946), followed by social entitlements (social contributions) (0.2275), economic development and industrial promotion (economic, industrial support). The lowest one was ICT convergence ecosystem (establishing system and policy) (0.1757), which shows the current state in South Korea.

Table 4. AHP analysis results: factors

Areas	Factors	Consistency Index* (Rank)
ICT Convergence Policy and System in relation to Autonomous Vehicles	ICT Convergence Ecosystem (establishing systems and policy)	0.1757 (4)
	Economic Development and Industry Promotion (economic, industrial support)	0.2020 (3)
	Social Entitlements (social contributions)	0.2275 (2)
	Technological Development (focusing on cooperative research and technology development)	0.3946 (1)

*CI (consistency index) <0.1. It is calculated by counting the weighted average in a dataset: n=10

5. Conclusion

5.1. Policy Implications

Altogether, Digital Platform and Ecosystem in ICT convergence policy on autonomous vehicles in Korea have not been fully established, and require technological development. The fact that technological development placed as a top priority in the area of autonomous vehicles is an evidence of difficulty in establishing Digital Platform and Ecosystem. Therefore, policy implications are discussed in this chapter based on group interviews of AHP questionnaires. In terms of technology, South Korea has not reached the international level (failed to get high scores at DARPA[8] Challenge). The leading universities are Kookmin University, Seoul National University, KAIST, and Hanyang University. KAIST focuses on drones, and Hanyang University does not stand out relatively due to a growing number of retired professors. Therefore, Kookmin University and Seoul National University[9] take the lead in research, followed by Keimyung University, Chungbuk National University, and Sungkyunkwan University. These universities participated in the autonomous driving festival of Creative Korea Expo, organized by the Ministry of Science, ICT and Future Planning at Coex, November 2015. The competition of Hyundai-Kia autonomous vehicles is organized as a preliminary for DARPA. As the competitions are divided into business-organized and government-organized ones, it is necessary to integrate and build ecosystem from the viewpoint of policy[10]. In addition, the need for R&D investment in technology development is heightened considering Europe (Benz), China, and Japan invest heavily in automobile R&D. According to the group interviews with experts, the technological level remains low in Korea, which requires further research in cooperation with the existing car manufacturing as well as electronics/IT companies[11]. From the perspective of industry/economy, the area of autonomous vehicles is promising, while various infrastructures and policy improvements are also necessary. Experts have also said that training professionals is an important issue because information sharing, cooperation, and platform in regards to technology have not been active. The autonomous vehicles are expected to come into the spotlight in the sense of convenience, safety, and environment effect, while take 50 years to put to practical use (to the extent of entire people receiving benefits, not high prices). Further discussions need to be involved in ethical problems (who will bear the responsibility of car accidents?). The finding has many implications for ICT convergence technology policy. Technological development which lags behind is the priority in the sense of ICT convergence ecosystem. The demand for government response is increasing as indicated in the survey results. Therefore, policy toward creative economy should be established and coordinated in accordance with priorities considering core values.

8 DARPA is organized by the US Department of Defense. The third DARPA competition was the most recent one, with a mission in urban areas. In the first competition, no team completed the whole course. In the second competition, held in the dessert, only 6 teams completed the course, which showed the differences between unmanned vehicles technologies (based on FGI interview).

9 Unmanned vehicles, authorized by MOLIT, are being operated for a test drive under the guidance of Professor at SNU, Kyeongsu Lee (based on FGI interview).

10 The KATECH, MSIP, and ETRI are supporting R&D without considering connectivity (based on FGI interview).

11 In terms of driving ability on the road, it ranks 5th in the world. In Korea, cars like Genesis EQ900 have been launched, which enable limited self-driving in low-risk areas, a 2.5 level. Various technologies are applied to domestic products and put to practice. For radar technology, all products used to be imported from Delphi, but now Hyundai Mobis has completed development and commercialization. In terms of cameras, both domestic and foreign products are utilized. Android operation system for cars is developed in cooperation with Hyundai-Samsung and Hyundai-Google. In addition, Hyundai-SK T-map as well as Kookmin University-Hyundai-Kia cooperation is also active.

In the future, factors which cause policy change in ICT convergence technology need to be examined further to set priorities, and be reflected in the government policy. To realize creative economy, features of factors should be continuously studied to make policy. Public-private sectors as well as civil society should cooperate to achieve our goals. Without concerted efforts, balanced policy of ICT convergence technology is some way off.

5.2. Limitations and Future Research Plans

This study is distinguished by the fact that areas and factors in priority are examined for realizing creative economy and digital platform/ecosystem through a comparative analysis with AHP. Unlike other surveys which require many respondents, AHP targets experts in the field to figure out priorities, providing qualitative data in decision-making, and is thus widely used in various sectors[12]. The study focuses on the latest trends to provide insight in terms of creative economy, and utilizes AHP to increase objectivity. Based on this study, further practical research can be applied to the real world, and open up an opportunity to connect with a variety of follow-up research. The case study helps to provide detailed, practical implications, and emphasizes the need for support and development of digital platform and ecosystem in the market of autonomous vehicles.

The study focuses on the latest trends to provide insight in terms of creative economy, and utilizes AHP to increase objectivity. Based on this study, further practical research can be applied to the real world, and can open up an opportunity to connect with a variety of follow-up research. The case study helps to provide detailed, practical implications, and emphasizes the need for support and development of digital platform and ecosystem in the market of autonomous vehicles.

As this study only focuses on Kookmin University unmanned vehicle research team, there are limitations to generalize the results. However, as Kookmin University research team takes the lead in unmanned vehicle studies, it is a worthwhile study to understand national ICT convergence policy regarding autonomous vehicles and to lay the ground for follow-up studies. In this regard, the loose ends may be tied up through future studies, in particular, on policy demands of consumers, markets, and companies, through AHP analysis on future consumers of autonomous vehicles.

12 AHP is used in cases where statistical analysis is impossible. This is widely used as a way of combining experts' opinions. This study does not adopt an absolute evaluation, but comparative analysis to maximize the strengths of AHP. In this regard, AHP as well as interviews are to be conducted to find out priorities of policy strategies that are necessary to building ICT digital platform and ecosystem in the area of unmanned vehicles in Korea.

References

Ahn, S., and Jeong, Y. (2008). The Current State of the U.S. Convergence Policy of Technology Development, Policy of Science & Technology, The Korea Society of Management Information Systems, 2013, 71-83.

Fishenden, J., and Thompson, M. (2002). Digital Government, Open Architecture, and Innovation: Why Public Sector IT Will Never Be the Same Again. Journal of Public Administration Research and Theory, 23(4), pp 977-1004.

Ha, J., and Lee, S. (2012). Development of IT Convergence Industry and Policy Implications: Focusing on Two-sided Market Theory. Korea Institute for Industrial Economics & Trade.

Han, T., and Lee, J. (2014). The Current State of Cars and ICT Convergence and Standardization. TTA Jounal, 154: 32-37.

Ju, D., and Kim, J. (2014). Plans for Creative Convergence of IoT in the Hyper-connected Era. Seoul, Korea Institute for Industrial Economics & Trade. Issue Paper 2014-342: 74-75.

Kim, D. (2010). Future Thinknet. The Korea Society of Management Information Systems. 2013, p 24.

Kim, B., and Kim, G. (2013). A Case Study of IT Convergence in Industry areas. The Korea Society of Management Information Systems Presentation Paper of Fall Conference, 857-861.

Kim, B., and Seo, H. (2013). A Study of ICT Policy and its Role for Accelerating Creative Economy. The Korea Society of Management Information Systems Proceedings of Fall Conference, 827-834.

Kim, J., Nam, S., Lim, J., Gong, Y., Kim, M., Lee, K., Jeong., H., and Kang., Y. (2013). Plans for Revitalizing ICT-based Convergent Industry, National Research Council for Economics, Humanities & Social Science Cooperative Research Series (Creative Economy Comprehensive Studies). 13-01-01.

Kim, D., and Hong, Y. (2014). A Study of Weighted Value on Informative Website with a Method of AHP: Focusing on Website of Dining Information. Information System Review, 16(3), 2-23.

Kim, J. (2015). The Current State of IT Convergence Policy in domestic/foreign Car Industry. Journal of Multimedia Information System, 19(2), 7-12.

Kim, E., Kwon, H., Kwon, H., Kim, Y., Baek, Y., Woo, H., Lee, S., Lee, J., Cho, D., Lim, S., Han, S., and Hwang, J. (2013). Framing Future Direction of ICT based Convergence Policy for Successful Implementation of Creative Economy. The Korea Society of Management Information Systems.

Korea Institute for Industrial Economics & Trade (KIET) (2012). Development of IT Convergence Industry and Policy Implications. 2012-171. pp 34-42.

Litman, T. (2014). Autonomous Vehicle Implementation Predictions: Implications for Transport Planning.

Min, K. (2013). Discussion on ICT Policy Direction in the Creative Economy Era. Proceedings of the ITFE Summer Conference, 87-92.

Ministry of Land, Infrastructure, and Transport (MOLIT). (2015). Support Plans for Commercialization of Autonomous Vehicles. Ministries' joint press release.

Moon, J. (2013). R&D Policy of Cars, IT Convergence and Smart Car. The Korea Society of Automotive Engineers Workshop, 5-42.

Namgung, M. (2008). Direction of IT Convergence Policy. Journal of Information and Telecommunication Facility Engineering, 649-667.