

# 인터넷전화의 정책 및 경영이슈측면에서의 이용자분석

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## Policy and Managerial Issues of Voice over Internet Protocol(VoIP)

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### Abstract

Which factors should influence consumer consideration to subscribe to Voice over Internet Protocol (VoIP)? Policy issues, managerial concerns, and demographic variables are possible factors. This paper discusses policy and managerial issues regarding VoIP adoption. A model that explains VoIP adoption is proposed and tested. This study analyzes a survey of 750 prospective VoIP users in Korea. The testing is accompanied by logistic regression and discriminant analysis. The results show that trust in VoIP, relative comparison of quality to fixed service, numbering plan, satisfactions of call quality and customer services on both fixed and mobile services have impacts on the adoption of VoIP. Implications for VoIP providers and policy makers are presented.

Keywords : Voice Over IP (VoIP), User Profile Analysis, Call Quality, Customer Service, Numbering Plan, Quality of Service (QoS), Logistic Regression, Discriminant Analysis

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## 1. INTRODUCTION

The rapid growth of new services like the Internet leads to various changes in the telecommunications market, which, in turn, inevitably leads to reconsider conventional voice-oriented telecommunication regulations. For example, VoIP has been spotlighted as a future substitution service of conventional voice telephony. However, under the existing telecommunication policies and legislation, VoIP was unable to be classified [Ono et al. 1998]. In order to cope with these problems, telecommunication regulators world wide have made an effort to set up policies [McKnight et al. 1998]. However, there is still room to improve and amend these policies.

VoIP now is at the stage of early diffusion. It is expected that VoIP will compete with existing telephone services, such as fixed and mobile telephone services. Adoption factors have the attention of VoIP providers and regulators. To survive in the competition, it is necessary to study the adoption factors of customers in the view of VoIP providers. For regulators, research on VoIP adoption factors has implications to improve fair competition and to promote the growth of industry, and to guarantee customer's welfare. There is a consensus that differences can be found from policy and managerial factors which may influence on consumer's behavior in subscribing to VoIP services [Mason 1998]. This study attempts to discover the differences combining policy and managerial issues.

In this study, policy and managerial issues

are discussed in a brief explanation on VoIP from the perspective of adoption of VoIP. Based on those issues, this study proposes a model that explains the adoption of VoIP. The model is designed to measure those police and managerial issues. Data are collected from prospective customers in Korea. Testing of the model is carried out by logistic regression and discriminant analysis. The research process, results, and conclusions are presented. Implications for VoIP providers and policy makers are discussed as well.

## 2. VOICE OVER INTERNET PROTOCOL (VOIP)

Voice over Internet Protocol (VoIP, IP Telephony, and Internet telephony) is the routing of voice conversations over the Internet or any other IP-based network. The voice data flows over a general-purpose packet-switched network, instead of traditional dedicated, circuit-switched telephony transmission lines. Protocols may be viewed as commercial realizations of the experimental Network Voice Protocol invented for the ARPANET. Voice over IP traffic might be deployed on any IP network, including ones lacking a connection to the rest of the Internet [Wikipedia 2006].

VoIP involves sending voice transmissions as data packets using the Internet Protocol (IP), whereby the user's voice is converted into a digital signal, compressed, and broken down into a series of packets. The packets are then transported over private or public IP networks and reassembled and decoded on the

receiving side. Residential customers can connect to IP-based networks by using the local loop from the public switched telephone network (PSTN) or high-speed lines, including the asymmetric digital subscriber loop (ADSL) /DSL and cable modems [Varshney et al., 2002].

Since the late 1990s, the international telecommunication service market has faced significant changes, due, in particular, to the rapid expansion of internet and mobile telephony services. VoIP, above all, has been spotlighted as the 'future substitution service' of conventional voice telephony. With the rapid growth of VoIP a major transformation of the conventional voice-oriented telecommunication regulatory regime therefore seemed inevitable, especially since VoIP has not been defined nor classified under existing telecommunication policies of most countries. Whether VoIP should even be regulated, however, has become a point of contention in some countries.

### 3. POLICY ISSUES ON VOIP

After Computer Inquiry and Steven's Report of the Federal Communications Commission (FCC) dealt with definitions and service classifications of VoIP, the world telecommunication regulators made policies on VoIP. Implications of these decisions are as follows: governments should develop appropriate policies without introducing economic and technical distortions into the newly deployed VoIP. Regulators should not apply the existing regulatory framework to this new service. Policy makers and regulators have responded to the

challenges brought about by VoIP. Their common approach seems to apply the existing regulatory framework to this new service. Those responses will not be aligned with the dynamically changing communications environment. Shifts from dedicated to non-dedicated and from low bandwidth to high bandwidth pointed out the necessity of reconsidering the relationship between the existing regulations and new emerging services, technologies, and players brought about by growing convergence [Ono et al., 1998].

The first challenging issues on VoIP policy are quality of service (QoS) regulation and numbering plan.

Quality is a popular issue in the acceptance of VoIP. Consumers are certainly unlikely to accept lower quality. They already have experiences that demonstrate a high-quality of voice services from dedicated telephone networks with a reasonable price. Many organizations have invested a great deal of money in PBX and other phone equipment. The availability of new hybrid PBX/VoIP systems, which can be installed as old equipment is phased out, might significantly influence the speed of VoIP adoption [Tsenga et al., 2005; Varshney et al., 2002].

The problem of network congestion by VoIP traffic could impact IP networks critically. VoIP traffic growth should be monitored and attempts made for allowing sufficient bandwidth for VoIP for required voice quality [Tsenga et al., 2005]. From the view of end users, differences in the preferences for congestion will drive networks to special-

ize [Mason, 1998].

Regarding QoS, questions are whether regulators should decide to establish a new higher service standard for VoIP because of the poor performance and low voice quality of early VoIP services. The questions are as follows. What level of QoS is necessary for Internet telephony in comparison to voice telephony? Were considerations given in separating regulatory control and licenses for service providers based on the QoS levels of each type of Internet telephony? What are the prospects and necessary qualities of VoIP services as viewed by regulators?

Another policy issue is an impact on the internetworking between the local installations. It needs to be a consensus on the unique and common numbering system [Dressler, 2002]. Rules for numbering IP telephony is one of the issues related to the implementing and application of IP telephony [Wang et al., 2004].

Regarding a telephone numbering scheme, there are two different options. The first is a closed numbering scheme in which the same number of digits is used for all kinds of services, like telephone numbers in the U.S. The other is an open numbering scheme in which each service is allowed to have a different number of digits for the service. Although in most countries a closed numbering scheme is encouraged, a practical and partially open scheme is used due to several changes in the numbering plan over a lengthy period. For the VoIP, the issue is whether VoIP has the same number of digits as the existing telephone service or has a different

number of digits.

#### 4. MANAGERIAL ISSUES ON VOIP

Previous studies consider technical, economic, and social factors to support or hinder the adoption of VoIP [Corrocher, 2003]. It is shown that the adoption of VoIP relies upon the attributes of technological applications and the characteristics of different users. Several factors regarding the adoption of VoIP make it difficult to forecast adoption rates. How quickly existing carriers might transition away from their current technology is a critical issue. Demand for services from emerging carriers and other service providers is also a considerable aspect. Regulatory environment is regarded as one of pre-conditions for the market [Varshney et al., 2002].

Most of the research in this area has addressed the supply side of the market, assuming the existence of a well-developed demand [Corrocher, 2003]. However, potential users will undoubtedly demand the same high QoS to which they are accustomed and cost-effective bundled services as well. Various approaches to explain the acceptance of VoIP have carried out.

Trust and the personal relationships between the company and the customer are significant in the telecommunication services [Kim et al., 2004b]. While some of these problems can be solved using end-to-end encryption techniques, trust and identity management remains a major unsolved security problem in p2p research domain [Banerjee et

al., 2006]. The effect on the VoIP features on how trust develops between participants in a webcast lecture is a current issue for conducting webcast lecture functionality [Baecker et al., 2006].

A customer service is an important for creating customer satisfaction. Interpersonal relationships between carriers and customers have a positive effect on the switching barrier [Kim et al., 2004b]. [Kim et al., 2004a] show that brand image, subscription duration, or income influence the customer churn in addition to the above variables.

The initial impetus given to VoIP by price arbitrage disappears quickly for Internet telephony service providers to move towards the provision of new high-value integrated services [Corrocher, 2003]. Additional features of VoIP contribute to get more attention from customers [Tsenga et al., 2005]. Efficiency advantages and the availability of integrated services can encourage business users to move rapidly to Internet communication based upon intelligent terminals. However, if firms want to implement these applications also in the residential market, they must overcome the existing barriers to the adoption of VoIP [Corrocher, 2003].

VoIP also has to address the issue of security for transmitted messages before it can become universal. The Internet's packet-switched architecture may provide carriers and businesses with huge security headaches. Along with IPv6, many versions of VoIP software have built-in encryption, offering better security than older implementations [Tsenga

et al., 2005; Varshney et al., 2002]. However, in the users' view the concern with security still remained. If the penetration of on-line PCs does not increase as predicted, PC-based Internet telephony applications, which constitute the most advanced solutions from a technological point of view, remain a tool just for business-to-business electronic commerce, because of the lack of security of financial operations and the scarce familiarity with on-line shopping [Corrocher, 2003].

Even though VoIP and PSTN reflect quite different design philosophies and commercial histories as to their switching mechanisms, they also share some of the same technologies and links. VoIP relies on the PSTN to enable its users to reach their ISPs and Internet gateway servers. The two systems are likely to coexist for the foreseeable future, each one serving a particular market or purpose. This competitive coexistence should continue until VoIP quality and reliability finally catches up to PSTN, and some of the older PSTN architecture becomes outdated and needs to be replaced [Varshney et al., 2002].

Beside the above mentioned regulations, global connectivity, network management, pricing and revenue sharing, reliability and failure issues, and user equipment requirements can affect VoIP adoption [Varshney et al., 2002]. <Table 1> summarized various issues on VoIP adoption.

## 5. RESEARCH DESIGN

Previous literature raises several issues which

〈Table 1〉 Factors affecting VoIP adoption

	Issues	Comments	References
Policy	Quality	Possible improvements with provisioned bandwidth; Better quality with private IP networks; Possible use of IPv6; Differences in control signaling and features may have to be addressed; infrastructure and inter-working effect on QoS should be considered.	[Corrocher 2003; Tsenga et al. 2005; Varshney et al. 2002]
	Numbering plan	Rules for numbering IP telephony; New numbering scheme for internetworking between the local installations	[Dressler 2002; Wang et al. 2004]
Management	Trust in VoIP	Trust and identity management remains a major unsolved problem; The effect on the VoIP features on how trust develops	[Baecker et al. 2006; Banerjee et al. 2006]
	Customer service	Bundled services can be provided with VoIP networks; cost savings and effect of network failure on all services should be considered.	[Corrocher 2003; Tsenga et al. 2005; Varshney et al. 2002]
	Security concern	Effect of security threats and possible security weaknesses in VoIP features and implementation should be considered; user authentication and authorization, along with billing software, should be carefully implemented and monitored.	[Tsenga et al. 2005; Varshney et al. 2002]

are critical to the adoption of VoIP. Based on those issues, this study proposes a VoIP adoption model and validates the model with empirical data and methodology. In this section, descriptions of the model, variables, data collection, and methodology are presented.

### 5.1 Model

For the adoption of VoIP, both by policy issues and by the characteristics of managerial issues are critical. From the point of view of the carrier, policy issues are recognized as external factors. In opposition, managerial issues are regarded as internal factors which the carrier uses to make decisions.

Policy issues consist of two categories, such as QoS issues and numbering plan. QoS has been spotlighted as one of the crucial

factors that influence the adoption of telecom services [Kim et al., 2004a; Kim et al., 2004b; Kim et al., 2004c]. QoS concerns can be captured by two different approaches. The first one is the evaluation of call quality with related services, such as the fixed telephone and mobile phones. The second one is the relative expectation on VoIP quality to existing services.

The other policy issue is the numbering plan. Two options are selectable. Those are the same digit numbering plan with existing services and the longer digits of VoIP number. In a closed numbering scheme which the U.S. adopted, the number of digits is not considered as an issue, because all services have the same number of digits. Except for the U.S. in most countries an open numbering scheme

is used. That means a new service can have the same number of number digits or a different one. Thus, except for the U.S. the numbering plan for VoIP could be one of the important decision-making issues.

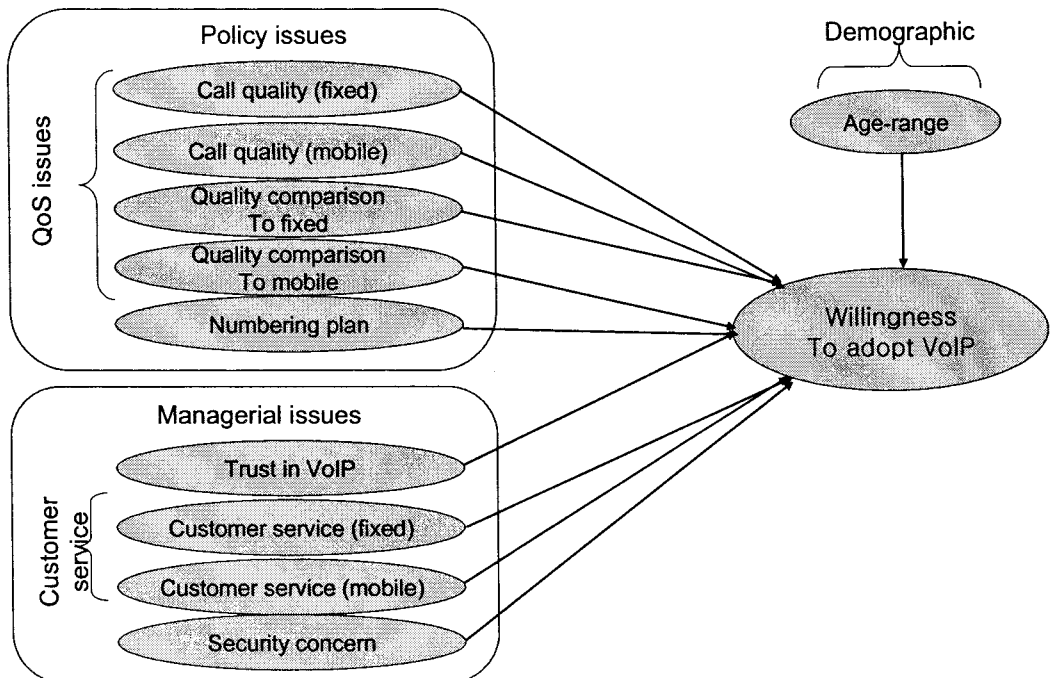
Managerial issues consist of three categories, such as overall trust, customer service, and security concern. Trust concern covers several technical issues which are network reliability, call flow congestion, network stability, and so on. Customer service is one of the influential factors from a marketing aspect [Kim et al., 2004c]. In this study, concerns on customer services are measured by the evaluation of existing services of fixed and mobile telephone. The last issue of managerial issue is about security which includes privacy and hacking-proof.

The other component of this model is demographic characteristic. As demographic variables which have impact on adoption of telecom services household income, age, sex, and house type are usually used [Kim et al., 2004a]. For the adoption of new telecom service, age is frequently used than factors related income. It is because younger generation is likely to adopt new services earlier than older. Thus the idea is that customers in different ages can show the different willingness to adopt VoIP.

<Figure 1> shows a research model explaining VoIP adoption.

### 5.2 Variables

Measurements on variables come from two



<Figure 1> Research Framework

perspectives. The first perspective is from the evaluation of existing services, such as the fixed telephone and mobile phone services. The proposition is that customers who are unsatisfied with their services are more likely to have the willingness to adopt VoIP. The second perspective is from the relative comparison of VoIP to existing services. The idea is that customers who evaluate VoIP as superior service to existing services are more likely to have the inclination of adoption of VoIP.

Question items on evaluations of existing services are measure by the 5 point Likert scale. Customers are classified into 5 groups by age range. For the survey question of comparison those are measured by 3 point scale. Preference on number plan is measured by two choices.

The willingness to adopt VoIP is used for the dependent variable in this study. The

willingness is measured by dichotomous scale. <Table 2> shows descriptive statistics of variables used in this study.

### 5.3 Data Collection

This study uses survey data from the Korean market. Sample data is assigned to classification by region and ages. The quota of sub-sections is followed by the National Census data by the Korea National Statistical Office (KNSO) [KNSO 2002].

The survey was conducted from June to August 2003 for two months by Hankook Research, a marketing research company in Korea. This survey research was sponsored by the Korea Information Society Development Institute (KISDI), a research institute sponsored by the Korean government. Interviewers in each region took a survey and reported their results to the central office. For the accuracy

<Table 2> Descriptive Statistics of Variables

Categories	Variables		Description	Mean	Standard Deviation
Demographics	Age-range		1 = 15-19, 2 = 20s, 3 = 30s, 4 = 40s, 5 = 50s	4.0307	1.23926
Policy issues	Satisfaction of call quality	Fixed	1 = unsatisfied, 5 = most satisfied	4.0501	0.77279
		Mobile		3.5261	0.88037
	Quality comparison to fixed		1 = worse, 2 = same, 3 = better	1.4813	0.68479
	Quality comparison to mobile			1.8520	0.70339
Numbering plan		1 = more digits than fixed, 2 = same as fixed	1.2573	0.43746	
Managerial issues	Satisfaction of customer service	Fixed	1 = unsatisfied, 5 = most satisfied	3.5104	0.77538
		Mobile		3.5491	0.86884
	Trust in VoIP		1 = strongly disagree, 5 = strongly agree	2.9092	0.83203
	Security concern			3.8507	1.04968



〈Table 3〉 Survey Scheme

Survey interviewee	Phone user(15-59 years-old)
Survey method	Face-to-face interview
Survey region	Seoul, Busan, Daegu, Daejeon, Gwangju(The largest metropolitan areas in Korea)
Sample size	750 persons
Sampling error	In 95% significant level, $\pm 3\%$
Sampling method	Quota sampling by region and age

of the survey, the central office verified results by calling interviewees back asking the same questions as the survey. They included the sample data only if the answers were correctly the same. The verification was carried out with 10% of the total survey sample of interviewees.

#### 5.4 Methodology

In this study two statistical methods are adopted for discovering influential factors that affect the willingness to adopt VoIP: logistic regression and discriminant analysis.

For the first step, we used the logistic regression method in order to sort out critical factors that influence the willingness to adopt VoIP. Logistic regression is recommended to be used in case the dependent variable is a discrete variable [Tabachnick et al., 2000]. Logistic regression is preferred when assessing the contribution of variables because it is less affected by variance covariance inequalities across groups, is able to handle categorical variables easily, and offers case-wise diagnostic measures for examining residuals [Hair et al., 1998].

The second step is to verify the model fit-

ness with factors which show relevant results at the first step of logistic regression, using the discriminant analysis. Discriminant analysis is suitable for the case of a single categorical-dependent variable and several independent variables. Discriminant function analysis is used to classify cases into the values of a categorical dependent, usually as a dichotomy.

## 6. RESULTS

〈Table 4〉 shows the result of logistic regression. Five variables that are significant results at 5% of confidence level: satisfaction of call quality on mobile service, quality comparison to fixed, numbering plan, trust in VoIP, and satisfaction of customer service on fixed service. Satisfaction of call quality on fixed service and satisfaction of customer service on mobile service are significant at 10% of confidence level.

It is interesting that customer services have a positive relationship with the adoption of VoIP. That means customers who satisfy their customer services from existing services are more likely to adopt VoIP, which is unexpected. It could be explained that customers who have positive preferences on their serv-

&lt;Table 4&gt; Results of the Logistic Regression

Variables	B	Std. Error	Wald Chi-square	p-value
Age-range	-0.104	0.102	1.034	0.901
Call quality (fixed)	-0.263	0.137	3.654	0.056
Call quality (mobile)	-0.257	0.122	4.405	0.036
Quality comparison to fixed	0.513	0.162	10.050	0.002
Quality comparison to mobile	-0.189	0.155	1.491	0.222
Numbering plan	-0.487	0.226	4.648	0.031
Trust in VoIP	1.271	0.135	88.382	0.000
Customer service (fixed)	0.289	0.144	4.006	0.045
Customer service (mobile)	0.211	0.127	2.748	0.097
Security concern	-0.105	0.094	1.258	0.262
-2 Log Likelihood	663.872			
Cox and Snell $R^2$	0.252			
Nagelkerke $R^2$	0.337			
Chi-square	176.862 (df=18) Sig. 0.000			

&lt;Table 5&gt; Results of the Discriminant Analysis

	Pooled Within Group Correlation Between Variables and Discriminant Function	Standardized Canonical Discriminant Function Coefficients	
Call quality (fixed)	-0.158	-0.238	
Call quality (mobile)	-0.140	-0.193	
Quality comparison to fixed	0.323	0.239	
Numbering plan	0.255	0.191	
Trust in VoIP	0.885	0.870	
Customer service (fixed)	0.097	0.122	
Customer service (mobile)	0.152	0.185	
Group Centroids	-0.594 (unwilling to adopt), 0.523 (willing to adopt)		
Eigenvalue	0.312		
Wilks' Lambda	0.762 Sig. 0.000		
Classification Results			
		Predicted	
		0	
		1	
Observed	0	205	86
	1	94	236
Ratio	0	70.4%	29.6%
	1	28.5%	71.5%

ices are more likely to adopt new services.

Explanation power of the model can be estimated by several measurements. In this study, Cox and Snell's  $R^2$  and Nagelkerke  $R^2$  are checked. About 25~33% of variance of

dependent variable can be explained by this model.

<Table 5> shows the result of discriminant analysis. Seven variables which show significant results at the logistic regression are

used to classify the observations into two groups of non-adoption and adoption customer groups. The model using seven variables predicts 70.4% of non-adoption customer groups correctly and 71.5% of adoption customer groups correctly. Overall the model shows 71.0% of correct ratio.

## 7. CONCLUSION AND IMPLICATIONS

Policy and managerial issues on VoIP are examined in this study. Call quality issues and a numbering plan are proposed as policy issues. Trust, customer services, and security issues are scrutinized in this study. Through the empirical testing with data in Korea major influential factors are discovered.

As we expected, call quality issues have found critical factors on the adoption of VoIP in both fixed and mobile services. The direct comparison to existing services shows the fixed service is a competitor of VoIP. That means customers who do not satisfy call quality from their fixed service are more likely to adopt VoIP. We discovered the numbering plan is also a critical policy issue on VoIP adoption.

For the managerial factors, trust in VoIP is the most critical factor. Service stability in terms of technology could impact customers' adoption of VoIP. Customer service from both fixed and mobile services have shown the positive relationship with VoIP adoption. Customers who have positive impressions on their customer services are likely to adopt new technology services.

From the results, we can derive several implications.

First of all, as the results show, managerial issues have impacts on the adoption of VoIP as well as policy issues have. VoIP providers should have more concerns what they should do rather than where we are. For a market which has indifferent service, marketing forces and advertising appeals have more attentions from potential customers. When technology has been stabilized, more specialized service from the perspective of customer plan could be appealed in this market.

Second, we can find out the relationship of VoIP with existing services such as fixed and mobile services. Fixed telephone service is definitely a competitor for VoIP. That means that customers who did not satisfy their fixed services are more likely to adopt VoIP as their alternate telephone services. Thus VoIP providers should have concerns on what and how they provide their potential customers in order to differentiate from existing fixed telephone services.

Third, we discovered that customers who are generous about on security concern are more likely to adopt VoIP. That means at the early stage of service provision security concern could not affect on the adoption of VoIP. In opposition, if VoIP providers want to have majority customers, at the stage of higher diffusion which is called growing stage, they need to show customers the solutions for security which reduce customers' worries.

In addition to, we find out policy issues such as quality regulation and numbering plan,

are still influential factors to the adoption of VoIP. It is necessary to consider the trade-off of regulation and the growth of markets.

Nevertheless, this study still has several limitations.

This study did not cover all aspects of VoIP which previous literature proposed, due to the limitation of data. A cross-sectional study which this study adopted could miss several critical factors as well. Finally, customers' recognition could be changed as a result of the development of technology and the deployment of VoIP. All the limitations are open to future studies.

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#### ■ 저자소개



#### 김 지 희

저자는 한국 항공대학교 경영학과 학사를 졸업하고 현재 동 대학교 일반대학원 경영학과 석사과정에 재학 중이다.

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한국전파진흥원 기획전략-예산팀장으로 재직하고 있다. 연세대학교에서 경영학 학사와 석사학위를 취득하였으며, 미국 American University에서 법학석사(LLM)학위를 받았다. 인터넷전화, 통방융합 등 Convergence 현상이 주요 관심분야이다.



#### 김 진 기

현재 한국항공대학교 경영학과 전임강사로 재직하고 있다. 한양대학교에서 경영학 학사와 석사학위를 취득하였고, 정보통신정책연구원(KISDI)

에서 책임연구원으로 근무하였고, 미국 State University of New York at Buffalo에서 경영학 박사(MIS 전공) 학위를 취득하였다. 주요 연구결과를 Decision Support Systems 등 학술지와 주요 국제학술대회 (AMCIS, HICSS, ITS, TPRC 등)에서 발표하였다. 주요 연구분야는 정보통신경영, 정보통신정책, digital convergence, IT Ecosystem, E-Business, 수요예측방법론, 긴급재난방재시스템 등이다.