Considering Service Factors in R&D Project Selection: Telecommunications and Broadcasting Convergence in Korea

Hyo-Jung Jun* *Regular Member*, Tae-Sung Kim**° *Lifelong Member*,
Seung-Jun Yeon***, Won-Gyu Ha**** *Regular Members*

ABSTRACT

Digital Multimedia Broadcasting (DMB) and Internet Protocol Television (IPTV) are now in commercial service, tearing down the traditional boundaries between the telecommunications and broadcasting sectors. These latest developments also hold important implications for research projects in related areas. Both telecommunications and broadcasting being fields with a strong service orientation, market demand should be the primary consideration when selecting research and development (R&D) projects in these areas. This study presents a process for selecting converged telecommunications-broadcasting technology development projects from a demand-oriented perspective, using criteria that are based on projected future demand characteristics. Aimed at increasing the efficiency of the R&D project selection process in telecommunications and broadcasting convergence, this study can point out new directions in R&D management in this field.

Key Words : Telecommunications and broadcasting convergence, R&D project selection, Service factors, AHP

Ⅰ. Introduction

Converged applications such as DMB and IPTV are now in commercial service, pulling down the traditional boundaries between the telecommunications and broadcasting sectors. The telecommunications and broadcasting convergence refers to the process whereby previously independent media such as TV, multimedia and telecommunications intersect with each other and are merged together, to give users integrated access to them. OECD (1992) defined broadcasting and telecommunications convertgence as a "process whereby, thanks to advances in the broadband evolution of telecommunications networks and digitalization of broadcasting, and progress in communications technology, voice, video and data services, as well as services designed for different devices, are provided through a single digital distribution system, and new types of service, adapted to such a single distribution system, are developed."[16] Convergence technologies can shape new high value-added business models and allow companies to tap the limitless potential of blue oceans. At a national level, convergence technologies hold a tremendous potential to bolster Korea's global competitiveness [7].

Unlike in Europe or the US, regulatory practices in Korea, concerning the telecommunications and broadcasting industries, are far from market-centered. Whilst Korea is well ahead of other countries in terms of technological readiness, such is not the case with its regulatory infrastructure. Much is still left to be done at a regulatory level, before Korea can fully embrace telecommunications and broadcasting convertgence. Regulatory inconsistencies and clashes of interest between stakeholders have been the major contributing factors to this stalemate. DMB, for example, was commercially rolled out at the end of

* 충북대학교 경영정보학과 (phdhyo@naver.com), ** 충북대학교 경영정보학과/BK21사업팀 (kimts@chungbuk.ac.kr), (° : 교신저자)
*** 한국전자통신연구원 기술전략연구본부 (sjyeon@etri.re.kr, wgha@etri.re.kr)
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a protracted deliberation by the Korean regulators, which lasted nearly five years. Now in its three years of service, DMB is utterly failing to produce the synergy expected at the outset. This delay is most unfortunate, especially when one considers how the Korean state of technology was ready for commercialization of applications of telecommunications and broadcasting convergence, long before this was the case in most developed countries. This failure to commercialize convergence technologies on a timely basis is largely due to the government's R&D policy, little aligned to market demand, and the regulators' inability to come to an agreement on practical terms of commercial launch.

This study starts out from the premise that to effectively respond to telecommunications and broadcasting convergence, a phenomenon with major social and economic consequences, technology development efforts must be closely linked to projected future demand characteristics in the convergence market. Such a demand-oriented approach to R&D should lead to the development of convergence technologies to a direction that is more market-centered, and should also help the government draw up a regulatory road map which better corresponds to market trends. How R&D projects are selected, and what criteria are used for their selection have a crucial impact on the long-term development of a technology field[21]. An efficient and systematic approach to the selection of R&D projects can help both public research institutions and corporate research centers more proactively respond to the needs and demands of the marketplace[10,21].

In this study, we begin by reviewing prior studies on the selection of R&D and technology projects. Next, we present priorities in selecting key technologies of telecommunications and broadcasting convergence and rank them in the order of importance, using the Analytic Hierarchy Process (AHP) methodology. Both telecommunications and broadcasting being sectors with a strong service orientation, market demand should be the primary consideration when selecting a technology project in these fields. The project selection criteria proposed in this study are, therefore, based on projected future demand characteristics in the telecommunications and broadcasting convergence market.

Ⅱ. Literature review

Criteria commonly used for selection of a R&D or technology project range from market considerations weighing the market potential of a technology or a project to technical considerations related to the intrinsic value of a technology and social considerations examining the potential social and economic impacts or spillovers of a technology. The future value of a technology and its appropriateness to organizational strategies are also among the popularly considered criteria. Whilst R&D project selection criteria vary somewhat according to the researcher, the principal ones are listed in Table 1.

Lee & Om (1996) determined priorities in selecting R&D projects among government-funded research institutions and corporate research centers in Korea, and ranked them in the order of importance, based on the results of a survey using a 5-point Likert scale. Their study found that technology spillovers were the highest priority for government-funded public research institutions, and the market potential, the highest priority for corporate research centers[15]. Balachandra & Friar (1997) investigated the effects of project selection criteria on the actual selection of a R&D project, by examining a series of selection criteria proposed by prior studies[20]. Meanwhile, Dey (1999) developed a project selection process, which draws on techniques of Business Process Re-engineering (BPR) to achieve greater efficiency[18]. Meade & Presley (2002) derived R&D project selection priorities from criteria proposed in the existing literature and ranked them according to importance, using the Analytic Network Process (ANP) method. They found that the market potential of a project was the highest priority[10]. Hsu et al. (2003), in their study on the selection process of government-funded research projects, created a hierarchy of criteria using the AHP. The criteria were ranked in the order of

Table 1. Traditional criteria for R&D project selection.

Researcher \ Criteria	Market considerations	Technical considerations	Social considerations	Organizational considerations
Lee & Om (1996)	√	√	√	
Balachandra & Friar (1997)	√	√		√
Dey (1999)	√	√		√
Meade & Presley (2002)		√		√
Hsu et al. (2003)	√		√	√
Coldrick et al. (2005)	√	√		
Lee et al. (2009)	√	√		√
Huang et al. (2008)	√	√		√

importance based on the results of an expert survey on technology projects planned by Industrial Technology Research Institute of Taiwan [25]. Coldrick et al. (2005) proposed a project selection process and a set of selection criteria for companies in technology-intensive sectors, to help them choose the most promising technology areas to invest in [22]. Lee et al. (2009) presented five key criteria for selecting a mode of technology acquisition (internal development, collaborative development or purchase) and determined their relative importance using ANP techniques[8]. Huang et al. (2008) looked at the level of government support directed at R&D projects included in the Industrial Technology Development Plan (ITDP) by the Taiwanese government and the criteria that were used for their selection, to determine priorities and rank them according to their relative importance. They found that technological competitiveness had the highest weight value[1].

The criteria proposed by prior studies, however, are not directly relevant for the purpose of this study, due, on the one hand, to the service orientation of the telecommunications and broadcasting sectors, and on the other, to the special characteristics of telecommunications and broadcasting convergence, a next-generation technology field.

Ⅲ. Research model

The AHP is a decision-making method. Proposed by Thomas Saaty during the 1980s, the AHP is a technique to structure complex decisions into a hierarchy of criteria and alternatives. The procedure derives weights for the decision-making criteria and determines preferences for each of the alternatives under the subcriteria through pairwise comparisons, to establish their priority and relative importance[24].

Based on AHP theory the research model for this study consists of three levels, as shown in Fig. 1. The top level is occupied by the most general objective of a decision problem, and the middle level is populated by various mutually-comparable attributes on which the decision is based, in other words, the criteria that influence decision-making. The lowest level of the hierarchy is composed of decision-making alternatives. When structuring a problem into an analytic hierarchy, evaluation criteria must be selected in such a way as to ensure that (1) they are mutually exclusive; (2) the elements of the lower hierarchy are dependent on the elements of the upper hierarchy; and (3) the total number of elements is small enough for processing. These three requirements in the selection of evaluation criteria were formulated by Saaty[24].

3.1 Research goal

As can be seen in the research model presented in Fig. 1, the goal of this study is to rank telecommunications and broadcasting convergence development projects in the order of priority.

3.2 Project selection criteria

To better reflect the special characteristics of the telecommunications and broadcasting convergence, a

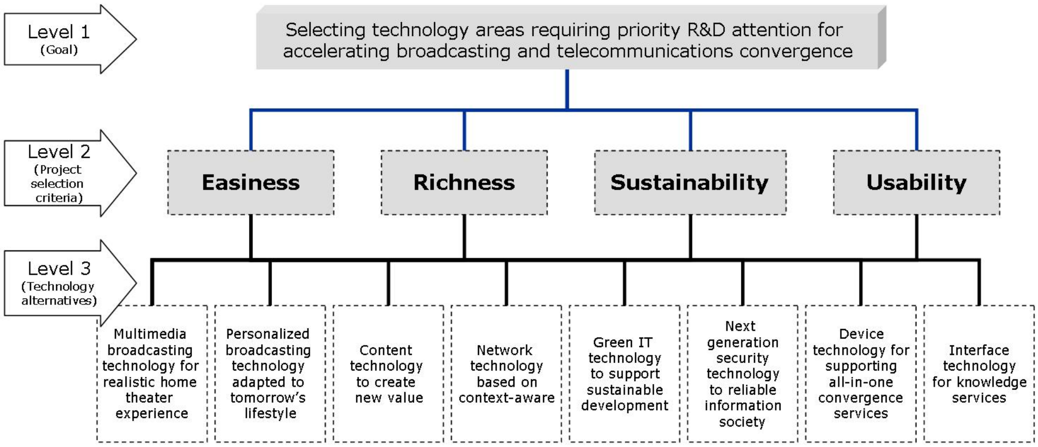


Fig. 1. Research model

whole-new technology field, this study uses a set of project selection criteria that are distinct from traditional project selection criteria proposed in the existing literature, such as market and technical considerations or strategic considerations.

To derive project selection criteria for this study, ten forecast reports predicting future trends in telecommunications and broadcasting from domestic and international sources, in the years leading up to 2020 were reviewed[2-4,6,7,9,11,12-14,19]. The characteristics of future demand in the telecommunications and broadcasting convergence market, identified through this review, are presented in Fig. 2.

From these projected future demand charac-

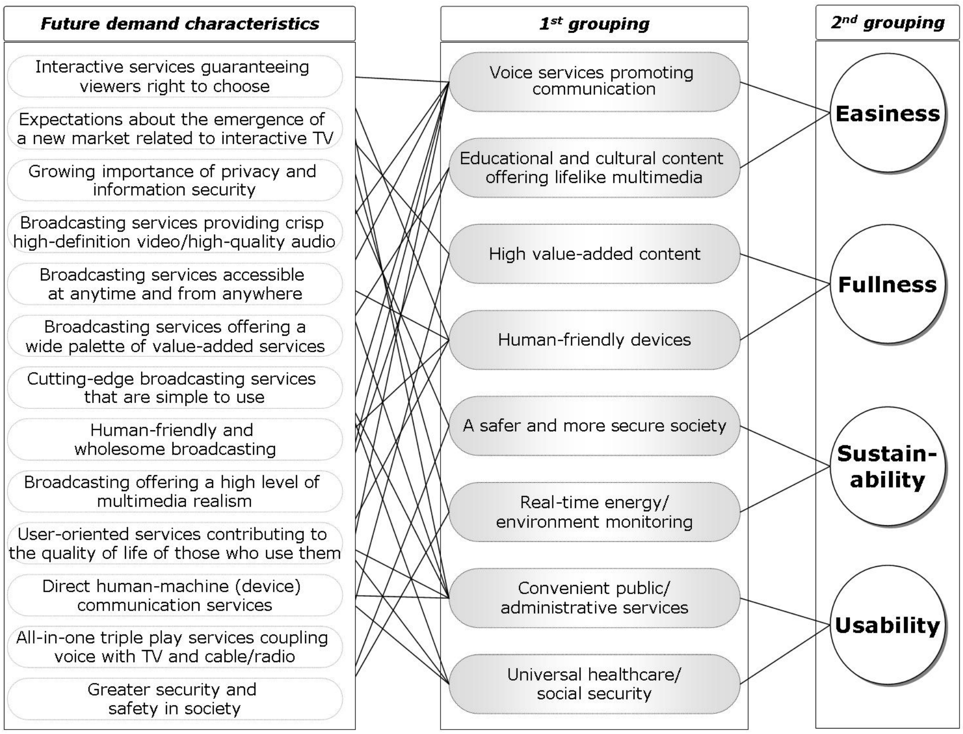


Fig. 2. Deduction process of project selection criteria of telecommunications and broadcasting convergence.

Table 2. Project selection criteria

Criteria	Description
easiness (easy communication)	Demand for broadcasting services that offer high-definition video and CD-quality audio, which provide easily at anytime and from anywhere, while fully guaranteeing viewers' right to choose and easiness to use
richness (context based contents)	Demand for a wider variety of value-added broadcast contents services, deliverable to a computer via the Internet
sustainability (sustainable lifestyle)	Demand for maximizing the use of IT for achieving sustainable development of the planet and a u-society in which life is safer and more secure, and information and networks are better protected
usability (convenient society)	Demand for ushering in a society where information and knowledge can be conveniently used by all thanks to advanced next-generation information interfaces

teristics, four selection criteria were extracted, as listed in Table 2. These four criteria are used in this study as the selection criteria for telecommunications and broadcasting convergence R&D projects. 'Easiness' means the demand for broadcasting services that offer high-definition video and CD-quality audio, which are furthermore accessible at anytime and from anywhere, while fully guaranteeing viewers' right to choose. Meanwhile, 'richness' refers to the demand for a wider variety of value-added broadcast content services, deliverable to a computer via the Internet. 'Sustainability,' for the purposes of this paper, means the demand for maximizing the use of Information Technology (IT) for achieving sustainable development of the planet and a ubiquitous society (u-society) in which life is safer and more secure, and information and networks are better protected. Finally, 'usability' refers to the demand for ushering in a society where information and knowledge can be conveniently used by all thanks to advanced next-generation information interfaces.

3.3 Technology alternatives

Technology alternatives are the elements of the lowest level in the analytic hierarchy that will be ranked in the order of priority. In this study, technology alternatives were selected, as was the case with the project selection criteria, by consulting ten Korean and international forecast reports predicting future trends in telecommunications and broadcasting during the years ending in 2020 as shown in Fig. 3.

The technology alternatives derived from literature analysis were grouped through the keyword-matching process, designed to eliminate any redundancy. This process reduced the number of telecommunications and broadcasting convergence technology alternatives to eight as shown in Table 3. 'Multimedia broadcasting technology for realistic home theater experience' refers to technology enabling two-way data broadcasting (terrestrial, cable or internet broadcast) and high-quality, customizable multimedia broadcasting services offering high-definition video and CD-quality audio. 'Personalized broadcasting technology adapted to tomorrow's lifestyle' refers to all technologies

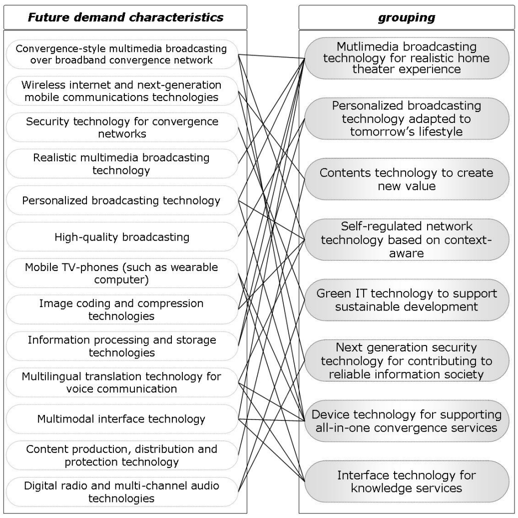


Fig. 3. Deduction process of telecommunications and broadcasting convergence technology alternatives.

Table 3. Technology alternatives.

Alternatives	Description
Multimedia broadcasting technology for realistic home theater experience	Technologies for enabling two-way data broadcasting (terrestrial, cable or internet broadcast) and high-quality, customizable multimedia broadcasting services offering high-definition video and CD-quality audio
Personalized broadcasting technology adapted totomorrow's lifestyle	Technologies for implementing personalized and customizable converged voice and multimedia services in keeping with web 2.0-led trends and responding to the increasing demand for personalization services
Contents technology to create new value	Technologies for supporting and assisting the production and secure distribution of digital contents of communications and broadcasting
Self-regulated network technology based on context-aware	Technologies for next-generation convergence network enabling secure broadband access to multimedia services with QoS guarantee
Green IT technology to support sustainable development	Technologies for integration of IT in wide-ranging industry sectors to introduce innovation in production and distribution processes, as well as consumption, leading to greater energy and resource efficiency and dramatic reduction in environmentally-harmful byproducts
Next generation security technology for contributing to reliable information society	Technologies for securing converged services such as u-business, u-education or u-home services
Device technology for supporting all-in-one convergence services	Technologies can be adapted to tomorrow's computing style creation and can support personalized digital services
Interface technology for knowledge services	Technologies for enabling simultaneous communication with people and devices such as multilingual translation for voice services, and multimodal interface technologies

enabling and supporting personalized and customizable converged voice and multimedia services in keeping with web 2.0-led technology trends and responding to the increasing demand for personalization services. 'Contents technology to create new value' collectively refers to technologies assisting and supporting the production and secure distribution of digital contents of communications and broadcasting. 'Self-regulated network technology based on context-aware' refers to technologies enabling secure broadband access to multimedia services with QoS guarantee. 'Green IT technology to support sustainable development' refers to technologies for integration of IT in wide-ranging industry sectors to introduce innovation in production and distribution processes, as well as consumption, leading to greater energy and resource efficiency and dramatic reduction in environmentally-harmful byproducts. 'Next generation security technology for contributing to reliable information society' designates network and application security technologies for converged or fused services such as u-business, u-education or u-home services. 'Device technology for supporting all-in-one convergence services' refers to technologies can be adapted to tomorrow's computing style creation and can support personalized digital services. 'Interface technology for knowledge services' refers to technologies for enabling simultaneous communication with people and devices such as multilingual translation for voice services, and multimodal interface technologies.

The project selection criteria and technology alternatives were reviewed by an expert panel composed of industry and technical specialists from the telecommunications and broadcasting fields in two successive occasions. The final lists of criteria and alternatives in Table 2 and Table 3 were created by incorporating expert feedback through appropriate modifications.

Ⅳ. Results

4.1 Survey

To collect data for the analysis, an expert survey was conducted, using a questionnaire developed based on the analytic hierarchy shown in Fig. 1. 50 industry professionals and technology specialists in the telecommunications and broadcasting fields surveyed returned 30 responses.

4.2 Discussion of results

The 30 responses returned were tested for consistency (cf. Table 4). Expert Choice 2000 software was used to calculate the consistency index (CI). As a general rule, the weights of a pairwise comparison matrix are considered consistent if the CI is about 0.20 or less[23,24]. In this study, we applied a more rigorous standard and considered only those judgment matrices having a CI of 0.15 or less. Based on this standard, 18 responses proved to have a satisfactory level of consistency.

The project selection criteria and technology alternatives were ranked in the order of priority only for those responses whose judgment matrices had a consistency index value of 0.15 and less. The ranking results by respondent are provided in Table 5. Concerning project selection criteria, there was a strong preference for criterion 1 (easiness), and the most preferred technology alternative was technology 6 (next generation security technology for contributing to reliable information society).

To assess the overall group response, a geometric mean of each pairwise comparison matrix was calculated, over all 18 respondents whose judgment matrix had a consistency index value of 0.15 or less. Using the geometric mean equation, new pairwise comparison matrices were created by taking into account expert opinions. Technology alternatives the most appropriate to the overall goal were selected based on these new pairwise comparison matrices. The new geometric mean matrices, created to derive an overall group response, in other words, a consensus ranking of project selection criteria and alternatives, had a CI of 0.02.

The highest ranking project selection criterion, based on the geometric mean matrices, was 'easiness,' receiving a weight of 0.347 (cf. Table 6). Meanwhile, the highest ranking technology alternative, based on the geometric mean matrices, capturing the overall group response, proved to be 'next generation security technology for contributing to reliable information society,' receiving a weight of 0.148 (cf. Table 7). This result appears to reflect the widely-recognized need for stronger security

Table 4. CI of pairwise comparison results by respondents

Respondent	R1	R2	R3	R4	R5
CI	0.22	0.07	0.10	0.36	0.15
Respondent	R6	R7	R8	R9	R10
CI	0.15	0.13	0.08	0.13	0.02
Respondent	R11	R12	R13	R14	R15
CI	0.14	0.02	0.05	0.13	0.07
Respondent	R16	R17	R18	R19	R20
CI	0.16	0.18	0.07	0.17	0.09
Respondent	R21	R22	R23	R24	R25
CI	0.06	0.20	0.18	0.06	0.11
Respondent	R26	R27	R28	R29	R30
CI	0.38	0.16	0.16	0.16	0.17

Notes: R represents Respondent.

Table 5. Pairwise comparison results by respondents (only CI of 0.15 or less)

Respondent	R1	R2	R3	R4	R5
Criteria	-	C1	C1	-	C1
Alternatives	-	T4	T8	-	T6
Respondent	R6	R7	R8	R9	R10
Criteria	C1	C1	C3	C2	C1
Alternatives	T6	T1	T5	T7	T6
Respondent	R11	R12	R13	R14	R15
Criteria	C3	C1	C1,4	C2	C2
Alternatives	T6	T1	T1	T2	T3
Respondent	R16	R17	R18	R19	R20
Criteria	-	-	C1	-	C3
Alternatives	-	-	T1	-	T5
Respondent	R21	R22	R23	R24	R25
Criteria	C1	-	-	C2	C1
Alternatives	T7	-	-	T1	T4
Respondent	R26	R27	R28	R29	R30
Criteria	-	-	-	-	-
Alternatives	-	-	-	-	-

Notes: R represents Respondent, C represents Criteria, A represents Alternative.

Table 6. Priority ranking results by selection criteria: overall group response

Criteria	Weight	Priority Ranking
Easiness	0.347	1
Richness	0.204	4
Sustainability	0.204	4
Usability	0.246	2
Total	1.000	

Table 7. Priority ranking results by technology alternative: overall group response

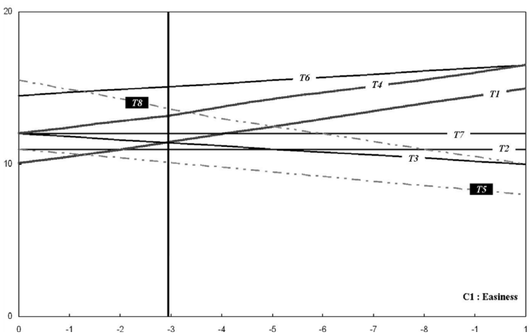
Alternatives	Weight	Priority Ranking
Multimedia broadcasting technology for realistic home theater experience	0.118	5
Personalized broadcasting technology adapted totomorrow's life style	0.113	7
Contents technology to create new value	0.116	6
Self-regulated network technology based on context-aware	0.137	3
Green IT technology to support sustainable development	0.103	8
Next generation security technology for contributing to reliable information society	0.148	1
Device technology for supporting all-in-one convergence services	0.127	4
Interface technology for knowledge services	0.138	2
Total	1.000	

standards in the new information and network environment. The 2nd highest ranking alternative was interface technology for knowledge services, receiving a weight of 0.127; a result echoing the growing demand for an easy-to-use interface technology adapted to tomorrow's information needs.

4.3 Sensitivity analysis

Sensitivity analysis tests the sensitivity and reactivity of a priority ranking. In this study, we tested the gradient sensitivity of the ranking, using Expert Choice 2000 software. Gradient sensitivity analysis indicates how a change in the rank position of a criterion affects the ranking of alternatives. The vertical line, read from the X-axis intersection, indicates the actual value of a criterion, and the priority rank of the criterion is varied by moving this vertical line toward left or right, causing changes in the ranking of alternatives.

For example, if criterion 1 (easiness) gains in importance, in other words, moves up in the ranking, this results in a commensurate increase in the preference or the need for technology 4 (self-regulated network technology based on context-aware) and technology 1 (multimedia broadcasting technology for realistic home theater experience), as can be seen in Fig. 4. On the other hand, this same change causes the demand for technology 5 (green IT technology to support sustainable development) and technology 8 (interface technology for knowledge services) to decline. The results of sensitivity analysis can provide pointers for determining priority investment areas in telecommunications and broadcasting convergence, according to the varying the policy or technology priority at a given point in time. If, for example, the top-ranking project selection criterion in a given situation is criterion 1 (easiness), corresponding to the demand for broadcasting services accessible at anytime and from anywhere, and guaranteeing viewers' right to choose, as proved to be the case in this study, this points to a need to allocate resources to projects related to technology 4 (self-regulated network technology based on context-aware) and technology 1 (multimedia broadcasting technology for realistic home theater experience). Gradient sensitivity analyses for other criteria are shown in Appendix.



Notes: T represents Technology

Fig. 4. Gradient sensitivity analysis.

V. Conclusion and implications

This study proposed a process for selecting R&D projects in telecommunications and broadcasting, designed to help policymakers and technology developers effectively respond to the new phenomenon of telecommunications and broadcasting convergence. The significances of this study are: First, the project selection process proposed by it closely reflects the service-orientation of telecommunications and broadcasting convergence. Using future demand characteristics of the telecommunications and broadcasting convergence market, derived through literary review, the study formulated a new set of project selection criteria. Second, through sensitivity analysis, the study demonstrated how changes in the priority ranking of project selection criteria, as a result of changing demand characteristics in the telecommunications and broadcasting convergence market, can affect the ranking of technology alternatives; information rich in implications for policymakers responsible for public investment-decision making as well as technology developers.

This study is, however, limited in that the project selection criteria and technology alternatives considered were selected through literature review and the consultation of an expert panel. Future research can further ensure the validity and objectivity of the results, by basing the selection of criteria and alternatives on a broad-based survey using, for instance, the Delphi survey method. Another limitation of this study is that the survey sample was restricted to technology developers with advanced understanding of future demand characteristics in the telecommunications and broadcasting convergence market and related technology projects. Future research can, therefore, benefit from expanding the sample to include policymakers and converged technology users.

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전 효 정 (Hyo-Jung Jun) 정회원

2001년 2월 충북대학교 경영정보학과 학사
2003년 8월 충북대학교 경영정보학과 석사
2007년 5월 ETRI 사업기획팀 기술원
2006년 9월~현재 충북대학교 경영정보학과 박사과정
<관심분야> 정보시스템 보안감사, ISP, AHP

김 태 성 (Tae-Sung Kim) 종신회원

1997년 2월 KAIST 산업경영 박사
1997년 2월~2000년 8월 ETRI 선임연구원
2005년 1월~2006년 2월 U of North Carolina at Charlotte 방문교수
2010년 7월~현재 Arizona State University 방문연구원
2000년 9월~현재 충북대학교 경영정보학과 교수
<관심분야> 통신 및 보안 분야의 경영 및 정책 의사결정

연 승 준 (Seung-Jun Yeon) 정회원

1997년 2월 청주대학교 회계학과 졸업
1999년 8월 충북대학교 경영학과 석사
2004년 2월 충북대학교 경영정보학과 박사
2004년 2월~현재 ETRI 기술전략연구본부 선임연구원
<관심분야> 정보통신정책, 정보기술경영, 정보시스템경영, 정보화전략, 시스템다이내믹스

하 원 규 (Won-Gyu Ha) 정회원

1988년 동경대학교 대학원 사회학 연구과 신문방송학 석사
1992년 동경대학교 대학원 사회학 연구과 사회정보학 박사
1981년 ETRI 입소
1995년 ETRI 정보정책연구실장
1999년 ETRI 정보기반연구팀장
2002년 ETRI IT정보센터장
2004년 ETRI 유비쿼터스 IT 전략연구센터장
2006년 ETRI 유비쿼터스 IT 전문위원
2007년 ETRI 기술전략연구본부 미래기술전략연구팀장
2008년~현재 ETRI 기술전략연구본부 책임연구원
<관심분야> 정보사회론, 국가정보화전략, 만물지능통신

Appendix

If criterion 2 (richness) gains in importance and moves up in the ranking, this results in a commensurate increase in the preference or the need for technology 3 (contents technology to create new value) and technology 2 (personalized broadcasting technology adapted to tomorrow's lifestyle), as can be seen in Fig. A1. On the other hand, this same change causes the demand for technology 5 (green IT technology to support sustainable development) and technology 4 (self-regulated network technology based on context-aware) to decline.

If criterion 3 (sustainability) gains in importance, this results in a commensurate increase in the preference or the need for technology 6 (next generation security technology for contributing to reliable information society) and technology 5 (green IT technology to support sustainable development), as can be seen in Fig. A2. On the other hand, this same change causes the demand for technology 2 (personalized broadcasting technology adapted to tomorrow's lifestyle) to decline.

If criterion 4 (usability) gains in importance, this results in a commensurate increase in the preference or the need for technology 8 (interface technology for knowledge services) and technology 7 (device technology for supporting all-in-one convergence services), as can be seen in Fig. A3. On the other hand, this same change causes the demand for technology 5 (green IT technology to support sustainable development) and technology 6 (next generation security technology for contributing to reliable information society) to decline.

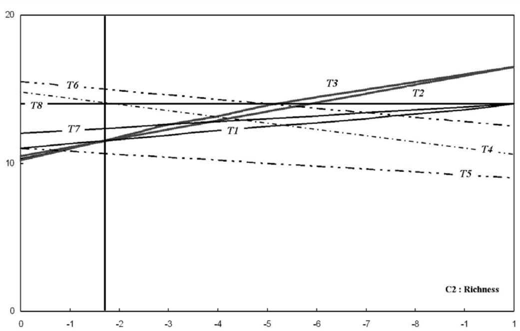

Fig. A1. Gradient sensitivity analysis for C2.

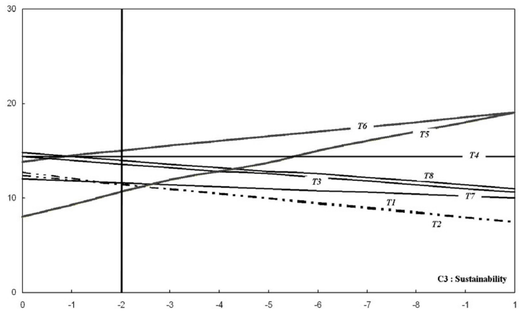

Fig. A2. Gradient sensitivity analysis for C3.

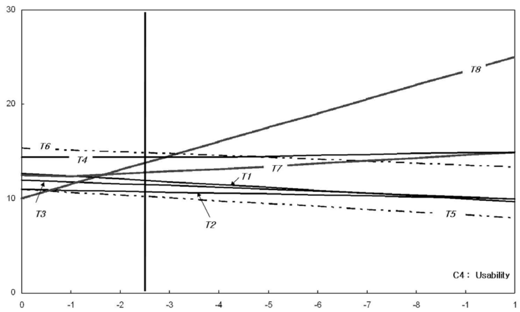

Fig. A3. Gradient sensitivity analysis for C4.