효과적인 미세먼지 정보전달을 위한 소비자의 미디어 이용충족 비교
-적소이론을 적용하여 -

Comparison of Consumer Media Use Gratification for the Effective Delivery of Fine Dust Information: Applying the Niche Theory

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요약

미세먼지는 전 세계 사망 원인 10대 중 하나이다. 세계 인구의 95% 이상이 그것에 의해 위험에 처해 있다. 본 연구는 적소 이론에서 미디어의 경쟁적 특성을 활용하여 위험 정보를 제공하는 다양한 유형의 미디어 사이의 상호 보완 관계를 정의, 효율적으로 제공하고 관리하기 위해 사용되는 방법을 탐구한다. 12일 동안 348명의 한국 대학생들로 구성된 설문조사는 미세먼지에 대한 소비자 인식, 미디어 이용, 미디어 이용 만족도 등 3가지 요인을 분석했다. 미디어 만족에 대한 응답 값은 적소 폭, 적소중복, 경쟁 우위를 도출하기 위해 방정식으로 대체되었다. 연구결과 미세먼지 예보 및 미세먼지 대응 지침 정보를 제공하기 위해 스마트폰 애플리케이션이 가장 효과적이었고, 스마트폰 애플리케이션이 미세먼지의 심각성과 발생원 등 추가 정보 제공에 제한돼 인터넷과 스마트폰 애플리케이션의 기능 확립이 필요한 것으로 조사됐다. 따라서 스마트폰 애플리케이션을 보완하는 위기전달 시스템을 개발해야 한다.

■ 중심어 : | 미세먼지 | 위험정보 | 적소이론 | 적소폭 | 적소중복 | 경쟁우위 |

Abstract

Fine dust is one of the top ten causes of deaths globally. More than 95% of the world's population are endangered by it. However, as the fine dust problem is difficult to address immediately, people should be informed of its risk and prepared to deal with it. This study explores the methods used to define, efficiently provide, and manage the complementary relationships between various types of media providing risk information utilizing the competitive characteristics of media in niche theory. A survey consisting of 348 Korean university students was conducted over 12 days, to analyze three factors: consumer perception of fine dust, media usage, and media use gratification. The response value for media gratification was substituted in the equation to derive the niche breadth, niche overlap, and competitive superiority. It was found that 1) for providing fine dust forecast and fine dust response guidance information, a smartphone application was the most effective; 2) smartphone applications were limited in providing additional information such as the severity and origin of fine dust, and hence, it is necessary to establish the functionality of the Internet and TV to complement smartphone applications. Thus, a system considering the above should be developed.

■ keyword : | Fine Dust | Risk Information | Niche Theory | Niche Breadth | Niche Overlap | Competitive Superiority |

I. Introduction

The introduction With fine dust levels having reached record levels in South Korea in recent years, it has been described as a "social disaster" by the Framework Act on the Management of Disasters and Safety[1], Particulate matter (or particle pollution) is a term used for a mixture of solid particles and liquid droplets found in the air.

A long-term exposure to microparticle air pollution was found to ,be a major factor causing cardiopulmonary diseases and lung cancer[2]. In 2013, the International Agency for Research on Cancer (IARC) under the World Health Organization classified (WHO) fine dust as a Group 1 carcinogen[3].

Pollution is still the largest environmental cause of premature death on the planet, killing 8.3 million people in 2017, and the Institute for Health Metric's (IHME's) data provides a range from 7 million to 10 million total premature deaths, attributing 5 million of those to air pollution[4].

In general, the smaller the particle size, the greater the impact on health. Based on this principle, developed countries have introduced air quality standards to regulate microparticles. For example, the United States set standards for PM2.5at15㎍/㎥ for annual average and 35 ㎍/㎥ for a 24-h average[5].

Addressing the fine dust problem in the short term is challenging due to the PM is produced as a result of urbanization and changes in the industrial structure. Therefore, to address it, the examination of energy structures as well as the overall industrial structure is required. Moreover, with prolonged exposure, fine dust can cause health and property damage[6-9],

and a short-term analysis of the dynamics related to this phenomenon is limited[10].

Furthermore, fine dust is invisible, making it difficult for the general public to identify. Hence, people can be exposed to significant amounts of particulate matter without realizing it. According to previous work[11-13], public risk awareness communication is critical because of the risk from air pollution is hard to recognize for the general public. In addition, the source of air pollution demands scientific knowledge that is difficult for the general public to understand, so the clear transmission of public risk information is very important. In recent years, air pollution has been referred to as an 'invisible killer,' and 'an invisible health crisis'[14].

Hence, effective information delivery and risk management communications can be crucial factors in minimizing the public risk of exposure to fine dust[15-18].

Additionally, the instances of air pollution caused by industrial accidents can also cause public fear. Here, the public may require the provision of accurate information on the incident in order to feel reassured. A scientific approach to crisis management communications and information has been attempted to address the public fears[17-20].

The effective message delivery requires an effective message design in order to better control risks or fear when the public faces health or environmental risks[21]. Public health and environment risk management has been used since the 1970s and involves numerous industrial technology-related risks. One of the key responsibilities of industries and governments is to effectively deliver the information to suitably address the public needs

and interests when the risks arise.

In particular, the risk level of fine dust increases with time, so everyone who is outdoors should check the fine dust information frequently and take appropriate measures. Those who are overconfident or lack interest in their health overlook this, even though they are aware of the dangers of fine dust. For this reason, it is important that information on fine dust is communicated effectively to the public.

This study aims to compare and analyze the attributes of the media used for information delivery based on the niche theory, to effectively deliver risk information on PM. Niche theory was developed in ecology to explain the competition between populations in ecosystems. The theory states that when new populations attempt to consume the resources the old group consumed, a competition occurs and, ultimately, different resources either coexist or are replaced[22].

This study explores the methods to define, efficiently provide, and manage the complementary relationships between different types of media which provide public risk information, by utilizing the competitive characteristics of media in niche theory. The study aimed the following: 1) Examine the public attitude toward fine dust problems; 2) Examine the type of media the public use to access information on fine dust/air pollution; 3) Examine the niche breadth, overlap, and competitive superiority of media as sources of information on fine dust. Based on these objectives, the study identifies a preferred and most effective type of media for providing information on fine dust as well as complementary relationships between different types of media.

The rest of the study is structured as follows. Section 2 presents the theoretical background behind this research and discusses the application of niche theory in this study. Section 3 presents research methods, while Section 4 presents the combined results and discussion. Conclusions are presented in Section 5.

II. Theoretical background

1. Risk information

Risk is defined as the possibility of loss or harmful consequences that can be caused by certain hazards over a designated time[23]. Sandman[24] states that risk is a dependent variable that occurs due to the hazards of daily life and defines it as "hazard + outrage".

Dunn and Ray[25] categorized various types of information into problem recognition, alternative search, and selection and implementation information. Problem recognition information is the consumer information that identifies the expected characteristics of the information target and methods to acquire the information. Alternative search information seeks to provide information related to methods for comparing sources and promoting comparisons. Finally, selection and implementation information refer to information that selects alternatives to be implemented or provides practical assistance for implementation.

This study defined the risk information as the information that provides practical assistance for identifying hazards and maintaining a safe life in order to limit the possibility of harmful consequences (health loss) that can result from

certain hazards (fine dust).

In order to achieve the objectives of risk communications presented above, risk, risk assessment, direction, and behavioral guidance for risks must be communicated to the public to ensure adequate safe behavior in risk situations. Hath and Nathan[26] also suggested that presenting both risk and control information to the public is the correct way to communicate risks.

Therefore, this study divided risk information into risk response guidance and diagnostic information, which corresponds to the risk assessment information.

2. The importance of media for risk information provision

When the public faces health or environmental risks, designing and developing effective messages are crucial and necessary for the message to be sufficiently conveyed[21]. Song[27] notes that risk communication via mass media is a factor that plays a significant role in making consumers understand the said risk and plan social stability. Also, Peters and Song[28] define risk as assumed and undefined harm and refer to the importance of public communication as it can save human lives.

Prior studies regarding the importance of providing risk information through media are as follows. Kim, et al.[29] explained that there was an increase in intentional preventive actions by the general public when they gained risk information through the media. Studies by Lipkua, Klein, Skinner, & Rimer [30] and Snyder & Rouse[31] examined the relationship between media and actual risk perception showing that the risk perception of media users differs by the media outlet and the amount of information

exposure. By categorizing media into the Internet, TV, and Facebook, Kwak, et al[32] reported that the exposure rate of each media leads to statistically significant differences in social and individual risk perceptions.

The above studies collectively show the importance of communicating risk information through media to the general public and the differences in the effects by the type of media.

3. Niche theory and gratification of media

With the recent globalization of the Internet and the emergence of mobile media such as smartphones and tablets[33], the media consumption environment is rapidly changing. Consequently, consumers of media consume content including risk information through various platforms, leading to an intense competition among different types of media.

As mentioned earlier, the niche theory has the advantage of being able to identify the relative superiority between comparable media at various sub-dimensions of fulfillment, when providing gratification to consumers, using the key concepts of niche breadth, niche overlap, and competitive superiority[33]. According to the media displacement effect, the media use is determined by the user's level of gratification, which, in turn, depends on the evaluation of the various services provided by the media [34-38].

The niche theory suggested the "gratifications obtained, gratification opportunities, user spending, media usage time, media content, and advertising costs" as the resources that the media wanted to gain through competition[39]. This means that various types of media compete to acquire user gratification, time, and money that the users spend, by providing

content to attract other users.

Existing studies on niche theory and gratification of media mainly relate to the question of whether existing media (e.g., traditional newspapers and print magazines) will be replaced by new media (Internet news, Web-provided media)[22][39].

For example, Whiting and Williams[40] investigated the reasons for people using social media, social interaction, information seeking, pastime, entertainment, and expression of opinion as attributes of user gratification. Kim and Kang[41] characterized the media dependence attributes of media users as timeliness, accessibility, reliability, and visual appeal. Research on alert technology of disaster media has identified the important characteristics of media use as the stability required for the continuous use of information provision systems, channels, and receivers; the efficiency of information channels to respond to information congestion in special situations; receiver wake-up call to provide alarm messages; and localized services to provide information[42].

The user gratification of media users shown in previous studies can be summarized as follows. 'Gratification obtained' is based on timeliness, accessibility, integrity, wake-up alerts, and interaction, while the attributes of 'gratification opportunities' include convenience and mobility.

Niche breadth refers to how widely a specific media utilizes the resources. Niche breadth is an index that shows the degree of satisfaction with the media; media of narrow niche breadth is called "specialist," and that of wide niche breadth is termed "generalist"[39].

The niche overlap index can identify the complementarity between media, and, in terms of user gratification, refers to the functional similarity between the types of media being compared[39].

The competitive superiority index identifies which of the two media being compared is superior at utilizing resources and serves as a tool to identify the competition between media, as is the case with the niche overlap. These two indices (niche overlap and competitive superiority) can be utilized to determine whether the relationship of the media being compared is a competitive displacement or a competitive exclusion.

Through niche overlap and competitive superiority, researchers can predict whether the newly emerging media will completely displace the existing media, partially displace it, or complement it. For a complete displacement, the level of redundancy must be high, and the displacing media must be superior to the existing media for all forms of gratification[43]. Here, the replacement of the existing media with the new media is called exclusion, and the partial replacement is called a competitive displacement[43].

Thus, according to the evaluation levels of media users, Niche breadth, Niche Overlap, and Competitive Superiority can be calculated and compared for analyzing useful media for the users. That is, if a specific media outlet has a narrow Niche breadth regarding fine dust information provision, it can be estimated as a specialized source for fine dust information. Also, by comparing Niche Overlap and Competitive Superiority between the two media outlets, their competitive and exclusive relationships can be understood to distinguish the main media outlet and supplementary

media outlet as fine dust information providers.

Ⅲ. Research methods

1. Sample size

Cheongju is a city with one of the most severe cases of fine dust pollution in South Korea. This is due to the fact that 18% of the country's waste incinerators are concentrated in Cheongju. As such, the government has acknowledged this issue and conducted a survey of the impact of fine dust on residents' health[44].

Hwang[45] analyzed US and Korean college students' perceptions of environmental issues and found that Korean university students had a low concern for the environment and participation. The study showed that college students living in Cheongju, South Korea showed low interest in the environment despite living in one of the most polluted cities in South Korea. Hence, they are considered a vulnerable group to fine dust exposure due to the low level of interest in fine dust-related information.

We conducted a survey of 348 college students. The duration of the survey was 12 days, from May 10 to May 21, 2019. The participants of the survey were students pursuing liberal arts courses at the university; they voluntarily expressed their willingness to participate in the survey. In terms of gender distribution, 42.5% was male and 57.5% was female. In terms of their academic year distribution, 30.5% were freshmen, 25.9% sophomore, 20.6% junior, and 23.0% senior. In terms of their fields of study, 20.1% were in humanities and social sciences, 15.5% in economics, 27.6% in natural science and engineering, 15.5% in agriculture, and 2.9% in medicine, 19.4% in others. In terms of residence, 17.8% resided in the Seoul Capital Area, 58.6% in the Chungcheong region, 13.8% in the Gyeongsang region, 6.3% in the Jeolla region, and 3.4% in the Gangwon or Jeju regions. In terms of average monthly allowance, 76.4% reported less than 500,000 KRW, 21.3% reported between 500,000 and 1 million KRW, and 2.3% reported more than 1 million KRW.

2. Measurement Variables

To analyze consumers' media use gratification for the effective delivery of fine dust risk information, the measurement variables were based on the previous studies.

First, it is known that consumers subjectively assess risks based on their own past experience or knowledge rather than objective data, which is called risk perception[46-49]. Similarly, the consumer perception of fine dust is a subjective risk assessment of fine dust as a dangerous object. By referring to previous studies, the perception of particulate matter was divided into three categories as follows: perception of the effect on the body, perception of the effect on the living environment, and perception of the effect on society. Kim[50] measured the risk perception of outdoor activities due to particulate matter. Ku et al.[51] and Kim et al.[52] measured the effects on one's own body and on those around them as a perceived risk of particulate matter. Furthermore, Jwa et al.[53] and Yi et al.[54] measured the perceived risk of particulate matter in terms of the effect on individuals and the effect on society in certain situations. In addition, by modifying the criteria used in prior studies[51-54], the following three categories were constructed:

effect on the body, effect on the living environment, and effect on the society. The physical impact was measured by the respondents' subjective evaluation of the negative effects of fine dust, based on the three statements: "It is dangerous to their health," "It is dangerous to the health of others," and "It damages the growth of infants." The impact of living environment was surveyed based on the following three statements: "The quality of life is poor," "It is frustrating because we cannot do outdoor activities," and "Anxious about the risk of fine dust exposure." The social impact was measured by the following three statements: "The consumption of fine dust-related goods has increased," "The fine dust has a negative impact on the economic development," and "Fine dust is the most serious problem in society."

Secondly, the Korean population use media channels such as the TV, smartphone, Internet, radio, text messaging, and electronic signboards for getting fine dust information. In South Korea, the fine dust information is provided through a smartphone application and text messages. The smartphone application is called "MiseMise," and was developed by MiseMise Corporation from South Korea and launched in 2015. This application utilizes the criteria used by the WHO to alert the public and classifies fine dust levels into eight depths, as presented in [Table 1]. When the fine dust level is 'very bad', 'extremely bad' or 'worst', the application alerts the user by providing recommendations such as wearing a mask or refraining from external activities. The application also provides fine dust risk information through text messages; when fine dust is severe, national-level alerts are issued.

In this study, we examine whether the respondents found fine dust information on TV, radio, Internet (blog), smartphone apps, text messages, or electronic signboards by referring to the research conducted by Lim et al.[55], who examined the status of risk information provided by the media in Korea according to the type of media. The questionnaire was modified by changing only the media component in the question "I check information on fine dust through a smartphone app." Respondents could use multiple media at the same time, so they were asked to answer whether they use each media with a yes-or-no answer.

Table 1. Classification of the levels of fine dust in South Korea as provided by the "MiseMise" smartphone application

Level	Best	Good	Not bad	Normal	Bad	Very bad	Extremely bad	Worst
Symbol	😎	😊	😌	🙂	😟	😠	😡	☠
Fine dust	0~15	16~30	31~40	41~50	51~75	76~100	101~150	151~
Ultra Fine dust	0~8	9~15	16~20	21~25	26~37	38~50	51~75	76~
Ozone	0~0.02	0.02~0.03	0.03~0.06	0.06~0.09	0.09~0.12	0.12~0.15	0.15~0.38	0.38~
NO2	0~0.02	0.02~0.03	0.03~0.05	0.05~0.06	0.06~0.13	0.13~0.2	0.2~1.1	1.1~2
NO	0~1	1~2	2~5.5	5.5~9	9~12	12~15	15~32	32~
SO2	0~0.01	0.01~0.02	0.02~0.04	0.04~0.05	0.05~0.1	0.1~0.15	0.15~0.6	0.6~

Third, the content of the risk information is divided into diagnostic information that defines or locates the problem and identifies the cause of the problem, and risk response that provides information on how to address the problem [49][56][57]. For the fine dust risk information user gratification for each media, the messages provided by each media were divided into diagnostic information and risk response

guidance, following which the items for user gratification were configured. The questionnaire for user gratification was composed by referring to previous studies, as shown in [Table 2]. As stated above, for the items to measure user gratification, "gratifications obtained" consisted of timeliness, accessibility, integrity, wake-up alerts, and interaction, while "gratification opportunities" consisted of convenience and mobility.

Table 2. Media use gratifications of risk information users

Category	Attribute	Citation
Gratifications obtained	Timeliness Accessibility Integrity Wake-up Interaction	Dimmick [39] Kim and Kang [58] Lee et al. [59] Bovee et al. [60] Rogova and Bosse [61]
Gratification opportunities	Convenience Mobility	Dimmick [56] Rogova and Bosse [61] Rogova and Bosse [61]

All theoretical concepts were generally measured by a five-point Likert scale ranging from one (strongly disagree) to five (strongly agree).

To verify the reliability of the scale, a reliability analysis was conducted for all items except media usage, which was measured by a nominal scale. All items showed a Cronbach's alpha value above 0.7, indicating that the scale is reliable [Table 3].

Table 3. Reliability analysis results of scale

Item		Measurement item	Number of questions	Cronbach's alpha value
Perception	Physical impact	Dangerous to my health	3	0.875
		Dangerous to the health of others		
		Harm to the growth of infants		
	Living environment impact	Reduced quality of life	3	0.846
		Frustration because I cannot do outdoor activities		
		Anxiety due to risk of exposure to fine dust		
	Social impact	Increased consumption of fine dust-related goods	3	0.733

		Negative effect on South Korea's economic development		
		Most severe problem in South Korean society		
Media usage (TV, Radio, Internet blog, Smartphone application, Text message, Electronic board)			6	–
Gratifications obtained (5 items) & opportunities (2 items)		TV	7	0.860
		Radio	7	0.867
		Internet (blog)	7	0.853
		Smartphone application	7	0.833
		Text message	7	0.886
		Electronic board	7	0.859

3. Niche Measures

The niche theory is composed of three aspects: breadth, overlap, and competitive superiority. In this study, the niche breadth, niche overlap, and competitive superiority were calculated using Dimmick's equations[39]. First, the niche breadth values closer to 1 are classified as generalist media and values closer to 0 as specialist media. Second, the niche overlap means the level of similarity in a field. "A high degree of niche overlap indicates a high degree of similarity between the perceptions of gratification obtained from each media[62]. Third, competitive superiority measures how superior one medium is over the other in a certain dimension. The first step is to calculate the difference between the two media in one dimension is by using the paired t-test. The degree of niche overlap between the media is indicated by the reverse measures of the niche overlap. That is, the lower the value of niche overlap, the greater the degree of niche overlap, the more intense the competition is among the media. Conversely, the higher the value of niche overlap, the lower the degree of niche overlap and the less intense the competition is among the media. A low niche overlap indicates that the two media provide different resources and are thus likely to complement rather than compete each other[63].

4. Analysis

Data analysis was performed using SPSS 20.0 (IBM SPSS Inc., Chicago). Participants' general characteristics, and the usage status of fine dust-related media was used to derive the frequency and percentages using descriptive statistics. Descriptive statistics were used to calculate the mean and standard deviation for the users' perception of fine dust. The overall mean for each dimension used the newly derived variable from the sum of each sub-measurement variable divided by the number of measurement variables to calculate the mean and standard deviation.

For niche breadth calculation, the respondents using the respective media were extracted and the response values were substituted into the niche breadth equations. To analyze the niche overlap and competitive superiority, we extracted the respondents who use all corresponding media. Overlapping user groups of TV/electronic scoreboard and text message/electronic scoreboard, with fewer than 50 users, were excluded, and the remaining eight relationships were analyzed.

Ⅳ. Results and Discussion

1. Perception of fine dust

[Table 4] shows the mean of the respondents' perception of fine dust. As mentioned earlier, the perception of fine dust was measured on a five-point scale assessing the level of danger associated with fine dust (with 1 being "strongly disagree" and 5 being "strongly agree").

The results showed that Korean university students had a high level of awareness of the risk of fine dust on the body, living environment, as well as social risks. Specifically, the respondents recognized the impact of fine dust on their bodies at a higher level and perceived it as "the most serious problem in society."

Table 4. Respondents' perception of fine dust

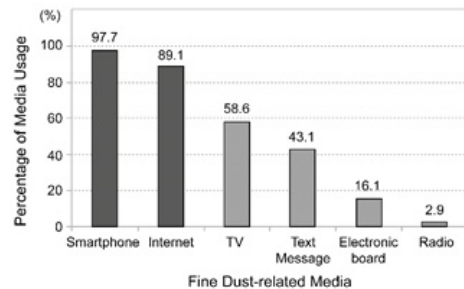| Question		Each item		Overall	
		mean	s.d.	mean	s.d.
Physical impact	Dangerous to my health	4.61	.605	4.56	.601
	Dangerous to the health of others	4.61	.595		
	Harm to the growth of infants	4.46	.795		
Living environment impact	Reduced quality of life	3.83	1.045	3.76	.921
	Frustration because I cannot do outdoor activities	3.66	1.040		
	Anxiety due to risk of exposure to fine dust	3.80	1.073		
Social impact	Most severe problem in South Korean society	4.24	,839	3.77	.741
	Negative effect on South Korea's economic development	3.74	.979		
	Increased consumption of fine dust-related goods	3.33	1.093		

2. Media usage

Figure 1. Percentage of usage of fine dust-related media

[Figure 1] shows the results of examining the respondents' usage status of the media providing fine dust-related information. 97.7% of the respondents checked fine dust information using a smartphone, which was the highest proportion of all respondents. This was

followed by using the Internet (89.1%), TV (58.6%), cellphone text messages (43.1%), electronic board (16.1%), and radio (2.9%).

3. Fine dust risk information media use gratification

3.1 Niche Breadth

According to the niche breadth analysis on the information that diagnoses the risk level of fine dust, smartphone application usage had the highest breadth, followed by the Internet, text messages, TV, electronic boards, and radio use [Table 5].

According to the niche breadth analysis on fine dust response guidance, smartphone had the highest breadth, followed by the Internet, text messages, TV, radio, and electronic boards.

These results indicate that, for our cohort, the fine dust information is primarily obtained through smartphone applications and the Internet, and that radio is used for this purpose only by a small proportion of the respondents. This is likely because our respondents were of a young and technologically savvy cohort.

Table 5. Niche Breadth values

Media	N	Information type	
		Diagnosis	Response guidance
Smartphone application	340	0.842	0.822
Internet (Blog)	319	0.770	0.754
TV	204	0.557	0.560
Text message	150	0.627	0.611
Electronic board	56	0.466	0.429
Radio	10	0.427	–

3.2 Niche overlap and competitive superiority

The results of niche overlap and competitive superiority analysis are shown in [Tables 6 and 7]. The niche overlap values of smartphone applications and the Internet were 1.3 in both diagnosis and response guidance information, and smartphone application was superior in terms of competitive superiority. The niche overlap values of smartphone application and TV were 3.8 and 2.7 in diagnosis and response guidance information, respectively. Furthermore, smartphone application was superior in terms of competitive superiority. The niche overlap values for the smartphone application and text messages were also 1.3 in both diagnosis and response guidance information, and smartphone application was superior in terms of competitive superiority. The niche overlap values of smartphone application and electronic boards were both 4.0 in diagnosis and response guidance information, and smartphone application was superior in terms of competitive superiority. The niche overlap values of internet blogs and TV were 3.4 in diagnosis and response guidance information, and internet blogs were superior in terms of competitive superiority. The niche overlap values of internet blogs and text messages were 2.6 for diagnosis information and 5.1 for response guidance, and internet blogs were superior in terms of competitive superiority. The niche overlap values of internet blogs and electronic boards were 3.9 for diagnosis information and 5.1 for response guidance, and internet blogs were superior in terms of competitive superiority. The niche overlap values of TV and text messages were 5.5 for diagnosis information and 3.3 for response guidance. In terms of competitive superiority, text message was superior for diagnosis information and there was no difference for response guidance.

To summarize, smartphone application showed

the highest competitive superiority among providers of fine dust diagnosis and response guidance information, followed by Internet blogs, text messages, TV, and electronic board. Furthermore, the smartphone application, Internet blog, and text messages provided similar levels of user gratification for diagnosis information, indicating a strong competition, and TV and text messages have a complementary relationship as they provide different user gratifications. Moreover, in terms of response guidance, while smartphone application, Internet blogs, and text messages compete strongly with each other, Internet blogs have a complementary relationship with text messages and electronic board.

Table 6. Niche overlap values

media			N	Diagnosis information	Response guidance
Smartphone app	vs	Internet blog	310	1.386	1.318
Smartphone app	vs	TV	204	3.880	3.742
Smartphone app	vs	Text message	150	2.637	2.637
Smartphone app	vs	Electronic board	52	3.981	4.337
Internet Blog	vs	TV	202	3.356	3.369
Internet Blog	vs	Text message	148	2.589	5.052
Internet Blog	vs	Electronic board	54	3.904	5.110
TV	vs	Text message	92	5.498	3.339

Table 7. Competitive superiority values

Category	media	N	Diagnosis			Response guidance		
			mean	s.d.	t-value	mean	s.d.	t-value
pair-01	Smartphone app	310	0.909	1.158	11.606***	0.814	1.079	10.450***
	Internet blog		0.123	0.389		0.146	0.367	
pair-02	Smartphone app	204	2.450	1.477	17.906***	2.084	1.237	17.043***
	TV		0.322	0.540		0.565	0.544	
pair-03	Smartphone app	150	1.797	1.541	10.929***	1.522	1.385	9.530***
	Text message		0.285	0.521		0.297	0.473	
pair-04	Smartphone app	52	2.464	1.262	10.581***	2.654	1.088	14.187***
	Electronic board		0.407	0.649		0.258	0.332	
pair-05	Internet blog	202	2.061	1.407	14.696***	1.914	1.373	11.576***
	TV		0.366	0.555		0.507	0.702	
pair-06	Internet Blog	148	1.568	0.112	5.455***	1.270	0.106	4.204***
	Text message		0.698	0.080		0.660	0.075	
pair-07	Internet blog	54	2.161	1.100	9.721***	1.829	1.272	6.841***
	Electronic board		0.379	0.509		0.447	0.644	
pair-08	TV	92	0.885	1.152	-2.979**	1.087	1.176	-1.474
	Text message		1.547	1.368		1.413	1.244	

** p< .01, *** p<.001

Korea, next to China, is the world's largest emitter of fine dust, which has long been a serious social problem. However, the fine dust problem is difficult to solve in the short term. Therefore, it is time to effectively provide fine dust information to ensure the safe life of consumers until the fine dust problem is finally resolved. In this study, we investigated the perception of fine dust risk among the Korean college students who were not familiar with fine dust information. We compared and analyzed the properties of information delivery media based on the niche theory in order to effectively deliver the risk information.

Hence, the study results can be summarized as follows. Firstly, Korean university students recognized the impact of fine dust on their bodies and perceived it at a high level that it is "the most serious problem in society". Secondly, 97.7% of the respondents checked fine dust information using a smartphone. Thirdly, the above analysis results indicate that fine dust information is primarily obtained through the smartphones application and the Internet; radio is used only by certain groups. Finally, the smartphone application showed the highest competitive superiority among providers of fine

dust diagnosis and response guidance information. Based on these, the following conclusion can be drawn.

First, Korean students have a high perception that fine dust negatively impacts their physical, living environment, and social conditions. Fine dust is a highly publicized issue in South Korea. That's why the Korean students' perception is high.

Second, providing fine dust diagnosis information through a smartphone application is the most effective way of informing our cohort, as it is the most commonly used medium by the Korean students, with the highest competitive superiority in terms of media use gratification. However, the most commonly used smartphone application in South Korea that provides fine dust information is a commercial information source; as such, its information is slightly different from the fine dust risk warning level provided by the Korea Meteorological Administration. In the future, it is important for smartphone applications to provide information on risk response guidance, to conform with the government data and provide an authorized risk warning system. However, for the users who do not use smartphones, it is desirable to provide fine dust alerts through text messages at that time. Moreover, the functionality of television as a medium for immediately providing risk diagnosis information is expected to be gradually reduced, as with the development of information and communication technology (ICT), the emergence of new media is replacing the functions of existing media.

Third, the provision of fine dust response guidance information through a smartphone application is the most effective means of communication, for the same reason as diagnosis information. For people who do not use a smartphone, fine dust response information must be continuously provided through Internet, text messages, and electronic boards. As these three media are complementary in terms of media use gratification, fine dust response guidance information should be delivered through all of them to gratify media users. In the future, however, we expect that most of these media will be replaced by smartphone applications, where smartphones are used to provide fine dust alert services and increase public awareness through information transmission. Therefore, fine dust crisis management using smartphones, the aim of this study, could be utilized as a useful message factor in China and, India, where air pollution levels are already high[64-67].

The study by Jung and Park[68], which analyzed the competition of media in the field of information, also predicted that social media for smartphones will replace many other traditional media. This is closely related to the penetration rate of smartphones in South Korea.

Ⅴ. Conclusions

South Korea has been seriously affected by fine dust in recent years, with effects on human health and the environment. However, due to its nature, providing a short-term solution to the fine dust problem is challenging. Therefore, it is important to provide effective fine dust information to ensure public safety, until the problem is addressed. This study investigated the perceptions of fine dust risk among Korean

college students, who were not familiar with fine dust information before this study. We compared and analyzed the properties of information delivery media channels based on the niche theory, in order to effectively deliver the risk information.

Our results showed that among media providing fine dust risk information, smartphones have the highest competitive superiority in terms of media user gratification. Furthermore, for our cohort, Internet blogs and text message alerts were found to compete with smartphone applications, although, unless new forms of media emerge in the future, the former will likely be replaced by the latter.

Hence, it is important to develop systems for providing fine dust risk warnings and response guidance through smartphone applications. For example, while the current fine dust information application provides warning alarms for each fine dust level, the user has to find the guideline information page for relevant response guidelines. Also, there is no information regarding the effects of fine dust separately provided at present. Therefore, the information should be provided as text for the user to directly identify action guidelines and the effects of fine dust at the same time the warning alarm is received. This information can be provided through text by utilizing the blank space of the fine dust guide icon screen. Furthermore, as smartphone applications are still limited in providing additional information such as the severity and causes of fine dust, it is necessary to establish the functionality of the Internet and TV as types of media to complement smartphone applications. The major roles of the Internet and TV are to provide diagnostic information regarding fine dust and to publicize the intensifying fine dust issues.

The contribution of this study is as follows. First, on an academic level, the study provides an understanding of behavior of users of fine dust information, and the user media outlet preference for fine dust information. Also, on a practical level, this study can be applied as evidence for preparing fine dust information provision policies by suggesting the preferred media outlets and supplementary media outlets of the general public when searching for fine dust information.

This study has the following limitations: First, it focused only on seven values among many value sets. Second, since this study was conducted among college students enrolled in a university in Cheongju, South Korea, it is necessary to expand the current research using various demographic groups and countries in order to generalize the study results. Third, this study only deals with information on fine dust, and future research should be carried out to identify the most effective media to provide information on other environmental problems such as air and water pollution.

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