Examining public perceptions of radiation emergency preparedness: Based on the survey among the citizens of Busan city

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1. Introduction

Approximately 3.5 million people reside in Busan city, where ten nuclear power plants are located nearby. Although the nuclear power plants have been safely operated through high-quality engineering, workforce, and safety regulations and guidelines involved in the operation, it is still critical to develop comprehensive radiation emergency preparedness plans. Along with developing a comprehensive plan, it is equally important to inform the publics of the plan effectively. This study conducted a survey of 2,117 citizens of Busan to investigate their level of knowledge, attitudes, and behavioural intentions related to radiation emergency preparedness in Busan.

Based on the theoretical framework of the IDEA (internalization, distribution, explanation, action) model (Sellnow & Sellnow, 2013), the results of this study provide several suggestions on how to develop an effective communication program to involve the residents in the radiation emergency preparedness plan.

2. Methods

This study employed both online and offline surveys. First, for the online survey, a professional research company sent a link to a questionnaire to 2,500 Busan citizens, and a total of 1,083 respondents completed the survey. The gender, age range, and the regions of residence were balanced through the stratified sampling (male: 50.1%; average age = 43.18).

As for the offline survey, the local officials at all sixteen provincial government offices in Busan directly distributed the questionnaires to their local residents and collected the completed responses from 1,033 residents (male: 54.2%; average age = 36.22).

The collected data from the offline survey were entered to the datasheet in SPSS22 program, and then combined with the data from the online survey for statistical analysis. As a result of a total of 2,117 respondents completed the survey. The regions of residence of the respondents are shown at Table 1. To analyze the data from two groups, a series of statistical tests using SPSS22 program were conducted.

Table1. Respondents' Regions of Residence

Online survey

	빈도	퍼센트
1) 중구	19	1.8
2) 서구	40	3.7
3) 동구	29	2.7
4) 영도구	35	3.2
5) 부산진구	127	11.7
6) 동래구	95	8.8
7) 남구	68	6.3
8) 북구	77	7.1
9) 해운대구	121	11.2
10) 사하구	92	8.5
11) 금정구	111	10.2
12) 강서구	30	2.8
13) 연제구	68	6.3
14) 수영구	60	5.5
15) 사상구	78	7.2
16) 기장군	33	3.0
총계	1083	100.0

Offline survey

	빈도	퍼센트
1) 중구	30	2.9
2) 서구	34	3.3
3) 동구	35	3.4
4) 영도구	43	4.2
5) 부산진구	111	10.7
6) 동래구	68	6.6
7) 남구	73	7.1
8) 북구	81	7.8
9) 해운대구	95	9.2
10) 사하구	72	7.0
11) 금정구	67	6.5
12) 강서구	56	5.4
13) 연제구	73	7.1
14) 수영구	61	5.9
15) 사상구	58	5.6
16) 기장군	47	4.5
총계	1004	97.2
시스템	29	2.8
	1033	100.0

3. Results

3.1. Awareness of Emergency Preparedness Plan

The respondents' levels of awareness regarding the emergency preparedness plan in Busan were measured by a series of questions: (1) "Which of the following is the organization in charge of controlling all radiation protection activities for the residents in case of a radiation emergency in the area of Busan (Kori/Shin-Kori)? To this question, 16.3% of online respondents and 24.6% of offline respondents answered Nuclear Safety and Security Commission (NSSC). A majority of online respondents answered Busan Metropolitan City (26.7%), Ministry of Public Administration and Security (MOPAS) (23.8%), Korea Hydro Nuclear Power Co. (KHNP) (9.5%), and "I don't know" (24.4%). As for the offline survey, the respondents answered as following: "I don't know" (33.1%), Busan Metropolitan

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City (20.7%), MOPAS (15.7%), and KHNP (5.8%). To the question (2) "Have you ever heard about the radiation emergency preparedness plan of Busan City?", approximately 78.8% of online respondents answered "No," while 41.9% of offline respondents answered that they had heard about the emergency plan before. Then the respondents were asked to rate the level of agreement with the following items designed to measure their perceptions of radiation emergency preparedness in Busan. As seen at Table 2, the offline respondents responded relatively positively to the City's radiation emergency preparedness system as compared to the online respondents.

Table 2. Awareness of Emergency Preparedness in Busan

items	Online respondents			Offline respondents		
	Yes (%)	No (%)	No response	Yes (%)	No (%)	No response
1) The nuclear power plant surveillance system has been established in Busan.	21.3	41.7	37.0	35.5	19.8	44.7
2) A radiation monitoring system has been established in Busan and is being released in real time.	18.3	38.7	43.0	31.8	24.6	68.2
3) Radiation emergency drills are being regularly carried out in Busan.	24.8	39.1	36.1	41.0	22.3	36.7
5) Radiation emergency preparedness education is regularly being carried out in Busan.	27.8	28.7	43.5	37.6	24.9	37.6
7) Radiation emergency response facilities (Emergency Rescue center, emergency hospital, etc.) have been established in Busan.	20.4	37.0	42.6	36.8	20.2	43.0
8) Busan City has stockpiles of radioactive disaster prevention products (thyroid protective agent, relief items).	24.8	38.3	37.0	39.3	21.2	39.6
9) Currently, the measures for radiation emergency preparedness in Busan are sufficient.	31.7	23.9	44.3	25.0	31.3	43.7

3.2. Risk perception of Radiation Emergency

The respondents' risk perception of nuclear or radiological emergency was measured using the following items on a 5-point Likert scale ranging from 1 (*Strongly disagree*) to 5 (*Strongly agree*). As you see from Table 3, the citizens of Busan tend to think that nuclear accidents can be prevented in advance. The likelihood of an accident occurrence was not relatively high. However, they tend to perceive that in the event of nuclear accident, the consequence would be severe. The online respondents showed the higher level of risk perceptions of radiation emergency in Busan, as compared to the offline respondents.

Table 3. Risk Perception of Radiation Emergency in Busan

Items	Online respondents		Offline respondents	
	Mean	S.D.	Mean	S.D.
1) Nuclear power plants in Korea are operated safely	3.12	.90	3.32	.99
2) Nuclear accidents can be prevented in advance	3.66	.98	3.76	1.07
3) Nuclear power plants in Korea are highly likely to have an accident such as explosion or radiation leakage.	3.19	.96	2.99	1.08
4) I think, in the event of a nuclear accident, the entire city if Busan will be dangerous.	4.13	1.02	4.07	1.07
5) The consequences of major nuclear accidents are fatal to humans and the natural environment	4.40	.89	4.33	1.02

3.3. Trust in Relevant Organizations and Source of Information

According to Talyor et al. (2011), public trust has implications for whether the public would follow the instructions of authorities in an emergency event. This study examined the level of trust which the citizens of Busan have toward the organizations related to nuclear application as well as the different sources of information about the nuclear power plants. As seen in Table 4, the participants demonstrated a relatively low level of trust in relevant organizations. The level of trust in nuclear energy experts was the highest, followed by the level of trust in nuclear energy technology, and the level of trust in the NPP operating company. The level of trust in nuclear energy-related government bodies was the lowest. The Busan city and KHNP were the most credible sources of information, followed by nuclear-related organizations, mass media, and the social media. Generally, the offline respondents showed the higher level of trust toward the organizations and sources of information related to nuclear power plants, as compared to the online respondents.

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Table4. Trust in Relevant Organizations and Sources of Information

Items	Online respondents		Offline respondents	
	Mean	S.D.	Mean	S.D.
1) I trust in the whole technology related to nuclear power plants in Korea	3.26	.91	3.30	1.01
2) I trust experts who develop nuclear power technology	3.36	.92	3.33	1.00
3) I trust KHNP that operates nuclear power plants	3.10	.97	3.22	.99
4) I trust government bodies that manage, monitor, and control the entire nuclear power generation	2.83	.96	3.06	.98
5) The information about the nuclear power plant that Busan City has obtained and released is credible.	2.89	.90	3.20	1.64
6) The information about the nuclear power plant released through KHNP is credible.	2.95	.93	3.15	.97
7) Nuclear power related information that is disclose d through nuclear-related organizations is reliable.	2.89	.92	3.11	.96
8) Nuclear power related information that is disclose d through the mass media (TV, newspaper, etc.) is reliable.	2.82	.93	2.94	.98
9) Nuclear power related information that is disclose d through the social media (*Youtube, Facebook, Twitter,* etc.) is reliable.	2.65	.95	2.72	1.06

3.4. Radiation Emergency Preparedness

The individuals' level of radiation emergency preparedness was measured by a series of questions listed in Table 5. As for the individual measures for a radiation emergency, approximately 71% of online respondents answered they did not know what to do in case of a radiation emergency. As for offline respondents, 58.5% did not know what to do in an emergency; 35.6% answered they "know a little" and 6.4% answered they "know well" what to do in a radiation emergency. Next, if a radiation emergency

event occurs in the area of Kori, 56.2% of online respondents and 52.8% of offline respondents would evacuate to "a relief camp that the Busan city would assign", followed by "other areas" (38.0% of online respondents; 39.0% of offline respondents), "house of relatives" (2.8% of online respondents; 3.6% of offline respondents), and "accommodation facilities such as condo" (1.4% of online respondents; 1.9% of offline respondents).

Table 5. Individuals' Radiation Emergency Preparedness

Items	Online respondents		Offline respondents	
	Yes (%)	No (%)	Yes (%)	No (%)
1) I know what to do in case of a radiation emergency.	23.7	76.3	37.8	58.5
2) I have an emergency contact network in case of a radiation emergency. (community chief, fire station, police station, relatives, etc.)	24.4	75.6	42.0	54.1
3) I know the place and route of evacuation in case of a radiation emergency (a place of gathering, route of movement, etc.)	14.9	85.1	31.5	65.0
4) I know the means of evacuation (buses, trains, etc.) and where to gather when a radiation emergency strikes.	12.2	87.8	24.4	71.9
5) I have prepared emergency goods (first aid kit, emergency food, flashlight, radio, etc.).	24.0	76.0	28.2	67.7

4. Conclusions

This study conducted a survey of 2,117 citizens of Busan to investigate their level of knowledge, attitudes, and behavioural intentions related to radiation emergency preparedness in Busan. Generally, the results show that the respondents' risk perceptions of nuclear accidents were high, but their level of trust in related organizations and awareness of the current system for radiation emergency preparedness in Busan were low. Their individual measures for radiation emergency were also fairly low, suggesting the need for more active efforts to involve the publics under the city's framework of radiation emergency preparedness.

The IDEA (internalization, distribution, explanation, action) model (Sellnow et al., 2017) provides the guideline for developing effective communication instructing people on how to protect themselves before and during high-risk events. The model consists of four elements: (1) Internalization – helping publics internalize the potential impact of the risk or emergency event; (2) Distribution – identifying and utilizing appropriate channels (i.e., sources of information) for distributing the information; (3) Explanation – Offering a clear explanation of the nature of the risk; (4) Action - providing specific self-protective action steps for publics to take.

The results of our survey suggest that the citizens of Busan may have internalized the potential impact of a radiation emergency event by witnessing the Fukushima accident and experiencing the recent earthquakes. However, as for the other components such as Explanation, Distribution, and Action, more comprehensive efforts may be required in order to offer them clear explanation on how the Busan city has established the system for radiation emergency preparedness, and what the publics should do in a time of emergency. The appropriate channels for communication before and during a radiation emergency should also be clearly established and publicized.

Also, it should be noted that the perceptions of respondents from the online survey versus the offline survey were different from each other. Considering that the offline survey recruited the participants directly through provincial government offices, the offline respondents may have had the higher level of interest, and background information related to the city's efforts for radiation emergency preparedness. The results of these two surveys, therefore, suggest practical implications for two respective target audiences. That is, the results of the online survey show the perceptions of general citizens whose interest or knowledge about nuclear application and emergency plans are relatively low. On the other hand, the results of the offline survey show the perceptions of the people whom the city offices and practitioners could contact and encourage participation in person. The city may need to develop different strategies for communication with these different groups of publics to maximize their effort to involve all publics in their radiation emergency preparedness plan.

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