Proceedings of the Korean Nuclear Society Autumn Meeting
Seoul, Korea, October 2001

MEASURING AND IMPROVING THE PUBLIC PERCEPTIONS ON NUCLEAR ENERGY

YOUNG SUNG CHOI

Korea Institute of Nuclear Safety
P.O. Box 114, Yusong, Taejon, Korea

Abstract — The purpose of this paper is to measure the public's perception on risk and benefit of nuclear power and to find ways to improve the perceptions. Latent Class Analysis is adopted for the perception measures, which quantify people's perception and reveal the perception structure. The measures resulted from Latent Class Analysis show that women perceive risks to be more existent and benefits to be less than men do. Moreover there is a tendency that if education level is high, perceived risk is low and perceived benefit is high. The perception of risk and benefit also depends on different channels through which people get information about nuclear energy. Comparing seven different information channels, the most effective ways of communicating with people to improve the risk and benefit perception of nuclear energy are found to be the visit to nuclear plants and the education through the regular schooling. Information dissemination through mass media is only effective to the benefit perception.

1. INTRODUCTION

Studies on the public acceptance of nuclear energy show that perceived risk and perceived benefit of nuclear energy are the main factors explaining the acceptance (Choi et al., 1995; Choi et al., 2000). Human perception on the risks and benefits for modern technology is mainly influenced and formed by prevailing arguments, whichever they are positive or negative toward the technology.

There have been many arguments about risks and benefits of nuclear power. If a person agrees with arguments of anti-nuclear groups, he/she may have negative perception on nuclear energy. On the other hand, if with pro-nuclear groups, he/she may have positive perception. This paper examines the perception differences between various groups by gender, education level and information channels through which people get nuclear knowledge. The results will give some insight for an effective way of public communication to improve the perception on risks and benefits of nuclear power.

2. REPRESENTING PERCEIVED RISK AND BENEFIT

The analysis used a nationwide public survey data, which was conducted in 1995 by Korea Survey Gallup Polls Ltd. The total number of respondents was 1525 and the number of effective ones was 1420. Since the data were drawn from multi-stage random

sampling, it could be representative of Korean people. Questions used in the paper are shown in Table 1.

Since perceived risk and perceived benefit are somewhat abstract concepts, it is difficult to measure them and, if measured directly by such questions as "how do you perceive the risk (or benefit) of ⋯", it would produce many errors due to the ambiguity. Avoiding such errors from direct measurements, a latent variable was introduced. The basic assumption of a latent variable is that it is linked with manifest variables and influences them, thus could be indirectly measured by measuring the manifest ones (Clogg, 1995).

Latent class analysis, a methodology to develop latent variables, was used to identify an underlying (latent) one-dimensional variable representing manifest categorical response of the survey data. Following common notational style, let $\pi_Y(y)$ denote the joint probability that observed variable vector $Y=(Y_1, Y_2, \cdots, Y_J)$ takes on value $y=(y_1, y_2, \cdots, y_J)$. It is assumed that Y_j's are manifest indicators of a latent variable X with T categories. The categories of X are called the latent class. The probability that X takes on level t is denoted by $\pi_X(t)$ $(t=1, 2, \cdots, T)$. Next, define conditional probabilities $\pi_{Y_j|X(t)}(y_j)=P(Y_j=y_j|X=t)$ with the understanding that the y_j denote the levels of j-th observed variable (e.g., y_1 has four levels in AUG data if *RAD* is indexed to Y_1). The latent class model is written as

$$\pi_Y(y) = \sum_{t=1}^{T} \pi_X(t) \prod_{j=1}^{J} \pi_{Y_j|X(t)}(y_j) \tag{1}$$

The model formalized by equation (1) implies that Y's are assumed to be conditionally independent given the level t of X. Chi-squared statistics can be used to test whether a given latent model is congruent with the data, which in fact would provide a test of condition (1).

Now, it is investigated whether the perceived risk variable, which will be denoted by *P_RISK*, could be constructed from $Y=(ACCD, RAD, ENV, SFTY)$ and the perceived benefit variable, denoted by *P_BNFT*, from $Y=(SUPL, ENV, NEC)$. Note that the ENV question is included in both of the risk perception and the benefit perception. This is because of the characteristics of ENV question, which presents a positive benefit argument and a negative risk one. Table 2 shows the likelihood-ratio chi-squared statistics for a given number of latent classes, which follow asymptotically chi-squared distribution and are calculated by

$$G^2 = 2N \sum_{\text{for all } y} P_Y(y) \log(P_Y(y)/\hat{\pi}_Y(y)) \tag{2}$$

where N is the sample size, $P_Y(y)$ is the sample proportion of Y's taking on value y, and $\hat{\pi}_Y(y)$ is the predicted probability derived from equation (1). It shows that latent class models with 4 classes for *P_RISK* and for *P_BNFT* are permissible for the survey data.

The maximum likelihood estimates of conditional probabilities, $\hat{\pi}_{Y_j|X(t)}(y_j)$, reveals the characteristics of each latent class. The scaled values were given to each class of perception variables using the conditional probabilities as follows

$$SV(t) = \sum_{j=1}^{J} \sum_{i=1}^{C_j} \pi_{Y_j|X(t)}(y_j = i) \cdot S_j(i) \cdot w_j \tag{3}$$

where j is the index of observed variables, C_j is the number of categories for j variable, $S_j(i)$ is the score assigned to i-th item of j variable, and w_j is the relative weight of variable j. Here, all w_j were set to have the same vale since different weights on variables could not be justified. The scaled value represents the amount of positive/negative perception of those who belongs to that class. Taking an example for *P_RISK*, individuals belonging to a higher value class perceive nuclear power as riskier than those in a lower value class do because the former has responded on high values of each manifest variable more probably than the latter.

In summary, the latent class model could produce perceived variables *P_RISK* and *P_BNFT*, which are difficult to measure directly. And the perception variables were scaled on the amount of perception, which could be used to compare different groups by the level of perception.

3. RESULTS AND DISCUSSIONS

The perception level is compared by different groups of gender, education level, and information channels through which people obtain nuclear knowledge. Figure 1 shows the difference of perception level by gender and education and Figure 2 by information. The standard errors are large due to the small sample size of the groups. Although it is not sufficiently significant to discriminate each group, some insights could be obtained from the results. Figure 1 shows that women perceive risks to be more existent and benefits to be less than men do. Past studies showed that there are some differences of risk perception in gender; women are less supportive of nuclear power than men are and women perceive risks to be much higher than men do (Flynn et al., 1994; Stainer et al., 1995), which are consistent with the result of this study.

In addition, there is a tendency that if education level is high, perceived risk is low and perceived benefit is high. This is perhaps because more information is given people of higher education, which is confirmed by the difference in information channel. Figure 2 shows that people who have visited nuclear power plants or got nuclear related knowledge in school perceive the risk to be low and the benefit high. Difference by information channel gives a valuable clue to improve the perception of nuclear energy. To improve both the risk and benefit perception of nuclear energy, most effective is the visit to the nuclear plants and the education through the regular schooling.

We can find some interesting results that people who have information from anti-nuclear group think that nuclear risk is very high but also they think that nuclear benefit is somewhat high. Second, mass media plays some role to improve the benefit perception, compared with those who have no information about nuclear power. But it plays little role to improve the risk perception: it only gives small improvement over no information.

In summary, the followings were concluded;

- Women perceive risks of nuclear energy to be more existent and benefits to be less than men do.
- There is a tendency that if education level becomes high, perceived risk does low and perceived benefit does high.

- The level of perception of risk and benefit also depends on different channels through which people get information about nuclear energy. Comparing seven different information channels, the most effective ways of communicating to improve the risk perception of nuclear energy are the program of visit to nuclear plants and the education through the regular schooling. Information dissemination through mass media is only effective to the benefit perception.

Although the quantitative comparisons among different groups were not carried out because of the small sample size of some groups, the method suggested in this paper, Latent Class Analysis, is worth paying attention to.

REFERENCES

Bartholomew, D.J. (1987) *Latent variable models and factor analysis*, Griffins Statistical Monographs & Courses: 40, London: Charles Griffin & Company Ltd.

Choi, Y.S., Lee, S.H., Cho, N.Z. and Lee, B.W. (1998) Development of the Public Attitude Model toward Nuclear Power in Korea, *Annals of Nuclear Energy*, **25** (12), 923-936

Choi, Y.S., Kim, J. S., Lee and B. W. (2000) "Public's Perception and Judgment on Nuclear Power", *Annals of Nuclear Energy*, 27 (4)

Clogg, C.C. (1995) Latent class models, in G. Arminger, C.C. Clogg, & M.E. Sobel (ed.), *Handbook of Statistical Modeling for the Social and Behavioral Sciences*, New York: Plenum

Flynn, J., Slovic, P. and Mertz, C.K. (1994) Gender, race, and perception of environmental health risks, *Risk Analysis*, **4** (6), 1101-1108

Stainer, A. and Stainer, L. (1995) Young people's risk perception of nuclear power - A European viewpoint, *International Journal of Global Energy Issues*, **7** (5), 261-270

Table 1. Questions of NOV data

Variable	Description	Question	Answering Items	Scores
For Risk Perception Measures				
ACCD	Possibility of Accident	(A) There will be no accident like Chernobyl in our nation (B) NPP is like a explosive bomb	• Full agreement with (A) • Somewhat agreement with (A) • Neutral to (A) and (B) • Somewhat agreement with (B) • Full agreement with (B)	-2 -1 0 1 2
RAD	Radiation Risk	(A) There is no risk by radiation release near NPP (B) There are possible health damages like a deformed child	• Full agreement with (A) • Somewhat agreement with (A) • Neutral to (A) and (B) • Somewhat agreement with (B) • Full agreement with (B)	-2 -1 0 1 2
ENV	Environmental Soundness	(A) Nuclear power is clean energy not producing global warming gas (B) Nuclear power has many possibilities to disrupt environment	• Full agreement with (A) • Somewhat agreement with (A) • Neutral to (A) and (B) • Somewhat agreement with (B) • Full agreement with (B)	2 1 0 -1 -2
SFTY	Subjective Risk Measure	What do you think about the safety of NPP of our country?	• Very safe • Somewhat safe • Little safe • Not safe at all	-2 -1 1 2
For Benefit Perception Measures				
SPLY	Security of Electricity Supply	(A) NPP is necessary to meet the rapid increase of electric demand for economic development (B) Our nation can afford to provide electricity without NPP	• Full agreement with (A) • Somewhat agreement with (A) • Neutral to (A) and (B) • Somewhat agreement with (B) • Full agreement with (B)	2 1 0 -1 -2
ENV	Environmental Soundness	(A) Nuclear power is clean energy not producing global warming gas (B) Nuclear power has many possibilities to disrupt environment	• Full agreement with (A) • Somewhat agreement with (A) • Neutral to (A) and (B) • Somewhat agreement with (B) • Full agreement with (B)	2 1 0 -1 -2
NEC	Necessity of Nuclear Energy	What do you think about the necessity of NPP of our country?	• Very necessary • Somewhat necessary • Little necessary • Not necessary at all	2 1 -1 -2

Table 2. Goodness-of-fit test for Latent Class Model of Perceived- Risk and Benefit

	T	G^2	df[*1)]	P-value[*2)]
P_RISK	3	771.18	577	0
	4	532.72	561	0.79
P_BNFT	3	569.02	460	0
	4	452.00	446	0.41

*1) Degree of freedom is adjusted due to the boundary solutions. If an estimate occurs at boundary, the parameter is constrained to that value, thus df is increased by one.

*2) Null hypothesis is that T-class model holds. Thus, the probability of type I error if rejecting the T-class model

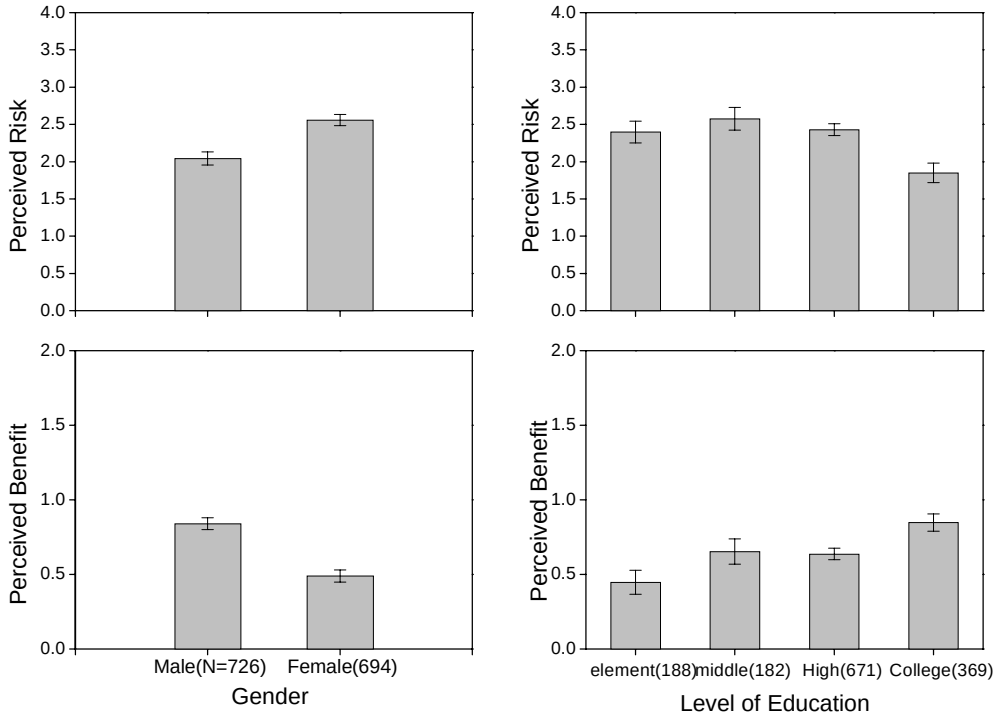

Figure 1. The level of perceived risk and benefit for different gender and education level (Number of persons in parenthesis)

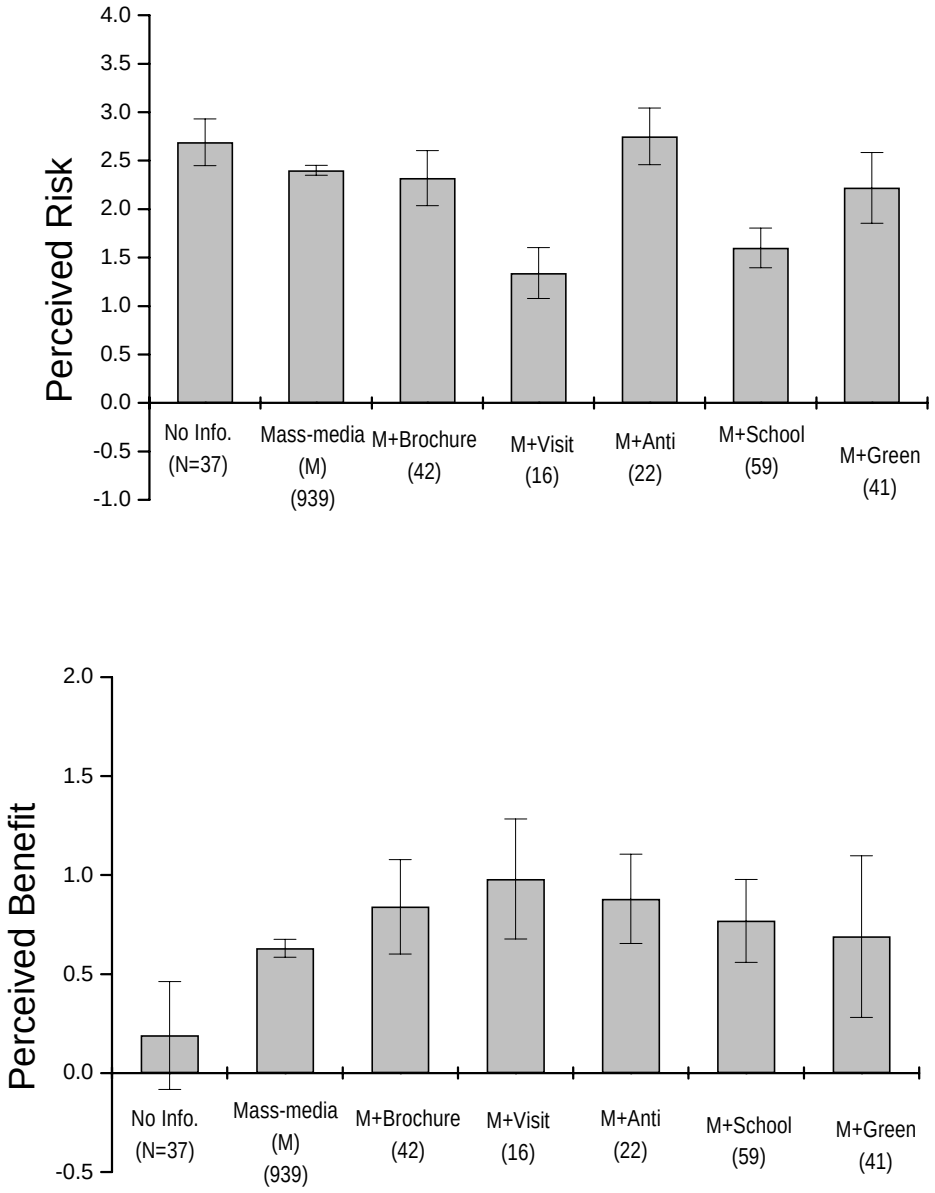

Figure 2. The level of perceived risk and benefit for different information channels (No Info. = No experience of receiving information about nuclear energy, Mass-media = Receiving it only by mass-media, M+Brochure = M and only by the brochure from nuclear industry, M+Visit = M and only by the visit to nuclear power plant, M+Anti = M and only from anti-nuclear group, M+School = M and only from regular schooling, M+Green = Mass-media (M) and only from environment group) (Number of persons in parenthesis)