

Trust perceptions among residents surrounding nuclear power plants: a descriptive and explanatory study.

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Abstract

Trust is an important factor in the management of risk and uncertainty. This research focuses on public trust in the safety of nuclear power plants in populations living near a nuclear facility. We examine the differences in the levels of local trust among residents in five communities as well as the role of sociodemographic and attitudinal factors in predicting trust. Results from a survey reveal first that the majority of respondents are ambivalent regarding their level of trust in the safety of nuclear power plants, and a significant minority of residents expresses a strong mistrust. Second, the analysis shows that levels of local trust vary significantly between the five communities. Results from the bivariate analysis indicate that individuals' level of trust is associated with sex, knowledge, familiarity, prior attitude towards nuclear energy and risk perception. Results from the multivariate analysis indicate that prior attitude towards nuclear and risk perception are the main predictors of trust. Practical implications of the results are discussed.

KEYWORDS: Confidence; nuclear energy; risk perception; local trust; populations around nuclear power plants

Introduction

Trust is considered a critical factor in the configuration of public and individual reactions to technological risk (see, e.g., Pijawka and Mushkatel, 1991/1992; Bord and O'Connor, 1992; Flynn et al., 1992; Siegrist, Gutscher and Earle, 2005). Trust is relevant in the public perception of risk: when the population has low knowledge about a specific risk, trust can play an important part in public perceptions about the severity of that risk (Siegrist and Cvetkovich, 2000). Trust is also considered a key determinant of the acceptability of technologies (Pidgeon et al., 2008; Whitfield et al., 2009), together with other psychological and contextual variables (Perlaviciute and Steg, 2014). Public trust is also critical in the success of public risk communication in the event of technological emergencies, as individuals are more likely to follow advice and instructions from institutions and individuals they trust (Love, Mackert and Silk, 2013)

Most researchers in the field of risk management agree that trust is an important factor in generating cooperative action (Löfstedt and Cvetkovich, 1999; Renn and Levine, 1991; Slovic, 1993). In this sense, low trust relations between stakeholders can have a negative impact on safety culture (Cox, Jones and Collinson, 2006). Although some studies suggest that distrust has positive associations with effective risk regulation (Pidgeon et al., 2003), a low level of trust can reinforce blame and foster non-reporting of safety-relevant information (Cox, Jones and Collinson, 2006). This is particularly relevant in the nuclear context, where trust issues have been considered of critical importance in the relationship between local communities and nuclear installations (Flynn et al., 1992; Williams, Brown and Greenberg, 1999; Pidgeon et al., 2008).

The current paper focuses on public trust in the safety of nuclear power plants among residents living near nuclear facilities in Spain. Research on communities living in close proximity to

nuclear facilities suggests that even where support and acceptance are expressed, there is a degree of underlying unease always present (Macgill, 1987; Zonabend, 1993; Pidgeon et al., 2008). Also, that perceptions of trust are a key factor to understand public responses to nuclear power (Williams, Brown and Greenberg, 1999; Pidgeon et al., 2008). Compared to other European countries, Spain has a relatively large number of nuclear reactors. The risks posed by the existence of nuclear facilities have played an important role in recent debates on the future of nuclear energy in Spain. In this paper, we study the differences in the levels of local trust in the safety of nuclear power plants among five Spanish communities as well as on the role of sociodemographic and attitudinal factors in predicting trust.

Methods

Procedure and sample

This is an observational study based on data collected through a questionnaire survey in five study populations. We surveyed samples of populations living within approximately 100 kilometers of five nuclear facilities (the nuclear power plants of Ascó, Vandellós, Cofrentes, Almaraz and Trillo; see figure 1). Respondents from the five populations were recruited from an online panel managed by a market research company. Quotas by sex, age, and educational attainment level were set to obtain an approximately representative sample. Survey questionnaires were completed in November 2017. A total of 639 residents completed the questionnaire. Table 1 shows the sociodemographic characteristics of the sample in each studied community.

Table 1. *Characteristics of survey samples*

	Ascó	Vandellós	Cofrentes	Trillo	Almaraz	Total
Area						
<30km	14%	29%	24%	10%	24%	21%
30-100km	85%	71%	76%	90%	76%	79%
Sex (women)	51%	52%	50%	50%	49%	50%
Age (mean)	46	45	44	47	42	45
Education (% university)	44%	43%	39%	43%	33%	40%
N	117	143	132	113	134	639

Measures

We developed a questionnaire to measure people's perception of radiological emergencies. The questionnaire consisted of five main sections: risk perception, attitudes towards nuclear energy, intended behaviors in situations of radiological emergencies, knowledge about nuclear and perception of sources of information. The questionnaire also included sociodemographic questions (years living in the area, age, sex and educational level) including area of residence (categorized, following the emergency planning zone classification, as <30km vs 30-100km.). The following variable measures were used:

Trust in the safety of nuclear power plants. It was measured utilizing the following item: "Nuclear reactors in Spain are operated in a safe manner". An additional reverse item was also included for further analysis: "There is insufficient control by authorities on the safety of

nuclear installations in Spain”. A 5-point response scale was used ranging from 1- strongly disagree to 5- strongly agree.

Familiarity. Respondents were asked, “Have you ever visited a nuclear power plant?” with responses: yes, no, don’t know.

Knowledge. It was measured utilizing the following item: “Does exposure to radiation always lead to radioactive contamination?” with responses: yes, no, don’t know.

Risk perception. Respondents were asked, “How do you perceive the potential risk to your health within the next 20 years from each of the following sources: An accident in a nuclear installation?” A 6-point response scale was used ranging from 1- no risk to 6- very high risk.

Attitude towards nuclear. Respondents were asked, “What is your opinion about the use of nuclear energy to generate electricity?” with responses from totally against (1) to totally in favor (5).

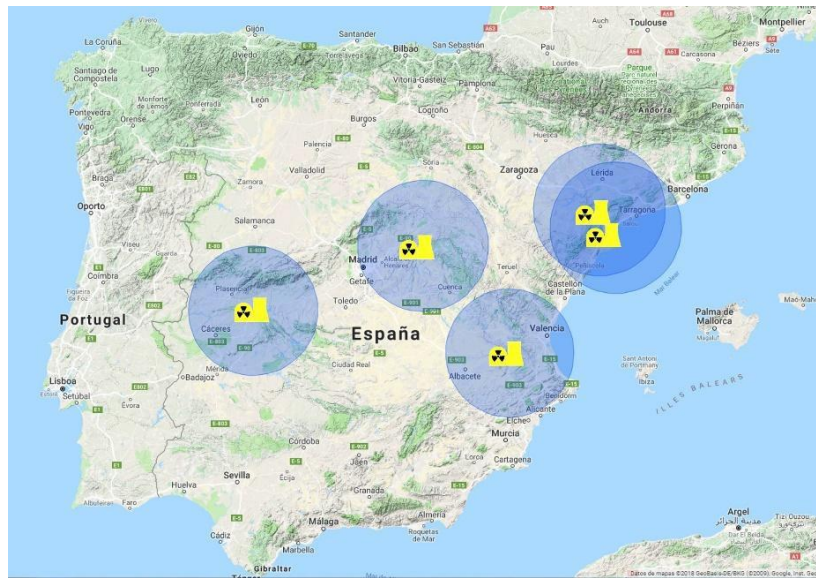


Figure 1. Map showing the location of study sites

Analysis

For data analysis, we first used frequencies and cross-tabs for descriptive and comparative analysis with community as the independent variable and trust in the safety of nuclear power plants as the dependent variable. For the comparison between respondents with relatively low and high levels of trust, we created a new variable through the combination of the two items measuring trust in the safety of nuclear power plants. Those who chose 1 and 2 in the first item and 3 and 4 in second item were considered as low-trust respondents; those who choose 4 and 5 in the first item and 1 and 2 in the second item were considered as high-trust respondents. Response 3 was considered neutral and the respondents who choose this answer were excluded from the analysis. Of the 639 respondents, 102 respondents were considered high-trust respondents and 86 low-trust respondents. Pearson’s χ^2 test and Student’s t-test were used to evaluate the differences across communities and between low-trust and high-trust individuals. Finally, a three-stage multivariate regression analysis with trust in the safety of nuclear power

plants as the dependent variable was carried out to examine the impact of a number of independent variables. All analysis was conducted using the statistical software IBM SPSS 19.

Results

Descriptive, comparative and bivariate analysis

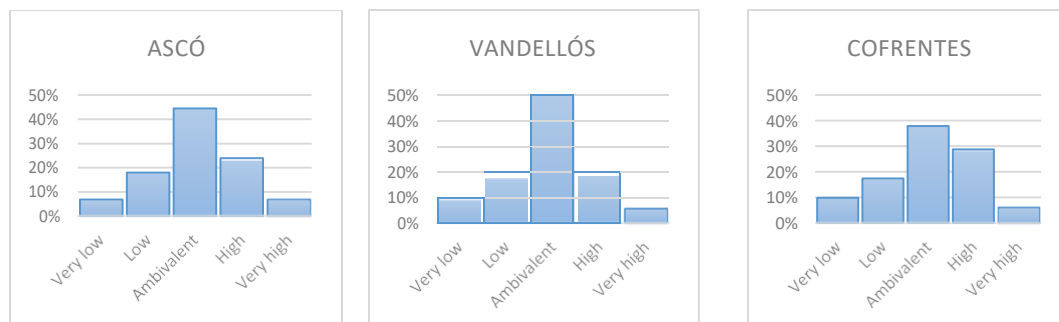
Table 2 and Figure 2 show the distribution of respondents in the five studied communities over the main dependent variable (item 1). Approximately 25 percent of respondents express a relatively low level of trust in the safety of nuclear reactors. Another 43 percent, the majority of respondents, is ambivalent or unsure. And a 33 percent of the respondents express a relatively high level of trust.

Table 2. Trust in the safety of nuclear power plants by studied population (as percentage of respondents; item: “Nuclear reactors in Spain are operated in a safe manner”)

	Ascó	Vandellós	Cofrentes	Trillo	Almaraz	Total
Relatively low	25%	27%	27%	16%	25%	24%
Ambivalent	44	50	38	40	40	43%
Relatively high	31	24	35	44	35	33%
Total	100% (117)	100% (143)	100% (132)	100% (113)	100% (134)	100% (640)

Table 2 also presents the comparative analysis by studied population. The data show that levels of trust vary significantly between the five communities (Chi-Square = 15.30, $p = 0.05$). For instance, whilst in the community around Vandellós NPP only 24 percent of respondents express a relatively high level of trust, this percentage is of 44 percent among respondents living around Trillo NPP. Although the ambivalent group is the majority group in the five studied populations, this group varies from 50 percent of respondents in Vandellós to 38 percent in Cofrentes.

Figure 2. Level of agreement with the item “Nuclear reactors in Spain are operated in a safe manner”



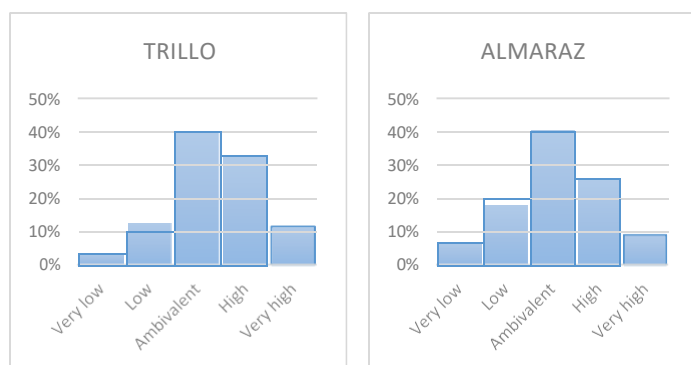


Table 3 shows the sociodemographic characteristics and levels of familiarity, knowledge about radiation, risk perception and attitude towards nuclear energy of those expressing a relatively low and high level of trust in the operation of nuclear reactors. In this analysis, we used a combination of items 1 and item 2 to differentiate between those respondents expressing a consistent relatively low and high level of trust in the safety of NPPs. Among participants expressing a low level of trust, 51 percent were female, the median age was 46.7 years old, had an average of 28.9 years living in the area, 41 percent had a university degree, 28 percent were familiar with a NPP, 34 percent provided a right answer to the knowledge question, had an average risk perception of 4.51 and 57 percent were against the use of nuclear energy. When comparing low-trust respondents to high-trust respondents, relevant differences include sex (51 percent female versus 28 percent), familiarity (28 versus 37 percent), knowledge (34 versus 52 percent), risk perception (4.51 versus 3.09) and attitude towards nuclear energy (57 versus 3 percent). Other characteristics such as age, area, years living in the area and educational level were very similar in both categories of respondents.

Table 3. Comparison between respondents with relatively low and high levels of trust in the safe operation of NPP in independent variables

	Low trust (n= 86)	High trust (n= 102)
Area (% , >30km)	72	79
Female (%)	51	28*
Age (mean)	46.7	45.6
Education (% university studies)	41	46
Years living in the area (mean)	28.9	29.5
Familiarity (% familiar)	28	37*
Knowledge (% correct)	34	52*
Risk perception (mean, 1-6 scale)	4.51	3.09*
Attitude towards nuclear (% against)	57	3*

* Statistically significant at $p < 0.10$ (Chi-square or t-test)

Multivariate analysis

Table 4 reports the results of the multivariate analysis (computed for the whole sample of 639 individuals) of the association between individual independent variables and trust. Three hierarchical multivariate models were run with trust in the safety of nuclear reactors (first item) as dependent variable. In the first model (modeling the association between socio-demographic variables and trust), only gender (beta coefficient for women of $-.14$, $p < 0.05$) was significantly associated with trust. As shown in the comparative analysis, women tended to express, on average, significantly lower levels of trust than men did. Education, age, years living in the area and distance to the nuclear power plant ($< 30\text{km}$ vs $30\text{-}100\text{ km}$) were not significantly associated with levels of trust.

Table 4. *Multivariate linear regression with trust in the safety of nuclear reactors as dependent variable*

	Model 1		Model 2		Model 3	
	<i>Beta</i>	<i>Sig.</i>	<i>Beta</i>	<i>Sig.</i>	<i>Beta</i>	<i>Sig.</i>
Sex (women)	-.14	.00	-.12	.00	-.06	.07
Age	-.07	.15	-.06	.20	-.05	.24
Education	.03	.51	.02	.70	.00	.89
Years living in the area	.03	.56	.02	.59	-.03	.36
Area	.04	.29	.05	.23	.04	.29
Familiarity			.07	.09	.04	.23
Knowledge			.08	.03	.03	.36
Risk perception					-.15	.00
Attitude towards nuclear					.48	.00

In the second model (modeling the association between sociodemographic variables, familiarity, knowledge and trust), only sex and knowledge were significantly associated with trust. Knowledge was positively associated with trust (beta of $.08$, $p < 0.05$): those respondents that provided a correct answer expressed, on average, higher levels of trust. Familiarity reached almost significance (beta = $.07$, $p = 0.09$): those respondents reporting having visited a nuclear power plant expressed higher levels of trust than those unfamiliar with a nuclear power plant.

Finally, in the third model (adding prior attitudes as independent variables), levels of trust were moderately associated with risk perception (beta = -0.15 , $p = 0.00$) and more strongly associated with attitude towards nuclear energy (beta = 0.48 , $p = 0.00$). Sociodemographic variables, knowledge and familiarity were not significantly associated with trust after controlling for prior attitudes. Only sex (beta = $-.06$, $p = 0.07$) almost reached the significance level. Attitude towards nuclear energy was the main predictor of trust.

Discussion

In this paper, we examined levels of public trust in the safety of nuclear power plants in five populations living within approximately 100 kilometers of nuclear facilities. We also examined the sociodemographic, personal and attitudinal predictors of trust.

We first found that trust varies significantly from one community to another. Although the majority of respondents in the five studied sites were ambivalent regarding their level of trust, the proportion of high-trust respondents ranged from almost 2 out of ten to around 4 out of ten. Second, the bivariate and multivariate analysis showed that prior attitudes and, in particular, attitude towards nuclear energy, were the strongest correlates of trust. Familiarity and knowledge of nuclear power plants and radiological issues were positively associated with trust,

but the strength of the association decreased significantly after controlling for prior attitudes. Sex was significantly associated with trust, with women systematically expressing lower levels of trust. Levels of public trust were not significantly associated to the distance to the power plant, age, level of education or years living in the area.

Our results are somehow similar to previous research with communities living around nuclear power plants in other countries. The study by Pidgeon et al. (2008) in three nuclear power sites in the United Kingdom showed that despite the apparent level of support for nuclear power in these communities, the majority of respondents were ambivalent towards nuclear power, and a significant minority of residents expressed a strong mistrust of both the industry and the government. Residents in these communities generally trusted the operators of the local plant as they were seen both as competent and ordinary people. Individuals with higher levels of distrust were highly skeptical of the nuclear industry generally and to a lesser extent of both the Government and the Environment Agency.

In our study, the majority of respondents were ambivalent about their level of trust in the safety of nuclear power plants, but there were some significant differences among the five studied communities. These differences are difficult to interpret. They could be the result of a different sociodemographic profile in the samples, although as we have seen, trust seems to be only significantly associated to sex and not with age, level of education or years living in the area. Differences in prior attitudes in the studied populations can partially explain the differences in trust. Attitude towards nuclear energy differs among the five studied populations, but the studied populations are slightly more similar in terms of attitudes towards nuclear than in terms of trust. Another potential contributing factor is the specific historical relationship between the nuclear industry and the local population in each of the studied communities, which could have derived in differing levels of local trust. Other potential explanations include potentially relevant prior attitudes and orientations not considered in this study such as ideological attitudes and personal values and beliefs (Vainio, Paloniemi and Varho, 2017).

Contrary to our initial intuitions, levels of public trust were very similar for respondents within approximately 30 kilometers and respondents within 30-100 kilometers of nuclear facilities. Trust was also independent of the number of years the person was living in the area. Research on communities living in close proximity to nuclear facilities has generally found that proximity is positively associated with levels of support for nuclear power (Eiser et al., 1995). However, qualitative research on local communities living close to nuclear reprocessing plants suggests that even where support and acceptance are expressed, there is a degree of underlying unease always present (Macgill, 1987; Zonabend, 1993; Pidgeon et al., 2008). Our findings suggest that residents living close to nuclear power plants do not necessarily report a much higher trust in nuclear safety than residents living far from them.

Regarding the association between trust and attitude towards nuclear energy, our results are consistent with previous survey research showing that the acceptability of nuclear power is closely related to levels of institutional trust (Pidgeon et al., 2008). In our study, differently from previous research, the focus of analysis has been on trust as a dependent variable and attitude towards nuclear as a predictor. This is in line with studies arguing that trust is often an indicator or expression of a more general attitude toward a certain activity or technology, that is, people base trust judgements on more general evaluative judgments (Eiser et al., 2002; Poortinga and Pidgeon, 2005; Slovic et al., 2002). Especially, when infrequent or absent interaction between two parties, the development of trust and distrust is likely to be affected by contextual factors such as group membership (McKnight et al., 1998) or prior attitudes

(Poortinga and Pidgeon, 2006). Our study clearly shows that attitude towards nuclear and trust in the safety of nuclear power plants are strongly associated and that, as indicated by other studies, a predisposition toward accepting a nuclear installation tends to correlate with high levels of trust (Williams, Brown and Greenberg, 1999).

There are some implications of the study. If we agree that local confidence plays an important role in the relations between the nuclear industry and local communities, the results argue against complacency about the future. The majority of the population living close to a nuclear power plant is ambivalent about their level of trust in the safety of nuclear power plants. There are also identifiable subgroups in which trust is particularly low, such as women, those less familiar with nuclear power plants and those with a low level of knowledge about radiation issues. The results also show that a negative prior attitudes towards nuclear and a high perception of risk from nuclear are the strongest predictors of low trust. This suggests that engagement efforts with local communities to increase trust will be affected by prior attitudes from the local population, which are negative in a significant proportion of the population. The nuclear industry will perhaps have an easier time making their case to those ambivalent residents.

There are also some limitations to our study. The sample of respondents from the area within 30 km to the nuclear power plant was relatively low and smaller than the sample of residents in the 30-100km area. The margin of error is, therefore, higher for this subsample. For the bivariate analysis, the group of low-trust respondents was smaller than the group of high-trust respondents. Smaller sample sizes decrease the power of statistical tests, which means that effect sizes need to be stronger to become statistically significant. On the other hand, while most variables used in the study were measured with high face validity, some of the measures, such as knowledge, familiarity or risk perception, could be improved. In particular, trust has been suggested to comprise of at least two dimensions (competence and affect) (Frewer et al. 1996; Eiser et al. 2009; Sjöberg, 2008) that might not perfectly correlate. In general, it may be worthwhile to study more in depth the psychological and social dynamics that may be underlying our findings about trust and distrust.

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