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Public participation processes related to nuclear research installations: What are the driving factors behind participation intention?

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Abstract
This article addresses organised public participation processes related to installations for nuclear research. The aim was to determine predictors that could provide an empirical insight into the motivations underlying people's intended level of involvement. The results highlight attitude towards participation and moral norm as the strongest predictors for participation intention. Other significant predictors were time constraints, attitude towards nuclear energy, subjective and descriptive norms, and knowledge. An opposing relationship is noted between participation intention and attitude towards nuclear energy. At the same time, people who are more knowledgeable about the nuclear domain seem more willing to get involved. The analysis also revealed that financial benefits do not influence people's intended involvement in participation processes related to nuclear research installations. The results reported here are based on empirical data from a large-scale public opinion survey (N = 1020) carried out in Belgium during May–June 2011.

Keywords
governance of science and technology, predictors, public participation

1. Introduction

Public participation is nowadays considered as an essential factor in the formulation and implementation of effective environmental policies, as well as in scientific and technological development. Examples in environmental policy making include the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental

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Matters, and the Espoo Convention on Environmental Impact Assessment in a Transboundary Context. A number of European directives (e.g. 85/337/EEC) specifically mention public information and consultation in drawing up plans and programmes relating to the environment. In Science and Technology Studies (STS), public engagement with science is nowadays widely promoted as an effective strategy that takes into account the bottom-up sense-making processes of the citizen (House of Lords Select Committee on Science and Technology, 2000; Irwin, 2001).

This effort to 'democratise' expertise implicitly or explicitly draws upon the ideal of deliberative democracy (Lövbrand, Pielke and Beck, 2011). Deliberative democrats emphasise the need to justify collective decisions through an open and reasoned debate among free and equal citizens (Cohen, 1996; Bohman, 2000; Gutmann and Thompson, 2004). In line with this central tenet of deliberative democracy, a growing cadre of STS scholars is today asking that scientific experts engage in a process of collective reasoning in order to justify their knowledge claims to a wider public than just their scientific peers. In particular, many scholars argue (e.g. Rogers-Hayden and Pidgeon, 2008; Xenos et al., 2011) that public involvement should be increasingly moved towards the early stages of technological research and development, ideally before significant decisions have been made and an established public discourse has developed. Without early deliberative engagement, public participation runs the danger of being led down the path of either determinism (i.e. redefining what has already been made possible as 'desirable') or reductionism (i.e. limiting the debate to a calculus of economic costs and advantages or risk assessment). According to the early engagement proponents, early public involvement is therefore needed in order to open up the debate on scientific and technological developments to issues of morality, ethics, uncertainty and social concerns. By asking on whose behalf scientific and technological choices are made, with what rights of representation, and according to whose definition of 'the common good', early deliberative public engagement is expected to hold scientific experts accountable to citizens of a given polity (Wilsdon, Wynne and Stilgoe, 2005).

There is, however, a significant gap between the theoretical deliberative democratic ideals and the way these ideals have been put into practice. Practical questions regarding the rationale of public engagement, the way such engagement should be initiated, who should be included in the deliberations, when is the right time to organise public engagement, and how public engagement should be grounded in an existing political culture, force choices and compromises in the transition from deliberative democratic theory to practice (Delgado, Kjølberg and Wickson, 2011). Lövbrand et al. (2011) even speak of an inherent 'democratic paradox' in science and technology studies, in the sense that even though STS scholars draw on the deliberative democratic notion of legitimacy, in practice they fail to meet the principles for legitimate rule prescribed by this same theory. For instance, Lövbrand et al. (2011) point out the practical difficulties involved in meeting the deliberative democratic ideal of inclusiveness (i.e. involving all those who will be affected by a decision in decision-making). The assumption here is that citizens who could be affected by a certain decision are in principle interested and eager to get critically engaged in public dialogue on scientific and technological issues, which is not always the case. It remains to be researched why – based on which motivations – some people choose to become involved in scientific and technological issues while others do not. In this article, we contribute to this empirical debate on the more restricted topic of public participation in decision-making on nuclear research installations. For this purpose we rely on social psychology models commonly used to predict human behaviour, among which is the Theory of Planned Behaviour (TPB) (Ajzen, 1991).

Nuclear energy represents a typical case of a complex technological issue where policy has previously been based on the belief that public acceptance results from adequate provision of information (OECD, 2002), as claimed by the so-called deficit model of science communication (see

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e.g. Lewenstein, 2003, for models of public communication of science and technology). Nowadays, increasing public knowledge on nuclear issues is no longer seen as sufficient and the need for greater public involvement in scientific and technical decision-making is gradually being more recognised (OECD, 2002: 9; IAEA, 2011: 7). Stakeholder involvement should be an integral part of decision-making, and is now widely recommended at national and supra-national level for all aspects of the nuclear fuel cycle: uranium mining (IAEA, 2009: 3); radioactive waste management (Bergmans et al., 2008: 25); siting of new nuclear power plants (e.g. NRC, 2004: 1); emergency situations (ICRP, 2009: 13); and rehabilitation of contaminated territories (OECD, 2006; Till, 2008). More generally, the main conclusion of the International Nuclear Safety Group in their 2006 report on stakeholder involvement in nuclear issues (IAEA, 2006) was that all 'stakeholders with an interest in nuclear decisions should be provided with an opportunity for full and effective participation' (p. vii).

In this context, higher forms of public and/or stakeholder involvement are increasingly called for in the framework of participatory risk governance, not only because they contribute to the democratisation of decisions, but also because they enhance the fairness and the overall efficiency of the process (Stirling, 2008), resulting in more sustainable decisions (OECD, 2004: 21; 2006: 6–9). Whether such calls serve as rhetorical tools or 'politics of talk' in high-level policy documents – instead of being characteristic of a wider philosophical switch in nuclear sector practices – is probably up for discussion and depends on detailed empirical investigation of actual cases of participatory engagement in nuclear policy making (Laes, 2007).

A closer look at the development of nuclear science and technology nowadays reveals that one of the focal points of nuclear research programmes is the design of new reactor types satisfying prerequisites such as producing lower amounts of highly or long-lived radioactive waste, increasing efficiency, improving safety and proliferation resistance. Given these highly innovative aspects, both from a scientific and a technical point of view, research installations are required to demonstrate the proof of the concepts. Such installations are in themselves complex projects, with potentially high impact (economic, political, societal) at local, regional or even national level. Aside from this, such installations may raise ethical questions, for example on the desirability of new nuclear research and development as compared to research into other forms of energy. This justifies the need for public participation in related decision-making and leads to the inherent interest in investigating the factors underlying the intention to participate or not in such processes. The call for a socially informed approach starting from the design phase of nuclear facilities (Goodfellow, Williams and Azapagic, 2011) could equally be applied to research facilities.

Motivating people to get involved in organised participation processes related to installations for energy research is, however, a challenging task. A European survey in 2010 (European Commission, 2010: 114) revealed, for instance, that only a quarter of Europeans would like to be directly consulted and to participate in decision-making processes on the development of national energy strategies. A previous survey in 2005 pointed out the little active involvement in science and technology issues among European citizens (European Commission, 2005: 23). Correlated to that, several studies show that when offered the opportunity to participate in processes related to new technologies, the public frequently refrains from active participation (Dijkstra et al., 2012).

The goal of this study was to determine predictors for the intended involvement in organised public participation processes related to new installations for nuclear research. The study is based on empirical data from a large-scale opinion survey in Belgium during May–June 2011. The investigation relies on the theoretical paradigm of the Theory of Planned Behaviour and the subsequent extensions proposed in the literature.

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In the following sections, we detail the theoretical background and the methodology underlying this study. In sections 4 and 5 we present and discuss the results, while in the final section we summarise the main conclusions.

2. Theoretical background

A number of models pertaining to social psychology that explain and predict human behaviour can be found in the literature. Among these, prominent ones are the Health Belief Model (Becker, 1974); Social Cognitive Theory (Bandura, 1997); the Theory of Reasoned Action (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980), revised and extended into the Theory of Planned Behaviour (Ajzen, 1991); and the Integrated Model of Behavioural Prediction (Fishbein, 2000; Fishbein and Yzer, 2003). These theories highlight three main categories of predictors for intention and behaviour (Fishbein and Yzer, 2003): i) attitudes towards the behaviour in focus (based on beliefs about the positive/negative consequences of performing the behaviour); ii) perceived norms (perception that various referent groups are supporting or performing the behaviour); and iii) self-efficacy (perception that one can successfully perform the behaviour). The influence of these predictors may vary depending on the behaviour in focus and the specific population studied.

These models were initially developed for and tested in the context of health behaviour, but have since found application in other domains, e.g. sustainable food consumption (Vermeir and Verbeke, 2008).

The Theory of Planned Behaviour (Ajzen, 1991) is one of the leading theories used for the prediction of human behaviour. It argues that actual behaviour is determined by the person's behavioural intention, which, in turn, is influenced by three independent predictors: specific attitudes towards the behaviour in question, the person's subjective norms and the perceived behavioural control.

Attitudes are 'psychological tendenc[ies] expressed by evaluating a particular entity with some degree of favor or disfavor' (Eagly and Chaiken, 1993: 1). In the context of the Theory of Planned Behaviour (TPB), attitudes are evaluative judgements related to the behaviour in focus. In particular, it has been suggested (Ajzen and Gilbert Cote, 2008) that attitudes specifically related to the behaviour in focus, having the same action, target, context and time elements as the behaviour itself, are better predictors of specific actions than global attitudes.

Subjective norms capture the social pressure of exercising a behaviour; such norms refer to beliefs about whether specific individuals or groups would approve or disapprove of one's exercising that behaviour. Since there may exist multiple referent groups with conflicting opinions about the same behaviour, it has been suggested in previous studies to distinguish between groups that are closely related to the respondents e.g. family and friends (who may be more supportive), and other groups.

Perceived behavioural control reflects one's perception of whether one has the resources, abilities and other prerequisites required to perform the behaviour successfully. It indirectly affects behaviour by its impact on intention (Ajzen, 2002a) and accounts for the non-volitional elements related to the behaviour. As Poliakoff and Webb (2007) point out, people might have positive attitudes and subjective norms, but still refrain from performing a particular behaviour owing to their belief that the behavioural action in focus is out of their control. According to Ajzen (2002a: 667), a high level of perceived control 'should strengthen a person's intention to perform the behavior, and increase the effort and perseverance'. He suggests, on the basis of a number of studies reported in the literature, that two inter-related components of perceived behavioural control may be

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distinguished: self-efficacy (a person's perception of his/her capability to successfully execute the behaviour) and controllability (the degree to which the performance of the behaviour depends on the actor him/herself). Among these two factors, self-efficacy is proven in several empirical studies to have a higher influence on behavioural intention. Constraints of time or money could be considered as pertaining to behavioural control, since they may be perceived as obstacles impeding the performance of the behaviour.

Several studies in the literature suggest augmenting the set of predictors derived from the TPB with past behaviour (Ajzen, 2002b); descriptive norm, linked to the belief that other referent groups perform the behaviour in a similar situation (Chassin et al., 1984); and moral norm, expressing the perceived moral correctness of performing the behaviour (Beck and Ajzen, 1991). A number of other variables, for instance socio-demographic characteristics, media exposure, risk perception and personality traits have been postulated in the literature as predictors of behaviour. However, their effect is likely to be indirect (Yzer et al., 2004), namely mediated by the three central variables (attitudes, norm, perceived behavioural control).

Parallel to the vast number of studies in the literature investigating human behaviour in other contexts, only a few aim at modelling and predicting participation behaviour related to science and technology issues. Some examples shall be given here. The studies mentioned in the remainder of this section refer to different levels of involvement, mostly not addressing participation in the actual decision-making. The findings are thus not comparable in the strict sense; however, they highlight potential predictors that could play a role in a more general model, as aimed for in our study.

Poliakoff and Webb (2007) applied the TBP to investigate scientists' participation in scientific communication engaging lay audiences. Their study highlighted four important predictors: past participation, attitude towards participation, perceived behavioural control and descriptive norm. Dijkstra et al. (2012) found that the strongest predictors for public participation in genomics research (ranging from reading about, to talking about, searching for information, attending public meetings, or active participation in discussions) were the self-reported knowledge, the information-seeking behaviour and the level of education. They found that people who communicate actively about the issues, have higher (self-reported) knowledge or have higher education are more likely to participate in genomics research. Other, weaker predictors in their model were the interest in genomics issues, age, gender, social involvement and trust in the influence of private or public persons or organisations.

Miller, Bell and Buys (2007) investigated the role of socio-demographic variables as predictors for participating in public discussions related to carbon dioxide capture and storage technology. They found small effect sizes showing that men were more prepared to take part in public discussions; at the same time, women were more likely to believe in the importance of public consultation by the government. The study of Miller et al. (2007) also suggests that people with higher education are significantly more willing to participate in public discussions. A recent study on nanotechnology by Xenos et al. (2011) found positive relationships between the willingness to engage in nano-related discussions and predispositions such as political interest or support for nanotechnology. The same study failed to demonstrate a relation between anticipation of discussion with opposing or similar others and the intention for future engagement. Knight and Barnett (2010) found positive correlations between the perceived importance of one's own involvement in science and technology and the general attitude towards citizens' involvement in policy issues, respectively one's own contribution to political decision-making. Finally a study on nanotechnologies by Retzbach et al. (2011) suggests that engagement with science (namely, participation in discussions about the issue) was slightly and positively related to higher risk perception.

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Our study investigated predictors for the intended level of involvement in organised public participation processes related to installations for nuclear research. On the basis of the literature, we first analysed the following variables: socio-demographic variables (sex, education and age), attitude towards participation, norms (subjective, descriptive and moral), as well as time and financial constraints.

In order to tackle the specifics of the nuclear domain we investigated as potential predictors the attitude towards nuclear energy; knowledge about nuclear energy and the applications of radioactivity; risk perception of an accident in a nuclear installation; and confidence in authorities. There is evidence in the risk research literature that these variables might directly or indirectly influence participation intention. For instance, psychometric risk perception theory developed by Slovic and colleagues (Fischhoff et al., 1978; Slovic, 1987) found that people respond to risks based on direct emotional influence. At the same time, social trust (Siegrist, Cvetkovich and Roth, 2000) and knowledge (Perko et al., 2012) may in some cases decrease risk perception and increase the acceptability of risks (Slovic, 1987).

3. Method

Data collection

Public participation in the context of new installations for nuclear research was a focal point in a larger public opinion survey in Belgium on nuclear-related topics (Turcanu, Perko and Schröder, 2011). Survey data were collected using Computer Assisted Personal Interviews, the respondents being selected through a multi-stage sampling procedure (response rate: 63%). The sample consists of 1020 respondents and is representative for the adult population (aged 18+) in Belgium with respect to sex, age, region, province and habitat. Table 1 summarises the characteristics of the sample.

The questionnaire was structured as a series of closed questions, most items having answer categories on a 5-point Likert scale, with categories typically ranging from ‘strongly disagree’ to ‘strongly agree’. An additional ‘don’t know/no answer’ option was allowed, but not encouraged.

Table 1. Socio-demographic characteristics of the sample.

Variable	Belgian population (%)	Survey sample (N = 1020) (%)
Sex		
Men	48.5	49.7
Women	51.5	50.3
Age		
18–34	26.9	26.8
35–54	36.5	37.7
55+	36.6	35.3
Education		
Lower (primary and lower secondary)	32.2	26.5
Intermediate (higher secondary)	37.0	44.3
Higher	30.8	29.2

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Measure for the dependent variable

Several typologies of public participation have been proposed in the past decades (see e.g. Krütli et al., 2010, for a review). Regardless of the particularities, public participation is mostly seen as a continuum, with higher levels of participation being characterised by a higher degree of empowerment of the citizen in the decision-making process. Arnstein (1969) defined a ladder of citizens' participation based on the extent of citizens' influence on the end product; the eight steps proposed ranged from 'manipulation' and 'therapy' to 'delegated power' and 'citizens' control'. Rowe and Frewer (2005) defined, based on the information flow between participants and sponsors, three levels of public engagement: information, consultation and participation. Health Canada (2000) makes a further differentiation depending on the goal of citizens' participation and the influence on the outcome of the decision-making process: inform/educate, gather information/views, discuss through a two-way dialogue; fully engage on complex issues; or partner in the implementation of solutions.

In our study, the choice of the measure for public participation was made taking into account three main issues: i) the hypothetical nature of our investigation (new installation for nuclear research); ii) the low knowledge concerning nuclear issues in the general public (Perko et al., 2012); and iii) the very limited experience (if any) in Belgium of public discussions concerning nuclear research installations. Thus, we chose a measurement scale derived from the four levels of participation proposed, among others, by Krütli et al. (2010): information, consultation, collaboration and empowerment. These four levels capture well the degree of empowerment of the citizen and offer a pragmatic classification that lends itself to adaptation for our study. First, the context was introduced as follows: 'Suppose there are plans to build an installation for nuclear research in your municipality'. The respondents were then asked to express their participation intention: 'If there is an initiative for citizens' involvement in decisions related to this installation, how much would you like to be involved?' The five answer categories offered to the respondents ranged from: no involvement (1 = 'I don't want to be involved'), to weak involvement (2 = 'receive information' and 3 = 'receive information and express my opinion'), to higher involvement (4 = 'participate in a dialogue' and 5 = 'active partner in decision-making').

Measures for the independent variables

The attitude towards participation was measured with three 7-point bipolar items ranging from 1 to 7. The respondents were asked 'Do you believe that your participation in decisions related to this installation for nuclear research would be', which was followed by the three bipolar items: *pointless – worthwhile, useless – useful* and *disappointing – rewarding*. As in Yzer et al. (2004), the scores on the three items were then averaged to yield an indicator of attitude towards participation. A higher value of this indicator indicates a more positive attitude towards participation. The reliability of the scale constructed with the three items was adequate: $\alpha = 0.82$.

Three items related to norms were used in the survey. Subjective norm was measured as the agreement with the statement 'Most people who are important to me (family, friends) would support my participation'. The item labelled moral norm was formulated as follows: 'I have a duty as a citizen to participate in such activities'. Descriptive norm captured the (lack of) social pressure of performing the behaviour: 'Of the people I know, nobody would participate in such activities'. For all three items related to norms, agreement with the statement was measured on a 5-point Likert scale ranging from 1 = 'strongly disagree' to 5 = 'strongly agree'. To facilitate further analysis, the item relating to descriptive norm was inverted in order to bring it to the same direction of

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connotation as the two other norm items. In this way, a higher score denotes for all the norm items a more favourable position with respect to participation.

The influence of time and financial constraints, respectively, was captured by the following items: i) 'I do not have enough spare time to participate in such activities' and ii) 'I would participate only if this activity were remunerated'. The respondents stated their agreement/disagreement with these statements using the same 5-point Likert scale as above. A higher score on these items indicates a less favourable position with respect to participation.

Attitude towards nuclear energy was measured with three general statements. These enquired whether the respondent believed that 'the benefits/advantages of nuclear energy outweigh the disadvantages', whether 'a reduction in the number of nuclear power plants in Europe is a good cause' and finally, if 'nuclear power plants endanger the future of our children'. The respondents stated their agreement with these statements on a 5-point Likert scale ranging from 1 = 'strongly disagree' to 5 = 'strongly agree'. A factor analysis applied on the three items (with the last two items inverted) revealed one factor, accounting for 64% of the variance in the data. The value $\alpha = 0.72$ of the reliability coefficient indicates a reliable scale, a higher value on the constructed scale representing a more positive attitude towards nuclear energy.

Knowledge of the nuclear domain was measured with 17 exam-style questions concerning nuclear energy and other applications of radioactivity (e.g. 'Is radioactive waste produced only by nuclear power plants', or 'Which of the following cities has a nuclear power plant (list)'). The questions were selected and adapted from: i) European surveys (European Commission, 2007, 2008, 2010); ii) previous surveys in Belgium (Van Aeken et al., 2007); and iii) discussions with experts. An index of knowledge about the nuclear domain was constructed based on these items, calculated as the number of correct answers given to the 17 questions. This ranged thus from 0 to the maximum 17 correct answers.

Risk perception of an accident in a nuclear installation was assessed with the following question: 'How do you evaluate the risks from an accident in a nuclear installation for an ordinary citizen of Belgium?' Confidence was measured by asking the respondents how much confidence they had in the authorities 'for the actions they undertake to protect the population against risks from an accident in a nuclear installation'. A 5-point answer scale was used for both risk perception and confidence in authorities, ranging from 1 = 'very low' to 5 = 'very high'.

4. Results

Descriptive analyses

Results showed that almost one third of the survey respondents (29% out of $N = 1020$) did not intend to participate in citizens' involvement activities related to nuclear research installations. Among the respondents willing to be involved, most of them wanted this to take the form of receiving information and having the opportunity to express an opinion (28% out of $N = 1020$). About 24% (out of $N = 1020$) were willing to get involved to a larger extent, either as a participant in a dialogue towards a consensual decision (12%) or as an active partner in decision-making (12%).

Table 2 indicates that the attitude towards participation is somewhat sceptical among the respondents interviewed, the average score across the entire sample (4.03) being the middle point of the scale. The opinions related to the moral norm were divided: 41% of the respondents agreed that participating in public involvement activities is a citizen's duty, while 36% disagreed. At the same time, 44% believed that their close environment would support such activities, while 32% had the opposite opinion. Lack of time was signalled by 32% of the responders, whereas 47% disagreed

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Table 2. Correlations and means of main model variables[a].

	1	2	3	4	5	6	7	8	9	10	11
1. Participation intention	1										
2. Attitude towards participation	.587**	1									
3. Subjective norm	.463**	.412**	1								
4. Time constraints	−.255**	−.151**	−.111**	1							
5. Financial constraints	.071*	.137**	.019	.051	1						
6. Moral norm	.583**	.518**	.519**	−.208**	.099**	1					
7. Descriptive norm (item inverted)	.397**	.307**	.396**	−.256**	−.079*	.385**	1				
8. Attitude towards nuclear energy	−.159**	−.008	−.038	−.020	.079*	−.093**	−.124**	1			
9. Knowledge about nuclear	.277**	.218**	.285**	−.078*	−.155**	.177**	.238**	.101**	1		
10. Risk perception of accident in nuclear installation	.031	.063	.028	.058	.060	.057	.011	−.213**	−.051	1	
11. Confidence in authorities w.r.t. accident in nuclear installation	.008	.106**	.090**	.029	.038	.025	−.009	.299**	.154**	−.166**	1
Mean	2.59	4.03	3.15	2.76	2.07	3.09	3.35	0	11.26	2.98	3.15
Standard deviation	1.34	1.64	1.31	1.33	1.19	1.28	1.19	1	2.96	1.19	1.14

[a]Range of measures: participation intention = 1 (not at all) to 5 (active partner); attitude towards participation = 1 to 7 (average of 3 items, higher score = more positive attitude); norms = 1 to 5 (one item each, higher score = less favourable position towards participation); time and financial constraints = 1 to 5 (one item each, higher score = less favourable position towards participation); attitude towards nuclear energy = -1.6 to 2.6 (factor, higher score = more positive attitude); knowledge about nuclear = 0 to 17 (index, high score = high knowledge); risk perception = 1 to 5 (one item, high score = high risk perception); confidence = 1 to 5 (one item, high score = high confidence).
*$p < 0.05$; **$p < 0.01$.

with the claim that they did not have enough time for participation activities. Expected financial benefits seem irrelevant: almost 70% of the respondents disagree that remuneration would condition their participation.

As expected from the TPB, attitudes, subjective norm and constraints (time related only) were strongly correlated with behavioural intention. The approval of participation by the close environment (subjective norm) was correlated stronger with intention than the perception of the actual behaviour of others (descriptive norm). A strong sense of the moral dimension of participation is highlighted by its significant correlation with participation intention. This is consistent with the weak correlation between expected financial benefits and participation intention. Time constraints are significantly correlated with participation intention, the perceived lack of time being inversely related with the intended level of participation.

Attitude towards nuclear energy and knowledge of the nuclear domain were also significantly correlated with participation intention; a more negative attitude towards nuclear energy and a higher knowledge are associated with a higher level of intended participation. The average attitude towards nuclear energy was biased towards a negative attitude, with notable changes since previous years that could be due to the nuclear accident at Fukushima (March 2011, three months before our survey). Knowledge is relatively low among the respondents, more than 75% having 13 or fewer correct answers on the 17 knowledge questions.

The variables measuring risk perception and confidence in authorities did not correlate with behavioural intention and were therefore excluded from the regression models presented in the following subsection.

Education and sex had low, but statistically significant correlations with behavioural intention (Kendal tau-b = 0.19, $p < 0.001$ for education; Cramer's V = 0.10, $p = 0.03$ for sex). The age category did not correlate significantly with behavioural intention (Kendal tau-b = -0.19, $p = 0.461$) and was not considered further.

Potential predictors of participation intention

Given the ordinal nature of the dependent variable, a set of ordinal logistic regression models (Table 3) was constructed to test the role and strength of the potential predictors. The independent variables were introduced in four steps.

The first model contained only the socio-demographic variables sex and education. At the next step, we added attitude towards participation, subjective norm, time constraints and financial constraints. Moral norm and descriptive norm were added in the third model, whereas the final model included also attitude towards nuclear energy and knowledge about the nuclear domain.

In the first model, the socio-demographic variables sex and education are statistically significant, but predict participation intention to a rather limited extent. The model suggests that higher involvement is more likely among men than among women. Respondents with lower or intermediate (secondary) education levels seem less willing to get involved than those with higher education.

Adding the attitude towards participation in the regression model (not presented in Table 3) reduces the significance of sex ($p = 0.40$), while the further inclusion of subjective norm and time/money constraints takes over completely the effect of sex (Model 2 in Table 3). Model 2 clearly highlights attitude towards participation, subjective norm and time constraints as influential predictors, alongside the education level. Interestingly, financial constraints did not come out as a statistically significant predictor.

Model 3 pinpoints moral norms as a predictor that is as important as the attitude towards participation. Descriptive norms are also significant, but less influential than, for instance, subjective

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Table 3. Ordinal logistic regression with participation intention as a dependent variable.

Dependent variable	Participation intention[a]			
Predictor	Model 1[b]	Model 2	Model 3	Model 4
	Estimate[c]	Estimate	Estimate	Estimate
Gender: male	**0.314****	0.195	0.176	0.162
Education: lower	**−1.083*****	**−0.610*****	**−0.425***	−0.342
Education: secondary	**−0.657*****	**−0.347***	−0.202	−0.073
(Education: higher, reference category)				
Attitude towards participation		**0.689*****	**0.545*****	**0.574*****
Subjective norm		**0.430*****	**0.250*****	**0.190****
Time constraints		**−0.310*****	**−0.226*****	**−0.257*****
Financial constraints		0.030	0.031	0.110
Moral norm			**0.541*****	**0.541****
Descriptive norm (item inverted)			**0.211****	**0.222****
Attitude towards nuclear energy				**−0.367*****
Knowledge about nuclear				**0.122*****
	N = 1005	N = 928	N = 907	N = 854
	pseudo R^2 = 0.06[d]	pseudo R^2 = 0.46	pseudo R^2 = 0.51	pseudo R^2 = 0.54

[a]1 = not involved; 2 = receive information; 3 = receive information and express opinion; 4 = participate in dialogue towards consensus; 5 = active partner (reference category).
[b]Ordinal logistic regression. Link function: logit. Bold font marks significant coefficients.
[c]The estimate gives the increase in log(odds), where the odds of an event with probability p is defined as odds(p) = p/(1 - p).
[d]Nagelkerke's R^2. A value closer to 1 means a better model.
*p < 0.05; ** p < 0.01; ***p < 0.001.

norm or time constraints. It can also be noticed that the effect of education loses significance when moral norms and descriptive norms are added into the model.

Finally, Model 4 shows that attitude towards nuclear energy plays an important role and is more influential than descriptive or subjective norms. Knowledge is also an influential predictor, higher knowledge being associated with increasing likelihood of higher involvement. Education was not a significant predictor in the final model. Additional regression models (not shown here) proved that it is the combined effect of knowledge and attitude towards nuclear that renders the education level as not significant.

The final model classified correctly more than 60% of the cases in the categories 'not involved' and 'receive information and express an opinion', and about half of the most engaged category ('active partner').

5. Discussion

As expected based on the TPB, the attitude towards participation was the most influential predictor for participation intention, the more positive the attitude, the higher the chance that the respondent expressed intention for a higher engagement level.

The second most influential predictor was moral norm. In the literature, moral norms were shown in some cases to be stronger predictors of intention and behaviour than the three factors suggested by the TBP (Beck and Ajzen, 1991). Given that participation in environmental issues goes beyond individual risks and benefits and, in the case of radioactivity, can even affect several generations, we expected that the moral dimension would play an important role also in our study. The results confirm this expectation: a stronger support for the claim that participation is a citizen's duty is likely to lead to intention for higher levels of involvement related to new installations for nuclear research.

Contrary to the study of Poliakoff and Webb (2007), in which constraints of neither time nor money could predict scientists' intentions to participate in scientific communication activities, in our study time limitations play an important role with respect to the intention to participate in public involvement activities regarding nuclear research installations.

Financial constraints proved inconsequential, as could be predicted from the findings of Poliakoff and Webb (2007) and Deci, Koestner and Ryan (1999). The latter study focused on the effect of extrinsic rewards on intrinsic motivation and showed that tangible rewards may decrease motivation in performing a given behaviour among the intrinsically motivated participants. Our results are in line also with the findings from the focus group research performed for the ITER project dealing with a demonstration facility for a fusion reactor in Cadarache (Fucks et al., 2003). This study revealed that among the local population, most participants were eager to be informed about the general activities and willing to further participate in the focus group discussions. However, several candidates 'strongly reacted against being remunerated as a compensation for their efforts, as they felt their participation to be a sign of good citizenship' (Fucks et al., 2003: 18).

Attitude towards nuclear energy came out as an influential predictor, a negative attitude towards nuclear energy being related to higher (intended) involvement, and thus higher desired influence on the decisions. On the one hand, this seems to contradict Xenos et al. (2011), whose study revealed that a more positive attitude towards nanotechnologies likely leads to a higher intended engagement in discussions on such issues in the future. On the other hand, our result confirms the findings of Knight and Barnett (2010) related to genetic science governance; they showed that those who believe in a more involved public are less approving of genetic science. Such results may suggest that increased criticism might be expected from the democratisation of science;

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however, such criticism does not necessarily lead to rejection of science applications perceived as risky. Poortinga and Pidgeon (2003: 961) argue that 'for a functioning society' it could be 'more suitable to have critical but involved citizens'.

Confirming various studies highlighting the role of descriptive norm in predicting behavioural intention and the critical role of social processes (e.g. Rivis and Sheeran, 2003; Poliakoff and Webb, 2007; White et al., 2009), our study accentuated the influence of this predictor alongside TBP predictors: the higher the belief that most people (known to the respondent) would participate in organised public involvement activities, the more likely is one's commitment to a higher level of involvement.

Knowledge about the nuclear domain has been found to be a significant predictor for participation intention, a positive relationship being detected between the two variables. This suggests that respondents who were more knowledgeable about the nuclear domain and technology were more likely to express an intention for higher levels of involvement. This result adds to previous studies showing that the more extensive a person's knowledge is, the better he/she is able to engage in issue-relevant thinking (Griffin, Dunwoody and Neuwirth, 1999; Kahlor et al., 2006; Huurne, Griffin and Gutteling, 2009). It is important to note that knowledge about the nuclear domain is rather low in the general public; thus, it presents an additional challenge for motivating people to participate. In Dijkstra et al. (2012), knowledge came out as a more influential predictor than in our study; however, they measured self-reported knowledge, rather than actual knowledge.

Risk perception of an accident in a nuclear installation and confidence in the authorities to manage related risks did not correlate with behavioural intention. This indicates that it cannot be assumed that people who intend to be actively involved perceive the risks as higher or trust the authorities to a lesser extent. We remind the reader here that conclusions of studies in the literature are divided as regards the influence of perceived risk on behavioural intention, and it has been suggested that it acts as a distal rather than proximal variable (Gerrard, Gibbons and Bushman, 1996, quoted in Fishbein and Yzer, 2003), having an indirect effect on behaviour (Yzer et al., 2004).

The effect of socio-demographic variables sex and education was moderated by attitude towards participation and norms, as postulated by Yzer et al. (2004).

A limitation of our study is that it explored perceived behaviour control only in terms of controllability. The inclusion of self-efficacy might improve the model further, as can be inferred from the studies by e.g. Poliakoff and Web (2007) and Dijkstra et al. (2012).

6. Conclusions

To satisfy the legal and legitimate requirements for public participation in decision-making processes, the organisers of such participation processes face a challenging situation. Our results clearly show that most people would like to get involved in decision processes related to new nuclear installations and to be able to at least express their opinion. For higher degrees of involvement people have to be convinced that their participation is worthwhile and brings benefits to the decision-making process. This is challenging because the issues surrounding the construction of new nuclear research infrastructures will of course not be discussed and decided exclusively within the confines of a particular participatory setting constructed specifically for this purpose. Organised civil society, general public opinion, the media, political parties, the administration and others will all play a role in deciding the fate of a new nuclear research programme. Public participation has a role to play, but it will be a role alongside and not above other channels of issue settlement. It is worth noting that while time constraints are recognised as a challenge, financial benefits are inconsequential as regards the planned degree of involvement.

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Many authors working in the deliberative democratic tradition point out the ethical necessity of long term programmes of stakeholder involvement, with early involvement at the outset of the process. They equally stress the importance of allowing divergent views to be expressed from the very beginning and creating the premises for a constructive dialogue. This article has added empirical evidence to these ethical principles in the sense that it has pointed out people's motivations for participating in nuclear decision-making processes and expectations about the use of the outcomes of such processes. We hope that it will prove helpful in the future for setting up effective public participation on nuclear installations.

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