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Who is willing to participate? Examining public participation intention concerning decommissioning of nuclear power plants in Belgium

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Abstract

Decommissioning of Nuclear Power Plants (NPPs) is now a pertinent energy-related matter since most of the nuclear reactors built during nuclear renaissance will soon reach the end of their operational life. Drawing on the theoretical framework based on elements of the Value-Belief-Norm theory, psychometric paradigm, deliberative theories of democracy and in the levels of participation as defined by Arnstein's ladder, this is the first large-scale study addressing the question of who is willing to participate in decommissioning-related decision-making procedures. Data for this study were collected via a large public opinion survey (N=1028) in Belgium in 2015, and were analysed using Structural Equations Modelling (SEM) as a method.

Results show that interest on the topic of decommissioning as well as radiological risk perception have direct effects on participation intention. Furthermore, we found that low trust in the nuclear industry, being ideologically leftist, having more negative attitudes towards nuclear energy, and living in the vicinity of a nuclear installation influences participation intention indirectly, through interest and risk perception. Based on these findings we point out to some challenges that can appear in decision-making processes and some recommendations on how to prevent or solve them.

Keywords

Participation intention; decommissioning of nuclear power plants; risk perception; interest; SEM

1. Introduction

On February 2020, there was a public consultation organized in the municipality of Dessel in Belgium related to a new storage building for radioactive waste. Although such consultations are highly recommended (Gugliermetti & Guidi, 2009; IAEA, 2017) and/or legally binding (Richardson, Rickwood, & Rickwood, 2013; UNECE, 1998), and although Dessel has almost 10,000 residents, the public consultation meeting attracted only 18 participants. Out of these 18 participants, only 2 of them were interested citizens, 3 were from a non-profit organization (STORA) and 1 journalist. The other ones were all either political decision-makers or experts from the nuclear field (SCK CEN; Belgoprocess; NIRAS-ONDRAF; FANC-AFCN).

Based on scientific evidence, this is not the first, nor will be the last case characterized with low public participation. Extant research shows that low public participation is an experience that many other situations that are not emergency-related have in common (European Commission, 2013; Ruostetsaari, 2017; Turcanu, Perko, & Laes, 2014; Webb, 2013). Low participation in participatory decision-making processes can be problematic since this is often a regulatory mandate by which the public's input on matters affecting them is sought. Likewise in literature, citizen participation is portrayed as a key component in policy decision-making (Fitzgerald et al., 2016). While other research focuses on types of participation (Arnstein, 1969), how much influence or authority is granted to the participation (Fung, 2006), how to design participatory processes (Bobbio, 2019) or public participation mechanisms typologies (Rowe & Frewer, 2005), this article tries to answer the question of *who is willing to participate in decision-making procedures*, by combining elements of the Value-Belief-Norm (VBN) theory (Stern, Dietz, Abel,

Guagnano, & Kalof, 1999) with other theories such as psychometric paradigm (Paul Slovic, 1993) and deliberative democracy (Cohen, 1997; Pateman, 2012) theories. In order to investigate the potential predictors to public participation intention, this paper focuses on decommissioning of nuclear power plants (NPPs) – another topic that the majority of the public might find non-urgent and/or purely technical.

After their operational time is finished, the nuclear installations must be decommissioned. This process involves removing the used fuel from the nuclear reactor, dismantling systems or components containing radioactive products (e.g., the reactor vessel); as well as cleaning up or dismantling contaminated materials from the facility (Nuclear Energy Institute (NEI), 2019). This makes the process much more expensive and time consuming for nuclear power plants than retiring other power plants (Energy Information Administration (EIA), 2017). While to most people, this would be a technical, not a social task, it actually involves many associated risks and public concerns which mainly arise as a result of the different perceptions, attitudes, opinions and concerns of stakeholders towards the risks and benefits of decommissioning programmes as well as lack of stakeholder involvement planning (Perko, Monken-Fernandes, Martell, Zeleznik, & O'Sullivan, 2019). This makes decommissioning of nuclear installations a vivid example of social links to a technical task.

Public involvement in decision-making processes related to decommissioning programs is required in Europe by multiple regulations (e.g. the amended Environmental Assessment Directive 2014/52/EU, European Council Directive 2011/92/EU, and the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters). There are various techniques and instruments explicitly designed to enhance public participation such as the organization and implementation of focus groups, expert panels or hearings, roundtables, interest groups, in-depth groups, citizen juries or panels, citizen advisory committees, consensus conferences, coercive dialogues and other public meetings (De Marchi & Ravetz, 2001; Di Nucci, Brunnengräber, & Isidoro Losada, 2017; Krütli, Stauffacher, Flüeler, & Scholz, 2010; Renn, 2008). However, a review of these instruments is out of

the scope of this paper as here we want to identify who is willing to participate on decommissioning-related decision-making processes.

Public participation in decision-making procedures concerning environmental aspects in general and related to nuclear waste disposal in particular, not only gives the communities a say on the matter, but also increases the social acceptance of predefined technical solutions (Hietala & Geysmans, 2020). That being said, arguments for public involvement in decision-making procedures have an instrumental rationale which is that participation may decrease conflict and increase acceptance of or trust in the science that feeds into the environmental management process; a normative rationale which argues that the processes of environmental assessment and environmental management should be legitimate; and a substantive rationale which argues that relevant wisdom is not limited to scientific specialists and public officials but mutual learning is needed (Stern & Fineberg, 1996). The relevance of public participation in decision-making procedures has also been supported by other empirical studies (Irvin & Stansbury, 2004; Liu, Bouman, Perlaviciute, & Steg, 2019; Pölzl-Viol et al., 2018; Schroeter, Scheel, Renn, & Schweizer, 2016) and has been translated in the EU governance frameworks and science policy strategies such as the one about Responsible Research and Innovation (RRI) (Owen, Macnaghten, & Stilgoe, 2012).

Despite all the recommendations, however, research shows that a major part of citizens are not motivated or willing to be actively involved in organized decision-making processes. For instance, a European Survey in 2013 showed that 37% of the Europeans think that public dialogue is not needed when it comes to decisions made about science and technology, whereas only 16% think that the public needs to be actively engaged (European Commission, 2013: 37). An earlier survey coming from the same institution found that only 25% of the EU population would like to be directly consulted and to participate in decision-making processes on the development of national energy strategies (European Commission, 2010). Similar results come from more recent articles too. For instance, Ruostetsaari (2017) found that when it comes to the

energy policy in Finland, the citizens prefer that these decisions are made by experts. Similarly, in a study about public participation related to new nuclear research reactors Turcanu, et al. (2014) found that more than half of the respondents (57% out of N=1020) did not intend to participate at all or only wanted to receive information related to such activities. Literature concerning the recent turn to authoritarianism points out to the same issue (Heinberg & Crownshaw, 2018; Murakami Wood, 2017). For instance, Hibbing & Theiss-Morse (2002) talk about stealth democracy when arguing that public participation intention is low simply because people do not want to participate and do not like being involved in a process of openly arriving at a decision in a situation of diverse options (Hibbing & Theiss-Morse, 2002). Further, they argue that the majority of the public prefers stealth democracy because it finds decision-making and conflict uninteresting and they want the job to be done by the people who are paid for this (McHugh, 2006). Participation fatigue (Lammi, 2009; Wesselink, Paavola, Fritsch, & Renn, 2011), non-responsive government (Muhlberger, 2018), and lack of trust due to previous experiences where public concerns have been disregarded (Neblo, Esterling, Kennedy, Lazer, & Sokhey, 2010) among others, have been found to play a role on low public participation intention.

By building on these theoretical and practical findings that (apart from protests and grass-root opposition), a major part of citizens are not willing to participate in organized decision-making process, this article attempts to find out who are those people that do or do not want to participate. In so doing, it addresses the gap in public participation in decision-making processes related to decommissioning of NPPs which is a pertinent energy-related matter since most of the world nuclear reactors built during nuclear renaissance (Goodfellow, Williams, & Azapagic, 2011) will reach the end of their operational lifetime in the next years, and in Belgium, which will be the specific focus of this study, all 7 reactors will reach their operational lifetime of 40 years in the period 2015–2025, which will need to be shut down according to the law (Latré, Thijssen, & Perko, 2019). Drawing on a theoretical framework based on elements of the Value-Belief-Norm theory (Stern et al., 1999), psychometric paradigm, and in the levels of participation as defined by

Arnstein's ladder (Arnstein, 1969), it is the first large scale empirical study investigating the extent to which "laypeople" wish to be involved in decommissioning-related decision-making processes. While previous research has only looked at the direct effect of the explanatory variables (Ruostetsaari, 2017; Turcanu et al., 2014), in this study, based on elements of the VBN theory and psychometric paradigm, we also analyse the mediating effects of risk perception and interest, which also offers a methodological contribution. In addition to theoretically and methodologically contributing to studies on public participation, this study also offers valuable insights for authorities responsible for decommissioning of NPPs and public engagement practitioners in order to successfully plan required public engagement in decommissioning processes.

In the next sections, we provide a more detailed explanation of the theoretical argument based on which the hypotheses of this paper are formed. Afterwards we explain the methods and the data collection process. In the fifth section, we reveal the results of the analysis and subsequently we discuss the implications as well as the limitations of the study. The last section is a conclusion of the paper.

3. Theoretical argument and hypotheses

3.1. Value-belief-norm theory and its elements tested in this study

A number of models from different disciplines that explain participation intention can be found in the literature (Ajzen, 1991; Fishbein, 1980; Sheppard, Hartwick, & Warshaw, 1988; Stern, 2000). An important theory explaining participation intention is the value-belief-norm (VBN) theory which links value theory (Dietz, Stern, & Guagnano, 1998), norm-activation theory (Schwartz, 1977, 1994) and new environmental paradigm (NEP) perspective (Dunlap & Van Liere, 1978) through a causal chain of five variables leading to participation intention (see fig. 1) (Stern, 2000). When compared to these theories alone, the VBN theory proved to explain the highest variance related to participation intention on environmental-related activities (Stern et al., 1999). The theory argues that individuals who feel that salient values are affected in

decisions that require public input, believe that there are some adverse consequences or threats to the objects they value, and believe that their actions can make a difference are more likely to participate (e.g. activism, public sphere support, private sphere activism, etc.) (Stern, 2000; Stern et al., 1999).

As can be seen in figure 1, the VBN theory argues that certain values have a direct effect on problem awareness, which then indirectly influences interest and participation intention. Such values can be biospheric values (reflecting an individual's care about the environment and nature), altruistic values (reflecting the extent to which people care about the others or nature), and egoistic values (whether people care about money and power) (van der Werff & Steg, 2016). Problem awareness, in the context of the VBN theory measures the extent to which people perceive something to be a threat or have adverse consequences for them, their families, their country or the nature (Stern et al., 1999). In practical terms related to decommissioning of NPPs, problem awareness is a similar measure as radiological risk perception, which measures the extent to which people perceive and evaluate risks from nuclear/radiological-related activities. For this reason, in this study we will use the term 'risk perception' instead 'problem awareness' or 'adverse consequences for valued objects' as termed by the VBN theory.

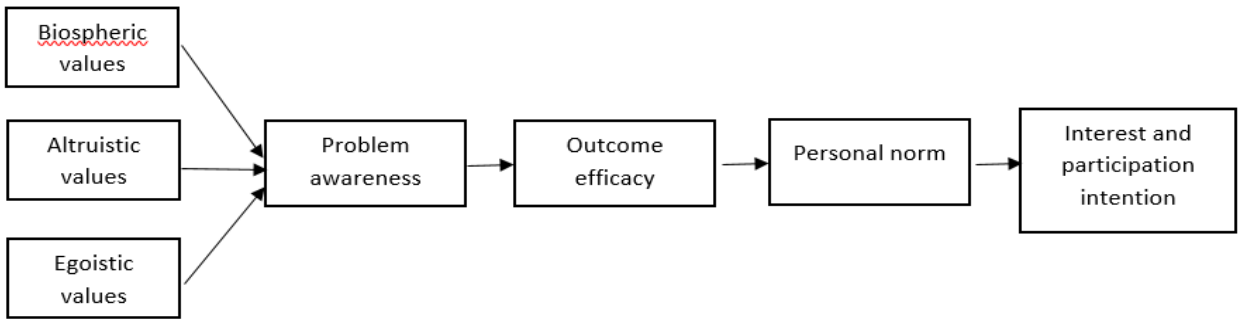

Figure 1. The Value-Belief-Norm (VBN) theory.

The following subsections describe first the independent and mediating variables that were derived from elements of the VBN theory in combination with other theories explained below; secondly they explicate

the hypotheses that link these variables with the dependent variable “intention to actively participate”; and thirdly address the issue of operationalizing this independent variable using the categories of Arnstein’s ladder of involvement.

3.2. Elements of risk perception theories tested in this study

Risk perception mainly denotes the mechanisms and processes of how individuals think and feel about the risks they face (Sjoberg, Bjorg-Elin, & Torbjorn, 2004; P Slovic, Finucane, Peters, & MacGregor, 2004). In this study we focus on radiological risk perception. Studies on risk research show that radiological risk perception is not only affected by values, but also by attitudes to objects or persons related to the risk, psychometric factors relating to specific properties of the risk or the risk situation and other attributes such as political preferences (Latré et al., 2019; Perko, Železnik, Turcanu, & Thijssen, 2012; Wiegman & Gutteling, 1995).Such influencing variables that may explain participation intentions related to decommissioning of NPPs include trust in authorities, attitude towards nuclear energy, living in the vicinity of a nuclear installation, and ideological position. For instance, studies focusing on risk perception towards nuclear energy (Ryu, Kim, & Kim, 2018; Paul Slovic, Flynn, & Layman, 1991), on Genetically Modified (GM) foods (Poortinga & Pidgeon, 2005), and other risk research fields (Ibitayo & Pijawka, 1999; Lobb, Mazzocchi, & Traill, 2007; Renn, 2008; Siegrist, Cvetkovich, & Roth, 2000; Siegrist, Gutscher, & Earle, 2005; Viklund, 2003) found trust in regulation to have an effect on risk perception, where low trust in regulation leads to higher risk perception. Consequently, trust is proven to have a strong impact on participation intention (Muhlberger, 2018). For instance, Neblo et al. (2010) argue that only when people do not trust the process or the decision-makers, will they be more dissatisfied and feel that they have to participate themselves in the decision-making process.

Turcanu et al.(2014) found that negative attitudes towards nuclear energy were one of the strongest predictors towards public participation intention related to nuclear research installations. Perlaviciute & Steg (2015) found that this attitude can be rooted in people's values, indicating that higher biospheric values lead to more negative attitudes towards nuclear energy (when it comes to environmental consequences). However, research also shows that attitudes towards nuclear energy can negatively influence risk perception. For instance, in 2008, Renn argued that more research needs to be done in order to improve our knowledge related to the links between risk perception, attitudes towards risk objects and behaviour. Four years later, Perko et al. (2012) found that the more an individual is against nuclear energy, the higher their risk perception is. For this reason, in this study we treat attitudes towards nuclear energy as an independent variable of participation intention, which can have a direct effect, as well as an indirect one, through risk perception.

Studies concerning vicinity show that living in the vicinity of a nuclear installation can have opposing effects on participation intention depending on the mediator (Perko & Martell, 2021; Perko, Železnik, et al., 2012). For instance, several empirical studies show that people living in the vicinity of operating nuclear installations perceive lower radiological risks than the regional or national average, suggesting that familiarity with such installations reduces perceived risks (Lyons, Akin, & Stroud, 2020; Maderthaner, Guttmann, Swaton, & Otway, 1978; Perko & Martell, 2021; Perko, Železnik, et al., 2012; Wiegman & Gutteling, 1995), and therefore makes people less likely to participate in decision-making procedures (Hibbing & Theiss-Morse, 2002; Perko, van Gorp, Turcanu, Thijssen, & Carle, 2013; Webb, 2013). On the other hand, living in the vicinity can have a positive direct effect on public participation. For instance, in post-nuclear accident issues, local actors in communities with personal experiences linked to nuclear were found to be more willing to engage in decision-making procedures (Pölzl-Viol et al., 2018) and in Slovenia a partnership approach for low and intermediate level waste was developed, which resulted in local communities that lived in vicinity of existing NPP to agree in hosting a new repository (Perko & Martell,

2020). Applying interest on the topic of decommissioning as a mediator also contributes to the opposing effect of vicinity on participation intention. For instance, living in the vicinity of a nuclear installation can increase one's interest on the topic, and therefore also increase his/her participation in decision-making procedures concerning decommissioning (Hibbing & Theiss-Morse, 2002; Neblo et al., 2010; Tommasetti, Singer, Troisi, & Maione, 2018). Finally, political preferences or ideologies are proved to influence risk perceptions as well. Several studies found that people with a left-wing political preference reported higher risk perception related to chemical plants and radioactive waste (Rothman & Lichter, 1987; Wiegman & Gutteling, 1995) and also that risk perceptions of nuclear power is 'anchored' with political ideology (Costa-Font, Rudisill, & Mossialos, 2008). Similarly, studies in Belgium show that left-wing parties are against nuclear energy, while the right-wing ones favour it more (Latré et al., 2019; PartiRep, 2014). In this study, based on McCollom, Trice, & Beyer (1994:33) we define ideology as "shared, relatively coherently interrelated sets of emotionally charged beliefs, values, and norms that bind some people together and help them make sense of their worlds." Similarly, Oliver & Johnston (2000:1) argue that "ideology is rooted in politics […] and points to coherent systems of ideas which provide theories of society coupled with value commitments and normative implications for promoting or resisting social change." Studies on climate change found that left-wing individuals have stronger altruistic and biospheric values (Dietz, Dan, & Shwom, 2007; Visschers, 2018), and are more likely to embrace environmentalism (Harring, Jagers, & Matti, 2017). That is why, in this study we use left-right ideological position as a proxy for measuring altruistic and biospheric values. Furthermore, research shows that left-wing citizens (with stronger altruistic and biospheric values) are more likely to support direct democracy, while those leaning to the right prefer more stealth democracy (Bengtsson & Mattila, 2009), thus being less likely to participate in decision-making procedures. By combining the VBN theory with the other theoretical arguments mentioned above, we hypothesize that:

[H1a] Individuals that have lower trust in nuclear industry's capacity to decommission NPPs have a higher radiological risk perception.

[H1b] Individuals that have more negative attitudes towards nuclear energy have a higher radiological risk perception.

[H1c] Individuals that live further away from a nuclear installation have a higher radiological risk perception.

[H1d] Individuals that are more ideologically leftist (biospheric values & altruistic values) have a higher radiological risk perception.

The VBN theory argues that when individuals recognize that a certain risk situation or potentially dangerous technology poses threat to other people, other species or nature (problem awareness) they are more likely to act against it. This was confirmed earlier by the norm-activation theory in the environmental-related field (Schwartz, 1977) but also in other fields such as political science (Hibbing & Theiss-Morse, 2002; Neblo et al., 2010; Webb, 2013) and risk research (Perko et al., 2013; Turcanu et al., 2014). Similar to VBN theory, these studies argue that risk perception is a predictor of participation intention, therefore, we hypothesize that:

[H2] *People that perceive higher risks from nuclear installations are more likely to participate in decision-making regarding decommissioning of NPPs.*

[H2a] *Risk perception will serve as a mediator between the explanatory variables as expected by hypotheses H1a-H1d and participation intention as a dependent variable.*

3.1.1. Interest on nuclear energy and decommissioning

According to the VBN theory, after problem awareness or risk perception, there are two more aspects that influence interest and participation intention, namely, outcome efficacy and personal norm. However, van der Werff & Steg [35] argue that a more parsimonious model is needed which uses less steps and more general predictors of participation intention. Furthermore, these authors argue that interest and participation intention should be treated separately, because interest measures someone's interest on the topic and their willingness to receive more information (Sheppard et al., 1988; van der Werff & Steg, 2016), whereas participation intention measures their willingness to voluntarily commit to a project, discussion, or a decision-making procedure (Arnstein, 1969; Krütli et al., 2010; van der Werff & Steg, 2016). While interest can influence participation intention, it itself can be influenced by other predictors too (Brandmo & Bråten, 2018; Latré et al., 2019; Lavezzolo & Ramiro, 2018; Neblo et al., 2010; Perko et al., 2013; Pölzl-Viol et al., 2018; Webb, 2013). That is why, similar to risk perception, in this study we treat interest as a mediating variable, rather than an integrated aspect of participation intention.

Several studies on participation intention found that interest or curiosity about a certain topic influences an individual's participation intention (Hibbing & Theiss-Morse, 2002; Neblo et al., 2010; Spielberger & Starr, 1994; Tommasetti et al., 2018; Webb, 2013). While trying to answer the question of why some individuals are interested in topics that others might find dull and vice versa, Fink [62] argues that the main explanation is not interest in some matter or content. Engagement with an object or a matter in which a person is greatly interested proceeds in a much more productive and qualitative character than does engagement with an object in which a person has little or no interest (Fink, 1994; Tommasetti et al., 2018). Based on these arguments we hypothesize that:

[H3]: More interest in nuclear energy and decommissioning leads to higher participation intention in decision-making regarding decommissioning of NPPs.

Similar to risk perception, interest in nuclear energy and decommissioning can also be influenced by trust, attitude towards nuclear energy, living in the vicinity of a nuclear installation, and ideological position. For instance, political, risk and nuclear-related studies have found that people that have higher interest about a certain matter at hand are those who have low trust in authorities (Brandmo & Bråten, 2018; Neblo et al., 2010; Perko et al., 2013; Webb, 2013) and are more dissatisfied or against that matter (Latré et al., 2019; Neblo et al., 2010; Webb, 2013). Furthermore, it has been argued that in post-nuclear accident issues, local actors in communities with personal experiences linked to nuclear (e.g. living in the vicinity of a nuclear installation) are more interested in the nuclear-related activities (Pölzl-Viol et al., 2018). This is also because people living close to a nuclear installation are much more often addressed in communication and decision-making practices (e.g. emergency exercises, consultations, etc.) (Perko, Tafili, et al., 2019; Perko et al., 2013). By combining the VBN theory with the above-mentioned arguments we hypothesize that:

[H4a] Individuals that have lower trust in nuclear industry's capacity to decommission are more interested in the topic of nuclear energy and decommissioning.

[H4b] Individuals that have more negative attitudes towards nuclear energy are more interested in the topic of nuclear energy and decommissioning.

[H4c] Individuals living close to nuclear installation are more interested in the topic of nuclear energy and decommissioning.

[H4d] Individuals that are more ideologically leftist (biospheric values & altruistic values) are more interested in the topic of nuclear energy and decommissioning.

[H5] *Interest in nuclear energy and decommissioning will serve as a mediator between the explanatory variables as expected by hypotheses H4a-H4d and participation intention as a dependent variable.*

3.3. Levels of citizen participation based on Arnstein's ladder: the dependent variable

Public participation can have different levels of engagement. The VBN theory focuses on different forms of participation. Such forms can be activism (active involvement in organizations and demonstrations), non-activist behavior in the public sphere (approval of regulations or willingness to pay more for a certain cause), private-sphere activism (e.g. buying environmental-friendly goods), and behaviour in organizations (Stern, 2000; Stern et al., 1999). For the general purpose of this paper, however, we are more interested in the *extent* to which an individual wants to participate in decision-making related to decommissioning, rather than other forms of behavioral engagements. The extent of public participation in decision-making can have different levels of intensity. Arnstein (1969) developed for this purpose a "ladder of citizen participation" which consists of an escalating series of engagement including manipulation, therapy, informing, consultation, placation, partnership, delegation and citizen control. The influence of citizens on decisions is lowest in the first two rungs of the ladder (labelled as 'non-participation') where the main goal of decision-makers is to "educate" and "cure" citizens. Rungs 3, 4, and 5 are labelled as 'degrees of tokenism' and are levels in which citizens are in dialogue with public authorities but they have no influence on their decision. The last three rungs of the ladder are labelled as 'citizen power' and these are the levels in which citizens have appointed seats in decision-making committees and/or deal themselves with the policy-making process and as such they influence decisions to a greatest level (Arnstein, 1969). Similar distinction was later made on other studies related to public participation (Almond & Verba, 2003; Krütli et al., 2010).

Given that in this study we want to know the extent to which an individual is willing to co-decide about certain issues or have a significant impact in the outcomes of a certain process (Arnstein, 1969), we divide participation intention in three levels, namely non-participation, tokenism and citizen power. This way, we can see the impact that risk perception and interest on nuclear energy and decommissioning have on all

these three levels. In figure 2 we show the hypothesized model which includes Arnstein's ladder in the structure of a combination of VBN and other theories in order to provide a better fit for the special context of decommissioning.

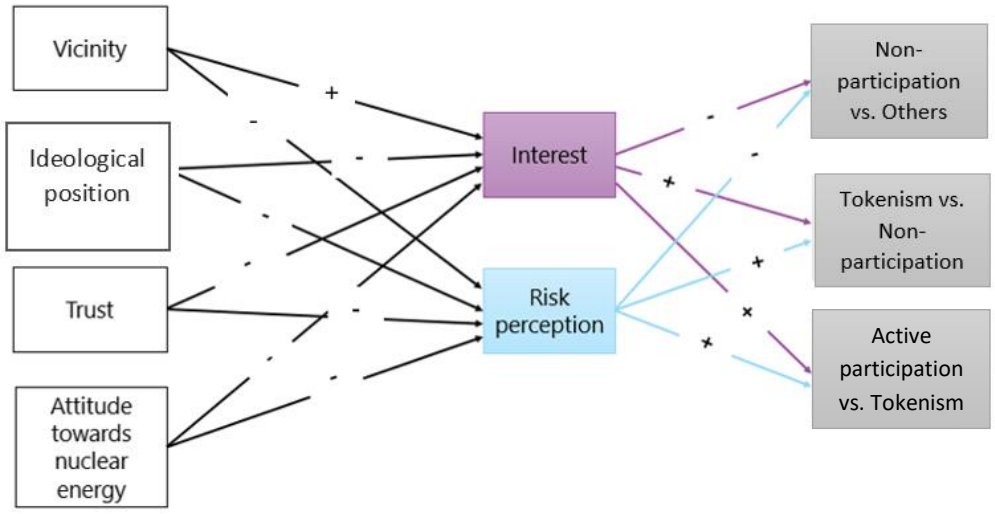

Figure 2. Hypothesized model explaining participation intention resulting from the combination of different theories and Arnstein's ladder of participation.

4. Method

4.1. Data Collection

Participation intention regarding decommissioning of nuclear power plants was analyzed in a large public opinion survey related to perceptions and attitudes towards nuclear technologies in Belgium in 2015 (Turcanu, Perko, & Latre, 2015). The survey data were collected using Computer Assisted Personal Interviews (CAPI), which entailed face-to-face interviews at the respondents' homes, the answers being directly recoded and stored on a portable hard disk. The sample consisted of N=1028 Belgian adults (18+) and is representative for the Belgian population with respect to gender, age, region and education (Table 1). Most items in the survey were formulated as questions or statements, while answering categories were

mostly expressed with a five points Likert-scale. The answering categories typically ranged from 'strongly disagree' to 'strongly agree', but some of them were adjusted to the context of the statement or question.

[Table 1 about here]

5. Variable measurement

5.1. Dependent variable: Participation intention

In order to find out to what extent the respondents would like to participate in decision-making related to decommissioning, our survey first introduces the context regarding decommissioning the following way: "*The Belgian nuclear power plants are reaching the end of their operating life and will be shut down permanently in the near future. These facilities will need to be decommissioned. This process is the removal of radioactivity from the installation to the point where control is no longer necessary*". Afterwards, it asks the participants to what extent they would like to participate in the decision-making concerning the decommissioning of nuclear power plants[1]. The answering categories derive from Arnstein's ladder (Arnstein, 1969) and range from: 1- I don't want to participate; 2- I want to receive information about the plant to be decommissioned; 3- I want to receive information and express my opinion; 4- I want to participate in a dialogue towards a decision; and 5- I want to be an active partner in decision-making. Respondents could only choose one option. In order to better fit our hypothesized model and the empirical analysis, we group these answering options in three separate dependent variables. The first one is called "non-participation" and it measures the first category (I don't want to participate) versus the other four.

[1] Note that this variable measures public participation intention once a decision to decommission nuclear installations has been made. We have also considered the extent to which the hypothesized explanatory variables would be related to public's preferences on what should happen with a nuclear installation once it is shut down, however, given that there was no significant correlation, we have not included it in the main analysis.

The second dependent variable is called 'tokenism' and it consists of category 2&3 versus category 1. The last dependent variable is called 'citizen power' and it consists of category 4&5 versus category 2&3.

5.2. Independent variables:

Trust in nuclear industry's capacity to decommission is conceptualized as the extent to which citizens trust the financial, technological and expert capacity of the nuclear industry and Belgian authorities to successfully decommission a nuclear power plant.

This variable is measured with four items (see table 2), namely, 1. The nuclear industry has the technology required to successfully decommission nuclear power plants; 2. The nuclear industry does not have the expertise required to successfully decommission nuclear power plants; 3. The owner of the nuclear plants has the financial resources needed for decommissioning; and 4. I trust the Belgian authorities to control what the nuclear industry does in the field of decommissioning. The participants had to choose answers on a scale from 1. Strongly Disagree to 5. Strongly Agree.

PCA (Principal Component Analysis) with these four items resulted in one factor which explains 47% of variance and has a Kaiser-Meyer-Olkin (KMO) index of 0.625. The reliability scale resulted with α =0.615.

[Table 2 about here]

Similar to (Latré, Perko, & Thijssen, 2018; Perko, Turcanu, & Geenen, 2012; Turcanu et al., 2014) *attitude towards nuclear energy* is measured with three items. These asked the respondents whether 1) they believed that 'the benefits of nuclear energy outweigh the disadvantages', 2) that 'reducing the number of NPPs in Belgium is a good cause', and 3) that 'NPPs endanger the future of our children'. The answering categories ranged from 1= 'strongly disagree' to 5= 'strongly agree'. For the purpose of the analysis, the items have been reverse-coded where a lower score means a more negative attitude whereas a higher score means a more positive attitude. PCA with these three items resulted in a single factor, explaining

66% of the variance. All of the three items have factor loadings of higher than 0.7 with a KMO index is 0.665 and a reliability scale of α =0.743.

[Table 3 about here]

To measure the *ideological position of the participants* in our study, we asked them which political party would they vote for in case a federal election were organized next Sunday. The respondents selected their favorite party and these answers were re-coded in a categorical variable were 1 means left, 2- center, and 3- right.

To see whether the participant ever lived *in the vicinity of a nuclear facility* we asked the respondents whether they have ever lived in an area close (within a 20 km radius) to a nuclear installation (power plant or nuclear research institute). They could answer with 1= yes or 2= no.

5.3. Mediating variables:

In order to measure people's *interest in nuclear energy and decommissioning* we use three items. The first item asks the respondents the following question: "In the past year, how often have you discussed about nuclear energy with other people?" (Answers ranging from 1= never to 5= very often). The second item asks the respondents if they would take the time to read an article about nuclear energy if they encountered it (answers ranging from 1= definitely not to 5= definitely yes). Finally, the third item asks whether the respondents ever thought of what happens after a nuclear power plant is shut down? They could answer with 1= Yes or 2= No, which were later reverted in order to fit the analysis better.

PCA with these three items resulted in a single factor, explaining 57% of the variance. All of the three items have factor loadings of higher than 0.7 with a KMO index is 0.627 and an α = 0.621.

[Table 4 about here]

Risk perception in this study is defined as a subjective judgement or belief regarding characteristics and severity of potential risks (Renn, 2008). Similar to Latré, Thijssen, & Perko (2019), we measure risk perception with three items. Respondents were asked how they perceive the potential personal health risk within the next 20 years from: radioactive waste, an accident in a nuclear installation, and a terrorist attack with a radioactive source. Answers ranged from 'no risk at all' (1) to 'a very high risk' (5).

The PCA of these variables resulted in a single factor which explains 70% of the variance. As table 5 shows, all factor loadings are higher than 0.65 and the KMO index is 0.691. The reliability of this scale is scα =0.792.

[Table 5 about here]

6. Results

6.1. Descriptive analyses

Descriptive results show that participation intention is quite low with almost half of the respondents (44%) not wanting to participate at all and around 27% only wanting to receive information, without becoming actively involved. 19% of the respondents want to receive information and express their opinion whereas only about 8% of the respondents want to actively participate in decision-making regarding decommissioning. As can be seen in table 6, trust in nuclear industry's capacity to decommission seems to be fairly high with a mean of 3.22 which is higher than the middle point. The same applies to attitude towards nuclear energy, which is higher than the median, pointing to a modest positive attitude towards nuclear energy. The respondents' ideological position ranges from about 41% considered as leftists, 15% favouring the centrist parties and around 43% favouring the right ones. Regarding the citizens' interest in nuclear energy, the majority of the participants (59%) stated that they would take the time to read a

newspaper article about nuclear energy. However, most of them (71%) stated that they have never or very rarely discussed about nuclear energy with other people and that they have never thought about what happens when a nuclear power plant is shut down (62%). This shows a rather low interest from the citizens although most of the reactors in Belgium are already approaching the end of their operation time. Risk perception seems to be quite high as well, with a mean of 4.19.

[Table 6 about here]

6.2. Who is willing to participate?

The hypothesized model of this paper included mediation variables and indirect relationships, therefore, we conducted a mediation analysis in Structural Equation Modelling (SEM) in order to test it. SEM is a multivariate technique that allows for examination of a series of interrelated causal relationships by combining aspects of factor analysis and multiple regression. This way, we can see which variables influence interest and risk perception, and then the effect that the latter have on participation intention.

We applied a Confirmatory Factor Analysis (CFA) to test and evaluate the results of our hypotheses. We conducted three separate analyses for the three different dependent variables and then integrated them in the path model (see figure 3) for simplicity reasons. All three models resulted with good fits. In CFA and SEM, the chi-square test is easily affected by the sample size. Therefore, here we report the comparative fit index (CFI), the standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA) as criteria for the goodness of fit. A good model fit is found when the SRMR is equal to or lower than 0.08, the RMSEA is equal to or lower than 0.08, and the CFI is equal to or over 0.95 (Hair, Black, Babin, & Anderson, 2010). The model we applied is visually explained in figure 3 below where only the significant effects are shown.

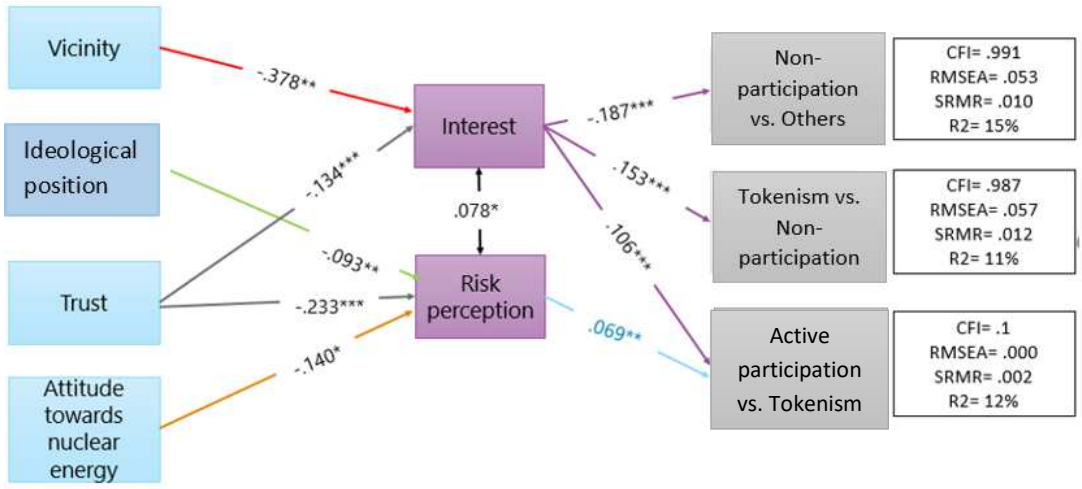

Figure 3: The final model based on SEM, including model statistics and significant standardized pathways.

**p < 0.05; **p < 0.01.; ***p < 0.001.*

The model with Non-participation as a dependent variable has a CFI of 0.991, a RMSEA of 0.053 and a SRMR of 0.01 which indicate a good fit of the model. The R-square of this model is 0.153 which means that the model predicts 15% of the variance in Non-participation variable.

The second model in which Tokenism is the dependent variable has a CFI of 0.987, a RMSEA of 0.057 and a SRMR of 0.012. The model predicts 11% of the variance in Tokenism, which is a comparison of people that don't want to participate at all versus people that want to 'hear and be heard'.

In the last model the dependent variable is called Citizen power and it is a comparison of people that want to receive information only or people that want to receive information and express their opinion versus people that want to participate in more active forms such as taking part in dialogues or being active partners in decision-making. This model has a CFI of 0.1, a RMSEA of 0 and a SRMR of 0.002. The model predicts 12% of the variance of this dependent variable.

As can be seen in figure 3, risk perception is influenced by ideological position, trust and attitude towards nuclear energy. This means that people who are more ideologically leftist (stronger biospheric and

altruistic feelings), have lower trust in nuclear industry's capacity to decommission an NPP, and have more negative attitudes towards nuclear energy perceive higher radiological risks. This was expected from our hypotheses 1a, 1b and 1d which resulted from the modified model of the VBN theory. Hypothesis 1c, however, cannot be confirmed as vicinity does not have a significant impact on risk perception in this model. Furthermore, one can see that risk perception serves as a mediator between the independent variables and participation intention which also supports our hypothesis 2a.

In our hypothesized model we also suggested that vicinity, ideological position, trust and attitude towards nuclear energy will also influence interest in nuclear energy and decommissioning. This, however, holds true only for vicinity and trust as these are the only independent variables that influence interest. Given that people who have ever lived close to a nuclear installation and who have lower trust in nuclear industry's capacity to decommission are more interest in nuclear energy and decommissioning, we confirm hypotheses 4a and 4c, whereas we reject hypotheses 4b and 4d given that ideological position and attitude towards nuclear energy have no significant impact on interest. Hypothesis 5 can also be confirmed given that as the results show, interest in decommissioning of nuclear installations serves as a mediator between vicinity, trust and participation intention.

Finally, we hypothesized that risk perception (H2) and interest (H3) will influence participation intention. After separating participation intention into three separate dependent variables, the results of the model show that interest has a significant impact on all of these three dependent variables whereas risk perception only influences citizen power which is the variable related to more active participation. Based on these results we can see that interest negatively influences non-participation which means that people who are more interested on the topic of nuclear energy and decommissioning are less likely to stay passive. As expected, the opposite applies to tokenism and citizen power which means that people who are more interested, are more likely to either want to 'hear and be heard' or to have active participation such as

being active partners in decision-making processes. Although risk perception has a significant impact on citizen power only, this means that people who have higher radiological risk perception are more likely to be willing to be actively involved instead of willing to receive information only. Based on these results, we can confirm both, hypothesis 2 as well as hypothesis 3 related to the impact of interest and risk perception on participation intention.

A summary of the direct, indirect and total effects of all the variables on the dependent ones is provided in table 8, appendix A.

7. Discussion

Based on a public opinion survey in Belgium, this study investigated citizen participation intention regarding decommissioning of nuclear power plants. Theoretically, the paper is built on the Value-Belief-Norm theory which included Arnstein's ladder of participation as a scaled indicator for measuring intention to act as a means to better fit the topic of nuclear decommissioning. We hypothesized that participation intention is affected by interest and risk perception directly, and by vicinity, trust, ideological position and attitude towards nuclear energy indirectly, through interest and risk perception.

Not surprisingly, the findings of the study pointed out that participation intention is influenced by risk perception and interest. People who are more interested on the topic of nuclear energy and decommissioning, and those who have higher radiological risk perception are more likely to be willing to actively participate in decision-making processes related to decommissioning of nuclear power plants. This was expected based on the different theoretical findings of the literature. For instance, the VBN theory argues that when individuals recognize that a certain circumstance, or technology poses threat to other people, other species or nature (problem awareness) they are more likely to act against it. This argument is in line with the result we obtained regarding risk perception. The impact of interest on participation

intention, on the other hand, has a long history starting from the XIX century by James, (1891) who developed a theory focusing on the capacity of curiosity to affect human behaviour (Tommasetti et al., 2018). Later on, many other studies found that interest is the main driving behaviour behind participation intention and qualitative engagement (Hibbing & Theiss-Morse, 2002; Neblo et al., 2010; Spielberger & Starr, 1994; Tommasetti et al., 2018; Webb, 2013). While this makes sense also from a rational reasoning point of view, very little research has considered interest as a mediating variable, along with risk perception in order to see which predictors have an influence on these two mediators.

After doing so, in this paper we found the effect of trust, vicinity, altruistic and biospheric values, as well as attitudes towards nuclear energy on participation intention was fully mediated by risk perception and interest as mediating variables. Specifically, we found that risk perception is influenced by ideological position, trust and attitude towards nuclear energy, which means that people who are more ideologically leftist, are more negative towards nuclear energy and those that have lower trust on nuclear industry's capacity to decommission have higher radiological risk perception. This was mainly expected from the VBN theory as well as other theoretical findings, which suggested that risk perception is affected by values, attitudes, psychometric factors as well as ideological positions (Latré et al., 2019; Perko, Železnik, et al., 2012; Turcanu et al., 2014; Wiegman & Gutteling, 1995). These findings thus confirm earlier studies related to these relationships as well as the hypotheses that were created based on these arguments. However, while some variables (e.g. attitude towards nuclear energy) had significant direct effects in previous studies (Turcanu et al., 2014), in our study the effect was fully mediated by risk perception.

The hypothesis [H1c] that radiological risk perception will be influenced by the situation of whether someone has ever lived close to a nuclear installation or not could not be confirmed based on this study. Although this was expected mainly by the familiarity effect, which argues that people who are familiar and have experiences with the risk or hazard perceive lower risks (Renn, 2008), the effect was not significant

in our study. Vicinity influenced participation intention indirectly, however, through interest. As can be seen in table 8 (appendix A), people living closer to a nuclear installation are more likely to have higher participation intention.

Finally, the findings of the study suggest that people who have ever lived close to a nuclear installation, and those who have lower trust in nuclear industry's capacity to decommission an NPP are more interested on the topic of nuclear energy and decommissioning. This was expected from several studies who found that people who have low trust in authorities (Brandmo & Bråten, 2018; Neblo et al., 2010; Perko et al., 2013; Webb, 2013) as well as personal experiences with the risk or hazard (e.g. living in the vicinity of a nuclear installation) (Pölzl-Viol et al., 2018; Renn, 2008) have higher interest about a certain matter at hand. Usually, people living close to a nuclear installation are much more often addressed in communication and included in decision-making practices (e.g. emergency exercises, consultations, etc.) (Perko, Tafili, et al., 2019; Perko et al., 2013), and this can serve as a boost to their interest and curiosity on similar nuclear-related activities.

In sum, based on the findings of this paper, it seems like the people that are more willing to participate in decision-making related to decommissioning are those that are more interested on the topic and have higher radiological risk perception (direct effects). Furthermore, people who are have lower trust, are ideologically leftists, have more negative attitudes towards nuclear energy and live in the vicinity of a nuclear installation are more likely to show a higher participation intention, albeit indirectly via interest and risk perception.

8. Will we be preaching to the converted? Recommendations for decision-making practices and future research

These findings give the impression of a "preaching to the converted" situation regarding participation intention. For instance, if we include only people that have already rather negative opinions and who are easily recruited, this would result in a negative bias in terms of fair representation of all viewpoints in the end of the joint decision-making process. As Strandberg, Himmelroos, & Grönlund (2017:3) argue, "pre-existing [negative] views are likely to be bolstered in like-minded groups because individuals tend to value arguments supporting their own previously held position". This way, if people with more negative views (e.g. lower trust, anti-nuclear, higher risk perception, etc.) are more likely to be actively involved, this could lead the discussion to end up with extreme, or at least very narrow, views (Sunstein, 2005). And because people usually seek social acceptance and tend to adjust their behaviour according to what they perceive as the dominant position in the group, opinion polarization or extremity bias can occur (Sunstein, 2007).

In order to prevent preaching to the converted, we need to find ways to include more diverse opinions in decision-making processes, for instance, by using stakeholder analysis to make sure that under-represented groups are also a part of the process as well as active conflict management to make sure that opinions and visions are properly interpreted and translated into results (Irvin & Stansbury, 2004). Furthermore, in the recruitment process the organizers of public engagement events should pay attention to potential biases and focus more on increasing the willingness to participate of those individuals who would normally not be willing to do so. To address this, participatory discourses are often used to make sure that ambiguities and value differences are addressed and common solutions are found (Rowe & Frewer, 2005). One suitable instrument to achieve this are randomly selected citizen panels or juries, which make sure to have a representative sample of the affected population. Although true representation of public may never be achieved, at least such citizen juries will ensure that there is high heterogeneity and mutual learning (Renn, 2008). Furthermore, to make the event more attractive, the organizers should explain the advantages of participation and the consequences of not doing so; the advantages of achieving a common satisfactory result and the potential consequences of not doing so; they should clarify and

guarantee in advance that participants will have a strong say in influencing the final decisions; and finally they should also organize such events at convenient time and venues (Perko, Monken-Fernandes, et al., 2019).

While this study adds to the scarce literature on decommissioning of NPPs by analyzing the predictors behind participation intention in the field of nuclear decommissioning, there are also some limitations which need to be better addressed in future research. For instance, we have faced the problem of 'inclined abstainers' in this study. This means that although we intended to measure participation intention, we cannot make any inference whether the respondents will actually participate in decision-making in reality. There are many cases where people intend to participate, but then fail to do so when they are faced with the opportunity to do so (Orbell & Sheeran, 1998). Furthermore, one criticism about this paper could be that we measured ideological position with one item only, namely by party preferences. However, given that parties in Belgium have clear and distinct position regarding nuclear energy, this item proves sufficient to measure the ideological stance of a respondent on this issue. Lastly, we are aware that the explained variance of the dependent variables is rather low, however, we believe that these results will serve as a good starting point for future research on participation intention related to nuclear decommissioning.

Based on these limitations we recommend further research to analyze whether making people aware that only those that already hold certain beliefs (e.g. less trustworthy, more interested, anti-nuclear) are willing to participate and that this could lead to biased results, might change their minds and make them more willing to participate. Furthermore, future research should also investigate the extent to which these explanatory variables apply to decision-making processes related to all environmental processes in general, and not only concerning decommissioning of nuclear installations, once a decision about it has been made. Different participatory techniques can also influence publics' willingness to participate in decision-making processes (Renn, 2008). Hence, we recommend future research to explore more into this

topic. Adding the outcome efficacy or public's perception on their ability to reduce perceived threats to the explanatory model would be an interesting investigation in future studies. Related to this, it would also be interesting to try to see whether telling people that even scientists and experts themselves are uncertain about some aspects of decommissioning, would increase public participation intention.

9. Conclusions and policy implications

Based on a public opinion survey in Belgium, this study analysed the extent to which individuals from the public intend to participate in decision-making regarding decommissioning of nuclear power plants and the factors that influence this intention. Relying on various experiences with public consultation and public engagement processes, as well as building on different empirical findings (European Commission, 2010, 2013; Turcanu et al., 2014), we started with the assumption that except for anti-nuclear protests or activism, a major part of the public in general does not intend to actively participate in organized decision-making procedures. This was confirmed by the results of the descriptive analysis which revealed that only 8% of the respondents would like to be actively engaged in decision-making processes concerning decommissioning of NPPs. Decommissioning of nuclear power plants is a vivid example of the link between a technical task and the society. Citizen involvement in decision-making about different topics is recommended and required by multiple EU science policy strategies and governance frameworks and this has an instrumental, normative and a substantive rationale.

Drawing on a theoretical frameworks such aselements of the Value-Belief-Norm theory, psychometric paradigm, deliberative democracy and augmented by degrees of involvement as defined by Arnstein's ladder (Arnstein, 1969), we found that the people that are more willing to participate in decision-making related to decommissioning are those who are more interested on the topic, have higher radiological risk perception (direct effects) are less trustworthy, are ideologically leftists, have more negative attitudes towards nuclear energy and live in the vicinity of a nuclear installation. This shows that while public

participation in decision-making seems as a promising way for inclusive, transparent and mutual decision-making, there are still some challenges that need to be addressed in practice. For instance, based on our results people that are already interested on the topic and hold certain negative opinions related to nuclear energy are more willing to participate than those who are more in favor of nuclear energy. Although these people may raise legitimate points and bring good arguments in the discussion, we need to make sure that all diverse opinions are represented in order for the discussion to be fair and comprehensive (Sunstein, 2007).

To prevent this situation, and to stop preaching to the converted, we recommend that, although challenging, the organizers of public engagement events pay attention to potential biases in public participation and invest resources into motivating individuals that would normally not participate to take part in the decision-making process. Although inclusion and exclusion often refer to the ethnic, racial, gender diversity of the people taking part in public participation, based on the results of this study we argue that other factors such as interest, risk perception, trust, attitudes and ideological position should also be considered when including people in decision-making regarding decommissioning of NPPs.

10. Research data

Data used and analyzed for this article are available here:

https://data.mendeley.com/submissions/ees/edit/d9sdcz9mpn?submission_id=JEPO_27354&token=7ece12ab-8724-4f56-921c-6b06ef36ed8a

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