A Theoretical Framework to Measure Social Acceptance of Nuclear Energy among Hungarian Residents

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SUMMARY

Global warming is a pressing issue, but so are economic development and the constantly increasing electricity demand. Governments have to find the balance between conserving the Earth's climate for future generations and fueling their country's economy to achieve higher output. Nuclear energy seems like a solid solution for both problems. It can help to replace fossil fuels in the electricity mix and at the same time reduce CO_2 emissions; however due to certain features of the technology many people are skeptical about it. The aim of this study is to review the currently available behavioral and technology acceptance models - such as TRA, TPB, TAM, Risk-Benefit Concept, PADM - and based on the results build a new model, that could serve as a basis for a future survey among Hungarian residents related to the acceptance of nuclear energy generation.

Keywords: Social acceptance, Technology acceptance, Nuclear energy, Theory of Planned Behavior, Risk-Benefit Concept,
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INTRODUCTION

Our daily lives are built on a cheap and steady electricity service, which is mostly produced by burning fossil fuels (coal, oil, or natural gas). With this constant energy supply, a wide range of services are available to the majority of the population (central heating, household electronic devices, or automobiles), which would have been unimaginable a couple of decades ago. While our lives have become extremely comfortable, the usage of fossil fuels carries two main risks, which will have a significant effect on our future lifestyle. The first one is that the availability of these resources is limited on Earth, so soon they will become scarce, and the second one is that burning fossil fuels releases greenhouse gases (GHG) into the atmosphere, which are responsible for global warming.

Instead of fossil fuels, nuclear energy could be a suitable solution for this problem, but many people do not share this belief. In case of a nuclear accident, the damage could be severe, and because of that fear, many countries do not support the spread of nuclear power plants or the development of the technology.

In order to support the phase-out of fossil fuels from the electricity mix researchers try to investigate the driving forces behind social acceptance, related to nuclear energy. Following different approaches, many technology acceptance and behavior analysis models have become popular, but none of them seems to perfectly cover the topic; therefore, scholars usually use a mixture of models and factors to support their own theories. In this article, I will do the same by reviewing the popular methods and then creating a new model, which could be later on used to measure the public acceptance of Hungarian residents related to nuclear energy generation.

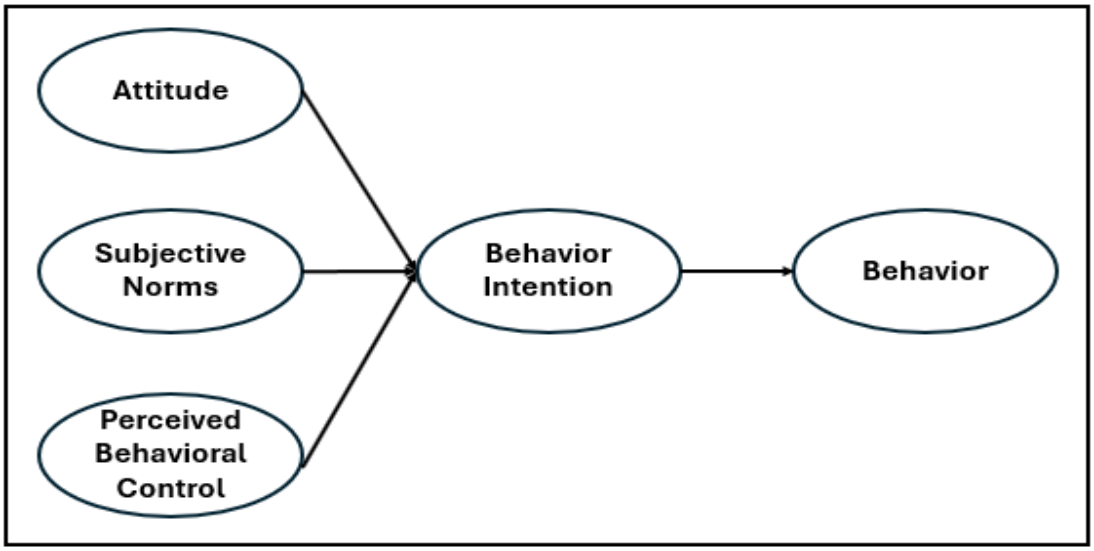
LITERATURE REVIEW

Scholars and business professionals alike are constantly trying to predict people's behavioral intentions associated with new products and technologies, and thus there is a wide range of methods available and used for such investigations. One of the most popular theories originates with Fishbein and Ajzen (1975) and is called the Theory of Reasonable Action. It supposes that

different motivational factors have an aggregated effect on people's behavioral intention, which directly influences their behavior and also the level of their engagement. The motivational factors identified by Fishbein and Ajzen (1975) are the following:

- Attitudes, which indicates that people always evaluate the outcome of their behavior in a given situation based on the assumption that it will have a favorable or harmful outcome for them and this perception will define their relation to the matter (Ajzen, 1991),
- Subjective norms, which refer to the individual's perception of their expected behavior based on the rules set by society or by the important people in their environment (for example: family, friends, or other meaningful connections in their life such as colleagues, doctors or personal trainers) (Fishbein & Ajzen, 1975; Nickerson, 2023).

Later Ajzen (1991) further improved his model by adding a third factor (Figure 1), named Perceived Behavioral Control, which aggregates the individual's belief and commitment to the desired behavior; this theory is known as the Theory of Planned Behavior (TPB). Studies have confirmed that if people believe that they can carry out a task successfully they will exert greater effort even against the odds, while those, who do not believe in their own capabilities tend to give up more easily. (Bandura, 1982; Bandura & Schunk, 1981; Schunk, 1984, 1991). The Theory of Planned Behavior has been widely and successfully used over the years in many areas such as health care and environmental-related topics. (Capasso et al., 2023; Chen, 2016; Wang et al., 2024; Xu et al., 2024)



Source: Ajzen (1991)

Figure 1: Theory of Planned Behavior model

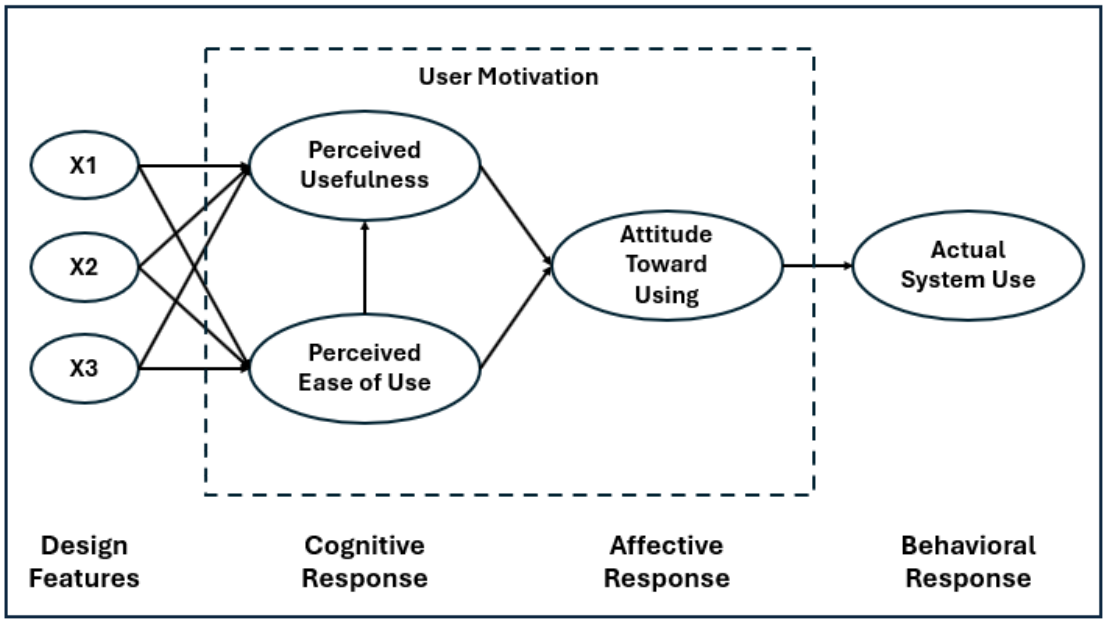
While researchers are using TPB in many cases, there are some limitations to take into consideration before applying it blindly:

- The model expects people to act rationally while excluding unconscious influences or emotions (Conner et al., 2013; Sheeran et al., 2013),
- It does not consider other important factors such as past experience, socio-economic status, or health (Sniehotta, 2014); however, it is a flexible model and therefore can be expanded with additional variables if needed (Aparna et al., 2024).
- The model does not consider that the behavioral intention can change with time (LaMorte, 2022).

Scholars usually extend or mix the TPB model, with other methods and factors such as the Technology Acceptance Model (TAM) (Ong et al., 2022; Wong et al., 2024) or the risk-benefit concept (Chang, 2023; Chen, 2016; Tang & Jiang, 2024).

The Technology Acceptance Model was introduced by Davis (1985) specifically for modeling users' acceptance of information systems or technologies. This time coincided with the growth of the use of personal computers, which in the long term significantly improved performance both on an individual and organizational level (Foley, 1984; Sharda et al., 1988).

For this reason, it was crucial to analyze when to switch from the old methods to the new ones and TAM was a great supporting tool for that. The model is a three-stage process (Figure 2), where numerous different Design Features can be selected to be analyzed depending on the technology and these external factors trigger a Cognitive Response in the potential user. Based on the perception of usefulness and ease of use a positive or negative Affective (emotional) Response forms, which eventually leads to a Behavioral Response determining whether someone will use the new technology or reject it (Davis, 1985; Lai, 2017).



Source: Davis (1985)

Figure 2: Technology Acceptance Model

In the model, Perceived Usefulness is defined as the user's belief that in time the use of a new technology will improve his performance, while Perceived Ease of Use refers to the effort that the user has to exert (whether is it mental or physical) to use the new technology. (Innovation Acceptance Lab, 2024; Lai, 2017) While the model was first used for measuring behavioral acceptance of personal computers, nowadays it is widely recognized and adopted in many areas related to new technologies such as chatbots, mobile banking, the sharing economy, or nuclear energy (Munoz-Leiva et al., 2017; Saif et al., 2024; Tang & Jiang, 2024; Zhang et al., 2020).

Over the years researchers have found many limitations of the model, mostly related to the parsimoniousness of external factors and their predictive power, therefore even Davis contributed to further develop his original model (TAM 2 by Venkatesh and Davis (2000) and TAM 3 by Venkatesh and Bala (2008)), but due to the simplicity and flexibility of the first model scholars are still commonly using the original version (Marikyan & Papagiannidis, 2023).

As mentioned before, the risk-benefit concept is also a popular method to measure the population's perception of technology-related topics such as nuclear energy. (Guo & Ren, 2017; Ho et al., 2019; Mah et al., 2014; Wang et al., 2019). The basic nature of people is to look for benefits in all situations and even in our relations, we cannot evade this mindset (Heider, 1958). A common interpretation of perceived benefits is the perceived likelihood that taking a recommended course of action will lead to a positive outcome, whether it results in material benefits or only those on a psychological level, such as reduced risk or worry. Related to nuclear energy, Heider's (1958) explanation can be modified in the study as the perceived belief that the individual or the society will benefit from utilizing nuclear energy technologies.

At the same time, risk can be generally described as "the probability of an event and the magnitude of its consequences" (Jacobs & Worthley, 1999, p. 226). In most countries, nuclear energy production is considered as a grave danger, because in case of an accident (malfunctioning, leakage, improper waste management) the consequences should be foreseeable, which would affect not just the individual's health, but the whole society, environment, and the economy of the region (Cha, 2000; Keller et al., 2012; Parkhill et al., 2010). Due to this perception, perceived risk will be used in this study as the extent to which the public believes that they

may be exposed to a certain risk or hazards arising from the usage of nuclear energy production (Wang et al., 2019). Based on the benefit-risk concept, people are constantly analyzing whether or not they can gain something from a given situation or technology. If they perceive more benefits, then they will probably engage, while if they feel that the potential risks outweigh the advantages then they will reject it.

It is also very important to understand that risk communication influences the individual's behavior, especially related to disasters or hazardous activities (e.g., the operation of nuclear power plants) (Lindell & Perry, 2004). Information about a dangerous situation or technology triggers people's risk perception and people may take protective actions in order to reduce this threat (Zhu et al., 2016).

DATA METHODS

Whether to use nuclear power plants (NPPs) for energy generation is a popular topic nowadays, thus many scholars have investigated the subject in the last two decades. Since the level of public acceptance of the technology can change rapidly within different countries, I used the ScienceDirect database to become familiar with the previous findings. I have chosen this database because there are more than 18 million pieces of content available on the site, which are all peer-reviewed, thus guaranteeing the high quality of the works. Then I used advanced search on the platform with the following criteria:

- Keywords: nuclear energy and social acceptance
- Years: after 2010
- Article type: research articles only
- Language: English

After filtering there were 5204 articles, so I sorted them by relevance and then chose to scrutinize the first 100. From these articles I found twelve which are indeed about nuclear energy, using one of the above-mentioned social acceptance models (or a mixture of them), while testing the different factors of the models one by one.

To avoid the chance of my information gathering being one-sided, I used the snowball sampling method on the selected articles for mapping other databases (this method refers to using the reference list of a paper to identify additional related papers). After I expanded my research one level backward from the original twelve articles I improved my data pool with two additional articles, so overall fourteen items were available to create an ideal model for the future Hungarian survey (Table 1).

Table 1

Considered articles related to nuclear energy acceptance with models

Title	Purpose of the study	Conceptual Framework and Factors	Conclusion
The acceptance of nuclear energy as an alternative source of energy among Generation Z in the **Philippines**: An extended theory of planned behavior approach (Belmonte et al., 2023)	The study aims to investigate the acceptance of nuclear energy among Generation Z citizens of the Philippines.	**Extended Theory of Planner Behavior** Factors: 1. Knowledge about Power Plant 2. Attitude 3. Perceived Behavioral Control 4. Intentions 5. Risk Perception 6. Benefit Perception 7. Subjective Norm 8. Technological Acceptance	Empirical results show that Risk Perception and Behavioral Intention had the greatest impact on the acceptance of nuclear energy, but knowledge also positively affects Behavioral Intentions, while Attitudes have a negative effect on it.
Social acceptance of nuclear power plants in **Korea**: The role of public perceptions following the Fukushima	The study investigates the public perceptions of NPPs in South Korea, after the Fukushima accident.	**Theory of Planned Behavior and Benefit-Risk concept** Factors: 1. Perceived Awareness 2. Perceived System Reliability 3. Environmental Knowledge 4. Perceived Costs	Perceived benefits played a key role in determining the public's intention to use NPPs. Perceived benefits are significantly affected by perceived costs, system reliability, awareness, and environmental knowledge.

accident (Jang & Park, 2020)		5. Perceived Benefits 6. Perceived Risks 7. Attitudes 8. Intention to use	
A framework of examining the factors affecting public acceptance of nuclear power plant: Case study in **Saudi Arabia** (Alzahrani et al., 2023)	The purpose of the study is to analyze the public attitudes and acceptance of nuclear energy among Saudi Arabian citizens by utilizing Protection Motivation Theory and the Theory of Planned Behavior.	**Theory of Planned Behavior and Protection Motivation Theory** Factors: 1. Nuclear Knowledge 2. Trust in Regulations 3. Social Influence 4. Proximity 5. Perceived Risk 6. Perceived Benefit 7. Acceptance	Regarding the first NPP constructed in Saudi Arabia people overweigh the perceived benefit compared to the perceived risk, but the location of the plant could seriously influence their acceptance. Although the benefit perception is strong in the country, 40% of the population is less than 24 years old, so to keep their support a national awareness program is proposed by the authors.
Modeling individual preferences for energy sources: The case of IV generation nuclear energy in **Italy** (Contu et al., 2016)	The study analyses the social acceptance of the new, fourth-generation nuclear energy technology in the light of the Fukushima Accident.	**Benefit-Risk Concept** Factors: 1. Egoistic 2. Altruistic 3. Biospheric 4. Benefits 5. Risks 6. Confidence 7. Acceptance	The study highlights the Confidence factor in the model as one of the most important components of public acceptance. At the same time it proposes that by deploying information campaigns, public confidence can be increased towards new generation NPPs.
An empirical study of the risk-benefit perceptions between the nuclear and non-nuclear groups towards the nuclear power plant in **Bangladesh** (Islam et al., 2023)	The study investigates the sectoral influence on people's risk and benefit perception regarding nuclear energy.	**Benefit-Risk Concept** Factors: 1. Public Participation 2. Risk Perception 3. Benefit Perception 4. Public Acceptance	The study revealed that non-nuclear people's participation in nuclear energy education is way lower than in the nuclear group. Obviously, risk and benefit perception was also significantly different between the two groups.
Predicting unsafe behaviors at nuclear power plants: An integration of Theory of Planned Behavior and Technology Acceptance Model (Zhang et al., 2020)	The study states that unsafe behavior is a key contributor to nuclear power plant accidents. For this purpose, the study investigates how worker's attitudes and perception factors would predict errors and violations at **Chinese** NNPs.	**Theory of Planned Behavior and Technology Acceptance Model** Factors: 1. Subjective norm 2. Perceived Behavioral Control 3. Perceived Usefulness 4. Perceived Ease of Use 5. Attitude	The results showed that attitude and perception play a key role in shaping unsafe behaviors, but Perceived Usefulness and Perceived Ease of Use also help reduce unsafe behavior through the Attitude factor.
Effects of information strategies on public acceptance of nuclear energy (Hu et al., 2021)	The study uses two types of information strategies (interest-focused and technology- focused) to identify the	**Theory of Planned Behavior and Protective Action Decision Model** Factors: 1. Environmental Concern	The study identifies the key determinants of psychological perception and public acceptance to be environmental concern and energy shortage belief. At

	predictors of public acceptance of NPPS in **China.**	2. Energy Shortage Belief 3. Perceived Risk 4. Perceived Benefits 5. Public Acceptance	the same time, the two types of questionnaires reveal that people in the interest-focused group have higher risk perception and lower benefit perception than people in the technology-focused group.
Climate change benefits and energy supply benefits as determinants of acceptance of nuclear power stations: Investigating an explanatory model (Visschers et al., 2011)	The study investigates public opinion on rebuilding nuclear power stations in **Switzerland** using a telephone survey.	**Extended Benefit-Risk Concept** Factors: 1. Trust 2. Affect 3. Risk Perception 4. Benefit perception on climate mitigation 5. Benefit perception on energy supply 6. Acceptance	The results showed that when investigating benefits, people give more value to the energy supply factor than to the climate mitigation factor, while trust and affect both can influence risk and benefit perception.
When it is unfamiliar to me: Local acceptance of planned nuclear power plants in **China** in the post-fukushima era (Guo & Ren, 2017)	Analyzing challenges at the planning stage rather than operation stage, the authors investigate local acceptance in two Chinese cities where the government was planning to build an NPP.	**Extended Benefit Risk Concept** Factors: 1. Perceived Knowledge 2. Emotional Identification 3. Social Trust 4. Perceived Benefits 5. Perceived Risks 6. Local Acceptance	The study revealed that people who live closer to the plant sites are less willing to accept nuclear power than those who live farther away. Surprisingly, the authors found that Perceived Knowledge does not significantly influence local acceptance, while Social Trust and Emotional Identification were accepted as significant factors.
Anti-nuclear behavioral intentions: The role of perceived knowledge, information processing, and risk perception (Zhu et al., 2016)	The study investigates the key factors behind people's anti-nuclear behavioral intentions in **China**	**Theory of Planned Behavior, Heuristic-Systematic Model and Protective Action Decision Model** Factors: 1. Perceived Knowledge 2. Information Seeking 3. Information Insufficiency 4. Risk Perception 5. Systematic Processing 6. Behavioral Intentions	The results showed that there is an inverted U shape relationship between Perceived Knowledge and anti-nuclear behavioral intention, and reducing Risk Perception is effective in decreasing opposition against nuclear power generation. The only hypothesis rejected in the model is that Behavioral Intentions can be stimulated by Systematic Processing.
How and when does information publicity affect public acceptance of nuclear energy? (Wang et al., 2020)	The study aims to investigate that how can nuclear energy development supported among **Chinese** residents by publicizing information about the technology	**Extended Benefit-Risk Concept** Factors: 1. Information Publicity 2. Perceived Risk 3. Perceived Benefit 4. Personal Willingness to Accept 5. Willingness to Persuade Others to Accept 6. Information Credibility	The study found that Information Publicity positively and directly impacts public acceptance, but the effect is relatively small, while also impacting acceptance indirectly via Perceived Benefit and Perceived Risk.

Investigating the acceptance of the reopening Bataan nuclear power plant: Integrating protection motivation theory and extended theory of planned behavior (Ong et al., 2022)	The study focuses on the acceptance and reopening of previously closed NPPs (shut down because of political reasons not because of safety problems) among **Philippine** residents who live close to the Bataan nuclear power plant.	**Extended Theory of Planned Behavior and Benefit-Risk Concept** Factors: 1.Knowledge about Nuclear Plant 2. Perceived Benefit 3. Perceived Risk 4. Perceived Behavioral Control 5. Subjective Norms 6. Attitude 7. Intention 8. Acceptance	The results showed that PBC and Attitude influence the local resident's acceptance, while the individual's knowledge can lead both ways based on the Benefit-Risk perception. If the Perceived Benefits outweigh the Perceived Risks, then this will have a positive effect on acceptance, but if not, then it will strengthen the willingness to reject.
Public Perception of the Nuclear Research Reactor in **Thailand** (Tantitaechochart et al., 2018)	The study analyses the public perception among local citizens regarding the future construction of a nuclear reactor in their neighborhood.	**Benefit-Risk Concept** Factors: 1. Social status 2. Information Perception 3. Trust 4. Risk Perception 5. Benefit Perception 6. Technology Acceptance	The study found that trust was the main exogenous variable that affected the risk and benefit perceptions, while social status had only a slight impact on the endogenous variables.
Extending the Coverage of the Trust–Acceptability Model: The Negative Effect of Trust in Government on Nuclear Power Acceptance in **South Korea** under a Nuclear Phase-Out Policy (Roh & Geong, 2021)	The study investigates trust toward nuclear energy in a country where nuclear phase-out is initiated by the government.	**Extended Trust-Acceptability model** Factors: 1. Trust in Government 2. Trust in Nuclear Energy Authority 3. Trust in Nuclear Academia 4. Trust in Environmental NGOs 5. Benefit Perception 6. Risk Perception 7. Nuclear Power Acceptance	The results show that in a nuclear phase-out situation trust in the government has a negative impact on nuclear power acceptance, thus on perceived benefits also, while higher trust in nuclear energy authorities resulted in a positive effect on public acceptance.

Source: own editing based on the database search

As can be seen in Table 1, researchers are building the core of their theoretical framework based on the available behavioral models, while adding different External Factors in to find a better explanatory model, since based on Aziz et al. (2020) the main TAM and TPB models usually have around 40-50% explanatory power.

At the same time based on the questionnaire literature, it is highly recommended to keep the survey as short as possible otherwise the response rate and the reliability of the results may drop, therefore in the article only the most relevant external factors will be selected. (Sharma, 2022)

HYPOTHESES

When talking about external factors, many scholars have concluded in recent years that knowledge can be a strong psychological factor that can influence risk perception and benefit perception, and based on the information gathered by the individuals, the scale could swing in either direction. Insufficient knowledge can even hinder the development of renewable energy sources, and this effect applies even more to nuclear energy projects (Frederiks et al., 2015; Kardooni et al., 2016, Ong et al., 2022). This was supported by S. Wang et al. (2019) in China, who found a positive effect between knowledge and perceived benefit among residents, while Huang et al. (2013) after the Fukushima accident investigated the same topic in China and found that the news about the catastrophe negatively affected people's risk perception. Based on Alzahrani et al. (2023) it is confirmed that as a result of people widening their knowledge about nuclear energy technologies, they became more favorable towards the operation of NNPs because their benefit perception became more significant than their risk perception. During this process, they also give up their

previous preconceptions and start to make decisions based on scientific facts instead of their faith, which can support the spread of this type of energy source (Wallquist et al., 2010). On the other hand, it could be unreasonable to expect deep knowledge about nuclear energy from the majority of the population, if only because of the lack of relevant knowledge and information available to them (Siegrist & Cvetkovich, 2002). For this reason people used to rely on the judgment of the experts on the field; however, this trend is slowly deteriorating due to increased internet availability. (Guo & Ren, 2017) Based on the findings, I propose the following hypothesis:

- H1: Knowledge about nuclear energy has a significant impact on Risk Perception.

- H2: Knowledge about nuclear energy has a significant impact on Benefit Perception.

Another interesting factor is trust, which based on the TAM model can be identified as a design feature. In modern societies people usually specialize in a single discipline alone to achieve well-being, thus they become greatly dependent on other persons or groups who are skilled in other disciplines or technologies. When people evaluate an object that is beyond their knowledge, they highly rely on the opinion of the authorities or experts and in this case, the presence of trust is necessary (Roh & Geong, 2021). Mayer et al. (1995) defined trust as the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party. Trust can be measured on many levels such as trust in the technology, in the regulations, in the government, in the regulatory authorities, in the media, or belief in honesty, integrity, and reliability of others, which is also known as social trust. As revealed by Jager (2006), in a situation where many homeowners equipped their property with photovoltaic solar energy systems, people who are part of an extensive social network are more dedicated to choosing this technology, because they perceive the installation as being less difficult than others do. Meira et al. (2024) investigated in Brazil the role of trust in the purchase intention of vegetables produced with pesticides and concluded that trust is a fundamental factor that influences risk and benefit perception. He also found that trust alone in the regulatory environment is not sufficient; people have to believe that the laws are enforced and stakeholders are regularly monitored. The effect of trust in the media on behavior intention was analyzed by Schultz and Kaiser (2012), who confirmed that the mass media and the quality of the information provided play an important role in decreasing perceived risks. The nuclear energy literature scrutinizing the role of trust in benefit and risk perception is also wide. Alzahrani et al. (2023) found that accidents related to nuclear energy generation can deteriorate the level of trust, especially when there are other, cleaner renewable energy sources available. Hoti et al. (2021) concluded that the lack of trust plays an important role in low public participation intention, while Tantitaechochart et al. (2018) argued that the presence of trust could reduce the resident's risk perception and at the same time increase their attitude and benefit perception towards nuclear energy. Based on the findings, I propose the following hypothesis:

- H3: Trust has a significant impact on Risk Perception.

- H4: Trust has a significant impact on Benefit Perception.

As discussed in the Theory of Planned Behavior model, Attitude describes people's relation to a given behavior or towards a new technology, which is the result of their evaluation of whether this behavior or in this case technology will be beneficial for them in a long term, or detrimental (Ajzen, 1991). Sometimes people can see both benefits and drawbacks and cannot choose a side so they take a neutral attitude, which means that they tolerate the technology, but that is hardly the case for nuclear energy generation (Huijts et al., 2012). Since this technology is considered as a two-edged sword, usually there is no middle ground; people either support it or reject it and take action against it, which is why it is extremely important to manage public acceptance, especially if policymakers would like to extend the usage of this energy source (Huang et al., 2018). These statements were confirmed by Ryu et al. (2018), who found that there is a negative relationship between perceived risk and public attitudes in case of nuclear energy technologies. Huhtala and Remes (2017) came to the same conclusion; if the risk perception of the locals is high, then this is directly shown in a lower public acceptance and larger social expenses for the community. On a positive note, Siegrist et al. (2014) affirmed that over the course of time attitudes can change, thus, paying attention to the influencing factors can have a positive effect on public acceptance. On the other hand, in case of a serious accident, it can have negative effects too, and abruptly reduce support, especially for those individuals who live near the nuclear facility (for example in the Fukushima accident). At the same time Choi et al. (1998) found that basic traits such as gender can fundamentally affect public acceptance towards nuclear energy, because male participants usually focus on the benefits of the technology, while female participants tend to give more credit to the perceived risks. Based on the findings, I propose the following hypothesis:

- H5: Risk Perception has a significant impact on Attitude.

- H6: Benefit Perception has a significant impact on Attitude.

Subjective norms represent the individual's perception of their expected behavior based on the perceived opinions of the most respected family members, friends, or close ones (Ajzen, 1991). Based on these opinions people assess their own values and the societal acceptability of their actions and decide whether they will carry out the given behavior (Zhu et al., 2024). The connection between subjective norms and behavioral intention has been proved by many scholars, such as Ursavas et al. (2019), who investigated preservice and in-service teachers' intentions to use new technology in teaching, or by Abushanab and Pearson (2007), who found that social norms have a significant impact on the adoption of internet banking in Jordan. In the field of nuclear energy, the studies of Perko et al. (2012), Zhang et al. (2020) and Ong et al. (2022) all concluded that the opinion of important relatives can influence the individual's behavioral intention. Based on the findings, I propose the following hypothesis:

- H7: Subjective norms have a significant impact on Behavioral Intention.

Perceived Behavioral Control refers to the individual's perceived level of control over their behavior, taking into consideration their past experiences, anticipated issues, and their skills and abilities. As slightly mentioned before, it is important to highlight, that PBC focuses on the perception of the control and not on the actual control, which are two different things. (Foltz et al., 2016) Based on Ajzen (1991) this is one of the strongest factors influencing behavioral intention, therefore this construct is widely known and analyzed among scholars in different areas. In the online space, Perez et al. (2023) identified PBC as one of the main indicators that influence people to engage in NFT games, while Meng et al. (2024) found the same when investigating the habits of people traveling with pets and staying at a pet-friendly hotel. In nuclear energy Ong et al. (2022) verified that one of the most important factors influencing behavioral intention is PBC, while this statement was also confirmed in the Philippines by Belmonte et al. (2023) Based on the findings, I propose the following hypothesis:

- H8: Perceived Behavioral Control has a significant impact on Behavioral Intention.

In the TPD model intention captures the essence of the antecedent motivational factors in order to measure a person's determination to perform a behavior. (Beck & Ajzen, 1991) "The stronger the intention, the more likely it is that the behavior will follow." (Ajzen, 2020, pp. 315) Based on Ajzen (1991) the core motivational factors that have a significant effect on the behavioral intention are Attitude, Subjective Norms, and Perceived Behavioral Control. In China, Liao et al. (2023) demonstrated that these factors impact behavioral intention throughout a survey about low-carbon travel preferences, while in Italy Capasso et al. (2023) came to the same conclusion when investigating the predicting factors of how mothers choose the food to buy for their children.

Ajzen's concept was proved in many areas by scholars and it is still a very popular research method, especially in environmental-related topics such as low-carbon-emission technologies (Li et al., 2020; Stigka et al., 2014; Wang et al., 2018) or nuclear energy development (Jang & Park, 2020). Although the model is attractive, the weight of the components may vary in different countries or it can even happen that some of them do not support the overall model, as was found by He et al. (2024), who - based on a survey - rejected the hypothesis that Attitude and Subjective norms affect behavioral intention. Therefore it is highly recommended to pay attention to these factors in any given analysis. Based on the findings, I propose the analysis of the following hypothesis:

- H9: Attitude has a significant impact on Behavioral Intention.

Public or technology acceptance refers to the society's general attitude towards an invention, which derives from complex social, cultural, and historical factors (Liu et al. 2008). Behavioral intention has a huge role in acceptance because it can drive people to use the technology thus making it popular and desired by others, or in case of rejection it can make the idea totally unacceptable to someone (Belmonte et al., 2023; Savari & Gharechaee, 2020). In the literature, examples are available for both outcomes. Based on Savari and Gharechaee (2020), who conducted their research on Iranian farmers, behavioral intention has a strong effect on technology acceptance and it could be influenced in such a way that would lead to complete rejection by the residents. In nuclear energy, Lim et al. (2017) investigated technology acceptance among Korean people and found that even if it would be beneficial on a national level for the society to build NPPs, the development could be prevented by those who live near the construction site if their willingness to accept is not managed properly. Xiao et al. (2017) came to the same conclusion; without the support of the local communities, there is no chance to successfully build nuclear power plants. This underlines the importance of the topic, especially in Hungary, where policymakers are trying to expand the capacity of the currently operating Paks Nuclear Power Plant. Based on the findings, I propose the following hypothesis:

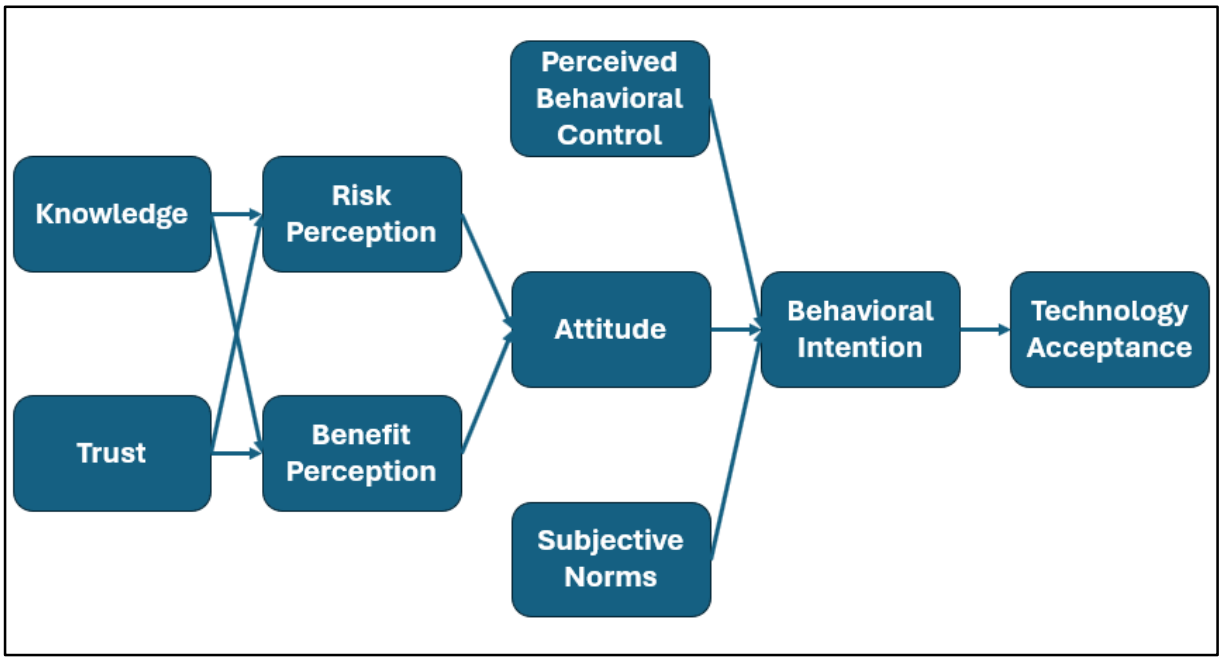
- H10: Behavioral Intention has a significant impact on Technology Acceptance.

As a result of the literature review, the following model is designed in order to capture the Hungarian resident's mindset related to nuclear energy.

THEORETICAL FRAMEWORK

The theoretical framework is built on the core of the TPB model because scholars in other countries have widely accepted these factors (see Table 1), and presumably Hungary should not be an exception. Figure 3 outlines the components of the model. In many research studies on technology acceptance - conducted in different fields - the process ends with the actual (system) use; however, related to nuclear energy, this type of behavior cannot be measured, because a single (Hungarian) resident has no chance to harvest the benefits of the technology on his own; it can be interpreted only on a community level, thus this stage is not added to the investigation.

Since the usage of nuclear energy can directly impact people's lives (especially in case of an accident), residents usually have a strong opinion about the risks and the benefits. Based on the articles listed in Table 1, risk perception can be extremely important to those people who live near a nuclear power plant or have previously been affected by an accident, while people living far from the operation site or not affected by accidents usually prioritize the benefits. Hungary is one of the few European countries where a nuclear power plant is still in operation, and although our country was not affected by the latest major nuclear accident (Fukushima), older residents still remember the accident in Chernobyl; these facts solidify the presence of the Risk Perception and Benefit Perception in the analysis.



Source: own editing based on the reviewed materials

Figure 3: Theoretical framework to measure social acceptance of nuclear energy among Hungarian residents

In the model Knowledge and Trust are considered as Design Features/External Factors, which can improve the explanatory power of the model by indirectly influencing the Behavioral Intention. These components are not just simply added to the model based on the fact that they were previously used in many scientific works, but also because of their relevance to the current geopolitical situation. The Hungarian government already started to explore the possibilities for a nuclear power plant expansion in 2009, which would involve the construction of two new units with a combined capacity of 2,000 MW, located next to the existing nuclear power plant. Since the implementation entered into the construction phase in 2023 there have been many ongoing debates about the necessity of the project, leaving people in doubt or even in fear. For this reason, it is crucial to scrutinize the following questions:

- What does an average Hungarian resident know about the process of generating nuclear energy in a power plant? (Knowledge factor)

- Do people trust in the local authorities, experts, or even in the media, when they are making a statement about the necessity of the construction? (Trust factor)

The validity of the model can be tested with a survey among Hungarian residents, using a 1 to 5 Likert scale. This has been selected because based on previous research the data from this type of questionnaire can be easily analyzed with statistical methods, such as Structural Equation Modeling. As can be seen by checking the related articles listed in Table 1, the number of questions for each factor may differ, but usually varies between two and six.

Although the model was designed for Hungarian citizens, this does not rule out the possibility of using it in other countries or other areas, if local researchers find the External Factors relevant based on the geopolitical situation.

CONCLUSIONS AND RECOMMENDATIONS

To reduce the global GHG and CO_2 emissions the electricity sector has to undergo serious changes in the future. As Rust (1979) and Knief (1981) pointed out, nuclear energy could be a solution for this purpose, because during its lifecycle nuclear fuels produce significantly less CO_2 than fossil fuels and are equivalent or in some cases even less than the renewables if measured on a generated energy unit basis. Simply based on this fact, the shift appears to be easy. However, there are other factors that also play a significant part in the transition, such as public acceptance. Based on their previous experience (either personal or only gained from the news) many people deem nuclear energy generation as an unsafe process, and therefore they oppose the spread of it. For this reason, scholars all over the world continue to investigate the attitude of residents toward this technology and identify the different external factors, which could speed up the development of social acceptance. Fortunately, several technology acceptance and behavioral intention models are available in the literature (TAM, TPB, Risk-Benefit concept, PADM) that could be used as a basis of the investigation; however, there is no single model which is universally accepted by everyone. The most frequently referred to limitation of the different models is that they cannot perfectly catch all the external factors because these factors may vary based on the economic sector being analyzed and on the given country, too. To tackle this inconsistency, mixed theoretical frameworks have come into use in the last decade, all trying to use the most suitable model for a particular country.

Related to nuclear energy, the most commonly used model is the Risk-Benefit concept in an extended version with various external factors and combined with the TPB model. Based on the literature review, the results are convincing, so I have decided to use the same model as the basis of my theoretical framework while adding two more external factors, namely Knowledge and Trust, which are also significant antecedents of technology acceptance.

Although measuring the social acceptance of the Hungarian residents related to nuclear energy generation is not part of this article, the developed model will serve as a basis for a future investigation on the topic.

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