



## Original article

# Investigating the acceptance of the reopening Bataan nuclear power plant: Integrating protection motivation theory and extended theory of planned behavior



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## ABSTRACT

Nuclear power plant (NPP) is currently considered as one of the most reliable power sources. However, 182 of them are considered decommissioned and inactive including the one in Bataan, Philippines. The aim of this study was to investigate the acceptance of the reopening of Bataan Nuclear Power Plant (BNPP) by integrating the Theory of Planned Behavior and Protection Motivation Theory. A total of 815 Filipinos answered an online questionnaire which consisted of 37 questions. The Structural Equation Modeling (SEM) indicated that knowledge towards nuclear power plants was the key factor in determining people's acceptance towards NPP reopening. In addition, knowing the benefits would lead to positive perceived behavioral control (PBC) and attitude towards intention. Results showed that PBC and attitude are mediators towards the acceptance of people regarding the reopening of BNPP. If an individual's knowledge gravitates towards the perceived risk, then this can lead to the negative acceptance of the NPP reopening. On the other hand, if an individual's knowledge gravitates towards the perceived benefits, then this will lead to positive acceptance. This study is the first study that explored the acceptance of the reopening BNPP. Finally, the study's model construct would also be very beneficial for researchers, government, and even private sectors worldwide.

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## 1. Introduction

Nuclear power plant (NPP) is a renewable energy that is currently considered one of the most reliable power sources [1,2]. NPP has been discovered to be sustainable and does not emit

carbon emission during operation [1]. Moreover, Rosen and Dincer stated that NPP produces base-load electricity that is considered less expensive [1]. Thus, NPP is more desirable compared to burning biomasses. People after the 19th century reduced the usage of burning biomasses as a source of fuel. People turned to nuclear

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energy for its reliable electric supplies, thus increasing the number of NPPs being built [3]. The NPP's reliability is evident in 50 countries, which utilizes a total of 440 nuclear reactors [4]. With a large number of nuclear reactors, it provides 10% of the world electricity worldwide [4] and the presented numbers will continuously increase [5].

Despite the growing number of nuclear reactors, 182 of them are decommissioned and inactive [6]. Among the 182 decommissioned and inactive reactors, one is in the Philippines called the Bataan Nuclear Power Plant (BNPP). In the year 1980, BNPP was opened and had the objective of generating 623 MW of electricity [7]. The construction cost around 2.1 Billion USD [8]. However, it was shut down in the year 1986 due to political liability and safety reasons [9].

Given the economic loss, the Philippine government is still planning to consider the reopening of the BNPP [10]. CNN Philippine Staff reported that the current administration is seeing BNPP as a potential solution to the ever-growing energy demand in the Philippines [10]. Despite the potential as a power source, the citizens within the vicinity of the NPP are much more concerned about the hazards and their perception of it as an outdated energy source [11].

Since the Philippines is a democratic country, the people's acceptance and perception should be taken into consideration. The acceptance of the people would lead to success in any development [12]. Moreover, the attitude of the people in a country will affect their behavior and intention, either positive or negative, on any development. Thus, it is important to distinguish the perception and acceptance of people to consider the reopening of BNPP. The perception and acceptance would lead to positive development and sustainability [13]. Yttredal and Homlong defined sustainability as any development that will help the current generation and will not compromise the future generation [13]. Therefore, the current perception and acceptance regarding the NPP should be explored.

The perception of the citizens about the nuclear power plant could be assessed by utilizing the Theory of Planned Behavior (TPB). TPB accurately predict intentions or behaviors by defining them by their motives, action, context, and time frame [14]. This will then result in varied behavioral predictions [15]. This theory was widely utilized in several countries particularly related to renewable energy and its acceptance. In Pakistan, Shakeel and Rahman assessed renewable energies and the acceptance of the residing citizens by extending the TBP [16]. In Korea, Kim et al. used TBP in investigating the relationship of attitude, perceptions, and behavior of policies involving nuclear energy [17]. In China, Zhang et al. also integrated the TPB and Technology of Acceptance Model (TAM) to measure violations and unsafe behaviors within nuclear facilities [5]. TPB was commonly integrated with several theories [18,19]. Heindenrich et al. [19] and Prasetyo et al. [18] considered the integration of the Protection Motivation Theory (PMT) with TPB to measure human behavior.

PMT deals with explaining how an individual changes behavior in mediating on a life-threatening or coping appraisal [19,20]. With this, PMT is applied to a wide variety of fields in research. Zhao et al. [21] used PMT as a framework in explaining the base of the pyramid consumers in environmental sustainability. Clubb and Hinkle [22] utilized PMT in understanding protective measures. In addition, Prasetyo et al. [18] analyzed factors of perceived effectiveness by integrated PMT and extended TPB. The integration of the theories dealt with measuring the COVID-19 preventive measures within Filipinos.

Despite the numerous studies about nuclear power plants worldwide [5,16,17], there was no literature relating to the acceptance of reopening of NPP in the Philippines. Lagmay et al. [23] assessed Natib Volcano geological hazards to BNPP. Their study only

revealed that there are volcanic hazards and active faults lying directly beneath the plant that should be considered to help the Philippine government decide on recommissioning the BNPP. In addition, Alipario only conducted a case study that discussed the perception, specifics, history, and knowledge of the Filipinos on BNPP [24]. Thus, it is important to investigate the perception of the citizens with the reopening of the BNPP. Supported by previous studies in different countries, the perception of citizens could be investigated by integrating PMT and TPB as frameworks. Utilizing PMT and TPB could holistically measure the behavior and determine factors affecting the acceptance of people.

With the discovery of different factors affecting acceptance of people across different countries regarding NPPs [5,16,17], it was of great interest to investigate the acceptance of NPP in the Philippines. Specifically, the aim of this study was to investigate the perception towards the BNPP by integrating the PMT and TPB. In accordance to the studies focusing on NPP across the world, different factors were considered for this study such as knowledge of the BNPP, perceived benefit, perceived behavioral control, perceived risk, attitude, subjective norms, and intention to accept on BNPP reopening were assessed using the SEM. This is considered as the first study to completely investigate factors affecting perception in the reopening of the BNPP. Moreover, this study is the first study that integrated TPB and PMT in the context of the NPP. The results could be beneficial to the government sectors in deciding on the planned reopening of the BNPP which is crucial for its development and sustainability. Finally, this study's model construct would also be very beneficial for academicians, government, and even private sectors particularly for investigating the reopening of the decommissioned and inactive nuclear power plants worldwide.

## 2. Literature review and conceptual framework

The conceptual framework of the study is represented in Fig. 1. The integration of the PBT and PMT created 12 hypotheses.

From the PMT, individuals tend to behave in a certain manner towards a threat because they balance the potential risk and benefits concerning themselves [25]. This is evident in numerous studies, especially on the nuclear industry. In China, Wang et al. [26] showed that knowledge among the general public towards nuclear energy has a positive and significant effect on Perceived Benefit (PB). In addition, Huang et al. focused on the Fukushima nuclear accident (FNA) [27]. They found out the knowledge towards the FNA significantly changed the Perceived Risk (PR) of the public towards nuclear technology. Thus, the researchers hypothesized that:

**H1:** Knowledge about nuclear power plant had a significant effect on PB.

**H2:** Knowledge about nuclear power plant had a significant effect on PR.

Staats defined PBC as the way a person behaves towards a PB on a certain subject [28]. If numerous people tend to commend the resulting behavior from the PB, then people can enhance the motive of it [29]. This chain of effects will then lead to certain attitudes towards the behavior that is based on beliefs and outcome evaluations [30]. With this, PB can have an effect on PBC, subjective norms (SN), and attitude (A) [31]. Thus, the researchers hypothesized that:

**H3:** PB had a significant effect towards PBC.

**H4:** PB had a significant effect towards SN.

**H5:** PB had a significant effect towards A.

Based on the concept of TPB, an individual will most likely do certain behaviors that can avoid the PR to the matter that they value [32]. The individual's value judgment is highly impacted by the

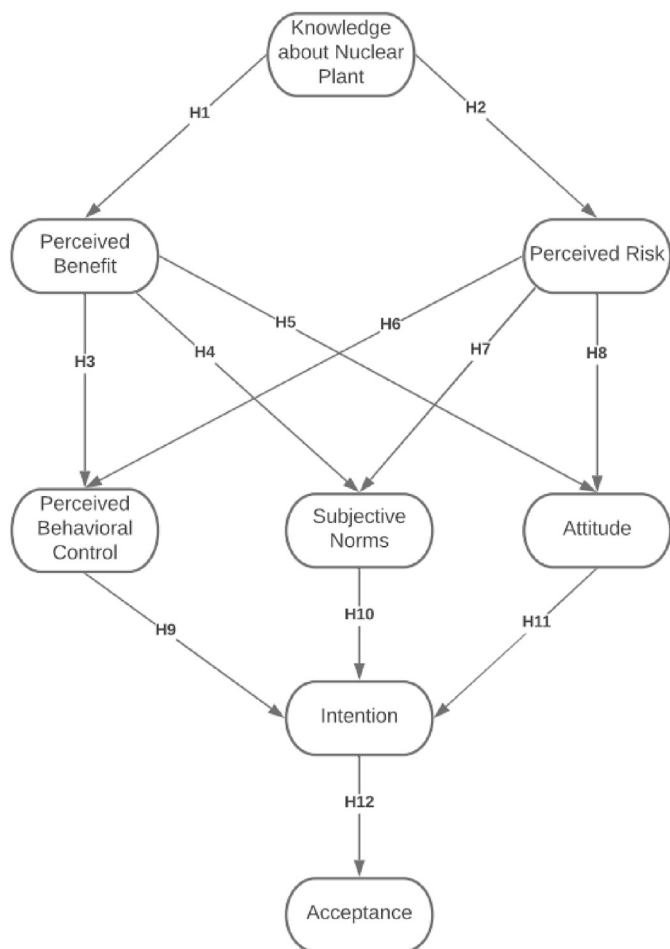


Fig. 1. Theoretical framework.

opinions of others who are considered important to them [33]. This will lead an individual to evaluate the outcome of the behavior, which yields certain attitudes towards it. Therefore, the researchers hypothesized that:

**H6:** PR had a significant effect on PBC.

**H7:** PR had a significant effect on SN.

**H8:** PR had a significant effect on A.

Based on the construct of Ajzen [31], PBC is one of the strongest factors of intention. This construct is evident in energy studies [5,35,36]. Zhang et al. found out that PBC has a significant effect on the types of behaviors and intentions within a nuclear facility in China [5]. Yuan et al. evaluated the public acceptance of the waste-to-energy project [35]. Their results showed PBC affected the behavior intention of use on the project. Hua and Wang investigated the purchasing intention of the consumer in energy-efficient appliances [36]. Their results showed that PBC is one of the factors that had a direct significant effect on intention when consumers' purchase. Thus, the researchers hypothesized that:

**H9:** PBC had a significant effect on intention.

Karaiskos et al. stated that SN is a strong factor of intention. This concept is evident in a variety of fields in research that deal with acceptance of technology, usage of technology, or consumers' buying intention [37]. Jung et al. studied the intentions of the use of wearable augmented reality [38]. The results showed that subjective norms are a strong factor in predicting intentions when using technology. Nguyen et al. studied functional yogurt consumers. The results showed that SN is a key predictor of intention [39]. Choi and

Park studied behavioral intentions among online duty-free users [40]. It is also evident in their results that consumers' behavioral intention is highly affected by SN. Thus, the researchers hypothesized that:

**H10:** SN had a significant effect on intention.

Based on TPB, attitude is the evaluation of an individual either unfavorable or favorable towards the behavior of interest [41]. It is evident in numerous studies that attitude has become one of the factors affecting behavioral intention. Foltz et al. studied factors influencing people's behavior towards changing security settings and social networking [42]. Their results supported that attitude can predict behavioral intention. Hussain et al. evaluated the influences that affect the intention of mobile users to use mobile health technology [43]. Their results showed that attitude significantly predicts the intention of use of the technology. Nguyen et al. resulted in a positive direct effect on consumer's intention [39]. Thus, the researchers hypothesized that:

**H11:** Attitude had a significant effect on intention.

Mamman et al. stated that intention is an individual's inclination towards willingness or measurement of motivation towards their plan to use, or towards performing a behavior [44]. This concept has been further proved by several researchers that it has an effect on the acceptance of a certain subject. Park and Ohm found out that perceived trust, risk, attitude, and intention to use in explaining acceptance of the public towards renewable energy has multiple dimensional matrices [45]. Xiao et al. stated that the majority of their respondents tend to accept nuclear technology due to goodwill trust and competence trust [46]. In addition, Lim et al. found out that people who are less vulnerable to power plant risks tend to accept nuclear technology [47]. This relates to the concept of intention in which people tend to gravitate on certain behaviors that are deemed to be favorable for them. Thus, the researchers hypothesized that:

**H12:** Intention had a significant effect on acceptance.

### 3. Methodology

#### 3.1. Participants

This study looked into the acceptance of the reopening BNPP. A total of 815 Filipinos voluntarily participated in this study. Table 1 presents the descriptive statistics of the responses. It could be seen that 54.7% were male while 45.3% were female, majority of which are within 15–24 years of age (94.4%). There were 2.1% within the age range of 25–34, 2% 45–54, 1.3% from 35 to 44 years old, and 0.1% for 55 years old and above.

Among the respondents, the majority are currently in senior high school (60.1%), followed by 31.7% of college students, 1.2% graduated from elementary, 0.4% graduated with Technical-Vocation courses, 5.9% are college graduates, and 0.4% from masters and Ph.D. graduates. The majority of the respondents have allowances/salary of less than 15,000 PhP (84.5%) and the rest are higher. Categorizing by region, most of the respondents are from NCR (57.2%), while 20.7% are coming from Region III, 14.4% are coming from Region IV-A, and the rest are coming from the other regions of the Philippines.

#### 3.2. Questionnaire

From the conceptual framework, 9 sections were utilized for the questionnaire. The sections were divided into Demographics (age, gender, educational background, monthly salary/allowance, and region), knowledge about NPP had 5 constructs, attitude had 4 constructs together with factors such as SN and PBC. In addition, PB had 7 constructs, PR and intention had 4 constructs each, and

acceptance had 5 constructs. The survey utilized a 5-point Likert scale to evaluate the different constructs (Table 2).

### 3.3. Structural Equation Modeling

SPSS 25 and AMOS 23 were utilized to compute for the SEM. Moreover, SEM was utilized to analyze the acceptance of the reopening of BNPP. The latent variables considered were: knowledge about nuclear power plant, subjective norm, attitude, perceived benefit, perceived behavioral control, perceived risk, intention, and acceptance.

Utilizing the SEM approach was considered because it is a convenient technique to test theories of different research [48,93–95]. Kiraz et al. stated that SEM can conveniently display results of all the exogenous and endogenous latent variables together [49]. This will determine the compatibility of the emerging results from the data simultaneously. This in turn may measure the investigation towards the acceptance of the reopening of BNPP with the integration of the PMT and the extended TPB.

## 4. Results

The initial SEM for investigating the acceptance of the reopening of the BNPP is represented in Fig. 2. It could be seen that all latent and constructs are considered significant.

The initial SEM for investigating the acceptance of the reopening of BNPP underwent modification indices processing to strengthen the model fit. Fig. 3 represents the final SEM for investigating the acceptance of the reopening of BNPP.

**Table 1**  
Respondents' descriptive characteristics (n = 815).

Characteristics	Category	N	%
Gender	Male	446	54.7
	Female	369	45.3
Age	15–24 years old	769	94.4
	25–34 years old	17	2.1
	35–44 years old	11	1.3
	45–54 years old	16	2.0
	55–64 years old	1	0.1
	More than 64	1	0.1
Education	Elementary graduate	10	1.2
	Junior high school graduate	490	60.1
	Senior high school graduate	258	31.7
	Technical – Vocation Graduate	3	0.4
	College Graduate	48	5.9
	Master Graduate	3	0.4
	PhD Graduate	3	0.4
Monthly Salary/Allowance	Less than 15,000	689	84.5
	15,000–30,000	48	5.9
	30,000–45,000	30	3.7
	45,000–60,000	13	1.6
	60,000–75,000	8	1.0
	More than 75,000	27	3.3
Location	Region I	15	1.8
	Region II	6	0.7
	Region III	117	14.4
	Region IV-A	169	20.7
	Region IV-B	11	1.3
	Region V	9	1.1
	CAR	1	0.1
	NCR	466	57.2
	Region VI	4	0.5
	Region VII	0	0
	Region VIII	8	1.0
	Region IX	2	0.2
	Region X	0	0
	Region XI	1	0.1
	Region XII	3	0.4
Region XIII	3	0.4	
BARMM	0	0	

The initial and final factor loading descriptive statistics from the SEM for investigating the acceptance of the reopening of BNPP are represented in Table 3. Running the Shapiro-Wilk statistical test in SPSS 25, it was seen that the data is normally distributed. Moreover, the skewness and kurtosis quotient values were within the range of  $\pm 1.96$ . In addition, Table 4 represents the composite reliability of the study. From the results, it could be seen that values were greater than 0.700 indicating that the constructs were valid and had overall reliability [18,50]. Moreover, the Variance Inflation Factor (VIF) had values less than 0.5, which indicated that there was no multicollinearity among the latent considered. Table 5 represents the model fit of the results, showing that IFI, TLI, CFI, GFI, AGFI were considered acceptable with values greater than or equal to 0.80 [92]. Moreover, the RMSEA with a value less than 0.07 is considered acceptable [92].

Table 6 represents the effects (direct, indirect, and total effects) between the causal relationship of the latent. In addition, the p-values for all the paths were less than 0.05. Interestingly, the highest direct effect was intention towards acceptance while for indirect effect, PB to intention was found to be the highest.

## 5. Discussion and implications

This study integrated PMT and Extended TPB in analyzing perception towards the reopening of the BNPP. Specifically, the researchers distributed an online questionnaire containing 37 questions regarding the acceptance of the BNPP reopening. SEM was utilized to investigate the causal relationship among different latent such as the knowledge about nuclear power plant (K), perceived benefit (PB), perceived risk (PR), perceived behavioral control (PBC), subjective norms (SN), attitude (A), intention (I), and acceptance (A). Among these latent, SEM revealed direct and indirect relationships that affected the acceptance of the Filipinos towards the BNPP.

From the results seen in Table 5, the highest relationship among the latent I towards A ( $\beta = 0.959$ ;  $p = 0.006$ ;  $I \rightarrow A$ ; H12), which was indirectly affected by PB towards PBC ( $\beta = 0.886$ ;  $p = 0.012$ ;  $PB \rightarrow PBC$ ; H3), A ( $\beta = 0.848$ ;  $p = 0.018$ ,  $PB \rightarrow A$ ; H5), and SN ( $\beta = 0.659$ ;  $p = 0.012$ ;  $PB \rightarrow SN$ ; H4). From which, PBC had the second highest direct effect towards I ( $\beta = 0.545$ ;  $p = 0.011$ ;  $PBC \rightarrow I$ ; H9), which means that the indicator for A is through PBC ( $\beta = 0.536$ ;  $p = 0.007$ ). Following which is K affecting PB ( $\beta = 0.436$ ;  $p = 0.015$ ;  $K \rightarrow PB$ ; H1), then SN to I ( $\beta = 0.103$ ;  $p = 0.010$ ;  $SN \rightarrow I$ ; H10). Interestingly, K had a low direct significant effect towards PR ( $\beta = 0.072$ ;  $p = 0.016$ ;  $K \rightarrow PR$ ; H2), which was caused by the negative perception of PR towards PBC ( $\beta = -0.327$ ;  $p = 0.010$ ;  $PR \rightarrow PBC$ ; H6), SN ( $\beta = -0.305$ ;  $p = 0.004$ ;  $SN \rightarrow PBC$ ; H7), and A ( $\beta = -0.181$ ;  $p = 0.009$ ;  $A \rightarrow PBC$ ; H8). Lastly, A had the lowest effect towards I ( $\beta = 0.103$ ;  $p = 0.010$ ;  $A \rightarrow I$ ; H11). It was seen that all hypotheses were accepted having a direct and significant effect.

The results of this study showed that I had the highest direct effect on A ( $\beta = 0.959$  and  $p = 0.006$ ). The awareness and perception of the potential of the BNPP as a future source of energy were some of the indicators that highlighted the causal relationship of I to A. Moreover, it could be seen that people will influence and support the reopening of the BNPP. Since the potential of the BNPP is understood, numerous studies have further proved that an individual can influence its social circle from its understanding of the technology [52–55]. This would lead to a chain of influences and belief formation [56–61]. Subsequently, this will positively affect society's acceptance of the power plant as a future energy source. It could be deduced that the acceptance of the positive outcome of power plants could lead to the acceptance of its reopening.

PB was found to have a significant effect on PBC ( $\beta = 0.886$  and  $p = 0.012$ ). The perception of the economic, societal, and

**Table 2**  
The construct and measurement items.

Variable	Code	Constructs	Reference
Knowledge about Nuclear Power Plant	<b>K1</b>	I understand the basic scientific principles behind nuclear power generation.	[82]
	<b>K2</b>	I understand the risk of nuclear radiation.	[26]
	<b>K3</b>	I know the policies and plans of Bataan Power Plant.	[26]
	<b>K4</b>	I am familiar with Bataan Power Plant.	
	<b>K5</b>	I know that Bataan Power Plant will utilize Nuclear energy by means of nuclear fission.	
Attitude	<b>A1</b>	Using nuclear power plants is a good idea for our society.	[83]
	<b>A2</b>	Using nuclear power plants will benefit our society.	[83]
	<b>A3</b>	I think that using Nuclear Power Plants in our society is valuable.	[83]
	<b>A4</b>	I think rehabilitation of Bataan Power Plant has great significance.	[84]
Subjective Norm	<b>SN1</b>	My residents, friends, and colleagues support the rehabilitation of Bataan Nuclear Power Plant.	[84]
	<b>SN2</b>	The government, authorities, and social media in my city support the rehabilitation of Bataan Nuclear Power Plant.	[84]
	<b>SN3</b>	Most people who are important to me would support the rehabilitation of Bataan Power Plant.	[85]
	<b>SN4</b>	Most people who influence me think we should support the rehabilitation of Bataan Power Plant.	[85]
Perceived Behavioral Control	<b>PBC1</b>	I believe the rehabilitation of Bataan Power Plant improves our society.	[86]
	<b>PBC2</b>	I am fully aware of the issues regarding the Bataan Power Plant.	[87]
	<b>PBC3</b>	I feel safe when Bataan Power Plant starts to operate.	[84]
	<b>PBC4</b>	I am confident with the quality and reliability of Bataan Nuclear Power Plant.	[88]
Perceived Benefit	<b>PB1</b>	Rehabilitation of Bataan Nuclear Power Plant can help to reduce the price of local electricity.	[82]
	<b>PB2</b>	Rehabilitation of Bataan nuclear power plant can help promote local economic growth.	[82]
	<b>PB3</b>	Nuclear Energy will contribute to improving Philippines' economic development.	[89]
	<b>PB4</b>	The power provided by Nuclear power plants provides an important guarantee for the long-term sustainable development of the Philippines' economy.	[89]
	<b>PB5</b>	Nuclear power plants contribute to solving societal problems.	[26]
	<b>PB6</b>	Nuclear power plants help us to mitigate climate change.	[26]
	<b>PB7</b>	Nuclear power plants create jobs for people in the region.	[26]
Perceived Risk	<b>PR1</b>	I will worry that my family may be harmed by Nuclear radiation during the normal operation	[82]
	<b>PR2</b>	I will worry about Nuclear accidents occurring at the local power plant.	[82]
	<b>PR3</b>	If a Nuclear accident occurred, it would have a negative impact on the local environment.	[82]
	<b>PR4</b>	If a Nuclear accident occurred, it would have a negative impact on my health.	[82]
Intention	<b>I1</b>	I intend to switch to Bataan power plant as my source of electricity in the future	[84]
	<b>I2</b>	I intend to encourage others to switch to Bataan Power Plant as their source of electricity.	[84]
	<b>I3</b>	I predict that our society will predominantly support the rehabilitation of Bataan Power Plant.	[90]
	<b>I4</b>	I recommend that our society should support the rehabilitation of Bataan Power Plant.	[90]
Acceptance	<b>AP1</b>	I support Philippines' Rehabilitation of Bataan Power Plant.	[91]
	<b>AP2</b>	The advantages of Nuclear power outweigh the disadvantages.	[91]
	<b>AP3</b>	It is necessary for Philippines to vigorously rehabilitate the Bataan Power Plant.	[91]
	<b>AP4</b>	I support the country's vigorous investment in research and development of Nuclear energy	[91]
	<b>AP5</b>	I am in favor of nuclear power generation.	[91]

environmental benefits of the BNPP positively affect the acceptance of the power plant. This means that if the benefits of the power plant are understood, then it is easier for the people to accept the BNPP as a future energy source. This relation of PB and PBC is explained and seen in the study of Armitage and Conner [32] and Salo et al. [62]. Armitage and Conner [32] explained the perceived opportunities and resources are the basis of an individual's PBC. Additionally, Salo et al. [62] emphasized that a person's means of accepting a specific subject matter is measured by predispositions. Thus, a positive predisposition and perception towards the BNPP will result in easier acceptance of the power plant as a future energy source.

PB was also found to have a direct and significant effect on A ( $\beta = 0.848$  and  $p = 0.018$ ). Numerous studies provided the determinant of an individual's attitude is the PB towards a certain subject [63–65]. Hedonic benefit, conceive benefit, economic benefit, and variety are the sub-dimension of PB that were highlighted in the studies. This relates to the positive effect of PB on A in this paper. It was evident in the results that perceived economic growth, job opportunities, and effect on prices in local electricity are key factors of PB. In addition, sustainability, environmental, and societal benefits are also PB on the reopening of BNPP.

PB resulted to have a significant and direct effect on SN ( $\beta = 0.659$  and  $p = 0.012$ ). Results revealed that the understanding of the economic, environmental, and societal benefits of the BNPP were directly affected by the approval of a person's social circle. SN is seen to be a strong factor, similar to the result of Karaiskos et al. [37] and other studies [39,40]. Jung et al. [38] discussed how a

person decides on the intention to use or accept an event or technology based on the people's decisions around them. If others accept it, then the person would be influenced to accept it as well, deciding to have positive intentions. In addition, Arafat et al. [66] stated that the more favorable behavior is, the higher the intention of an individual to accept it. Subsequently, Manning [29] stated that people will tend to commend or criticize the behavior depending on the predisposition of risk and benefits. Thus, this explains the direct effect between PB on SN. Moreover, this also supports the relationship of SN and intention having a direct effect on the acceptance of BNPP ( $\beta = 0.103$  and  $p = 0.010$ ).

PBC resulted in a significant effect on I ( $\beta = 0.545$  and  $p = 0.011$ ). SEM indicated that the perception, knowledge, and confidence towards the BNPP as a future energy source positively determined their intention to accept the power plant. The role of PBC as a factor of I is also evident in numerous studies. Utami [67], Vasquez et al. [68], and Chen et al. [69] conducted studies that revealed that PBC affects, determines, and predicts the behavioral intention of an individual towards a certain subject matter. Moreover, Zhang et al. [5] indicated the people in China had positive PBC towards intention, specifically in utilizing the NPP in their country. Moreover, Yuan et al. [35] evaluated the acceptance of energy utilization in China. The results showed that people knowing the benefit would lead to positive PBC towards acceptance of the project. This shows how PBC directly affects intention and would lead to the acceptance of the reopening of BNPP. Based on the constructs, safety, and knowledge towards how power plants operate led the respondents to have the intention of accepting the reopening of the BNPP.

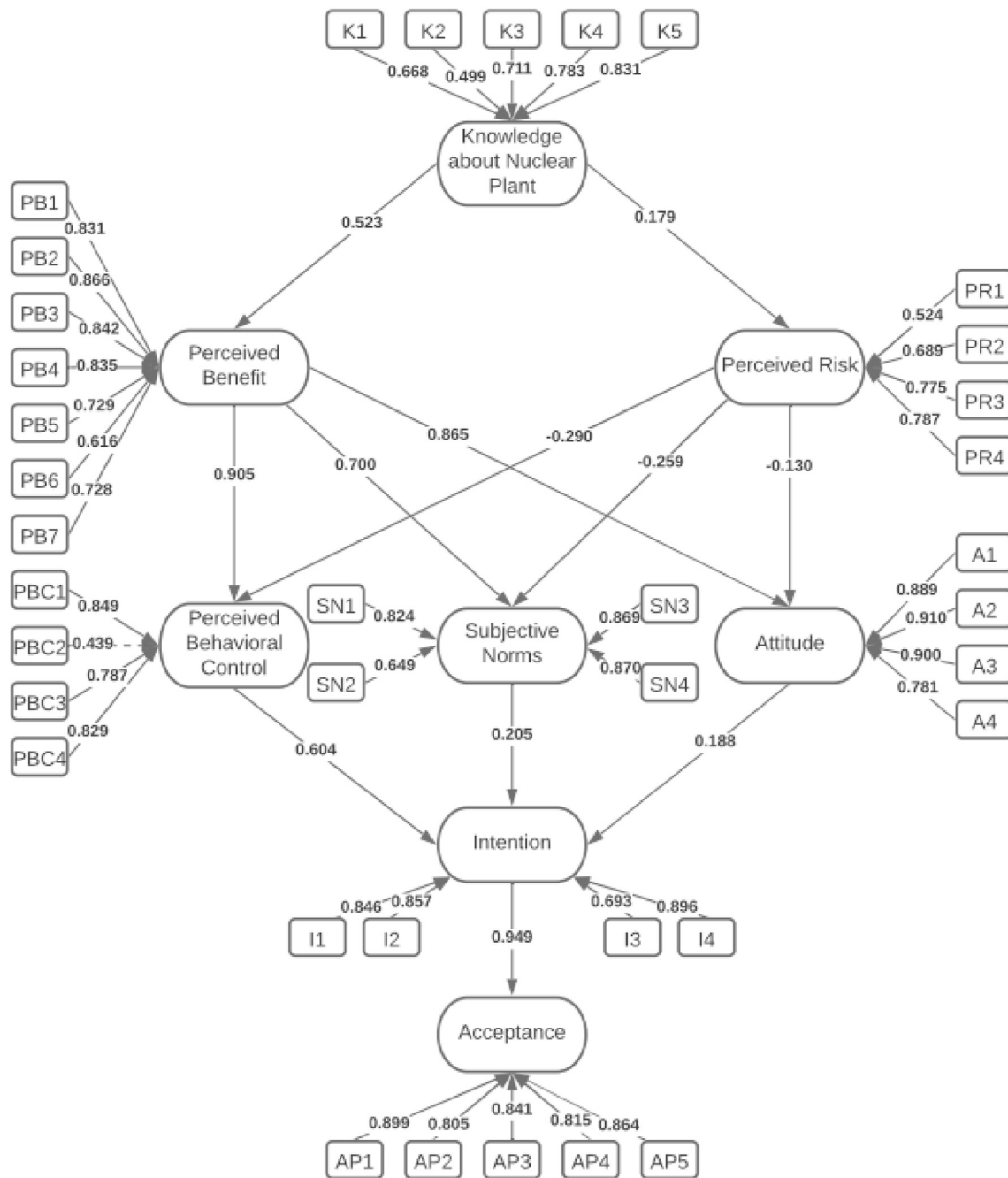


Fig. 2. The initial SEM for investigating the acceptance of the reopening of Bataan Nuclear Power Plant.

Knowledge towards BPNN also had a direct and positive effect on PB ( $\beta = 0.436$  and  $p = 0.015$ ). The result showed how people these days are well aware of the power plant, specially how it works, and understand the BPPN energy generation. This would lead to the positive relationship of K with PR ( $\beta = 0.072$  and  $p = 0.016$ ). It could be seen that the benefit outweighs the risks on the perception of people towards the reopening of the BNPP. The constructs that demonstrated this relationship are the negative effect of radiation, the negative impact on health and the local environment, and accidents that may happen upon operation. There may be risks that could be seen from the relationship. However, people are more eager to utilize the BNPP as renewable energy benefiting society and helping the country's economy grow. In China, Wang et al. [26] showed that knowledge among the

general public towards nuclear energy had a significant effect towards PB. Results showed that people in China are knowledgeable on how NPPs could be beneficial for their country. Sugiawan and Managi [70] and Yu et al. [71] showed that knowledge of power plants should be employed to know its benefits and impact on society. Moreover, the trust towards the government to utilize renewable energy for the benefit of the country would greatly affect the perception of people towards the acceptance of the power plant reopening [70].

Interestingly, it was seen that PR had a negative direct relationship towards A ( $\beta = -0.181$  and  $p = 0.0109$ ), SN ( $\beta = -0.305$  and  $p = 0.004$ ), and PBC ( $\beta = -0.327$  and  $p = 0.010$ ). This implies that a negative perception towards the powerplant would negatively affect the attitude, opinion of an individual's social circle, and a

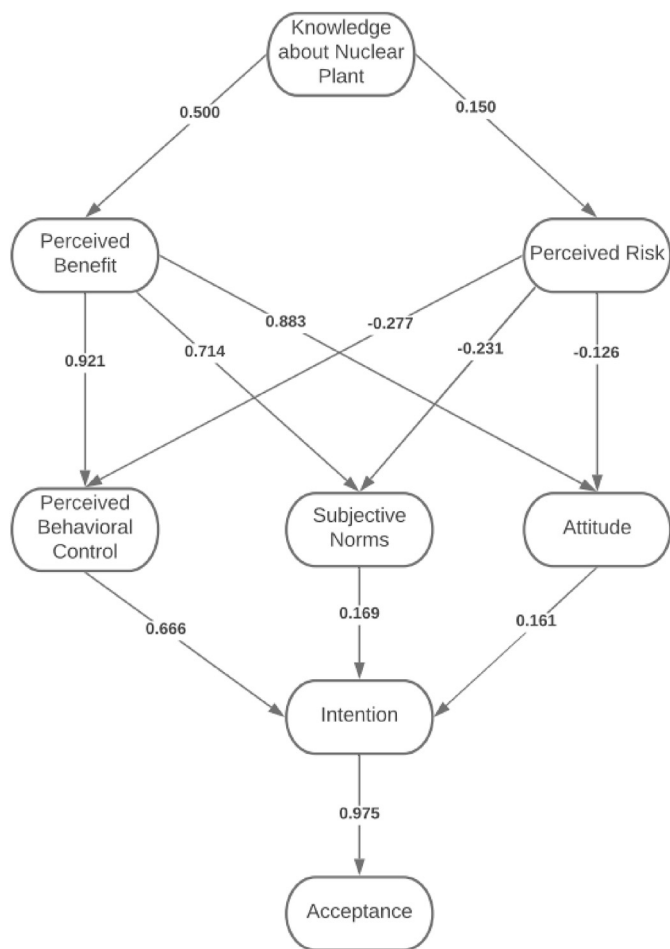


Fig. 3. The final SEM for investigating the acceptance of the reopening of Bataan Nuclear Power Plant.

harder acceptance of the BNPP. The relationships of PR, PBC, and A are explained in the study of Marza et al. [72] and Anastasia and Santoso [73]. Both of the said studies had a result that showed the direct correlation among the PR, A, and PBC. However, the negative relationship between SN and PR is explained in the study of Manning [29]. It indicated that people will tend to criticize a certain behavior if they have a negative perception of risk towards a certain subject matter. In relation to this study, people see that there are negative implications towards the reopening of BNPP. The people considered accidents that may happen upon operation such as health-related and nuclear radiation. In support, Huang et al. [27] indicated that K had a direct significant effect towards PR, especially after the Fukushima nuclear accident. However, based on the relationship of K and PB, people would still consider the reopening of BNPP with the benefits it may provide to the country. This shows that the PB outweighed the PR BNPPs could bring.

Overall, it can be seen that K had a higher effect on the A ( $\beta = 0.328$  and  $p = 0.012$ ) rather than the PR ( $\beta = -0.290$  and  $p = 0.005$ ). This shows that understanding BNPP utilization is crucial when it comes to acceptance [17,74,75]. With that, knowing the benefits would lead to positive PBC and A towards intention. This shows that PBC and A are mediators towards people accepting NPP reopenings [71]. If an individual's knowledge gravitates towards the PR, then this can lead to the negative acceptance of the BNPP. On the other hand, if an individual's knowledge gravitates towards the PB, then this will lead to

Table 3 Indicators statistical analysis.

Variable	Item	Mean	StD	Factor Loading	
				Initial	Final
Knowledge on Nuclear Power Plant	K1	3.364	1.092	0.668	0.762
	K2	4.150	0.903	0.499	0.599
	K3	2.713	1.205	0.711	0.752
	K4	3.469	1.284	0.783	0.782
	K5	3.477	1.170	0.831	0.710
Attitude	A1	3.584	0.955	0.889	0.882
	A2	3.723	0.944	0.910	0.903
	A3	3.734	0.927	0.900	0.890
	A4	3.712	0.982	0.781	0.823
Subjective Norm	SN1	3.102	0.936	0.824	0.809
	SN2	3.157	0.850	0.649	0.624
	SN3	3.189	0.948	0.869	0.868
	SN4	3.248	0.961	0.870	0.872
Perceived Behavioral Control	PBC1	3.692	0.951	0.849	0.852
	PBC2	3.384	1.199	0.439	–
	PBC3	3.059	1.001	0.787	0.773
	PBC4	3.217	1.019	0.829	0.816
Perceived Benefit	PB1	3.966	0.909	0.831	0.802
	PB2	3.898	0.891	0.866	0.834
	PB3	3.922	0.900	0.842	0.816
	PB4	3.805	0.965	0.835	0.833
	PB5	3.583	0.947	0.729	0.731
Perceived Risk	PB6	3.400	1.041	0.616	0.622
	PB7	3.934	0.870	0.728	0.715
	PR1	3.631	1.098	0.524	0.702
	PR2	3.994	0.936	0.689	0.828
	PR3	4.248	0.909	0.775	0.629
Intention	PR4	4.183	0.932	0.787	0.596
	I1	3.349	1.018	0.846	0.800
	I2	3.291	0.981	0.857	0.803
	I3	3.352	0.972	0.693	0.670
Acceptance	I4	3.448	0.951	0.896	0.878
	AP1	3.535	1.024	0.899	0.899
	AP2	3.439	1.021	0.805	0.805
	AP3	3.438	0.995	0.841	0.842
	AP4	3.714	1.004	0.815	0.799
	AP5	3.598	1.023	0.864	0.863

positive acceptance. Moreover, their perception would influence others to whatever decision they have. With that, proper knowledge regarding NPP will lead people to accept the reopening of decommissioned NPPs. This would lead to the acceptance of the government as well to invest using the tax of the country. Salloum et al. [76], Zhu and Deng [77], and Meher and Mishra [78] stated in their studies that K is a determinant of PBs and PR, which also affects the entirety of their constructs. Thus, the knowledge towards the BNPP is the vital factor that will dictate their stance towards the reopening of BNPP.

Knowledge may be delivered through the curriculum in schools or universities. Taking the Philippines as an example, the curriculum includes the subject of disaster risk reduction and management [79]. The topic of NPP could be discussed, considering the benefits and risks as well. This would highlight how people would be able to gauge the PB and PR. Moreover, local communities could propose programs and activities such as forums or discussions about NPPs or the BNPP for those who cannot attend school. This could be helpful in delivering proper information among citizens, especially in local communities.

### 6. Conclusions and policy implication

As one of the renewable energy sources, nuclear power plants have been widely utilized worldwide. However, despite the number of nuclear power plants being utilized, 182 nuclear power

**Table 4**  
Construct validity of the model.

Factor	Cronbach's $\alpha$	Average Variance Extracted (AVE)	Composite Reliability (CR)	Variance Inflation Factor (VIF)
Knowledge in Nuclear Power Plant	0.829	0.524	0.845	1.318
Attitude	0.920	0.766	0.929	3.243
Subjective Norm	0.874	0.639	0.875	2.262
Perceived Behavioral Control	0.858	0.663	0.858	3.915
Perceived Benefit	0.915	0.590	0.910	3.229
Perceived Risk	0.790	0.482	0.786	1.172
Intention	0.895	0.626	0.869	2.921
Acceptance	0.922	0.710	0.924	–

**Table 5**  
Model fit.

Goodness of fit measures of SEM	Parameter Estimates	Minimum cut-off	Suggested by
Incremental Fit Index (IFI)	0.921	>0.80	[92]
Tucker Lewis Index (TLI)	0.910	>0.80	[92]
Comparative Fit Index (CFI)	0.921	>0.80	[92]
Goodness of Fit Index (GFI)	0.833	>0.80	[92]
Adjusted Goodness of Fit Index (AGFI)	0.800	>0.80	[92]
Root Mean Square Error (RMSEA)	0.064	<0.07	[50]

**Table 6**  
Direct, indirect, and total effects.

No	Variable	Direct Effect	P-Value	Indirect Effect	P-Value	Total Effect	P-Value
1	K → PR	0.072	0.016	–	–	0.072	0.016
2	K → PB	0.436	0.015	–	–	0.436	0.015
3	K → A	–	–	0.351	0.015	0.351	0.015
4	K → SN	–	–	0.264	0.013	0.264	0.013
5	K → PBC	–	–	0.352	0.012	0.352	0.012
6	K → I	–	–	0.333	0.015	0.333	0.015
7	K → AP	–	–	0.328	0.012	0.328	0.012
8	PR → A	–0.181	0.009	–	–	–0.181	0.009
9	PR → SN	–0.305	0.004	–	–	–0.305	0.004
10	PR → PBC	–0.327	0.010	–	–	–0.327	0.010
11	PR → I	–	–	–0.295	0.006	–0.295	0.006
12	PR → AP	–	–	–0.290	0.005	–0.290	0.005
13	PB → A	0.848	0.018	–	–	0.848	0.018
14	PB → SN	0.659	0.012	–	–	0.659	0.012
15	PB → PBC	0.886	0.012	–	–	0.886	0.012
16	PB → I	–	–	0.842	0.018	0.842	0.018
17	PB → AP	–	–	0.814	0.019	0.814	0.019
18	A → I	0.055	0.011	–	–	0.055	0.011
19	A → AP	–	–	0.053	0.011	0.053	0.011
20	SN → I	0.103	0.010	–	–	0.103	0.010
21	SN → AP	–	–	0.105	0.008	0.105	0.008
22	PBC → I	0.545	0.011	–	–	0.545	0.011
23	PBC → AP	–	–	0.536	0.007	0.536	0.007
24	I → AP	0.959	0.006	–	–	0.959	0.006

plants are decommissioned and inactive, including the one in Bataan, Philippines. Reopening the decommissioned and inactive nuclear power plant would face challenges including the acceptance of the citizens.

This study integrated the TPB and PMT and measured the acceptance of reopening the BNPP among 815 respondents from the Philippines. The different latent utilized in this study were knowledge about nuclear power plant, perceived benefit, perceived risk, perceived behavioral control, subjective norms, attitude, intention, and acceptance. Among these latent, Structural Equation Modeling revealed direct and indirect relationships between factors that affected the acceptance of the Filipinos towards the reopening of BNPP.

The SEM indicated that knowledge towards nuclear power plants would be the key factor in determining people's acceptance either positively towards the PB or negatively because of the PR. If

an individual's knowledge gravitates towards the PR, then this can lead to the negative acceptance of the BNPP. On the other hand, if an individual's knowledge gravitates towards the PB, then this will lead to positive acceptance. It is therefore proposed that policymakers in charge of the BNPP should take this into consideration. The enhancement and implementation of protection policy within the area and publicity of the benefits of NPPs should be done. The policymakers could benefit from utilizing social media platforms, posters, and even emerging media networks to distribute the information. As seen from the results, the more the residents know about the benefits of NPPs may outweigh the PR. The assurance of protection against risks may lead to more positive acceptance from the citizens.

Focusing on the health and risk among residents of the country, the policymakers may ensure the protection by considering the resources around the BNPP. The policymakers may implement



strict laws and regulations regarding the safety of utilizing NPPs. This may include the measurement of nuclear risk and accidents that may happen. Reducing such would increase the confidence of the citizen around the BNPP leading to an increase in acceptance. In addition, the resources should be monitored and tested regularly such as water and farm stocks. Moreover, the health of the people should also be monitored regularly. The effectiveness of open information regarding NPPs and available communication regarding NPP queries would lead to a decrease in the negative perception as protection against any harm is highly considered.

With the findings of this study, it would be best to keep the citizen of the country informed and are provided with proper knowledge regarding the BNPP. The additional information would help the government gain trust and acceptance among the citizen. This would help promote reinforcement with the reopening of BNPP. Moreover, all hypotheses of this study were found to be significant. The internal consistency and validity of constructs and latent, together with the model fit of this study indicates that the integration of PMT and TPB as a framework could be utilized. Specifically, the integration of PMT and TPB could be a framework that may be utilized to measure people's behavior holistically. With positive results, the framework could also be utilized for evaluation of acceptance among reopening of decommissioned and inactive NPPs, not only in the Philippines but also worldwide.

The implication of positive knowledge from the educational section would lead to the current and future generation's acceptance if the BNPP is reopened. Currently, the Philippines included the Risk Reduction Management as part of the curriculum. The addition of benefits and risks of NPPs in the subject may enhance the knowledge of the citizen. This could also be a way of promotion to reach different generations regarding BNPPs. The perception would influence others to whatever decision they have. The acceptance of people will result to influencing others to the positive or negative perception regarding the reopening of BNPP. With that, proper knowledge regarding NPP will lead people to accept the reopening of decommissioned NPPs. This would lead to the acceptance of the government as well to invest using the tax of the country.

This study is the first study that explored the acceptance of the reopening of BNPP. This study can be beneficial for the government in deciding on the planned reopening of the BNPP. Similar to the study of Tantitaechochart et al. [79], the results of this study could be utilized in public communication by the government to impart proper knowledge. With the reopening of the inactive NPP, employment opportunities for citizens may be available as well. Finally, our model construct would also be very beneficial for academicians, government, and even private sectors worldwide, particularly for investigating the reopening of the decommissioned and inactive NPPs.

### 6.1. Theoretical contribution

This study integrated the TPB and the PMT and it could be utilized to investigate the acceptance towards reopening of the BNPP. Moreover, this model can also be utilized for other countries' nuclear power plants. Aside from this, Prasetyo et al. [18] also stated that this integrated model can be utilized for the investigation of different natural disasters around the world. Mitigation plans [80] and knowledge measurement towards disasters [18] and phenomena [81] could also be evaluated using integrated theories. Lastly, SEM as a tool could holistically measure the different latent that may be included in different studies.

### 6.2. Practical implication

The reopening of BNPP can enhance cleaner energy especially in developing countries. This renewed source of energy can be utilized to help promote economic growth, reduce environmental problems, and also promote societal development [96,97]. Moreover, the additional industry upon opening of a power plant can help give opportunities for the government to assist in creating jobs for the people, mitigate climate change, and advocate sustainability among the people of the country. This will eventually set a platform for the world to realize how renewable energy can be beneficial to a country.

### 6.3. Limitations

Even with the evident positive result of this study, there were limitations considered. First, this study was conducted having respondents from different regions of the country. The current strict lockdown due to the COVID-19 pandemic left the research with online distribution of surveys. It is therefore recommended to conduct the study after the COVID-19 pandemic among residents near the BNPP. The results may be different if the respondents came from areas near the proximity of the power plant. It is recommended to conduct multi-group analysis using SEM or data mining. This will extend the result of this study towards the relation of distance towards the acceptance of the BNPP reopening. Second, the study was able to measure only respondents from younger generations. Due to the COVID-19 pandemic and strict implementation of lockdown, the only way to distribute the questionnaire was online. It was seen that majority of people online were younger generation. According to Vogels [81], people active in social media are of the younger generations since they are more inclined in utilizing social media platforms. This in turn resulted in skewness with the age and monthly salary/allowance. It is suggested to include more diverse respondents from different age groups after the lockdown and COVID-19 pandemic. Third, the measurement of knowledge was through a self-administered survey only. Seeing that the result showed that knowledge is the key factor for the acceptance of people towards the reopening of BNPP, it would be beneficial to measure their knowledge thoroughly. This would give a more distinct explanation towards their acceptance especially on the PB and PR of NPPs. Lastly, the trust towards the government's utilization of the power plant was not measured. According to Sugiawan and Managi [70], the government would play a crucial role in how people would perceive the acceptance of the NPP. This may be included to further evaluate the acceptance and would be beneficial for the government. The government may take into consideration the possible responses of the people to give assurance and promotion towards industrializing nuclear power plants in a country.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### References

- [1] M.A. Rosen, I. Dincer, Nuclear energy as a component of sustainable energy systems, *Int. J. Low Carbon Technol.* 2 (2007) 109–125, <https://doi.org/10.1093/ijlct/2.2.109>.
- [2] I. Wayan Ngarayana, T.M.D. Do, K. Murakami, M. Suzuki, Nuclear power plant maintenance optimisation: models, methods & strategies, *J. Phys. Conf.* 1198 (2019), <https://doi.org/10.1088/1742-6596/1198/2/022005>.
- [3] B.W. Brook, A. Alonso, D.A. Meneley, J. Misak, T. Blee, J.B. van Erp, Why

- nuclear energy is sustainable and has to be part of the energy mix, Sustainable Materials and Technologies. <https://doi.org/10.1016/j.susmat.2014.11.001>, 2014, 1–2,8,16.
- [4] World Nuclear Association, Current and Future Generation, World Nuclear, 2021. <https://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx>.
  - [5] T. Zhang, Z. Liu, S. Zheng, X. Qu, D. Tao, Predicting errors, violations, and safety participation behavior at nuclear power plants, International Journal of Environmental Research and Public Health Article. (n.d.). <https://doi.org/10.3390/ijerph17155613>.
  - [6] D. Iurchak, 200 – 400 Nuclear Reactors to Be Decommissioned by 2040, Energypost.Eu, 2020. <https://energypost.eu/200-400-nuclear-reactors-to-be-decommissioned-by-2040/>.
  - [7] J.P. Terry, J.R. Goff, Natural Hazards in the Asia-Pacific Region: Recent Advances and Emerging Concepts, Marine Geophysical Research, 2012.
  - [8] F. Butterfield, Filipinos Say Marcos Was Given Millions for '76 Nuclear Contract, The New York Times, 1986. <https://www.nytimes.com/1986/03/07/world/filipinos-say-marcos-was-given-millions-for-76-nuclear-contract.html>.
  - [9] V. Files, VERA FILES FACT SHEET: A Sleeping Power Giant, Bataan Nuclear Power Plant Explained, VERA Files., 2020. <https://verafil.es.org/articles/vera-files-fact-sheet-sleeping-power-giant-bataan-nuclear-po>.
  - [10] C.P. Staff, Duterte Orders Consultations with Bataan Residents amid Calls to Reopen Nuclear Plant, CNN Philippines, 2020. <https://www.cnnphilippines.com/news/2020/10/1/Duterte-consultation-Bataan-nuclear-power-plant.html>.
  - [11] R. Cabato, Russian Ambassador: Bataan Nuclear Power Plant Revival "Not Possible at All," CNN Philippines, 2018. <https://cnnphilippines.com/news/2018/04/04/Russian-ambassador-Igor-Khovaev-Bataan-nuclear-power-plant-revival-not-possible.html>.
  - [12] C.Y. Hsu, M.Y. Chen, S.C. Yang, Residents' attitudes toward support for island sustainable tourism, Sustainability 11 (2019) 1–16, <https://doi.org/10.3390/su11185051>.
  - [13] E.R. Yttredal, N. Homlong, Perception of Sustainable Development in a Local World Heritage Perspective, (n.d.). <https://doi.org/10.3390/su12218825>.
  - [14] I. Ajzen, The Theory of Planned Behavior: Frequently Asked Questions, 2020, <https://doi.org/10.1002/hbe2.195>.
  - [15] A.T. Services, What Is Theory of Planned Behavior? A Division of Information Technology Services, 1998, p. 6654.
  - [16] S.R. Shakeel, S. ur Rahman, Towards the establishment of renewable energy technologies' market: an assessment of public acceptance and use in Pakistan, J. Renew. Sustain. Energy 10 (2018), <https://doi.org/10.1063/1.5033454>.
  - [17] J. Kim, S.K. Lee, J. Lee, M.Y. Choi, S.P. Jung, M.K. Kim, S. Kim, S.J. Nam, J.E. Lee, W.H. Kil, Breast cancer screening knowledge and perceived health beliefs among immigrant women in Korea, Journal of Breast Cancer 17 (2014) 279–286, <https://doi.org/10.4048/jbc.2014.17.3.279>.
  - [18] Y.T. Prasetyo, A.M. Castillo, L.J. Salonga, J.A. Sia, J.A. Seneta, Factors affecting perceived effectiveness of COVID-19 prevention measures among Filipinos during enhanced community quarantine in luzon, Philippines: Integrating protection motivation theory and extended theory of planned behavior, Int. J. Infect. Dis. 99 (2020) 312–323, <https://doi.org/10.1016/j.ijid.2020.07.074>.
  - [19] A. Heidenreich, T. Masson, S. Bamberg, Let's talk about flood risk – evaluating a series of workshops on private flood protection, International Journal of Disaster Risk Reduction 50 (2020) 101880, <https://doi.org/10.1016/j.ijdrr.2020.101880>.
  - [20] R.C. Plotnikoff, L. Trinh, Protection motivation theory: is this a worthwhile theory for physical activity promotion? Exerc. Sport Sci. Rev. 38 (2010) 91–98, <https://doi.org/10.1097/JES.0b013e3181d49612>.
  - [21] G. Zhao, E. Cavusgil, Y. Zhao, A protection motivation explanation of base-of-pyramid consumers' environmental sustainability, J. Environ. Psychol. 45 (2016) 116–126, <https://doi.org/10.1016/j.jenvp.2015.12.003>.
  - [22] A.C. Clubb, J.C. Hinkle, Protection motivation theory as a theoretical framework for understanding the use of protective measures, Crim. Justice Stud. Crit. J. Crime Law Soc. 28 (2015) 336–355, <https://doi.org/10.1080/1478601X.2015.1050590>.
  - [23] A.M.F. Lagmay, R. Rodolfo, H. Cabria, J. Soria, P. Zamora, C. Abon, C. Lit, M.R.T. Lapus, E. Paguican, M.G. Bato, G. Tiu, E. Obille, N.E. Pellejera, P.C. Francisco, R.N. Eco, J. Aviso, Geological Hazards of SW Natib Volcano, Site of the Bataan Nuclear Power Plant, the Philippines, vol. 361, Geological Society Special Publication, 2012, pp. 151–169, <https://doi.org/10.1144/SP361.13>.
  - [24] M.G. Alipario, The Bataan Nuclear Power Plant in the Philippines: A Nuclear Plant, and a Dream, Fizzles, Energycentral, 2020. <https://energycentral.com/c/pip/bataan-nuclear-power-plant-philippines-nuclear-plant-and-dream-fizzles>.
  - [25] P. Janmaimool, Application of Protection Motivation Theory to Investigate Sustainable Waste Management Behaviors, (n.d.). <https://doi.org/10.3390/su9071079>.
  - [26] S. Wang, J. Wang, S. Lin, J. Li, Public perceptions and acceptance of nuclear energy in China: the role of public knowledge, perceived benefit, perceived risk and public engagement, Energy Pol. 126 (2019) 352–360, <https://doi.org/10.1016/j.enpol.2018.11.040>.
  - [27] L. Huang, Y. Zhou, Y. Han, J.K. Hammitt, J. Bi, Y. Liu, Effect of the Fukushima nuclear accident on the risk perception of residents near a nuclear power plant in China, Proc. Natl. Acad. Sci. Unit. States Am. 110 (2013), <https://doi.org/10.1073/PNAS.1313825110>, 19742–19747.
  - [28] H. Staats, Pro-environmental attitudes and behavioral change, Encyclop. Appl. Psychol. (2004) 127–135.
  - [29] M. Manning, The effects of subjective norms on behaviour in the theory of planned behaviour: a meta-analysis, Br. J. Soc. Psychol. 48 (2009) 649–705, <https://doi.org/10.1348/014466608X393136>.
  - [30] T.H. Skoglund, T. Brekke, F. Steder, O. Boe, Big Five Personality Profiles in the Norwegian Special Operations Forces, Fornties in Psychology, 2020.
  - [31] I. Ajzen, The theory of planned behavior, Organ. Behav. Hum. Decis. Process. 50 (1991) 179–211, [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T).
  - [32] C.J. Armitage, M. Conner, Armitage and connor 2001.Pdf>, Br. J. Soc. Psychol. 40 (2001) 471. <https://pdfs.semanticscholar.org/ab83/87ae29317c651a129efc7a2297bc5f348a95.pdf>.
  - [33] C. Neighbors, R.M. O'connor, M.A. Lewis, N. Chawla, C.M. Lee, N. Fossos, The Relative Impact of Injunctive Norms on College Student Drinking: the Role of Reference Group, (n.d.). <https://doi.org/10.1037/a0013043>.
  - [35] L. Hua, S. Wang, Antecedents of Consumers' Intention to Purchase Energy-Efficient Appliances: an Empirical Study Based on the Technology Acceptance Model and Theory of Planned Behavior, (n.d.). <https://doi.org/10.3390/su11102994>.
  - [36] D. Karaiskos, E. Tzavellas, G. Balta, T. Paparrigopoulos, P02-232 - social network addiction : a new clinical disorder? Eur. Psychiatr. 25 (2010) 855, [https://doi.org/10.1016/s0924-9338\(10\)70846-4](https://doi.org/10.1016/s0924-9338(10)70846-4).
  - [37] T. Jung, M. Claudia Tom Dieck, H. Lee, N. Chung, Relationships Among Beliefs, Attitudes, Time Resources, Subjective Norms, and Intentions to Use Wearable Augmented Reality in Art Galleries, (n.d.). <https://doi.org/10.3390/su12208628>.
  - [38] N. Nguyen, H. Viet Nguyen, P. Thao Nguyen, V. Thao Tran, H. Nam Nguyen, T. My Nguyet Nguyen, T. Khanh Cao, T. Hung Nguyen, Some key factors affecting consumers' intentions to purchase functional foods, A Case Study of Functional Yogurts in Vietnam 9 (2020) 24, <https://doi.org/10.3390/foods9010024>.
  - [39] Y.-J. Choi, J.-W. Park, Investigating Factors Influencing the Behavioral Intention of Online Duty-free Shop Users, (n.d.). <https://doi.org/10.3390/su12177108>.
  - [40] W. LaMorte, The Theory of Planned Behavior, Behavioral Change Models, 2019. [https://sphweb.bumc.bu.edu/otlt/mph-modules/sb/behavioralchangetheories/BehavioralChangeTheories3.html#headingtaglink\\_1](https://sphweb.bumc.bu.edu/otlt/mph-modules/sb/behavioralchangetheories/BehavioralChangeTheories3.html#headingtaglink_1).
  - [41] B. Foltz, H.E. Newkirk, P.H. Schwager, An Empirical Investigation of Factors that Influence Individual Behavior toward Changing Social Networking Security Settings, vol. 11, 2016, <https://doi.org/10.4067/S0718-18762016000200002>, 2016–2017.
  - [42] S. Hussain, W. Ahmed, R.M.S. Jafar, A. Rabnawaz, Y. Jianzhou, eWOM source credibility, perceived risk and food product customer's information adoption, Comput. Hum. Behav. 66 (2017) 96–102, <https://doi.org/10.1016/j.chb.2016.09.034>.
  - [43] M. Mamman, A.F. Ogunbado, A.S. Abu-bakr, Factors influencing customer's behavioral intention to adopt islamic banking in northern Nigeria: a proposed framework, J. Econ. Finance 7 (2016) 51–55, <https://doi.org/10.9790/5933-07135155>.
  - [44] E. Park, J.Y. Ohm, Factors influencing the public intention to use renewable energy technologies in South Korea: effects of the Fukushima nuclear accident, Energy Pol. 65 (2014) 198–211, <https://doi.org/10.1016/j.enpol.2013.10.037>.
  - [45] Q. Xiao, H. Liu, M.W. Feldman, How Does Trust Affect Acceptance of a Nuclear Power Plant (NPP): A Survey Among People Living with Qinshan NPP in China, 2017, <https://doi.org/10.1371/journal.pone.0187941>.
  - [46] G.H. Lim, W.J. Jung, T.H. Kim, S.Y.T. Lee, The cognitive and economic value of a nuclear power plant in Korea, Nuclear Eng. Technol. 49 (2017) 609–620, <https://doi.org/10.1016/j.net.2016.10.007>.
  - [47] M. Savari, H. Gharechae, Application of the extended theory of planned behavior to predict Iranian farmers' intention for safe use of chemical fertilizers, J. Clean. Prod. 263 (2020) 121512, <https://doi.org/10.1016/j.jclepro.2020.121512>.
  - [48] A. Kiraz, O. Canpolat, C. Özkurt, H. Taşkın, Analysis of the factors affecting the Industry 4.0 tendency with the structural equation model and an application, Comput. Ind. Eng. 150 (2020) 106911, <https://doi.org/10.1016/j.cie.2020.106911>.
  - [49] N. Mundra, R.P. Mishra, Business sustainability in post COVID-19 era by integrated LSS-AM model in manufacturing: a structural equation modeling, Procedia CIRP 98 (2021) 535–540, <https://doi.org/10.1016/j.procir.2021.01.147>.
  - [50] J.H. Steiger, Understanding the limitations of global fit assessment in structural equation modeling, Pers. Individ. Differ. 42 (2007) 893–898, <https://doi.org/10.1016/j.paid.2006.09.017>.
  - [52] S. ten Kate, S. Haverkamp, F. Mahmood, F. Feldberg, Social network influences on technology acceptance: a matter of tie strength, centrality and density, 23rd Bled EConference ETrust: implications for the Individual, Enterprises Soc. Proc. (2010) 18–32.
  - [53] V. Venkatesh, M.G. Morris, G.B. Davis, F.D. Davis, User acceptance of information technology: toward a unified view, MIS Q.: Manag. Inf. Syst. 27 (2003) 425–478, <https://doi.org/10.2307/30036540>.
  - [54] D.F. Jennings, S.L. Seaman, Aggressiveness of response to new business opportunities following deregulation: an empirical study of established financial firms, J. Bus. Ventur. 5 (1990) 177–189, [https://doi.org/10.1016/0883-9026\(90\)90031-N](https://doi.org/10.1016/0883-9026(90)90031-N).

- [55] L.C. Freeman, *Social Networks and the Structure Experiment*, Research Methods in Social Network Analysis, 1989.
- [56] J. Hartwick, H. Barki, Explaining the role of user participation in information system use, *Manag. Sci.* 40 (1994) 440–465, <https://doi.org/10.1287/mnsc.40.4.440>.
- [57] E. Karahanna, D.W. Straub, N.L. Chervany, Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs, *MIS Q.: Manag. Inf. Syst.* 23 (1999) 183–213, <https://doi.org/10.2307/249751>.
- [58] H.C.J. Lucas, V.K. Spittler, *LucasSpittler.pdf*, *Decis. Sci. J.* 30 (1999) 291–311.
- [59] S. Taylor, P. Todd, Assessing IT usage: the role of prior experience, *MIS Q.: Manag. Inf. Syst.* 19 (1995) 561–568, <https://doi.org/10.2307/249633>.
- [60] J. Lu, J.E. Yao, C.S. Yu, Personal innovativeness, social influences and adoption of wireless Internet services via mobile technology, *J. Strat. Inf. Syst.* 14 (2005) 245–268, <https://doi.org/10.1016/j.jsis.2005.07.003>.
- [61] J. Salo, M. Lankinen, M. Mäntymäki, The use of social media for artist marketing: music industry perspectives and consumer motivations, *JMM Int. J. Media Manag.* 15 (2013) 23–41, <https://doi.org/10.1080/14241277.2012.755682>.
- [62] C. Yue, S. Zhao, C. Cummings, J. Kuzma, Investigating factors influencing consumer willingness to buy GM food and nano-food, *J. Nanoparticle Res.* 17 (2015), <https://doi.org/10.1007/s11051-015-3084-4>.
- [63] P. Sinha, S. Singh, Comparing risks and benefits for the value enhancement of online purchases, *Gadjah Mada Int. J. Bus.* 19 (2017) 307–326, <https://doi.org/10.22146/gamajib.10512>.
- [64] X. Bu, H. Viet Nguyen, T.P. Chou, C.-P. Chen, A Comprehensive Model of Consumers' Perceptions, Attitudes and Behavioral Intention toward Organic Tea: Evidence from an Emerging Economy, (n.d.), <https://doi.org/10.3390/su12166619>.
- [65] M.Y. Arafat, I. Saleem, A.K. Dwivedi, A. Khan, Determinants of agricultural entrepreneurship: a GEM data based study, *Int. Enterpren. Manag. J.* 16 (2020) 345–370, <https://doi.org/10.1007/s11365-018-0536-1>.
- [66] C.W. Utami, Attitude , subjective norms , perceived behavior , entrepreneurship education and self-efficacy toward entrepreneurial intention university student in Indonesia christina whidya utami lecturer at the university of ciputra surabaya, *European Res.Stud. J.* 20 (2017) 475–495.
- [67] A.K. Vasquez Id, C. Foditsch, S. Phie-Anne, C. Dulièpre, J.D. Siler, D.R. Just, L.D. Warnick, D. v Nydam, J. Sok, Understanding the Effect of Producers' Attitudes, Perceived Norms, and Perceived Behavioral Control on Intentions to Use Antimicrobials Prudently on New York Dairy Farms, 2019, <https://doi.org/10.1371/journal.pone.0222442>.
- [68] H.-S. Chen, C.-H. Liang, S.-Y. Liao, H.-Y. Kuo, Consumer Attitudes and Purchase Intentions toward Food Delivery Platform Services, (n.d.), <https://doi.org/10.3390/su122310177>.
- [69] Y. Sugawawan, S. Managi, Public acceptance of nuclear power plants in Indonesia: portraying the role of a multilevel governance system, *Energy Strategy Reviews* 26 (2019) 100427, <https://doi.org/10.1016/j.esr.2019.100427>.
- [70] N. Yu, Y. Zhang, J. Wang, X. Cao, X. Fan, X. Xu, F. Wang, Knowledge of and attitude to nuclear power among residents around tianwan nuclear power plant in jiangsu of China, *Int. J. Med. Sci.* 9 (2012) 361–369, <https://doi.org/10.7150/ijms.4629>.
- [71] S. Marza, I. Idris, A. Abror, The Influence of Convenience, Enjoyment, Perceived Risk, and Trust on the Attitude toward Online Shopping, 2019, <https://doi.org/10.2991/piceeba2-18.2019.40>.
- [72] N. Anastasia, S. Santoso, Effects of subjective norms, perceived behavioral control, perceived risk, and perceived usefulness towards intention to use credit cards in surabaya, Indonesia, *SHS Web of Conferences* 76 (2020), 01032, <https://doi.org/10.1051/shsconf/20207601032>.
- [73] F.M. Annan, K. Oppong Asante, N. Kugbey, Perceived seriousness mediates the influence of cervical cancer knowledge on screening practices among female university students in Ghana, *BMC Wom. Health* 19 (2019) 1–8, <https://doi.org/10.1186/s12905-019-0842-y>.
- [74] S.S. Daniali, E. Al, Knowledge, risk perception, and behavioral intention about hepatitis C, among university students, *J. Educ. Health Promot.* 4 (2015).
- [75] S.A. Salloum, M. Al-Emran, K. Shaalan, A. Tarhini, Factors affecting the E-learning acceptance: a case study from UAE, *Educ. Inf. Technol.* 24 (2019) 509–530, <https://doi.org/10.1007/s10639-018-9786-3>.
- [76] H. Zhu, F. Deng, How to Influence Rural Tourism Intention by Risk Knowledge during COVID-19 Containment in China: Mediating Role of Risk Perception and Attitude, (n.d.), <https://doi.org/10.3390/ijerph17103514>.
- [77] J.R. Meher, R.K. Mishra, Evaluation of Perceived Benefits and Employee Satisfaction through Knowledge Management practices, *Global Knowledge, Memory and Communication*, 2021, <https://doi.org/10.1108/GKMC-11-2020-0181>.
- [78] S. Tantitachochart, N. Paoprasert, K. Silva, Analyzing local perceptions toward the new nuclear research reactor in Thailand, *Nuclear Eng. Technol.* 52 (2020) 2958–2968, <https://doi.org/10.1016/j.net.2020.05.013>.
- [79] A.K.S. Ong, Y.T. Prasetyo, F.C. Lagura, R.N. Ramos, K.M. Sigua, J.A. Villas, M.N. Young, J.F.T. Diaz, S.F. Persada, A.A.N.P. Redi, Factors affecting intention to prepare for mitigation of “the big one” earthquake in the Philippines: integrating protection motivation theory and extended theory of planned behavior, *International Journal of Disaster Risk Reduction* 63 (2021) 102467, <https://doi.org/10.1016/j.ijdrr.2021.102467>.
- [80] M. Abolmaged, G. Hashem, S. Mouakket, Predicting subjective well-being among mHealth users: a readiness – value model, *Int. J. Inf. Manag.* 56 (2021) 102247, <https://doi.org/10.1016/j.ijinfomgt.2020.102247>.
- [81] E. Vogels, Millennials Stand Out for Their Technology Use, but Older Generations Also Embrace Digital Life, Pew Research Center, 2019, <https://www.pewresearch.org/fact-tank/2019/09/09/us-generations-technology-use/>.
- [82] Y. Guo, T. Ren, When it is Unfamiliar to Me: Local Acceptance of Planned Nuclear Power Plants in China in the Post-Fukushima Era, *Energy Policy* 100 (2017) 113–125, <https://doi.org/10.1016/j.enpol.2016.10.002>.
- [83] X. Ru, S. Wang, Q. Chen, S. Yan, Exploring the interaction effects of norms and attitudes on green travel intention: An empirical study in eastern China, *J. Clean. Prod.* 197 (1) (2018) 1317–1327, <https://doi.org/10.1016/j.jclepro.2018.06.293>.
- [84] D. Lili, Y. Ying, H. Qiuhui, L. Mengxi, Residents' acceptance of using desalinated water in China based on the theory of planned behaviour (TPB), *Marine Policy* 123 (2021) 104293, <https://doi.org/10.1016/j.marpol.2020.104293>.
- [85] C. Chen, W. Chao, Habitual or reasoned? Using the theory of planned behavior, technology acceptance model, and habit to examine switching intentions toward public transit, *Transportation Research Part F: Traffic Psychology and Behaviour* 14 (2) (2011) 128–137, <https://doi.org/10.1016/j.trf.2010.11.006>.
- [86] F. Fornana, P. Pattitoni, M. Mura, E. Strazera, Predicting intention to improve household energy efficiency: The role of value-belief-norm theory, normative and informational influence, and specific attitude, *J. Environ. Psychol.* 45 (2016) 1–10, <https://doi.org/10.1016/j.jenvp.2015.11.001>.
- [87] D. Mishra, I. Akman, A. Mishra, Theory of Reasoned Action application for Green Information Technology acceptance, *Computers in Human Behavior* 36 (6) (2014) 29–40, <https://doi.org/10.1016/j.chb.2014.03.030>.
- [88] E. Park, S. Kim, Y. Kim, S. Kwon, Smart home services as the next mainstream of the ICT industry: determinants of the adoption of smart home services, *Universal Access in the Information Society* 17 (2018) 175–190, <https://doi.org/10.1007/s10209-017-0533-0>.
- [89] T. Goh, B.W. Ang, X.Y. Xu, Quantifying drivers of CO2 emissions from electricity generation – Current practices and future extensions, *Applied Energy* 231 (1) (2018) 1191–1204, <https://doi.org/10.1016/j.apenergy.2018.09.174>.
- [90] N. Thongsri, L. Shen, Y. Bao, I.M. Alharbi, Integrating UTAUT and UGT to explain behavioural intention to use M-learning: A developing country's perspective, *J. Sys. Information Tech.* 20 (2018) 278–297, <https://doi.org/10.1108/JST-11-2017-0107>.
- [91] Y. Hao, Y. Guo, B. Tian, Y. Shao, What affects college students' acceptance of nuclear energy? Evidence from China, *J. Clean. Prod.* 222 (2019) 746–759, <https://doi.org/10.1016/j.jclepro.2019.03.040>.
- [92] D. Gefen, D. Straub, M. Boudreau, Structural equation modeling and regression: guidelines for research practice, *Commun Assoc Inf Syst* 4 (2000), <https://doi.org/10.17705/1cais.00407>.
- [93] Y.T. Prasetyo, A.K.S. Ong, G.K.F. Concepcion, F.M.B. Navata, R.A.V. Robles, I.J.T. Tomagos, M.N. Young, J.F.T. Diaz, R. Nadlifatin, A.N.N. Perwira Redi, et al., Determining Factors Affecting Acceptance of E-Learning Platforms during the COVID-19 Pandemic: Integrating Extended Technology Acceptance Model and DeLone & McLean IS Success Model, *Sustainability* 13 (15) (2021) 8365, <https://doi.org/10.3390/su13158365>.
- [94] Y.T. Prasetyo, A. Kumar, A.J.P. Canlas, K.T.A.M. Ong, M.K.A.S. Siochi, A.K.S. Ong, Evaluation of Chair Dimensions, Anthropometric Measurements and Subjective Comfort Among Filipino High School Students: A Structural Equation Modelling Approach, *Proceedings of the International Conference on Industrial Engineering and Operations Management Sao Paulo, Brazil (April 5 - 8, 2021)*, <http://www.ieomsociety.org/brazil2020/papers/642.pdf>.
- [95] Y.T. Prasetyo, S.A.R. Tumanan, L.A.F. Yarte, M.C.C. Ogoy, A.K.S. Ong, Blackboard E-learning System Acceptance and Satisfaction Among Filipino High School Students: An Extended Technology Acceptance Model (TAM) Approach, 2020 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM) (2020) 1271–1275, <https://doi.org/10.1109/IEEM45057.2020.9309876>.
- [96] A.K.S. Ong, R.A.C. Robielos, Y.T. Jou, H.M. Wee, Three-Level Supply Chain considering Direct and Indirect Transportation Cost and Carbon Emissions, *IOP Conf. Ser.: Mater. Sci. Eng.* 847 (2020) 012050, <https://doi.org/10.1088/1757-899X/847/1/012050>.
- [97] A.K.S. Ong, A.I.R. Convento, G.J.D. Fradas, V.L.M. Sumera, J.M.C. Villacarlos, M.J.J. Gumasing, A Three-Level Supply Chain of Self-Healing Packages Considering Direct and Indirect Carbon Emission of Industrial and Transportation Cost, *Proceedings of the 11th Annual International Conference on Industrial Engineering and Operations Management Singapore (March 7-11, 2021)*, <http://www.ieomsociety.org/singapore2021/papers/730.pdf>.