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Original Article

Analyzing local perceptions toward the new nuclear research reactor in Thailand

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A B S T R A C T

Understanding public perception on nuclear research reactor is necessary for the policy maker to adopt such technology in Thailand, especially the locals who live in the proposed location. The study compared perceptions between the locals living near the proposed nuclear research reactor location (within 5 km) and those living in the outer region (5–15 km). Structural equation modeling technique was adopted by assuming casual relationships between latent variables including social status, information perception, trust, benefit perception and risk perception on the local acceptance of research reactor. The results showed that the strongest relationships for both the inner and the outer perimeters were from information perception toward technology acceptance via trust and benefit perception. While both zones showed similar results, the outer perimeter seemed to show slightly stronger effects than those in the inner perimeter.

1. Introduction

Thailand has never possessed any nuclear power reactor. Also, nuclear power has recently been excluded from the latest Power Development Plan [1]. However, there is currently a nuclear research reactor, called the Thai Research Reactor-1/Modification 1 (TRR-1/M1). The main purpose of the reactor is to produce neutrons to facilitate nuclear research and development, and industrial, agricultural and medical applications. It has been operated since 1961, located inside the Thailand Institute of Nuclear Technology (TINT) in Bangkok.

Due to the increase in domestic and regional demand, TINT has planned to build a new nuclear research reactor at its headquarters in Ongkharak District, Nakhon Nayok Province. Although the consequences of an accident from a research reactor if happens are significantly smaller than those caused by a nuclear power reactor; unfortunately, the risk is sometimes mistakenly assessed to be similar [2]. It is therefore essential for the government to carefully design the public involvement program in order to gain public awareness and acceptance of the project.

Several methods have been selected to explore public perception toward nuclear power such as the multivariate regression [3–5], descriptive analysis or qualitative methodologies [3,6], linear and multinomial logistic regression analysis [7], and structural equation modeling (SEM) technique [8–18]. The SEM technique, a combination of multiple regression analysis and factor analysis, was employed in this study. It could estimate the multiple and interrelated dependency in a single analysis which enable the visualization of linkages between different aspects of public perception and the reasons behind. SEM allows tests of whether certain assumptions are valid. This included studies whether a latent (unobserved) variable could be explained with the assumed observed variables, and also whether the latent variables had casual impacts quantitatively on another latent variables.

To our knowledge, there has not yet been any study that has analyzed public perceptions for a nuclear research reactor using the SEM technique. There have been a number of studies for nuclear power reactor which can serve as a good starting point. Visschers and Siegrist [9] showed that the benefit perception and risk perception influenced the acceptance of nuclear power plants. Furthermore, the public acceptance could significantly change due to a serious accident like the Fukushima Nuclear Accident even though it happened elsewhere. Song and Kim [12], Ryu et al. [17]

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and Li et al. [19] also found negative effect of risk perception on public acceptance of nuclear energy. This tendency could also be found in renewable energy in which risk perception had a negative impact on public intention to use renewable energy [10]. Wang and Li [11] found that acceptance of nuclear power by Chinese university students was mainly influenced by perceived energy supply benefits and perceived environmental benefits. They also found that trust strongly affected perceived energy supply benefits, environmental benefits, and risk perception.

Nonetheless, due to the substantial difference between research reactor technology and nuclear power reactor technology, there is no guarantee that findings from the studies in a nuclear power reactor can be applied directly to the research reactor project. Besides, aforementioned studies were conducted in Switzerland, China and South Korea, all of which own nuclear power plants. Their social context can be significantly different from Thailand which has never experienced nuclear power generation. Moreover, having both benefit and risk perceptions as intervening variables in our structure was one novelty in this current study. In particular, we were interested in how independent latent variables (social status and information perception) affected benefit and risk perceptions, especially via trust toward the governmental organization. The authors conducted a preliminary study [20] to investigate the perception and acceptance of a nuclear research reactor of the local public residing within 5 km around the proposed research reactor site. The result showed that trust was the main factor that affected risk and benefit perceptions and also technology acceptance. The study was conducted only in two out of twelve subdistricts. The two subdistricts have received the largest amount of information and opportunities including financial support from TINT. Other subdistricts located further from the planned site of the new research reactor (having rather limited access to the information and opportunities) may have different perception. It was worth extending the survey target area to confirm whether there were any differences in perception in order to establish a comprehensive public participation strategy for the new research reactor. Note, however, that this study did not focus on supporting the construction of nuclear research reactor. Rather, it was aiming toward the objective of exploring reasonable public communication strategies if the reactor was to be built.

2. Methodology

This research began by carefully designing Likert-scale questionnaire to ask individuals residing around the new reactor site regarding to their perceptions toward the new research reactor. Path structure was also constructed based on existing literatures and expert opinions. Structural equation modeling technique was applied to validate the assumptions of casual network relationships among latent variables. Detailed methodology is explained below.

2.1. Sample selection

In this current study, responses were collected from people residing both in the inner subdistricts (0–5 km from the planned site consisted of the Municipality of Ongkharak and Sai Mun district) and the outer subdistricts (5–15 km from the planned site covering four subdistricts including Sisa Krabue subdistrict, Bang Pla Kot subdistrict, Bang Luk Suea subdistrict and Khlong Yai subdistrict).

Individuals from each village in each subdistrict were randomly selected to answer the questionnaire. The sampling strategy was to have at least 7 participants per village. The outer perimeter had greater number of respondents than the inner perimeter since the area was wider. The Bureau of Registration Administration [21] reported in 2017 that the inner subdistricts and the outer

Table 1
Questionnaire (Likert scale of 1–5).

Latent variable	ID	Question
Information perception (I)	I1	Nuclear research reactor does not affect the environment.
	I2	Detailed information on the past accidents of the nuclear research reactor should be readily available.
	I3	Activities organized by TINT are accessible.
	I4	Operations of nuclear research reactor are known.
Trust (T)	T1	Complete information about the nuclear research reactor is reachable.
	T2	Nuclear research reactor is efficient.
	T3	Nuclear research reactor is safe.
	T4	The nuclear policy of the government is trustworthy.
	T5	The local government openly provides the public with information about nuclear research reactor.
	T6	The government has the ability to deal with the accidents from nuclear research reactor.
	T7	Staffs operating the nuclear research reactor are competent.
	T8	TINT staffs are acquainted.
	T9	The role of TINT when organizing important events for the community is benevolent.
Risk perception (R)	R1	The risk degree of the nuclear research reactor accidents is greater than that of traffic accidents.
	R2	An accident accompanied by environmental pollution, property loss, or health damage may occur in the future site of the nuclear research reactor.
	R3	Residing near the nuclear research reactor site is very terrified.
	R4	Nuclear research reactor accidents could yield environmental pollution, property loss, or health damage frequently.
	R5	If a nuclear research reactor accident happens nearby, the danger is very catastrophic and dreadful.
Benefit perception (B)	B1	Nuclear research reactor can produce electricity.
	B2	Nuclear research reactor can do gem irradiation.
	B3	Nuclear research reactor can produce nuclear weapons.
	B4	Nuclear research reactor can produce radiopharmaceuticals.
	B5	Nuclear research reactor can do fruit radiation and sterile insect technique.
	B6	Nuclear research reactor construction can increase local employment opportunity and revenue.
	B7	Nuclear research reactor can increase the total revenue of Thailand.
	B8	Nuclear research reactor can improve Thailand's technology and science status.
Technology acceptance (A)	A1	Nuclear research reactor should be used in our country.
	A2	Nuclear research reactor construction, but the site should be somewhere far away.
	A3	It is acceptable to have a construction of nuclear research reactor nearby.
	A4	Nuclear research reactor construction is worthwhile.

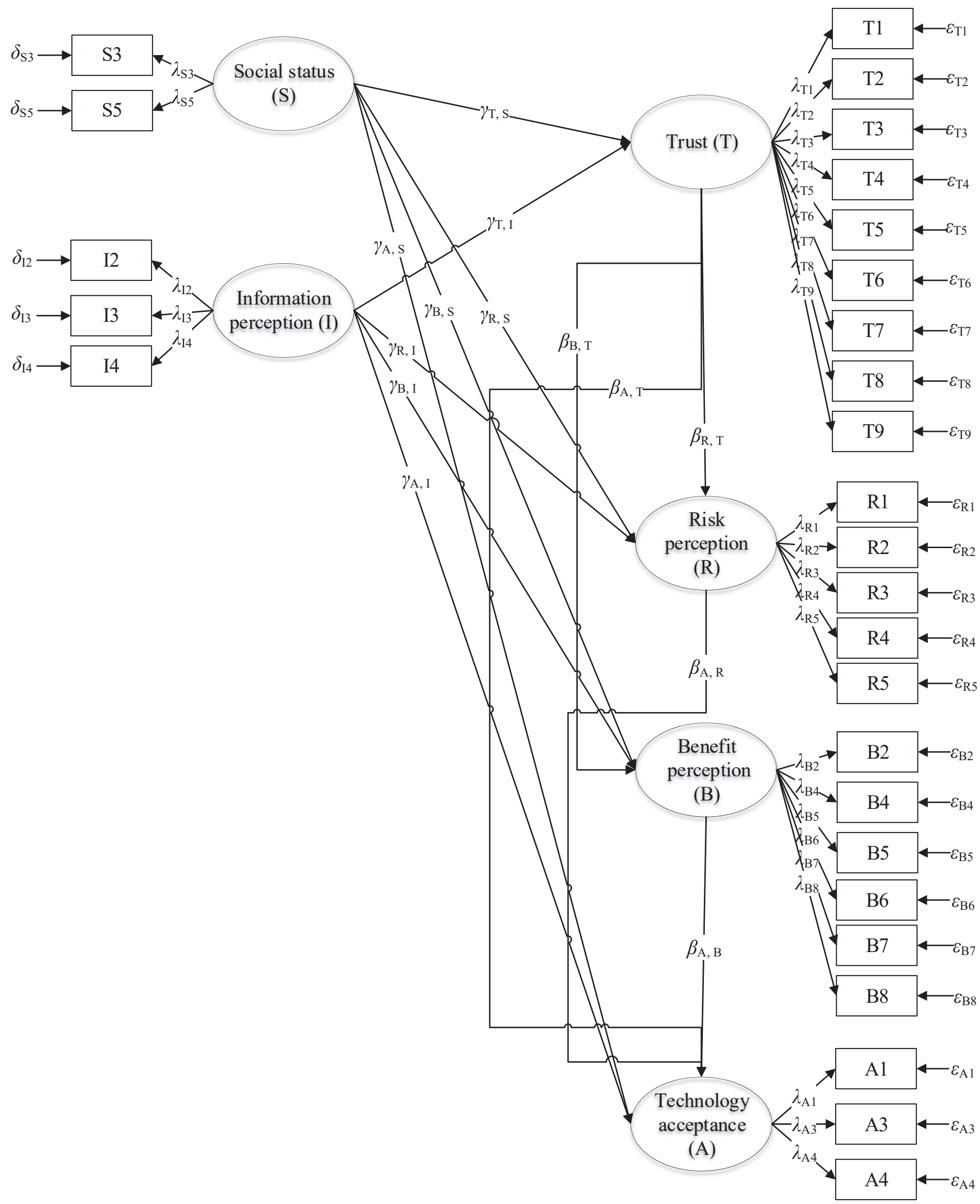

Fig. 1. Hypothesis model.

subdistricts population were 9,999 and 24,524, respectively. Hence, using the Yamane method with 90% confidence level [22], the minimum numbers of samples were calculated to be 99 $\left(number\ of\ samples = \frac{9999}{1+9999(0.1)^2}\right)$ and 100 $\left(number\ of\ samples = \frac{24524}{1+24524(0.1)^2}\right)$ for the inner and the outer perimeters, respectively.

2.2. Questionnaire design

The survey included demographics and residential location, and questions regarding to perceptions on the new nuclear research reactor. Six latent variables—Social status, information perception, trust, risk perception, benefit perception, and technology acceptance—were of interest. Table 1 shows the 5-point Likert scale questionnaire used in Joshi et al. [23] explained that the construction of Likert scales was rooted into the aim to understand about the perceptions/opinions of participants related with the assumed latent variable. In these questions, there were several

Table 2
The measurement model constructs reliability.

Latent Variable	Cronbach Alpha Coefficient
Inner zone	0.819
Information perception (I)	0.607
Trust (T)	0.832
Risk perception (R)	0.697
Benefit perception (B)	0.790
Technology acceptance (A)	0.642
Outer zone	0.802
Information perception (I)	0.601
Trust (T)	0.858
Risk perception (R)	0.736
Benefit perception (B)	0.746
Technology acceptance (A)	0.666

referrals to TINT since it was the agency that was mainly responsible for public communication with the public regarding to installation of the new nuclear research reactor.

Besides the Likert-scale questions, other questions such as social status and residential location [8,20] were included. These social status questions were represented in IDs S1–S7 and D1. S1–S7 and D1 were sex, age, education, occupation, household monthly income, whether the public was working with TINT, whether the public had close friends or acquaintances working at TINT, and location, respectively.

2.3. Data collection

There were in total 416 survey respondents. The number of 116

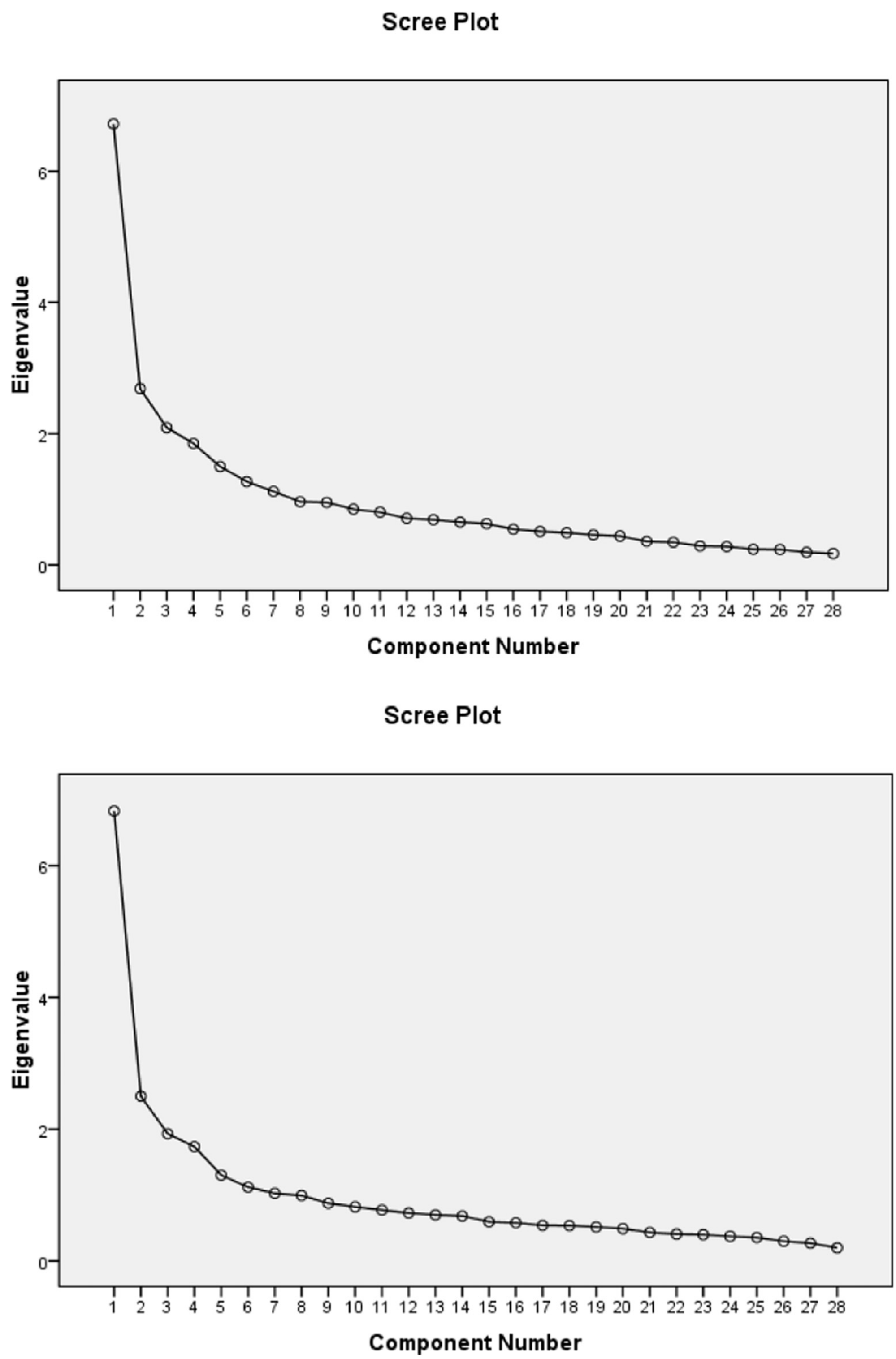

Fig. 2. Scree plots of the inner (top) and the outer (bottom) perimeters.

locals were collected in the inner subdistricts. The number of 300 locals were collected in the outer subdistricts.

2.4. Path structure of variables

We determined the paths based on our previous study [20], nuclear power plant studies and hypotheses from TINT expert opinions. From literatures, it was found that social status seemed to directly affect risk perception [24,25], benefit perception [25], and technology acceptance [26]. Information perception seemed to directly affect risk perception [2,27,28], benefit perception [2,27], and technology acceptance [8,27,29,30]. Studies also showed that social status [31,32] and information perception [17,33] affected trust. Trust seemed to directly affect risk perception [2,9,12,15,17,19], benefit perception [2,9,12,15,19], and technology acceptance [8,17,30], and also incurred an indirect impact on technology acceptance (via risk, benefit perception) [2,9,12,15,19]. Moreover, risk perception seemed to directly affect technology acceptance [2,8,9,12,15,17,27,30] and benefit perception seemed to directly affect technology acceptance [2,8,9,12,15,27,30]. Hence, trust, risk perception, and benefit perception were treated as the intervening variables in our model.

The hypothesis model was created by reviewing the relationships between factors, γ_{ji} and β_{jk}, where γ_{ji} was the relationship between exogenous i and endogenous j variable and β_{jk} was the relationship within the endogenous j and k variables. Factor loading of an observed variable l was represented as λ_l. Standard deviations of the observed variable l, δ_l or ε_l, were either for exogenous or for endogenous variable, respectively. The structure was shown in Fig. 1.

From Fig. 1, variables S1, S2, S4, S6, S7, D1, I1, B1, B3, and A2 from the questionnaire were omitted. Variables S1, S4, S6, S7 and D1 were the general data of the respondents which seemed not to be reasonable to include in the analysis and were not an ordinal question. Variable S2 was omitted since the distribution of the age was not significant. Variables I1 and A2 were asked to check for the responders' consistency in the answers; hence, it was redundant. Variables B1 and B3 were false questions to confirm the knowledge level of the responders, and were thus omitted.

From Fig. 1, hypotheses were formulated based on the SEM model. Those include the following:

1. S→A: There is a direct effect from social status (S) toward technology acceptance (A).
2. I→A: There is a direct effect from information perception (I) toward technology acceptance (A).
3. S→R→A: There is an indirect effect from social status (S) toward technology acceptance (A) via risk perception (R).
4. S→B→A: There is an indirect effect from social status (S) toward technology acceptance (A) via benefit perception (B).
5. I→R→A: There is an indirect effect from information perception (I) toward technology acceptance (A) via risk perception (R).
6. I→B→A: There is an indirect effect from information perception (I) toward technology acceptance (A) via benefit perception (B).
7. S→T→R→A: There is an indirect effect of social status (S) toward technology acceptance (A) through trust (T) and risk perception (R).
8. S→T→B→A: There is an indirect effect of social status (S) toward technology acceptance (A) through trust (T) and benefit perception (B).
9. I→T→R→A: There is an indirect effect of information perception (I) toward technology acceptance (A) through trust (T) and risk perception (R).
10. I→T→B→A: There is an indirect effect of information perception (I) toward technology acceptance (A) through trust (T) and benefit perception (B).

After the hypotheses were formulated, model identification was conducted to test whether the model was sufficient to further analyze the relationships among all variables. The model identification was based on Schumacker and Lomax [34] provided that the number of equations must be greater than that of the estimated parameters or models should be over identified or exact identified. This model was over identified.

3. Results

3.1. Reliability and validity of the measurement variables

All key indicators suggested that the model was sufficient for further analysis. The results of KMO for the inner and the outer perimeters showed that sample indices were sufficient. The sizes of the observed coefficients to the sizes of the partial correlation coefficients for the sum of analysis variables were 0.784 and 0.856 for the inner and the outer perimeters, respectively. Both values were greater than 0.5. This indicated that a factor analysis may be useful with our data. In addition, supposition test of sphericity by the Bartlett test (H_o: All correlation coefficients are not quite far from zero) was rejected on a level of statistical significance ($p \leq 0.05$). Consequently, the coefficients were not all zero, so that the second acceptance of factor analysis was satisfied.

All diagonal values in the anti-image correlation matrices of both the inner and the outer subdistricts were all greater than 0.5. Moreover, the communalities of both the inner and the outer zones were mostly greater than 0.4 except for the extraction value of I2 (0.398) in the inner zone. However, since I2 was included in the outer zone, we also included I2 to in the outer zone since the communality of I2 was still very close to 0.4. According to Osborne et al. [35], these cut-offs for the anti-image correlation matrices and the communalities were recommended.

Additionally, Cronbach alpha coefficients of the public for the inner and the outer zones were shown in Table 2 below. All variables had Cronbach alpha coefficients of at least 0.6 which passed the construct reliability criteria [36]. Note that Cronbach alpha coefficient could not be obtained for the social status since the

Table 3
Factor loadings of the CFA for the inner zone.

Group	Observed variable								
S	S3	S5							
Λ	1.01**	0.34***							
SE	0.46	0.18							
I	I2	I3	I4						
Λ	0.51*	0.58*	0.66*						
SE	0.11	0.10	0.11						
T	T1	T2	T3	T4	T5	T6	T7	T8	T9
Λ	0.59*	0.81*	0.77*	0.49*	0.62*	0.68*	0.69*	0.38*	0.52*
SE	0.09	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09
R	R1	R2	R3	R4	R5				
Λ	0.38*	0.58*	0.73*	0.54*	0.58*				
SE	0.10	0.10	0.10	0.10	0.10				
B	B2	B4	B5	B6	B7	B8			
Λ	0.54*	0.63*	0.62*	0.55*	0.76*	0.66*			
SE	0.09	0.09	0.09	0.09	0.09	0.09			
A	A1	A3	A4						
Λ	0.48*	0.65*	0.74*						
SE	0.10	0.10	0.10						

Based on the $t_{0.01,115} > 2.619$, *p < 0.01; $t_{0.05,115} > 1.981$, **p < 0.05; $t_{0.20,115} > 1.289$, ***p < 0.20.

Table 4
Factor loadings of the CFA for the outer zone.

Group	Observed variable								
S	S3	S5							
Λ	1.01**	0.34***							
SE	0.46	0.18							
I	I2	I3	I4						
Λ	0.51*	0.58*	0.66*						
SE	0.11	0.10	0.11						
T	T1	T2	T3	T4	T5	T6	T7	T8	T9
Λ	0.59*	0.81*	0.77*	0.49*	0.62*	0.68*	0.69*	0.38*	0.52*
SE	0.09	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09
R	R1	R2	R3	R4	R5				
Λ	0.38*	0.58*	0.73*	0.54*	0.58*				
SE	0.10	0.10	0.10	0.10	0.10				
B	B2	B4	B5	B6	B7	B8			
Λ	0.54*	0.63*	0.62*	0.55*	0.76*	0.66*			
SE	0.09	0.09	0.09	0.09	0.09	0.09			
A	A1	A3	A4						
Λ	0.48*	0.65*	0.74*						
SE	0.10	0.10	0.10						

Based on the $t_{0.01,115} > 2.619$, *$p < 0.01$; $t_{0.05,115} > 1.981$, **$p < 0.05$; $t_{0.20,115} > 1.289$, ***$p < 0.20$.

questions were not in Likert scale.

Confirmatory Factor Analysis (CFA) was performed to measure how well each latent variable represents the observed variables. Scree plots were observed to determine the number of latent variables shown in Fig. 2. From these scree plots, it was reasonable to select any number of factors ranging between 6 and 9. We decided to have six latent variables for both zones since the explanations of the latent factors made the most sense. The total variance explained were 57.55% and 55.06% for the inner and the outer zones, respectively.

The goodness of fit analysis of the CFA showed that χ^2/df were equal to 1.16 and 1.32 for the inner and the outer zones, respectively. For both zones, the CFI, NNFI, and IFI were greater than 0.95, the SRMR were less than 0.08, and the RMSEA were less than 0.05. These measurement indices fulfilled the cut-off values. Thus, this result indicated that the construct validity was satisfied.

The factor loadings of the observed variables toward their latent variables and their standard errors were shown in Tables 3 and 4. The asterisk symbols in these tables indicated the significant levels of effects (* was for 99% confidence level, ** was for 95% confidence level, and *** was for 80% confidence level). The results showed that almost all factors were significant at 99% confidence level. Only S3 and S5 were significant at 95% and 80% confidence levels, respectively. Since the latent variables S and its observed variables S3 and S5 were included in the outer zone (with significant level of 99%), for comparison purpose, we also included these variables in the SEM for the inner zone.

3.2. Structural equation modeling (SEM)

All goodness of fit criteria were met for both the inner and the outer zones. Specifically, for the inner zone, the $\chi 2$/df = 1.12, CFI = 0.96, NNFI = 0.96, IFI = 0.96, SRMR = 0.077, and RMSEA = 0.032. For the outer zone, the $\chi 2$/df = 1.54, CFI = 0.97, NNFI = 0.96, IFI = 0.97, SRMR = 0.061, and RMSEA = 0.042.

The coefficients, t-values and the standard errors of the

Table 5
Effect decomposition the exogenous on endogenous variables for the inner zone.

	Gamma coefficient (γ_{ji}) (*t*-value, SE value)	
Endogenous variables	Exogenous variables	
	Social status	Information
Trust		
Direct effect	−0.11 (−0.96, 0.11)	0.71 (**4.64***, 0.15)
	−0.11 (−0.96, 0.11)	0.71 (**4.64***, 0.15)
Total effect	0.11 (0.96, 0.11)	−0.05 (−0.26, 0.18)
Risk perception		
Direct effect	0.11 (0.96, 0.11)	−0.05 (−0.26, 0.18)
Indirect effect	0.03 (0.84, 0.03)	−0.18 (**-1.49*****, 0.12
Total effect	0.14 (1.10, 0.13)	−0.23 (**-1.62*****, 0.14)
Benefit perception		
Direct effect	0.13 (1.04, 0.12)	−0.24 (−1.17, 0.21)
Indirect effect	−0.09 (−0.93, 0.10)	0.61 (**3.11***, 0.20)
Total effect	0.03 (0.30, 0.11)	0.37 (**2.44****, 0.15)
Technology acceptance		
Direct effect	−0.16 (−1.09, 0.15)	0.05 (0.22, 0.22)
Indirect effect	0.02 (0.17, 0.10)	0.24 (1.26, 0.19)
Total effect	−0.14 (−1.01, 0.14)	0.29 (**1.78*****, 0.16)

	Beta coefficient (β_{jk}) (*t*-value, SE value)		
Endogenous variables	Endogenous variables		
	Trust	Risk	Benefit
Risk perception			
Direct effect	−0.26 (−1.51***, 0.17)	–	–
Total effect	−0.26 (−1.51***, 0.17)	–	–
Benefit perception			
Direct effect	0.86 (3.67*, 0.24)	–	–
Total effect	0.86 (3.67*, 0.24)	–	–
Technology Acceptance			
Direct effect	−0.16 (−0.58, 0.28)	−0.21 (−1.26, 0.16)	0.83 (2.89*, 0.15)
Indirect effect	0.77 (2.57**, 0.30)	–	–
Total effect	0.61 (2.64*, 0.23)	−0.21 (−1.26, 0.16)	0.83 (2.89*, 0.15)

*Based on the $t_{0.01,115} > 2.619$, *$p < 0.01$; $t_{0.05,115} > 1.981$, **$p < 0.05$; $t_{0.20,115} > 1.289$, ***$p < 0.20$.*

Table 6
Effect decomposition the exogenous on endogenous variables for the outer zone.

Gamma coefficient (γ_{ji}) (*t*-value, SE value)		
Endogenous variables	Exogenous variables	
	Social status	Information
Trust		
Direct effect	−0.32 (−2.61*, 0.12)	0.63 (5.35*, 0.12)
Total effect	−0.32 (−2.61*, 0.12)	0.63 (5.35*, 0.12)
Risk perception		
Direct effect	−0.07 (−0.59, 0.12)	0.18 (1.34***, 0.13)
Indirect effect	0.17 (2.10**, 0.08)	−0.32 (−3.15*, 0.10)
Total effect	0.10 (0.91, 0.11)	−0.14 (−1.61***, 0.09)
Benefit perception		
Direct effect	0.11 (0.86, 0.12)	0.08 (0.63, 0.13)
Indirect effect	−0.18 (−2.20**, 0.08)	0.34 (3.57*, 0.10)
Total effect	−0.07 (−0.61, 0.12)	0.43 (4.05*, 0.11)
Technology acceptance		
Direct effect	0.01 (0.089, 0.12)	−0.02 (−0.13, 0.14)
Indirect effect	−0.13 (−1.12, 0.12)	0.46 (3.70*, 0.13)
Total effect	−0.12 (−0.96, 0.13)	0.45 (4.10*, 0.11)

Beta coefficient (β_{jk}) (*t*-value, SE value)			
Endogenous variables	Endogenous variables		
	Trust	Risk	Benefit
Risk perception			
Direct effect	−0.51 (−3.75*, 0.14)	–	–
Total effect	−0.51 (−3.75*, 0.14)	–	–
Benefit perception			
Direct effect	0.55 (4.19*, 0.13)	–	–
Total effect	0.55 (4.19*, 0.13)	–	–
Technology Acceptance			
Direct effect	0.19 (1.23, 0.16)	−0.18 (−2.03**, 0.09)	0.74 (4.56*, 0.16)
Indirect effect	0.50 (3.70*, 0.14)	–	–
Total effect	0.69 (4.95*, 0.14)	−0.18 (−2.03**, 0.09)	0.74 (4.56*, 0.16)

*Based on the $t_{0.01,299} > 2.592$, *p < 0.01; $t_{0.05,229} > 1.968$, **p < 0.05; $t_{0.20,229} > 1.284$, ***p < 0.20.*

hypothesized structural model for the inner and the outer perimeters were shown in Tables 5 and 6, respectively. The values in these two tables without the parentheses were the coefficients of the exogenous on endogenous and among endogenous variables. The values inside the parentheses were the t-values and standard errors. Asterisk symbols show significant levels (the same meaning as those in Tables 3 and 4 described earlier).

Tables 7 and 8 showed factor loadings of the observed variables and their standard errors (underneath the factor loading values) after model modification for the inner and the outer perimeters, respectively.

From these tables and Figs. 3–4 (which showed the coefficients graphically), hypothesis 1 (S→A) did not show significant effect for both inner and outer zones. Hypothesis 2 (I→A) was rejected for both areas. We also failed to accept hypotheses 3 (S→R→A) and 4 (S→B→A) for both areas. Hypothesis 5 (I→R→A) was accepted at 80% confidence level in the outer zone; while hypothesis 6

Table 7
Factor loadings of the CFA for the inner zone.

Group	Observed variable								
S	S3	S5							
Λ	1.04**	0.33***							
SE	0.52	0.19							
I	I2	I3	I4						
Λ	0.52*	0.58*	0.66*						
SE	0.11	0.10	0.10						
T	T1	T2	T3	T4	T5	T6	T7	T8	T9
Λ	0.89	0.78*	0.75*	0.49*	0.60*	0.67*	0.66*	0.37*	0.51*
SE	–	0.12	0.12	0.10	0.11	0.13	0.11	0.09	0.10
R	R1	R2	R3	R4	R5				
Λ	0.37	0.72*	0.93*	0.53**	0.59*				
SE	–	0.26	0.33	0.21	0.23				
B	B2	B4	B5	B6	B7	B8			
Λ	0.55	0.57*	0.51*	0.57*	0.65*	0.52*			
SE	–	0.12	0.10	0.14	0.13	0.12			
A	A1	A3	A4						
Λ	0.47	0.64*	0.64*						
SE	–	0.16	0.16						

Based on the $t_{0.01,115} > 2.619$, *p < 0.01; $t_{0.05,115} > 1.981$, **p < 0.05; $t_{0.20,115} > 1.289$,***p < 0.20.
T1, R1, B2, A1 have no SE values as they are fixed parameters.

Table 8
Factor loadings of the CFA for the inner zone.

Group	Observed variable								
S	S3	S5							
Λ	0.50*	0.47*							
SE	0.12	0.12							
I	I2	I3	I4						
Λ	0.55*	0.44*	0.63*						
SE	0.07	0.07	0.07						
T	T1	T2	T3	T4	T5	T6	T7	T8	T9
Λ	0.56	0.64*	0.80*	0.72*	0.67*	0.76*	0.68*	0.41*	0.54*
SE	–	0.08	0.08	0.90	0.07	0.09	0.08	0.06	0.08
R	R1	R2	R3	R4	R5				
Λ	0.53	0.74*	0.92*	0.61*	0.49*				
SE	–	0.11	0.13	0.09	0.09				
B	B2	B4	B5	B6	B7	B8			
Λ	0.62	0.50*	0.47*	0.63*	0.66*	0.60*			
SE	–	0.07	0.08	0.09	0.09	0.09			
A	A1	A3	A4						
Λ	0.68	0.59*	0.68*						
SE	–	0.07	0.08						

Based on the $t_{0.01,299} > 2.592$, *p < 0.01.
T1, R1, B2, A1 have no SE values as they are fixed parameters.

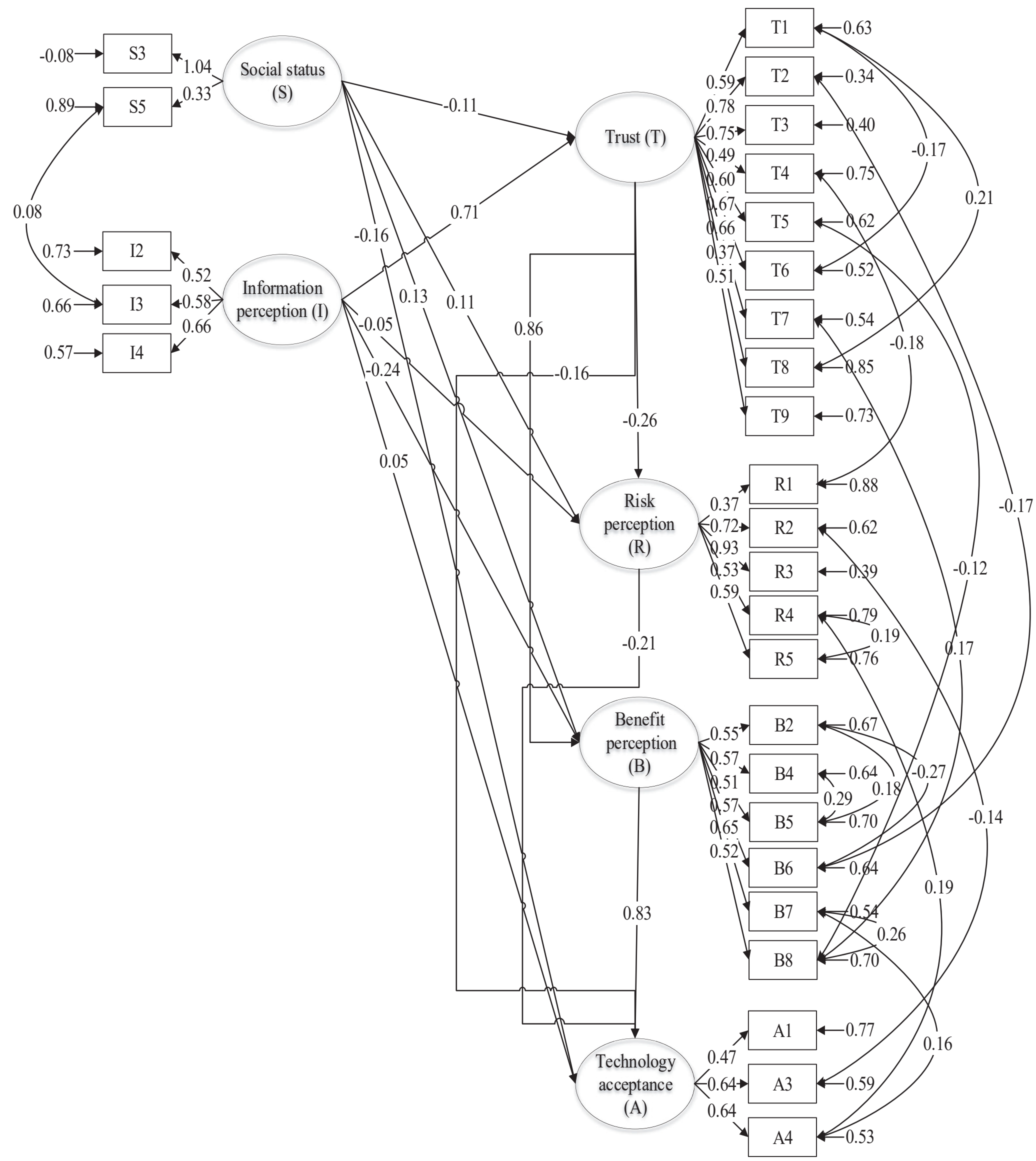

Fig. 3. Coefficients in the structural model for the inner zone.

(I→B→A) was rejected for both areas.

When trust was the intermediate factor, effects were stronger than the previous hypotheses (i.e., higher confidence levels). Hypotheses 7 and 8 (S→T→R→A and S→T→B→A) were both accepted at confidence level of 99% for the outer zone. For the inner zone, we reject these hypotheses since the impact from S to T for the inner zone was not significant. Hypothesis 9 (I→T→R→A) was accepted at 99% confidence level for the outer zone. For the inner zone, this hypothesis was accepted at 80% confidence level only for the chain (I→T→R). Hypothesis 10 (I→T→B→A) was the strongest effect. The hypothesis was accepted at 99% confidence level for both areas. Overall, effects in the outer zone were slightly stronger than those in the inner zone.

In terms of factor loadings for the observed variables shown in Tables 7 and 8, almost all factors were significant at confidence level of 95%. For the inner zone, S5 was accepted at 80% confidence level. The results for both areas showed that factors T1, R1, B2, and A1 were not significant. On the other hand, Table 9 showed the factors with the highest loadings for each latent variable. Note that since the number of observed variables in social status was too small, we omitted the explanation of factor loadings for this latent variable.

4. Discussion

The correlations between I→T→B→A found in this study was supported by Komiak and Ilyas [33] who stated that higher perceived information could increase trust. Increase in trust from perceived information on nuclear research reactor observed in this study was similar to the correlation found in online reputation system [33]. Even if the contexts between nuclear research reactor and online reputation system were different, it was still reasonable to presume that these relationships were valid in many applications.

For the outer perimeter, one result showed that information perception directly impacted risk perception in a positive manner. Thus, the TINT needed to be careful when providing information directly to the public since risk perception could increase. The results were consistent with those found in a few literatures. Stoutenborough and Vedlitz [29] and Roh and Kim [37] mentioned that

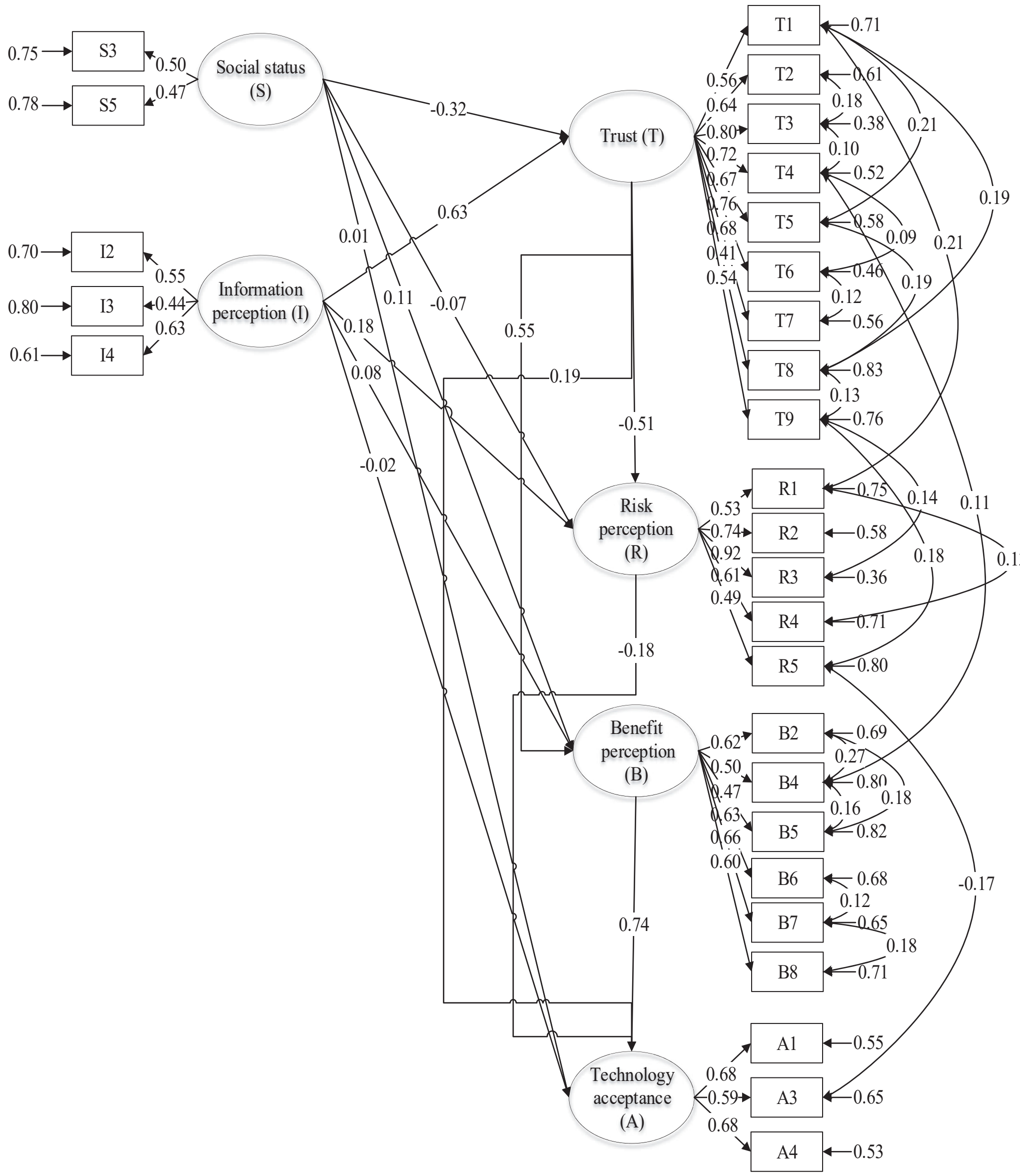

Fig. 4. Coefficients in the structural model for the outer zone.

Table 9
Factors with the highest loadings for each latent variable.

Latent variables	Factors/Questions with high loadings
Information Perception (I)	I4. You know how nuclear research reactor operates.
Trust (T)	T3. You agree that nuclear research reactor is safe.
Risk Perception (R)	R3. If you resides near the nuclear research reactor site, you feel very terrified.
Benefit Perception (B)	B6. You believe that nuclear research reactor construction can increase local employment opportunity and revenue.
	B7. You believe that nuclear research reactor can increase the total revenue of Thailand.
Technology Acceptance (A)	A4. You agree that nuclear research reactor construction is worthwhile.

public memory of the Fukushima nuclear accident was still fresh resulting in risk perception that was more than normal. Secondly, Zhu et al. [38] mentioned that it was hard to decrease risk perception by increasing public knowledge since the public had low perceived knowledge and are unfamiliar about nuclear energy. Thus, they had limited positive and negative information led to low-risk perception. Thirdly, Sjöberg and Drottz-Sjöberg [39] stated that negative information could easily lead to incorrect ideas and misconceptions of nuclear energy, resulting in high risk perception. Other studies [40–42] also had consistent results with our I→R relationship.

The I→R relationship was significant only in the outer zone. This may due to the fact that Thailand had not personalized the experience of the nuclear accident. Studies in the area where the long-operational nuclear power plant had never encountered any accidents showed that people living near the power station had more positive attitude toward nuclear energy [40,41] and were less likely to identify risks associated with nuclear energy production [42]. In other cases where people can establish strong connection between themselves and the nuclear accident, a U-shaped relationship between the acceptance of nuclear power and the residential proximity was observed [43]. People living in direct vicinity and those living far away from the nuclear power station had a larger tendency of accepting nuclear power production than those living in between. This may also be similar for the case of nuclear research reactor in Thailand.

For the I→T→R relationships, there were several researchers who explored the relationship between trust and risk perception in nuclear energy. For example, Xiao et al. [15], Ryu et al. [17] and Li et al. [19] found that when increasing trust, risk perception was decreased.

In terms of factor loadings for the observed variables, the major results showed that R3 was the most explicit significant factor. This showed that the public residing near the nuclear research reactor site still felt very terrified if the reactor was constructed in their area. This phenomenon was consistent to the NIMBY characterization (the public oppose to the building of land in their immediate area but bringing lots of negative externalities to their back yard) [44].

5. Conclusions

The strongest relationship from our hypothesized structure was the impact from information perception to technology acceptance via trust and benefit perception. This result implied that in order to eventually achieve technology acceptance from the locals, TINT's strategy should focus on first building trust from the locals. This could come from providing information to the public, especially focusing on the information of benefits from the new nuclear research reactor.

We also found that information perception directly increased risk perception in the outer perimeter, but this relationship was not significant for the inner perimeter. Since Thailand had never experienced any severe nuclear-related incident, the people living near the proposed research reactor had more positive attitude toward nuclear technology than those living farther away. Furthermore, if TINT aimed to acquire acceptance on the research reactor technology, it might be useful to extend information distribution, especially those related to benefits from the reactor, to the people in the outer perimeter.

Our findings shed some lights on the public communication strategy for the government (via the TINT). The main concern for constructing the communication strategy must be to provide complete information regarding the research reactor construction. The increase in employment opportunity and the total revenue of local and country could be provided. Information regarding to the research reactor operation to make people feel that the reactor was safe should also be available, mainly to build trust. Finally, providing information that the reactor was worthwhile to the country and to the locals could make the acceptance in nuclear research reactor.

The study could be improved for better results. In this study, even if samples were randomly selected, those answered the questionnaire may be the ones who were already familiar with the technology to some extent. Perhaps, other sampling methods could be used in the future studies. Also, behavioral theories related to risk and benefit perceptions such as cognitive skills and perception of danger could also be included to explore risk assessment of the people.

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.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.net.2020.05.013.

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