A CONCEPTUAL FRAMEWORK OF A MODIFIED TAM AND TRA MODEL IN THE INTENTION TO USE ELECTRICITY FROM NUCLEAR POWER ADOPTION IN THAILAND

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Abstract— The demand for electricity increase every year depended on economic growth. Accordingly, Thai government plan to seek the new sources of energy to fulfill electricity capacity and reduce fossil fuels called Power Development Plan (PDP). The nuclear power technology is one of the new sources that can produce more electricity, low environmental impact and low production cost per unit. In addition, the public attitude of broad citizen is the main factor driving the Nuclear Power Plant (NPP) project in Thailand. However, after the Fukushima accident affected public attitudes toward NPPs then the governments around the world have revised the NPP projects. Nonetheless, there is insufficient research in public attitude on developing countries like Thailand and limited understanding of the underlying factors that affect its adoption. Hence, in this paper we developed a conceptual framework of a Technology Acceptance Model (TAM) and Theory of Reason Action model (TRA) with knowledge factors towards the intention to use electricity of nuclear power in Thailand. However, the paper's approach is based on an in-depth literature review.

Keywords— Nuclear power, Electricity, TAM, TRA, Intention to use**.**

I. INTRODUCTION

Nuclear power plants have been considered viable for electrical generation to compensate the diminishing fossil fuels, especially when considering environmental impacts, the stability in power of the country and production cost [1]. In 2014, there were 436 nuclear power plants (NPPs) in 29 countries, which contributed 11.5% of world electricity production [2]. Recently, 48 countries have proposed to operate 322 NPPs within 15 years [3] which will contribute 15 – 20% of world electricity production [2]. Among these nations, Thailand planned to build 4 of 1,000 MWe nuclear power plants in 2020 to meet the increasing demand for electricity every year.

However, after the nuclear accident at Fukushima in March 2011 the ongoing nuclear power projects have been reconsidered. Apparently, the Fukushima accident has influenced the intention to use nuclear power around the world [4, 5]. For example, the U.S. government has stopped the future NPP projects [6]. In addition, the German government has reduced the number of the proposed NPP projects [7]. Furthermore, South Korea, China and India have reduced the number of their new NPP projects [8]. Likewise, the Fukushima accident has affected Thailand's decision on the NPP plans. The Thai government canceled 2 NPPs in the Power Development Plan (PDP). Moreover, it has delayed the construction of NPPs for 3 years. It has assigned the responsible government agencies to review the nuclear safety, legislative, regulatory frameworks and stakeholder involvement [9].

Nonetheless, two years after the Fukushima accident the Japanese government has operated the NPPs again since November 2014 for energy sustainability in the long term, and low electricity cost of the country. Sooner or later, Thailand will move forward to launch NPP projects to gain competitive advantages for domestic industries. Nuclear power is the technology that produces electricity with lowest cost per unit, providing sufficient energy quantities [10] and low environmental impacts.

The knowledge, opinions and attitudes of people in the country are the key factors that can speed up or delay NPP projects. However, there have been few studies on the factors influencing public attitudes toward NPPs around the world [11, 12, 13, 14, 15] and the knowledge factors affecting public attitudes toward electricity production from NPPs [16, 17, 18]. Regardless, Judith and Linda [19] showed that the public had positive intention to use electricity from NPP in the Netherlands. In Thailand,Bhanthumnavin and Bhanthumnavin[20] reported on the factor analysis of public opinions and attitudes of undergraduate students about nuclear power. Although some literature is available on public knowledge, attitudes and social influence of nuclear power plants, little information is available on the public intention to use electricity from NPPs.

In particular, there has not been NPP's research that focuses on public knowledge, TRA model and its linkage to the intention to use electricity from nuclear power plants in broad citizens. Therefore, the purpose of this study was to investigate these factors in Thailand. The factors under investigation in this study could be of importance in developing the Technology Acceptance Model for nuclear technology acceptance and the

Thai government could plan activities to educate the public and boost public support for NPP projects.

II. CONCEPTUAL DEVELOPMENT

2.1. Technology Acceptance Model (TAM)

Davis [21] presented the relationship between external variables, internal beliefs variables, attitude and intention to use information technology as known as Technology Acceptance Model (TAM). The model could show the relationship and predict the level of acceptance and the intention to use the new information technology. Many scholars applied TAM to test the acceptance and intention to use new technologies in many fields for two decade such as IT field [22], e-learning field [23] and renewable energy field [18, 24].

Marangunić and Granić [25] reported that there have been more than 80 studies applied TAM since 1989 and concluded the extension of TAM by four main factors (external predictors, factors from other theories, contextual factors and usage measure) as shown in Fig.1.

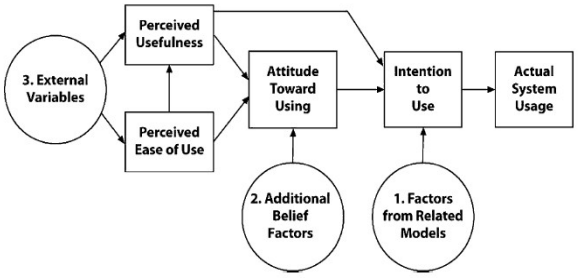

Fig.1 The extensions of TAM(Marangunić and Granić [25])

2.2. Theory of Reason Action Model (TRA)

The Theory of Reason Action Model (TRA) was presented by Ajzen and Fishbein[26] studied in psychology field that has been used broadly to predict and explain human behavior in various domains. It based on hypothesis that human do anything with reason and use information for decide and show behavior. The behavior can control and show the intention. There were 2 parts affected the intention before show behavioras shown in Fig.2. The first part was inside attitude concerning behavior that was behavioral belief . The second part was social influence that many scholars used as subjective norms that was normative belief motivated to comply with the referent. In recent years, TRA has been used to explain individuals' use in many fields such as IT field [27], e-learning field [28] and renewable energy field [29, 30].

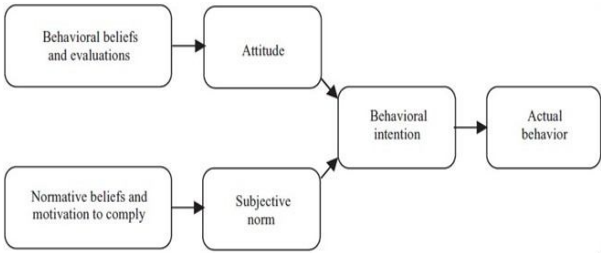

Fig.2 Theory of reasoned action(Ajzen and Fishbein [26])

2.3. Public Knowledge

Knowledge is an awareness or understanding of someone or something, such as facts, information, which is acquired through experience or education. Public knowledge is a key external factor affecting public attitude directly. There was a few research that studied in electricity production from nuclear technology showed that public knowledge had positive effect directly to public attitude toward NPPs. For example, Showers [16] reported that knowledge of student grade 10 – 12 in Pennsylvania and Ohio states had positive effect to their attitudes about nuclear power.Moreover, Kim et al. [18] showed that public knowledge of 19 countries which are the member of IAEA had positive effect to public acceptance about nuclear power.Furthermore, Stoutenborough et al. [31]reported that public knowledge had positive direct effect to nuclear power perception in USA.

2.4. Public Attitude and the Intention to use

There have been a few research studying on the relationship between public attitude and intention to use electricity from nuclear technology. Duff [32] showed that after the Fukushima accident American citizens had higher level of risk perception about intention to use electricity from NPPs. However, there have been a lot of studies in related fields. Hsinag-Yung Feng [33] applied theory of reasoned action, technology acceptance model and Roger's diffusion of innovation studied Taiwanese attitude toward renewable technology. He found that the level of education had positive effect to public attitude and the public attitude depending on perceived benefits and ease of use had positive effect to the intention to use technology. In addition, Claudy, Peterson and O'Driscoll [34] reported that public attitude toward renewable energy had positive effect to intention to use renewable energy in Ireland. Moreover, Read et al. [35] found the same result in Australia and Park and Ohm [24] showed after the Fukushima accident public attitude had positive relationship with intention to use renewable technology in south korea. Furthermore, Kim et al. [18] reported that public attitude and satisfaction had positive effect to intention to use solar energy technology in south korea.

2.5. Social influence and the Intention to use

Previous studies of the theory of reason action has identified that social influence have effect to the intention to use new technology. Hobman and Ashworth [36] showed that social influence and knowledge about nuclear technology had positive effect to support nuclear technology for electricity production in Australia. However, there have been many studies in the relationship between social influence and the intention to use new technology for electricity production. For example, Hsinag-Yung Feng [33] showed that social influence had positive

effect to intention to use renewable energy technology in Taiwan. In addition, Yun and Lee [30] found this same relationship in USA. However, Yazdanpanah, Komendantova and Ardestani[37] did not find this relationship in Iran. Moreover, Read et al. [29] reported that social influence also had positive effect to the intention to support the wind farm technology in Australia. In addition, Sang and Bekhet[38] found that social influence had positive effect to the intention to use electric vehicle in Malaysia.

2.6. Proposed Conceptual Framework (Fig.3)

The analysis of the above literatures have provided the ground work for the development of the conceptual model based on the suggested hypotheses (H1-H3). The conceptual model is proposed and shown in Fig. 3.

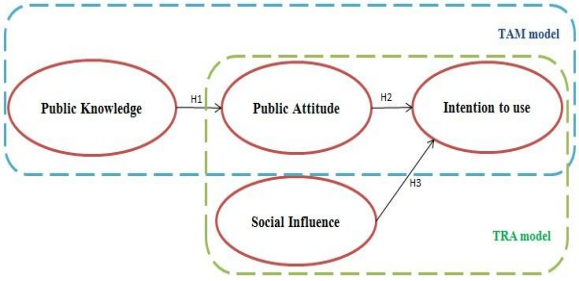

Fig.3. the conceptual framework mode

2.7. Research Hypothesis

H1: Public knowledge has positive effects on the public attitude toward electricity production from nuclear power plant.
H2: Public attitude toward NPPs has positive effect to the intention to use electricity from NPPs
H3: The social influence has positive effect to the intention to use electricity from NPPs

III. METHODOLOGY

To find the relationship between factors influencing the intention to use electricity from nuclear power plant, the population in this study included 20,452,075 Thai electricity users in 2013 [39]. The sample size depended on the method of Yamane [40], so the total sample size in this study was 400 people. Stratified random sampling technic was used in this study. The total sample size was split into 77 provinces in Thailand depending on electricity users ratio. Furthermore, Arikawa, Cao and Matsumoto [41] showed that the level of education had positive effect to public attitude toward NPP after Fukushima accident. Nuclear technology is specific, high technology and there have not been electricity production from NPPs in Thailand. Thus, the judgmental sampling technic was used focusing only the sample that graduated at least with a bachelor's degree. The survey was conducted from May - June 2016 by online survey using google doc program.

The main instrument in this study was the questionnaire developed based on previous studies in nuclear technology and renewable energy fields. The questionnaire consisted of two main parts. The first part collected general information of the respondents such as sex, age, education, province of living and income. The second part gathered opinions information of the samples and each question was related to the observed and latent variables in this study. All respondents answered each item in the second part by marking on a 7-point likert scale (from 1: strongly disagree to 7: strongly agree). The public knowledge in nuclear technology adopted thirteen items previously used by Kim et al. [18], Park and Ohm [24], Stoutenborough et al. [17]. The public attitude toward NPP was examined by nine items from Kim et al. [18] and Bhanthumnavin and Bhanthumnavin [20]. The social influence contained fifteen items adopted from Yun and Lee [30], Bronfman et al. [12], Hobman and Ashworth [36], and Römer et al. [42]. The intention to use electricity from NPP adopted nine items previously used by Kim et al.[18], Park and Ohm [24] andHsinag-Yung Feng [33].

To clarify and increase the validity of the survey questionnaire, it was examined by 5 professional experts who are specialized in nuclear technological innovation and electrical production studies. Where the meaning was ambiguous or the questions were redundant, the questionnaire items were reviewed and modified accordingly. In addition, we could eliminate several poor items, which were not able to satisfy the threshold value of item-to-total by calculating Cronbach's alpha. Therefore, all Cronbach's alpha values of the final pre-testing were acceptable (more than 0.7; Cronbach [43]).

The Structural Equation Modeling (SEM) approach was used to test the hypothesized model. The parameters of the model were computed using the program AMOS version18. The Comparative Fit Index (CFI) and residuals values were used as criteria to assess the model's fit. The proportion of variance explained by each model was measured using the Squared Multiple Correlations (R^2_{SMC})

CONCLUSION

The research on public attitude toward nuclear power in developing countries especially Thailand has not been sufficiently researched. Considering the rarity of research in the intention to use electricity from nuclear technology especially with the use of the Technology Acceptance model (TAM) or Theory of Reason Action model (TRA), this paper investigates the TAM and TRA model and proposed a modification specifically with regards to knowledge factor and the perceived risks for the integration of

these constructs into the model in context of Thailand.

However, the research presented is limited being that, the proposed framework is based on literature review in nuclear energy and renewable energy fields. The paper proposes a conceptual framework for the intention to use electricity from nuclear power in Thailand. Consequently, further research would focus on empirical validity and reliability of this conceptual framework.

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