CHAPTER 2

Theories and Literature Reviews

For the study of Public Decision Making on Nuclear Power Plant Policy in Thailand under Asymmetric Information, the researcher studied relevant documents and literature reviews such as the following.

2.1 Theories

2.1.1 Asymmetric Information

Asymmetric Information means both players in the market do not have the same amount of information. The one who has more information is called the agent, and the other who has less information is called the principal. This advantage reflects two problems: moral hazard and adverse selection. The difference of this advantage is Asymmetric Information (Charin, 2005).

Information Asymmetry can lead to two main problems:

1. Adverse selection immoral behavior takes advantage of asymmetric information before a transaction. For example, a person who is not in optimal health may be more inclined to purchase life insurance than anyone who feels fine.

2. Moral Hazard immoral behavior takes advantage of asymmetric information after a transaction. For example, if someone has fire insurance he or she may be more likely to commit arson to reap the benefits of the insurance.

Akerlof, Spence, and Stiglitz (1970) argued asymmetric information to Vickrey and Mirrlees the economic problems of the information, and the special case of asymmetric information had been under discussion for some time prior to the serious breakthroughs.

2.1.2 Transformations

A range of pre-defined transformation functions and a general transformation based upon the arithmetic expression evaluator were written. The subject of transformation can be especially confusing for the non-statistician for two main reasons.

First, transformations are performed for different purposes. Second, transformation changes the measurement scale of data; therefore, there is considerable scope to misconceive the use of transformed data (Bland and Altman, 1996; Armitage and Berry, 1994). Additional explanation on transforming data was thus added to the help system.

2.1.3 Logistic Regression

In case of one independent variable, the model of logistic regression can be written as follows:

$$\text{Prob(event)} = \frac{e^{\beta_0+\beta_1 X}}{1+ e^{-(\beta_0+\beta_1 X)}} \quad (1)$$

$$\text{or Prob(event)} = \frac{1}{1+ e^{-(\beta_0+\beta_1 X)}} \quad (2)$$

By

β_0 and β_1 = Estimated Coefficient from Data

X = Independent Variable

e =Natural Logarithms (Approximation is 2.718)

From the mentioned equation, we can write a new equation as follows:

$$\text{Prob (event)} = \frac{e^z}{1+ e^z} \quad (3)$$

$$\text{or Prob(event)} = \frac{1^{e^z}}{1+ e^{-z}} \quad (4)$$

By

$$Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p \quad (5)$$

And the probability of the event that may not happen can be guessed from the equation.

$$\text{Prob(no event)} = 1 - \text{Prob (event)} \quad (6)$$

In the linear regression analysis, the value of the parameter model is calculated by using the least squares by selecting regression coefficients that make the sum of the squared deviation.

$\left(\sum(Y - \acute{Y})^2\right)$ shows the least value. For the logistic regression, the value of parameter is evaluated by using maximum-likelihood that is iterative algorithm to get the value of parameter most similar to the empirical data.

2.1.4 Multiple Discriminant Analysis

Discriminant analysis is a suitable analysis technique for various variables that measures class interval or ratio to predict dependent variables that are variable groups or categorical variables. Variable groups may be classified into 2 groups or more. They are called two-group discriminant analysis. If they are divided into more than two groups, they are called multiple discriminant analysis: MDA.

For the multiple discriminant analysis, the squares show the relationship between dependent variables and independent variables as the following.

$$\hat{Y}_1 = a + b_{11}X_1 + b_{12}X_2 + \cdots + b_{1p}X_p \quad (7)$$

$$\hat{Y}_2 = a + b_{21}X_1 + b_{22}X_2 + \cdots + b_{2p}X_p \quad (8)$$

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$$\hat{Y}_1 = a + b_{k1}X_1 + b_{k2}X_2 + \cdots + b_{kp}X_p \quad (9)$$

By

$\hat{Y}_k$ = Dependent variable or discriminant score

b_{kp} =Coefficient of classification square

X_p =Independent variable

a = Constant

p =Number of Independent Variable

k = Number of Dependent Variable

2.1.5 Multinomial Logistic Regression Analysis

Logistic regression is an analysis technique to study the relationship between dependent variables and independent variables and it is used to calculate or predict the value of dependent variables in order to set the value of independent variables.

1. Binary logistic regression has two groups of dependent variables.

2. Multinomial logistic regression has two groups of dependent variables or more.

For the multinomial logistic regression, the predicted square from the analysis shows the probability of such interesting events as the following.

$$\hat{Y}_i = \frac{e^{u_i}}{\sum_{k=1}^{j} e^{u_k}} \tag{10}$$

$$u = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \tag{11}$$

By

$\hat{Y}$ = Probability of event *Y*

β_n = Coefficient of logistic regression

e = Exponential function

i = Dependent variable *i*

J = All variables

2.1.6 Chi-Square Test

Chi-square methods are presented to test the association between various forms of classification. Methods for common two-dimensional contingency tables including stratification are presented in an interactive form that is presented in the style of explanatory textbooks (Armitage and Berry, 1994; Agresti, 1996; Bland, 1996).

1) Two by two tables

The basic chi-square statistic for testing association is calculated as:

$$X^2 = \sum_{i=1}^{r}\sum_{i=1}^{n}\frac{(O_{ij}-E_{ij})^2}{E_{ij}} \quad (12)$$

For r rows and c columns of n observations, O is an observed frequency and E is an estimated frequency expectation. The expected frequency for any cell is estimated as the total row and columns, thendivided by the grand total (n).

Yates' continuity correction improves the approximation of the discrete sample chi-square statistic to a continuous chi-square distribution (Armitage and Berry, 1994):

$$\text{Yates}'\text{corrected } X^2 = \sum_{i=1}^{r}\sum_{i=1}^{n}\frac{(|O_{ij}-E_{ij}|-0.5)^2}{E_{ij}} \quad (13)$$

The user gave the option to calculate Fisher's exact test and is informed in the help text of Cochrane's rules (no expected frequency should be less than 1 and at least 80% of expected frequencies should be greater than 5).

The user prompted to specify the nature of the data; if they are from a case control study, the odds ratio (with confidence interval) is calculated. If they are from a cohort study, the relative risk (with confidence interval) is calculated.

2)Two by k tables

A two by $k$chi-square test is calculated for testing independence and linear trend in a series of k proportions.

The basic statistic for independence is calculated as:

$$X^2 = \sum_{i=1}^{r}\sum_{i=1}^{n}\frac{(O_{ij}-E_{ij})^2}{E_{ij}} \quad (14)$$

For r rows and c columns of n observations, O is an observed frequency and E is an estimated frequencyexpectation. The expected frequency for any cell is estimated as the row total times the column total divided by the grand total (n).

The linear trend statistic is calculated as (Armitage and Berry, 1994):

$$X^2_{trend} = \frac{\left[\sum_{i=1}^{k} r_i v_i - R\mu\right]^2}{p(1-p)\left[\sum_{i=1}^{k} n_i v_i^2 - N\mu^2\right]} \quad (15)$$

$$\mu = \sum_{i=1}^{k} \frac{n_i v_i}{N} \quad (16)$$

When each of k groups of observations is denoted as r_i successes out of n_i total with score v_i assigned. R is the sum of all r_i, N is the sum of all n_i, and $p = \frac{R}{N}$.

Goodness of fit

A distribution of classes of observations is compared to an expected distribution. The user is asked to prove data that consists of a random sample of independent observations, the expected distribution of which is specified (Armitage and Berry, 1994; Conover, 1999).

Pearson's chi-square goodness of fit test statistic is calculated as:

$$T = \sum_{j=1}^{c} \frac{(O_j - E_j)^2}{E_j} \quad (17)$$

When O_j is the observed count, Ej is the corresponding expected count, and c is the number of classes which counts/frequencies are being analyzed.

The user warned that "the test has relatively low power (chance of detecting a real effect) for all but has large numbers or big deviations from the null hypothesis (all classes contain observations that could have been in those classes by chance)" (Armitage and Berry, 1994; Conover, 1999).

The user also warned that the handling of small expected frequencies is controversial. Koehler and Larnz (1980) asserted that the chi-square approximation is adequately provided all of the following are true:

Total of observed counts (N) $\geq$ 10

Number of classes (c) $\geq$ 3

All expected values $\geq$ 0.25

2.1.7Statistical Significance (T-Test)

T-test is the student's explication to compare two averages. Besides, it shows the mean, standard deviation and standard error of each variable. The t-test can be used in two cases:

Case 1: If the two groups have no relationship that is called independent test. If the two groups have no relationship (dependent), the differences of averages of one group must be found and see if they are different from the other group. For example, we want to know that the learning achievement of the group who was taught by traditional method and the other group taught by a special method is different or not. In this case, the two groups are independent. We can set the hypothesis as the following.

Hypothesis 1 $H_0: \mu_1 = \mu_2$ (18)

$H_0: \mu_1 \neq \mu_2$

Or Hypothesis 2 $H_0: \mu_1 = \mu_2$ (19)

$H_0: \mu_1 > \mu_2$

Or Hypothesis 3 $H_0: \mu_1 = \mu_2$ (20)

$H_0: \mu_1 < \mu_2$

Calculation formula

First step, the variability of the two groups is different or not by using F-test as the following:

$$H_0: \sigma_1^2 = \sigma_2^2 \quad (21)$$

$$H_1: \sigma_1^2 \neq \sigma_2^2$$

Calculate by:

$$F = \frac{S_1^2}{S_2^2}; \qquad df_1 = n_1 - 1; df_2 = n_2 - 1 \quad (22)$$

In consideration of the values of F-test, if it is not significant ($Sig > \alpha$), that means H_0 is accepted and shows the same variability of two groups. Using the first formula, called Pooled Variance, ifF-Test is significant ($Sig < \alpha$), that means it refuses

H_0 but acceptsH_1.This shows the variability of the two groups are not equal. The second formula, called Separate Variance, is used instead.

Second step, formula selectionto calculate T-Test

Formula 1, when $\sigma_1^2 = \sigma_2^2$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}\left[\frac{1}{n_1} + \frac{1}{n_2}\right]}} \tag{23}$$

$$df = n_1 + n_2 - 2 \tag{24}$$

Formula 2, when $\sigma_1^2 \neq \sigma_2^2$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \tag{25}$$

$$df = \frac{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)^2}{\frac{\left(\frac{S_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{S_2^2}{n_2}\right)^2}{n_2 - 1}} \tag{26}$$

In consideration, if the statistic of *t* is not significant (Sig > α), it means $H_0$is accepted, and the average of the two group is not different. If the value of *t* is significant (Sig < α), $H_0$is refused, but$H_1$is accepted, and the average of the two groups is different (more or less).

Case 2: The sample groupsare related, called Pair t-test

If the two groups have relationship, the comparison of the average is different or not. The two averages are measured from the two related groups twice,or from two groups by pairing the equivalent characteristics by calculating the differences of the average as the following:

Hypothesis 1 $H_0: \mu_{Before} = \mu_{After}$ (27)

$H_0: \mu_{Before} \neq \mu_{After}$

Or Hypothesis 2 $H_0: \mu_{Before} = \mu_{After}$ (28)

$H_0: \mu_{Before} > \mu_{After}$

Or Hypothesis3 $H_0: \mu_{Before} = \mu_{After}$ (29)

$H_0: \mu_{Before} < \mu_{After}$

Calculation formula

$$t = \frac{\bar{d}}{\frac{S_d}{\sqrt{n}}} \quad (30)$$

When $\bar{d} = \frac{\sum d}{n}$, $S_d = \sqrt{\frac{\sum(d-\bar{d})}{n-1}}$, and $df = n - 1$ (31)

In consideration of the values of t-test, if it is not significant ($Sig > \alpha$), that means H_0 is accepted and shows the averages before and after are not different. If T-test is significant ($Sig < \alpha$), that means H_0 is rejected and $H_1$is accepted.This showsthe average before and after are different (the averages before are more or less than after).

2.2 Literature Reviews

Wichit Jintananuwat (2009) studied about attitudes concerning nuclear power plants from people who live in Bangkok. The sample of population in this study is people who live in Bangkok. This study used a random sampling and questionnaire for measuring knowledge about nuclear power plants. The study found that most people have less knowledge they disagree to build a nuclear power plant. They are afraid of the environmental impact and people's lives. But most people agree that the creation of a nuclear power plant can be controlled to prevent adverse effects on the environment and care for people's lives. A nuclear power plant could be built in the suburban areas or islands where there are not people.

Nattawadee Punyasakulvong (2012) studied about the influences of reading and writing persuasionstowards the acceptance of the nuclear power plant in undergraduate programs. The purpose is to study the influences that affect the building of nuclear power plants. The method of the study is post-test only with control group design and random without bias in second-year and third-year undergraduates in a university. There are 7 categories of variables about attitudes and opinions on nuclear power plants in Thailand. The results show that students who read the article, which contains incentives to build nuclear power plants, showed their disagreement about the construction of nuclear power plants more than students who did not read the article. It can be concluded that when students gain knowledge or information about nuclear power plants, they are more willing to accept a nuclear power plant in their own homeland.

Somsak Meenakorn (2012) studied about appropriate forms to manage energy in Amphawa and alternative energy, renewable energy, and energy-saving equipment for appropriate energy in Amphawa. The sample in this case is divided into 2 groups; one is the population in Amphawa and the other one is people living in Bang Nang Li. The method used in this research is in-depth interviews divided for scholars and community leaders. The results showed that Amphawa produced biodiesel from used oil. However, the amount of raw materials is not enough to make biodiesel and not widespread in their area. The original energy plan in the past is emphasized top-down in the form of centralized decision-making. As a result, the energy is still being ignored and it is still being used efficiently.

Lucas W. Davis (2011) studied about the future of nuclear power plants in the United States after Fukushima. This researcher studied a trend on extending construction of nuclear power plants in the United States. The electricity from nuclear power is clean and supported by the federal government as well. The accident in Fukushima made an awareness of accidents and storing fuel in nuclear power plants. However, nuclear power plants have been further supported by government because the cost of electricity is lower than coal and natural gas used in power plants.

Kitsada Wongwuttikul (2012) studied about the international standards and a comparison of guidelines of the National Nuclear Safety Organization by examining standards of nuclear safety of other countries. In the analysis of guidelines of the National Nuclear Safety Organization of Thailand, the structure and authority of nuclear safety organizations of five countries were studied and compared, such as the United States of America, Canada, France, Japan, and the Republic of Korea. The structure of organization is divided into two kinds: independent public sectors and public sectors under the ministry. The national nuclear safety organizations of other countries are based on the international standards of the International Atomic Energy Agency (IAEA) because the international standards are conditions of the construction of nuclear power plants and guarantees for international communities. If an accident happens because of carelessness, the disaster will not only cause damage in the original country but also affect other countries nearby and worldwide. National nuclear safety monitors both nuclear power plants and safety of nuclear power usage.

Peerawut Boonsuwan (2011) studied about the Six Decades of Nuclear Accidents, Nuclear Compensation, and Issues of Radioactive Waste Management in order to plan for nuclear power usagein Thailand by starting from the Power Development Plan: PDP in 2010. The nuclear power plant will be opened in 2020. However, after the nuclear accident in Fukushima in Japan, it has been postponed for three years. This accident can cause serious worries of safety. Thus, this research aimed to study basic information of techniques related to nuclear accidents and the development of techniques of nuclear safety. Even though the nuclear power has huge benefits,its danger cannot be overseen. The researcher studied the important nuclear accidents during 1950 – 2011, the classification of severity of nuclear accidents, indemnity caused

by nuclear accidents under the international laws and other relevant laws, and basic information of techniques related to waste of radioactive management.

Charles Thomas Poston (2008) studied the Nuclear Power Plant Systems and Security because nuclear power is popular in the United States. A lot of use of nuclear power plants makes lots of people want to know about nuclear power. The researcher studied the nuclear power plantincluding safety systems, readiness of nuclear power, and experts in the field of nuclear power. The researcher both studied theories of the nuclear power plantand visited the Nuclear Science and Engineering Institute (NSEI) at the University of Missouri-Columbiato observe what the students learned aboutnuclear power. The researcher agreed that two issues should be added in the lessons, emergency preparedness and emergency response, because the researcher thought that security and safety should be given more focus.

Ministry of Energy(2015) studied the Power Development Plan of 2015-2036 which is the main plan of power development of the country because of Thailand's economic growth and infrastructure investment plan under government policy and in preparation for ASEAN Economic Community: AEC in 2015. These factors affect the electricity use of Thailand. The Ministry of Energy set 5 national integrated plans: 1) Thailand Power Development Plan: PDP, 2) Energy Efficiency Development Plan: EEDP, 3) Alternative Energy Development Plan: AEDP, 4) Natural Gas Resource of Thailand, and 5) Power Development Plan focusing on three important issues: energy security, economy, and ecology. From the efficient power development plan, the use of electricity will decrease by about 89,672 million units (GWh) in 2036. Besides, there are more alternative energy development plans emphasizing the potentiality of development of alternative energy in each area, promoting the production of power plant waste, biomass, biogas, and other renewable energies such as wind and sun light.

Bruce E. Hansen (2003) studied the Econometrics and divided it into the following points: Preliminaries, Method of Moments Estimation, Multivariate Regression, Small Sample Theory (Optional), Functional Form, NonLinear Regression, Feasible GLS, Generalized Method of Moments, Empirical Likelihood, Endogeneity, The Bootstrap, Univariate Time Series, Multivariate Time Series, Limited Dependent Variables, and Panel Data. Other theories are cited in these topics.

Iain Edward Buchan (2000) studied the Development of a Statistical Computer Software Resource for Medical Research that was studied to solve the problems of using statistics that were not related to the research. The writer collected the fundamental contents and calculation formulas that themedical researchersapplied in their research. That included formulas, steps, and contents of basic statistics that were the point of research needs. The contents were divided into three parts: numerical validation, comparisons with other resources, and evidence of use and application to medical research. This research is important for statistic citation and methods.

Jarunee Kraikaew (2011) studied the general information of nuclear power plants providing knowledge and understanding about nuclear power plants by using simple words that are suitable for anyone who was interested in nuclear power. The aim of nuclear power plant construction underThailand's Power Development Plan (PDP) for2010 – 2030 lacked the clarity of understanding of communities. What most people do not understand about the nuclear power plant is that it is a useful technology. The price of electricity from nuclear power plants is not expensive. Thailand planned to build 5 nuclear power plantsproducing 5,000 megawatts (MW) of power capacity. The first nuclear power plant will be in the system in 2020. The preparation step is between 2008 – 2010; meaning that the construction area must be set and decided if they will be built or not before the second step. After the earthquake in Japan on 11 March 2011 and the accident of Fukushima Dai-Ichi, the Energy Policy and Planning Office, Ministry of Energyput off the construction of a nuclear power plant for three years. The original plan wasfor 2020, so it has been changed to 2023.

Supoj Koerdmee and others (2011) studied the Development of Biogas Usage from Livestock Manure and Agricultural Wastes. The reason was that, in 2004, the trend of biomass use in Phetchaburi province decreased. However, the LPG use increased. The study showed that most people in Tambon Namkor are farmers and raised livestock and grew plants all year round. The waste from farming can be fermented as biogas, and it can be used as good as a renewable energy like LPG. This research aimed to 1) study and develop the capacity of using biogas energy of Namkor community, 2) develop and adapt the waste from farming for everyday life, and 3) study the use of biogas energy instead of LPG in daily life. The researchers examined the

amount of waste from farming and quantity of energy fuel use to promote the economic use that can create the highest effectiveness and strengthen the communities and local development. The findings showed that the development of using biogas energy from dung and waste from farming could build simple biomass stoves instead of normal stoves and gas stoves used in these days. The comparison showed that the consumption of fuels of biomass stoves was less than normal stoves.

Prasit Siritiprussamee (2011) studied the Impact Management: Nuclear Power Plant Project in Thailand including information of the amount of energy resources used in Thailand and examined steps of nuclear power plants divided into five stages: 1)Pre-Project, 2) Project Decision Making concerned with social impacts and political impact 3) Plant Construction, 4) Plant Operation concerned with social impacts, economic impacts, health impacts, environmental impact, and political impact, and 5) Plant Decommissioning concerning with grounds impacts, demolition or cancellation of using the nuclear power plant. In summary, the construction of a nuclear power plant is in the Economic Development Plan found in the five stages of the nuclear power project implementation in Thailand. The management and plan focuses on public safety, health of people, and environmental impacts. However, the problems and obstacles of nuclear power plantconstruction are the lack of skilled labor, unstable policies, and risky readiness of taking care of the system. The researcher suggested that the government should explain to people the actual disadvantages and impacts of a nuclear power plant that may happen.