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A Proposed Model to Determine Public Acceptance on Willingness to Pay Maximum Demand (MD) Charge in Malaysia

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Maximum demand (MD) is the peak load imposed by the customer to TNB system at any point of time. MD charge is important to ensure that customers is paying a fair share on the burden that they place on the electric grid. Currently, the MD charge is only being imposed on Commercial and Industrial customers. In order to achieve economic viability-reflective of market price, electricity price should be cost-reflective. This means the MD charge should be paid by all electricity customers including the domestic sector. It is the purpose of this study is to investigate if the MD charge eventually need to be paid, how willing are the public to pay market reflective energy pricing with an addition of MD charge in their electricity bill. Hence, this study aims to evaluate the relationship between determinants such as understanding of electricity bills, understanding of electricity pricing, awareness on amount electricity consumption, socio-economic factors and public affordability on the public willingness to pay for the MD charges. For data collection purpose, a questionnaire on 5-point likert scale will be developed and data will be collected from 300 random respondents from peninsular Malaysia. Ten hypotheses have been developed in this study. Correlation will be analyzed using SPSS version 19.0, while, ordered probit model will be used to measure linear regression.

Keywords: Maximum Demand Charge, Willingness to Pay, Electricity Bills, Acceptance Level, Malaysia

1. INTRODUCTION

Currently, with frequent fluctuation in the world fuel pricing, energy providers are exploring new tariff design to address this issue. One of the potential solution which is in the interest of this paper is adding Maximum Demand charge in the residential electricity bills. This is important to ensure cost of servicing electricity is being distributed to all electricity users. This demand charge is derived based on the highest level of electricity supplied at the facility at one time during the billing period and at the time of the day (measured in monetary units, m.u, per kilowatt, kW) [1]. In Malaysia, Tenaga Nasional Berhad (TNB) commonly referred demand charge as maximum demand (MD) charge. Commercial and Industrial customer has been paid for MD charge for many years. But, residential is rarely paying for this MD charge [2].

However, more experience of the residential MD charges is available in Europe. Residential MD claims are essential for utilities and regulators to establish a supervisory framework that will further demonstrate the actual cost of generating and delivering electricity [2]. Any approach to change the design of the residential rate structure should begin with a detailed study on the condition of the residential rate. Hence this paper aims to conduct a survey on public willingness to pay the MD charge and factors influencing the acceptance of MD

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charge as additional charge in their electricity bill.
This paper is organized as follows. Second section, explains the background of the study which include significant of the study and research objectives. Third section, literature review of the study and relationship analysis of the theoretical framework. Fourth section regarding research methodology. Fifth section will explain the implication and future scope of the research and lastly conclusion.

2. BACKGROUND OF THE STUDY

Maximum demand (MD) is the highest level of electricity demand monitored within a month. The amount of MD charge will be calculated by multiply MD charges based on the maximum demand recorded in Kw and maximum demand rate for each residential consumption. Tenaga Nasional Berhad (TNB) as the supplier of electricity in Malaysia needs to meet this peak load when required by consumers. There is enough generation, transmission and distribution capacity to meet the highest demand. Thus, MD charge is needed to reflect the peak load imposed to the system. Generally, MD charge is designed to encourage consumers to control their electricity demand at daytime peaks. Other than that, the study in [3] stated that MD charge is created as an incentive to reduce peak usage by increasing the bills of those consumers who cannot moderate their usage profile. This is important to avoid higher amount of MD charge.

Malaysian Electricity Supply Industry (MESI) Reform has stated in one of its objective aiming for public to pay market reflective energy pricing. This can be achieved when all TNB customers include industrial, commercial and residential customers are paying the total cost of supplying electricity. This can be done by including MD charge in the total cost of supplying electricity. The payment of the service charge, energy charge and MD charge can encourage better grid capacity usage, minimize cross-subsidies between customers and encourage adoption of advanced technology. However, very high MD charge could make electricity unaffordable for low usage and low income customers [3][4]. High MD charge can cause low-income residential which are generally use less electricity than higher income to pay higher average prices for their electricity bill. This concern will influence public willingness to pay MD charge.

To ensure MESI could sustain in supplying electricity and generate revenues [5], this study will investigate if MD charge is eventually needed to be paid, how willing are the public to pay for the market reflective energy pricing with an additional charge of MD charge in their electricity bill.

A. Significant of Study

As discussed earlier, this paper aims to evaluate the relationship between public willingness to pay the MD charge and its determinants that are understanding of electricity bills, understanding of electricity pricing, awareness on amount electricity consumption, socio-economic factors and public affordability. In order to ascertain the public acceptance of MD charge, the study of the willingness of the public to accept market reflective energy pricing is very crucial.

Thus, this study could potentially help to achieve objective in MESI Reform that aims for reflective market price in terms of economic viability and long-term electricity system security and supply quality. Moreover, MESI could sustain in its operation by distributing a fair share of electricity cost to all consumers in Malaysia.

B. Research Objectives

The following are the three research objectives:

1) To describe the socio-economic factors of public acceptance on maximum demand (MD) charge.
2) To measure the correlation between the determinants (understanding of electricity bills, understanding of electricity pricing, awareness on amount electricity consumption, socio-economic factors and affordability) and public willingness to pay for the maximum demand (MD) charge.
3) To evaluate the effects of the determinants (understanding of electricity bills, understanding of electricity pricing, awareness on amount electricity consumption, socio-economic factors and affordability) and public willingness to pay for the maximum demand (MD) charge.

3. LITERATURE REVIEW

C. Overview development MD charge in Malaysia and other countries.

In Malaysia, the forward-looking approach has set the average base rate in the four-year regulatory period. Thus, it will achieve the income requirement with efficient prediction cost. [6]. Currently, Commercial and Industrial customers only involve in paying MD charge in Malaysia. MD charge is important to avoid very high energy rate and at the same time, it will encourage customers to use electricity efficiently. However, the small customers such as residential at low voltage level are only being imposed an energy charge, kWh as their peak load requirement is low [7]. The MD charge is not included in their electricity bill.

However, in other countries, there are a few utilities that already use MD charge for residential customers. There are nine utilities involve in this residential MD charge such as Alabama Power, Alaska Electric Light & Power (AELP), Arizona Public Service (APS), Black Hills (in South Dakota and Wyoming), Dominion (in Virginia and North Carolina), Duke Energy (in North Carolina and South Carolina), Georgia Power, the Los Angeles Department of Water and Power (LADWP), and Xcel Energy (in Colorado). All of these utilities offer the demand rate for residential as a voluntary option [2]. There

are 10% of APS's and 8% of Black Hills' residential customers enrolled in the demand rate which are representing around 20% and 17% of residential sales. In addition, the demand rate for residential is between $1.5/Kw per month and $18.10/kw per month.

D. Relationship between Independent Variables and Dependent Variable.

1. Relationship between understanding of electricity bills and willingness to pay MD charge.

Households are mostly do not have enough knowledge on their electricity bills or their electricity consumption costs. Most of them do not know that the cost of using certain electrical appliances during peak period and its influence on the electricity consumption costs. This poor knowledge is related to the lack of facility of metering technology that could give information to access on household usage profile. Currently, TNB electricity bill layout does not have this information yet, thus this study will analyze whether with an understanding on components of existing electricity bill. Therefore, understanding on the electricity bills will be the first determinant that could potentially affects public willingness to pay the MD charge.

Furthermore, understanding of electricity bill will help consumers to control in each charge involved in their monthly electricity bill and identify which energy savings measures give the biggest impact on their electricity bills. Indirectly, the knowledge on current billing charge will facilitate public understand on MD charge. This is because the public would have the required basic knowledge to understand more advanced concepts of electricity charge [3]. Hence, this would increase public willingness to pay for the MD charge and their acceptance towards market reflective energy pricing. This is important to ensure that the MESI could sustain in its operation in operating electricity for a long-term.

2. Relationship between understanding on electricity pricing and willingness to pay MD charge.

As stated by one study [8] Residential in Ontario, Canada, seem to face difficulty in understanding the price that they pay for electricity. There are only a few of them who knowledgeable in the calculation of electricity pricing in their bills. The study finds that only 4% of consumers say that they are 'very knowledgeable' about how the price they pay for electricity is being determined. This gap indicates that lack of understanding on electricity pricing will lead to confusion and cause many consumers to be dissatisfied with the pricing they are paying for electricity bill. Considering that the price of electricity is such a key issue for consumers, then educating the public on how electricity prices are being set and determined would be the main issues to be concerned.

Therefore, the second determinant that will be considered in this study is the understanding on electricity pricing. This is important to increase the public acceptance towards market reflective energy pricing based on the MD charge. A basic understanding of electricity pricing includes the public understanding on the existing tariff rates, energy charge and imbalance cost pass through (ICPT) charge with respect to their electricity consumption. This will help consumer to manage their consumption because MD charge may be high during peak periods and should be able to shift their load wisely as well [9].

3. Relationship between awareness on amount electricity consumption and willingness to pay MD charge.

Energy consumption in the residential sector represents an important part of total electricity demand. A study [10] found that awareness on energy efficiency affect the energy consumption of consumers. However, even though consumers who has a high awareness on energy efficiency but place low priority for a certain item in practice, this could have an overall effect of an increase in energy consumption at home. Other than that, one survey [11] find that respondent who live in Upstate (non-Mid-Hudson Counties), believe that respondents are adequately capable to be involved in discussions about electricity power. Moreover, respondents on Long Island are more interested in being involved in these discussions than those who live elsewhere in the state [12]. These interest is contributed by their high awareness on amount of electricity consumption.

Thus, information on electricity consumption such as awareness on the amount of electricity being consumed could potentially influence the public willingness to pay the MD charge. In a study by Farah [13], shows that residential awareness on amount of electricity consumption will give impact on consumer daily usage especially during peak hour. This awareness could motivate the public to participate in energy efficiency program. Therefore, the third determinant chosen in this study is the public awareness on the amount of electricity consumption.

4. Relationship between socio-economic factors and willingness to pay MD charge.

The fourth determinant in this study is the socio-economic factors. This includes various household factors that could shape broader trend of household behaviour towards MD charge. In a study by H.Fan [15], results show that households' electrical appliances and demographic features seem to influence the households's contribution to aggregate network peak demand. Hence, by understanding the relationship between different appliances ownership, households' behaviour and demograhics on peak demand, the study will be able to desribe the the public willingness to pay for the MD charge based on different socio-economic factors.

Furthermore, in relation to customer socio-

economic factors, individual customer characteristics that are associated with a demand for reliability showed little ability to predict the value that customers consuming electricity [14]. However, the study also indicates that accounting on multiple characteristics will improve the ability to predict customers' value of reliability. In addition, the study finds that public willingness to pay to avoid the outage depends on the different type of outage that they are facing in different region, educational level, number of bedrooms in their home, ownership of generator and age. Thus, these characteristics are important in predicting value of reliability on public's willingness to pay.

5. *Relationship between public affordability and willingness to pay MD charge.*

Affordability is the percentage of income spends on electricity. The popular norm is that if a household spends more than 10% of the income on electricity, it is considered as unaffordable level. The study by Athula Ranasinghe [16] found that only 15% of respondents cannot afford paying the electricity bill. The study states that percentage of income goes into electricity bill, percentage of income goes into essentials and basic need electricity are three-alternative measurement of electricity affordability. Public who cannot afford to pay electricity will affect their willingness to pay MD charge in their electricity bill. Currently, a lifeline tariff is used to subsidize TNB's customers with monthly consumption of 300kWh and below. Therefore, this study is interested to investigate the effect of the fifth determinants which is public affordability on the public willingness to pay for the MD charge.

4. RESEARCH METHODOLOGY

E. Research Concept

1. *Observation, Data Gathering and Problem Defining*

The main purpose of this study is to evaluate public acceptance level towards MD charge in the electricity bills. Then, careful steps in formulating the research problem is taken to avoid omitting the true problem. In order to define the research problem, quantitative method will be used through numerous literature reviews in electricity and energy field. The data will be collected from government and private organizations in Klang Valley, Malaysia.

2. *Theoretical Framework*

A substantial number of empirical studies on willingness to pay MD charge has been reviewed in order to develop a theoretical framework. Willingness to pay MD charge as the cost reflective pricing is decided to be the dependent variable. While the other determinants such as understanding of electricity bill, understanding of electricity pricing, awareness on amount electricity consumption, socio-economic factors and public affordability are representing as independent variable. Hence, based on reviewing several literatures, theoretical framework that has been created for this study as per figure 1.

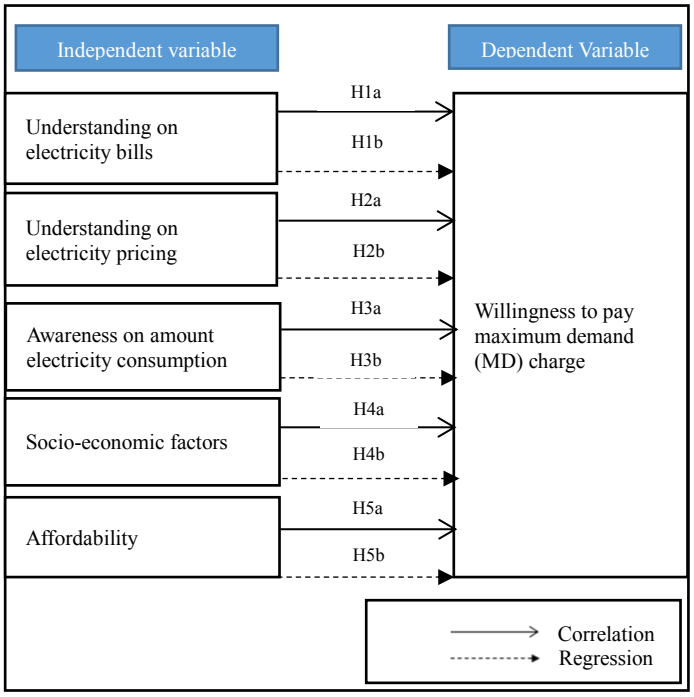

Figure 1: Theoretical Framework

3. *Research Hypotheses*

Based on the theoretical framework developed, 10 specific hypotheses for this research has been developed. (Refer table 1).

Table 1. Hypotheses

Hypotheses	Antecedents of Willingness to pay MD charge
H1a	There is a positive and significant relationship between understanding on electricity bills and willingness to pay on MD charge.
H1b	Understanding on electricity bills has a positive impact on willingness to pay MD charges.
H2a	There is a positive and significant relationship between understanding on electricity pricing and willingness to pay MD charges.
H2b	Understanding on electricity pricing has a positive impact on willingness to pay MD charges.
H3a	There is a positive and significant relationship between awareness on amount electricity consumption and willingness to pay MD charges.
H3b	Awareness on amount electricity consumption has a positive impact on willingness to pay MD charge.
H4a	There is a positive and significant relationship between socio-economic factors and willingness to pay MD charge.
H4b	Socio-economic factors have a positive impact on willingness to pay MD charge.
H5a	There is a positive and significant relationship between affordability and willingness to pay MD charge.
H5b	Affordability has a positive impact on willingness to pay MD charge.

F. Research Design

i. Instrument

The instrument of questionnaire will be divided into three parts. Part I consists of 8 questions, regarding socio-economic information. Part II consists of 10 questions, regarding public willingness to pay MD charge in Malaysia, and Part III consists of determinants of willingness to pay MD charge with comprises of four constructs. This paper will has about 50 questions.

ii. Method of Collection

The research will be conducted by first acquiring the basic information and email address of workers in private and government sectors in Klang Valley, Malaysia. Then, from continuous list, 300 target respondents will be sampled for the survey. Systematic random sampling method will be used to ensure the list are repeated for every n'th individual, which is highly unlikely. Firstly, researcher randomly select the 1st item from 1400 population as starting point. Then, the researcher will choose next item from the list until the targeted amount is achieved.

iii. Data Analysis Procedures

The content validity of this study will be reviewed by three experts on the subject matter, one from electricity area, survey expert and the other, a language expert to translate the questionnaire from English into Bahasa Malaysia correctly. While this study construct validity by using factor analysis method, i.e. Exploratory Factor analysis (EFA). Then Cronbach's Alpha with prescribed 0.70 of the scale for reliability is being measured using as thresholds [17]. Analysis methods of statistics that will be applied are Descriptive Statistic, Correlation, and Regression.

5. IMPLICATION AND FUTURE SCOPE OF RESEARCH

The theoretical implication for this study will be the relationship between willingness to pay on MD charge and its determinants that will affect public acceptance towards MD charge. Thus, this study could potentially influence TNB to implement several educational programs on the efficient electricity consumption to raise public's awareness on electricity consumption and increase their knowledge on electricity bill and pricing. The MD charge also will be charge considering socio-economic factors and public's affordability that will be done in the survey.

The study also recommends suggestion for further research that can be undertaken to ascertain the relationship between willingness to pay and its determinants. Since this study only focuses 300 respondents in Peninsular Malaysia, then it is possible for future scope if the researcher increases the amount of respondent and expanding the research area throughout the whole country include Sabah and Sarawak.

6. CONCLUSIONS

The determinants such as understanding of electricity bill, understanding electricity pricing, awareness on electricity consumption, socio-economic factors and public affordability are very crucial in the public willingness to pay the MD charge as the additional charge in residential electricity bill. This study will lead to quite big impact on residential in Malaysia that currently not paying MD charge in their electricity bill.

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