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A Discrete Choice Experiment in Estimate Public Willingness to Pay for Attributes of Water Services in Terengganu, Malaysia

(Kaedah Eksperimen Pilihan Diskret dalam Menentukan Kesanggupan Membayar Orang Awam bagi Perkhidmatan Air di Terengganu, Malaysia)

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ABSTRACT

Water service is usually taken for granted as important amenities with required levels needed, however little is known about how much consumers are willing to pay for particular water service levels. Improved water services should be based on the understanding built upon consumers' choice and preferences. Thus, this study aims to estimate willingness to pay (WTP) of consumers in Terengganu, Malaysia for improvement in domestic water services. A choice experiment method was conducted to assess consumer preferences for water service attributes: i.e. water quality, water disruption, water pressure and water price. Primary data were collected using face-to-face interviews of structured questionnaire from a sample of residents in eight districts in Terengganu. A conditional logit model was carried out for data regression. The results showed significant willingness to pay (WTP) and the contribution of the level of education, age and income in supporting the specific attributes of water services improvements. Identifying the attributes and their prices based on consumers' preferences would help water provider to recognize and deliver preferred water service attributes, effective water tariff policy for cost recovery and water service sustainability to consumers.

Keywords: Discrete choice experiment; conditional logit model; Terengganu water service; willingness to pay

ABSTRAK

Perkhidmatan air biasanya dipandang remeh sebagai kemudahan yang penting dengan tahap yang diperlukan, walau bagaimanapun hanya sedikit yang diketahui berkenaan kesanggupan untuk membayar para pengguna bagi perkhidmatan air yang tertentu. Penambahbaikan perkhidmatan air seharusnya berdasarkan pemahaman mengenai pilihan dan keutamaan pengguna. Oleh itu, kajian ini bertujuan menganggar kesanggupan untuk membayar (WTP) pengguna di Terengganu, Malaysia bagi meningkatkan perkhidmatan air domestik. Kaedah eksperimen pilihan telah dilaksanakan untuk menilai keutamaan pengguna bagi atribut perkhidmatan air seperti: kualiti air, gangguan air, tekanan air dan harga air. Data primer dikumpulkan melalui kaedah temu bual bersemuka dengan menggunakan soal selidik berstruktur dari sampel penduduk dari lapan daerah di Terengganu. Model logit bersyarat dijalankan bagi regresi data. Keputusan menunjukkan kesanggupan untuk membayar dengan nilai yang tinggi dan dipengaruhi oleh tahap pendidikan, umur dan pendapatan dalam menyokong atribut khusus penambahbaikan perkhidmatan air. Mengenalpasti atribut dan harga adalah berdasarkan keutamaan pengguna dapat membantu pembekal air mengenalpasti dan menawarkan atribut perkhidmatan air pilihan pengguna, dasar tarif air yang berkesan untuk pemulihan kos dan kelestarian perkhidmatan air kepada pengguna.

Kata kunci: Eksperimen pilihan diskret; Model logit bersyarat; perkhidmatan air Terengganu; kesanggupan untuk membayar

INTRODUCTION

Water is one of the most essential basic human needs and the importance of water to all living beings and nature is undeniable. As the most valuable natural resource, water is needed for the fundamental purpose and can be used for different aspects of life. Lately, increase in population and economic activity has led to an increase in water consumption. Population growth, industrialization, urbanization and the expansion of irrigated agriculture are imposing rapidly thus, increasing demands on water resources. As water is a necessity to

the public, water services benefits cannot be estimated through the conventional market structure. Estimated monetary values for environmental goods and services that do not normally have market prices are important for resource management.

In Malaysia, water services are commonly provided by either a local government agency or a regulated organization. There are various related ministries and departments involved with the water industry such as the National Water Services Commission, Ministry of Energy, Green Technology and Water and so on. The study was conducted in Terengganu, Malaysia. Terengganu is situated in the eastern Peninsular of Malaysia. It is bordered in the northwest by Kelantan, the southwest by Pahang, and the east by the South China Sea. Terengganu is divided into eight administrative districts; Kemaman, Dungun, Marang, Kuala Terengganu, Kuala Nerus, Hulu Terengganu, Setiu, and Besut. Malays are the largest ethnic group in Terengganu. Main water supplies in Terengganu are from river and dams. The supplier of water services in Terengganu is Syarikat Air Terengganu Sdn. Bhd (SATU). SATU is the exclusive water supplier in Terengganu. Their missions are to sufficiently supply good quality clean water and to improve their services quality in order to fulfil consumer's satisfaction from time to time. Mahirah et al. (2016) enlightened that upgrading the water services is a significant aspect in planning and implementing efficient policies for societies' well-being and economic development of the country.

Terengganu has below cost water tariff which is one of the reasons contributing towards operational inefficiency of the water provider. The rates charged to consumers are low compared to the cost of processing clean water at 52 cents for first 35 cubic meter charged compared to 59 cents for processing water. The water price is the second lowest in Malaysia after Pulau Pinang while the last water tariff review in Terengganu was in 1997, about 20 years ago. Besides the fact that the water tariff in Terengganu was last reviewed in 1997, Terengganu is also one of the states with water tariff that is far below the national average (Malaysia Water Association 2015). The low cost tariff rate is among the reasons causing inefficient operation among the water providers (Nariman & Azhar 2017).

The number of population served by SATU has increased significantly every year. Table 1 below displays the percentage of population served by SATU. It can be seen that the population served has increased in both urban and rural area. This percentage of population served can be related to the increasing populace. In Terengganu, the number of the population rises annually. Increasing population results in increased demand for water thus accelerate the depletion of water resources in the state therefore population growth is known to be one of the many challenges in the state's water supply management (Mahirah et al. 2018). The total estimated population in Terengganu was around 1.15 million people in 2015 and it is expected to increase to two million by 2035. In terms of water consumption per capita per day, it has shown an increasing number of usages (Table 1). In Malaysia, average water consumption is very high as stated at 211 liters per capita per day, even though the World Health Organization (WHO) sets it should be at 160 liters per capita per day. In Terengganu, water consumption is increasing every year for example at 216 liters per capita per day in 2014 compared to 205 liters per capita per day in 2012 (Malaysia Water Association 2015).

TABLE 1. Population served by SATU and domestic water consumption in Terengganu

Year	% Population Served			Consumption per capita per day
	Urban	Rural	Average	l/cap/day
2008	98.5	82	90.4	189
2009	98.6	82.5	90.7	192
2010	98.6	92.7	95.7	187
2011	98.8	92.8	95.8	207
2012	99.1	92.9	96	205
2013	99.1	92.9	96	211
2014	99.1	92.9	96	216
2015	99.1	92.9	96	214

Source: Malaysia Water Association (2016)

Water price in Terengganu is ranked at second lowest after Pulau Pinang and the last review of water price is in1997. Mahirah et al. (2018) mentioned that, water price should be restructured in order to encourage conservation for this valuable resource. They also clarify that, low water price will put much burden to the government and water provider. Even though Pulau Pinang has the lowest water price in Malaysia, they reviewed their water price during 2001, 2010, 2011 and 2015 (Malaysia Water Association 2016). There are very few official statements on the role of water tariffs in economic development (Lee 2004). When the water price reflects their true cost, the resource will be put to its maximum valuable uses. Agreeing to Mahirah and Azlina (2019), water provider should charge the consumer the costs of water needed in providing the service to prevent revenue instability.

Table 2 shows the current water service condition in Terengganu. This is based on Syarikat Air Terengganu Sdn. Bhd. (SATU). In order to cater to consumers'

TABLE 2. Current water service condition in Terengganu

Attributes	Attributes level
Water quality	Satisfactory
Water disturbance	Frequent
Water pressure	Low water pressure
Water price	Current water price

satisfaction, the value that households put on the attributes of domestic water service is very significant and useful for the water provider management as a guideline to improve the water services from the current level to better service provision.

In an effort towards becoming developed countries, water management needs to be aligned with the rapid development of the industries. It is essential to demonstrate and value the demand for water services improvements in order to inform policy decisions in the allocation of financing and efficient management of water resources. As mentioned by Gürlük and Rehber (2008), the failure to determine the value of the natural resources would lead to an underestimation of the true value of the resources. Therefore, this study is conducted to estimate the willingness to pay for improved domestic water services in Terengganu. The specific objectives of this study are (1) To identify the socio-economic profile of the respondents; and (2) To determine the consumers' preferences for the domestic water service attributes in Terengganu by using the Choice Experiment (CE) method. The valuation of water service attributes is important in order to make sure that the service fulfils and meets the requirement of the consumers' preferences. According to Roseliza et al. (2018), preferences may differ among individuals initiated by their particular characteristics such as socio-demographics, attitude and constraints.

LITERATURE REVIEW

From an economic perspective, water resources such as wetlands, marine, aquifers or coastal ecosystems and river basins, offer assortments of goods and services that can be translated as economic services. These kinds of services have direct or indirect values to the human population and thus they contribute to social well-being (Remoundou & Koundouri 2009). As mentioned by Othman and Jafari (2014), nurturing and purification of water resource is one of the examples of non-marketed benefits. However, many of the benefits and values associated with the roles performed by water resources are non-marketed and frequently disregarded in future planning and decision making which result in the reduction and degradation of the water resources. A number of studies have been done to evaluate the consumer willingness to pay for water services. Thus, the next section will discuss previous studies on valuation of water services.

PREVIOUS STUDIES ON VALUATION OF WATER SERVICES

Monetary valuation of the environment can be performed in many ways, by either using market price information or eliciting consumer's preferences or by applying a wide range of non-market valuation methods (Syamsul Herman et al. 2013). In the absence of market prices for environmental services, value estimation is concerned with a change in people's welfare (Nijkamp et al. 2008). Economists have developed a variety of techniques to value non-market environmental and cultural amenities consistent with the valuation of market goods either using revealed preference methods (production function, travel cost, hedonic pricing, simulated markets and market prices) or stated preference methods (contingent ranking, choice experiment and contingent valuation) (Navrud 2000; Hanley & Spash 1993; Grafton et al. 2011).

Kaliba et al. (2002) conducted an analysis to estimate WTP to improve community-based rural water utilities in the Dodoma and Singida Regions of Central Tanzania. Filippidis (2005) conducted a survey on the willingness to pay for improved water supply conditions in the Taxiarchis municipal district of Halkidiki prefecture in North Greece. The study highlighted on determining consumers' willingness to pay (WTP) for improvements of water supply conditions, identifying the factors affecting WTP and describing their impact on WTP for improved supply conditions through logistic regression analysis. Komatsu et al. (2007) conducted a WTP study for rural water supply improvements for pastureland conservation in Mongolia and found that distance from the water points, education, herders' perception of pastureland degradation, income and initial bid value significantly determine their WTP for improved water supply. Adenike and Titus (2009) have studied WTP for improved water supply in Osogbo Metropolis, Nigeria using a binary logit model and found that income determines willingness to pay for improved water supply. Mahirah et al. (2013) assessed consumer's WTP for domestic water services in Kelantan and found that people are willing to pay the new proposed water price as long as they are guaranteed a high standard in water services. The study further revealed that people are willing to contribute more on 'water supply interruption' attribute as people prefer the disruption to be reduced to at least once a year. Malama (2015) conducted a study on Willingness to Pay for Improved Irrigation Water Supply in Zambia. The article highlighted an estimation of the WTP for the improved water supply and sanitation services in Kabwe lead-polluted areas in order to determine if the improved irrigation water supply project was viable. However, this study only focused on improved irrigation water supply in Zambia by using a contingent valuation method with a double-bounded dichotomous choice question format.

Recent studies on DCE in water management issues include valuation of wetland quality (e.g. Morrisson et al. 1999; Carlsson et al. 2003; Hanley et al. 2006; Birol & Cox 2007), non-use value of wetlands (e.g. Birol et al. 2006), valuing groundwater function (Hasler et al. 2003) and also water use planning for residential landscapes in Kelowna, British Columbia (Conrad et al. 2019). For domestic water demand, Hensher et al. (2005) found that households in Canberra, Australia are willing to pay for improved water services specifically in reducing the frequency and the period of water service disruptions

and waste-water overflows. Another study is by Wang et al. (2018) in investigating consumers' WTP to improve water supply safety (WSS) in China. They found that, urban residents willing to pay significantly higher for WSS. Still, most of the studies are in developed countries.

The welfare economic concept of willingness to pay (WTP) is a utility measure with the application of e.g. the choice experiment (CE) method. A large number of studies have been conducted using CE over the decades to examine the welfare effects and consumer preferences attributes for water services (Abou-Ali & Carlsson 2004; Willis et al. 2005; MacDonald et al. 2005; Hensher et al. 2005; Kanyoka et al. 2008; Poirier & Fleuret 2010; Latinopoulos 2014). However, most of the studies are in developed countries.

The uses of the CE approach in valuing water service are very few in developing countries. Acharya and Barbier (2000) valued the groundwater recharge function in northern Nigeria and they found that a decrease in recharge to the aquifer is estimated as €32.27 for each vegetable farmer and €328.69 for farmers growing wheat and vegetables. Nam and Son (2005) compared the choice experiment and contingent valuation methods for valuing domestic water quality and pressure in Ho Chi Min City in Vietnam. In assessing household's WTP for improved drinking quality water in Damaturu, Mohd Rusli et al. (2013) used the CE for their study in Damaturu, Nigeria and the result proved that households are willing to pay more than what they have been paying in order to get improved quality drinking water. Ndunda and Mungatana (2013) in their study estimated the benefits of improved wastewater treatment programs to mitigate the impacts of water pollution in Nairobi, Kenya. The results showed that urban and peri-urban farmers are willing to pay municipality taxes per month for treatment of wastewater.

In Malaysia, limited number of studies applied a DCE in water service valuation. Estimation of the non-market values provided under different wetland management options by Othman et al. (2004) found that non-users households were willing to pay €0.17 for an additional 1% of environmental forest area in Malaysia. Mahirah et al. (2013) assessed user's WTP for domestic water services in Kelantan and found that people are willing to pay the new proposed water price if they are assured of high standard in water services. The study further revealed that people are willing to pay more on 'water supply disruption' attribute as people prefer the disruption to be reduced to at least once a year. Mohd Rusli et al. (2011) determined households' willingness to pay (WTP) for water service improvement in Selangor. They found that consumers are willing to pay higher for drinking water with improved water quality, reduction in the regularity of water interruption, and increase in consumers' trust to tap water. Zuraini (2018) in her study in Johor revealed that, the most important factors influencing the WTP of water services are age, income, gender and number of persons in the household. The importance of knowing which attributes influencing WTP among consumers is particularly useful for the government and water services providers in Malaysia mainly in Terengganu to understand what attributes they should consider and focus on when planning for water services improvement in the near future.

METHODOLOGY

CHOICE EXPERIMENT METHOD

Choice Modelling (CM) originated from the conjoint analysis and was initially developed in the marketing and transport literature by Louviere and Hensher (1982) and Louviere and Woodworth (1983). CM is one of the survey-based methodologies in preferences for goods or services modelling, where goods or services are defined in terms of attributes with their own level that had been decided (Hanley et al. 2001). In CM, there are four approaches which are Contingent Rating, Contingent Ranking, Paired Comparisons and Choice Experiment (Hanley et al. 2001). The ways of measuring preferences are different corresponding to different variants of the CM approach by either to rate the alternatives, rank them, or choose their most preferred goods/service option. For analytical purposes, the discrete choice experiment (DCE) approach was used. The method is drawn upon Lancaster's theory of consumer choice (Houessionon et al. 2017). DCE has seen an increasing usage in environmental economics (Bateman et al. 2002), but is relatively new to the water resource economics literature (Young 2005; Griffin 2006).

A number of studies have been conducted using CE to examine the welfare effects and consumer preferences attributes for water services (Abou-Ali & Carlsson 2004; Willis et al. 2005; MacDonald et al. 2005; Hensher et al. 2005; Kanyoka et al. 2008; Poirier & Fleuret 2010; Latinopoulos 2014). Nonetheless, it is to be noted that most of the studies are in developed countries. These studies employed DCE used to measure consumer preferences and estimated the willingness to pay for improved domestic water services in Terengganu, Malaysia. In this study, water price attribute is a monetary attribute or cost term. The monetary attribute is included as one of the attributes for estimating marginal utility that can be converted into a willingness to pay value for changes in attribute levels and welfare estimates obtained for the combination of attribute changes (Hanley et al. 2006). The DCE approach allows trade-offs between goods/services in the choice set (Hanley et al. 2001). From this study, water provider in Terengganu can have the information on the attributes related to water services that the consumers are willing to trade off for one another. This valuable information can be used to improve the effectiveness of the services in the future.

There are two models in this study. First, the simple Conditional Logit (CL) model was estimated by allowing the basic model for domestic water service attributes enter indirectly into utility model specification. Second, the estimation by improving the basic model by interacting the main attributes with the socio-economic variables into utility specification. These two models were compared using statistic indicators such as Pseudo-R^2, adjusted Pseudo-$R^{2,}$ and the log-likelihood ratio test. CL known as McFadden's logit is generally used to estimate the CM exercise. In this study, a respondent may face *n* choices among *J* alternatives in a choice set. The observed attributes can be labeled in the qualitative term (e.g. very good, good, satisfactory) or quantitative term (e.g. RM0.50, RM0.78, RM0.95). The probability function for this study can be represented as below:

$$P_{in} = f\,(X_{in}, X_{jn}\,; j \neq i, \beta) \tag{1}$$

Where:

P_{in} = Probability of respondent *n* choosing alternative *i*

X_{in} = A vector of observable characteristics of alternative *i* available to respondent *n*

X_{jn} = A vector of observable characteristics of alternative *j* available to respondent *n*

In this case, *f* is the function that relates the observed attributes with respondent's choice probabilities. This function is specified for some vectors of taste parameters β to be estimated where it can be interpreted by estimating the marginal value of each attribute preferred by respondents. *i* is a quantitative or qualitative term of alternative given in the choice set and *n* is a vector of X_{in}. Thus, in order to derive the function of *f* in Equation (1), each alternative is considered as acceptable by respondents. Z_{in} represents all the attributes of alternative *i* as faced by respondent *n*. The utility of that respondent *n* acquires from alternative *i,* indicates that U_{in} can be written as $U_{in} = U(Z_{in})$. The respondent will choose the alternative that provides the greatest utility to them. When respondent *n* choose alternative *i,* the utility function will be $U_{in} > U_{jn}; j \neq i$. Substituting the utility function into (2); $U(Z_{in}) > U(Z_{jn}); j \neq i$. Hence, the alternatives are combinations of attributes, wherein choice probability the element Z_{in} in (2) will be divided into two parts which is a systematic component (denote as V) and random component or error term (denote as ε_{in}), $U_{in} = V(X_{in}) + \varepsilon_{in}$.

In this situation, the ε_{in} is unknown and therefore treated as a random term. Thus, the probability the respondent *n* choosing alternative *i* in random utility terms is (Train 2009);

$$\begin{aligned} P_{in} &= \text{Prob}\,(U_{in} > U_{jn}) \quad ; \text{j} \neq \text{i} \\ &= \text{Prob}\,(V_{in} + \varepsilon_{in}) > (V_{jn} + \varepsilon_{jn}) \quad ; j \neq i \\ &= \text{Prob}\,(V_{in} - V_{jn}) > (\varepsilon_{jn} - \varepsilon_{in}) \quad ; j \neq i \end{aligned} \tag{2}$$

The probability that an individual is randomly drawn from the sample population of respondents will choose alternative *i* equals to the probability of the difference between the systematic utility levels of alternative *i* and *j* for all alternatives in the choice set. When the probability of random term $\varepsilon_{jn} - \varepsilon_{in}$ is lower than the observed quantity $V_{in} - V_{jn}$, the probability is regarded as a cumulative distribution. In this study, developing a conditional logit model will be based on McFadden (1974). By assuming all error terms are independently and identically distributed (IID) with a Weilbull distribution, the conditional logit model can be developed. Therefore, the probability of respondent *n* choosing alternative *i* can be formed as;

$$P_{in} = \frac{\exp(\mu\, V_{in})}{\sum_j^J \exp(\mu\, V_{jn})} \tag{3}$$

By assuming V_{in} is a linear parameter, the functional form of the respondent of the utility function can be expressed as $V_{in} = \beta_1 X_{in} + \beta_2 X_{2in} + \ldots\, \beta_k X_{kin}$ where β is a vector of parameters to be estimated and *X* signifies all explanatory variables in the model,

$$P_{in} = \frac{\exp(\beta' X_{in})}{\sum_j^J \exp(\beta' X_{jn})} \tag{4}$$

Where;

P_{in} = Probability of respondent *n* choosing alternative *i*

X_{in} and X_{jn} = Vector describing the attribute of *i* and *j*

β = Vector of coefficients

Next, estimate the willingness to pay that is based on β values where, the β values show the effect on the utility of changes in the attributes. The ratio of an attribute's coefficient and the price coefficient signifies the marginal implicit price of the attributes. Thus, WTP is derived by dividing the β value of each non-monetary attribute by the β value of the monetary attribute which is water price attribute..

$$\text{WTP} = \frac{\beta_{attribute}}{\beta_{monetary}} \tag{5}$$

This value indicates changes in implicit price or marginal rate substitution (MRS) of the attribute relative to the current condition or status quo (Hanley et al. 2009).

CHOICE EXPERIMENT DESIGN

Basically, there are six stages in Choice Experiment (CE) which are (i) selection of relevant attributes, (ii) assigning appropriate attributes level, (iii) making a choice of experimental design, (iv) construction of choice set, (v) measurement of preferences and (vi) estimating the parameters. In this study, the goods or services to be valued are the domestic water service attributes in Terengganu. The descriptions of the attributes and its levels are presented in Table 3.

TABLE 3. Domestic water service attributes in Terengganu

Attribute	Level	Descriptions
Water quality (QUAL)	*Satisfactory*	*Meets the level of indicators set by WHO but need to be improved*
	Good	Meets the level of indicators set by WHO
	Very Good	Meets the level of indicators set by WHO and improves the quality constantly
Water disruption (DIST)	*Frequent*	*Water supply interruption has been more than 12 times/year*
	Sometimes	Water supply interruption has been below than 6 times/year
	Never	Never experienced with water supply interruption or once/year
Water pressure (WPRESS)	*Low*	*Low water pressure*
	Moderate	Moderate water pressure
	High	High water pressure
Water price (PRICE)	*No change*	*Maintain the current water price (RM0.50 for the first 30m^3)*
	Increase 28%	Increase by 28% from recent water prices (RM0.64)
	Increase 56%	Increase by 56% from recent water prices (RM0.78)
	Increase 90%	Increase by 90% from recent water prices (RM0.95)

Note: *Italics* text signifies the *status quo*/base level.

In this study, there are four water service attributes selected. The first attribute is water quality (QUAL) that follows the World Health Organisation (WHO) guideline. It specified through the contents such as *Acidity* (*pH*), level of *Nitrate* (NO_3), *Nitrite* (NO_2), *Ammonia* (NH_3), *Turbidity* (NTU) and *Hardness* or *Calcium* (Ca2+). The guideline can monitor the water utilities to meet national standards. Three levels are chosen; satisfactory, good and very good. The attribute levels illustrate whether it meets WHO standard but needs to be improved or not.

Innumerable daily activities can be affected by repeated water supply disruption and this problem reflects on the performance of water provider. It can happen because of the shutdown of water plants, pipes leakage, replacement of new pipes or meters, maintenance works and so forth. The levels assigned for this attribute are frequent, sometime and never. These attribute levels describe the frequency of water supply disruption occurring in respondent's house in a yearly basis.

Water pressure can vary at different time in the same day. For some areas in Terengganu, the water pressure at night is high compared to during the day. This problem can affect various activities during the day where the use of water during the day is more frequent than at night. The levels assigned for this attribute are low, moderate and high. These attribute levels describe the condition of water pressure when the water flows out from the tap water in respondent's homes.

Finally, the water price attribute contains four levels: increase of 0%, 28%, 56% and 90% for the first 30 cubic meters (m3). Water price is the most important parameter which measures consumer's WTP and preferences since the change in the prices brings a major influence on consumer's decisions. As the water prices differ from state to state in Malaysia and it is controlled by the state government, Terengganu is ranked second lowest in terms of domestic water prices in Malaysia (MYR0.50 applies for the first 30 m^3). For water price level, this study chooses the national average water price, which is RM0.64 on the first 30 cubic meters, which is 28% increase from current water price (RM0.50 for the first 30 cubic meters) and maximum water price in the country, which is domestic average water price in Johor (RM0.95 for the first 30 cubic meters) which is 90% increase from current water price.

The following utility function of individual n choosing choice set i was used for simple Conditional Logit (CL) model and can be written as follows:

$$U = \beta_1 X_{QUAL2} + \beta_2 X_{QUAL3} + \beta_3 X_{DIST2} + \beta_4 X_{DIST3} + \beta_5 X_{WPRES2} + \beta_6 X_{WPRES3} + \beta_7 X_{PRICE}$$

A number of socio-economic variables (parameters S) and main attributes of water services were included as interaction terms with the attributes X_k. This was done to improve the goodness of fit of the basic model and to capture preference heterogeneity among respondents;

$$\begin{aligned} U = {} & \beta_1 X_{QUAL2} + \beta_2 X_{QUAL3} + \beta_3 X_{DIST2} + \beta_4 X_{DIST3} + \\ & \beta_5 X_{WPRES2} + \beta_6 X_{WPRES3} + \beta_7 X_{PRICE} + \\ & \gamma_1 (X_{QUAL2} S_{EDU}) + \gamma_2 (X_{QUAL3} S_{EDUCATION}) + \\ & \gamma_3 (X_{DIST3}\, S_{EDUCATION}) + \gamma_4 (X_{WPRES2} S_{EDUCATIO}) + \\ & \gamma_5 (X_{WPRES3}\, S_{EDUCATION}) + \gamma_6 (X_{QUAL2}\, S_{AGE}) + \\ & \gamma_7 (X_{DIST2}\, S_{AGE}) + \gamma_8 (X_{WPRES2}\, S_{AGE}) + \\ & \gamma_9 (X_{DIST2}\, S_{INCOME}) + \gamma_{10} (X_{WPRES2}\, S_{INCOME}) \end{aligned}$$

DATA COLLECTION

The questionnaire is considered as the most appropriate method to categorize respondents Ngai *et al.* (2006) and it has been widely used in the study of human behaviour (Nardi 2003). The data for this study was obtained from the survey where face-to-face personal interview of a structured questionnaire was employed. This is

the highly applied technique in economic valuation studies as employed by Blamey et al. (1999), Christie et al. (2006), Kanyoka et al. (2008), Mohd Rusli et al. (2011), Syamsul Herman et al. (2012), Mohamad Safee et al. (2013), Latinopoulos (2014), Mahirah et al. (2016), Nur Syuhada et al. (2019) and Matthew et al. (2019). In this research, the survey was a face-to-face interview conducted by the researcher with the help of field assistants. The questionnaire was administrated in a single interview with each respondent and all of them were briefed on the objectives of the study before the questions were asked.The questionnaire was designed into four parts where the first one is an introduction to the objective of the study with the portrayal of current water service issues and description for each attribute and their level. The second part presented the Choice Experiment. The third part explored the consumers' attitude and perceptions by asking the information on water service in their residential area and also their water consumption. The last part focused on the demographic backgrounds of respondents. The survey was conducted at eight districts in Terengganu by using face to face interviews with a sample of 384 local residents. The questionnaire was designed based on choosing a set of domestic water service attributes related to the issues of the study. Bennet and Blamey (2001) explained that, the attributes used to describe the alternatives in each choice set must be relevant to the water provider or policymakers and should be meaningful to the persons who would be answering the questionnaire.

The questionnaire was administered face-to-face in personal home interviews. A stratified random sample of 384 individuals was selected as applied by Bullock (2008) and Campbell et al. (2008). For this study, the calculation of sample size was based on Krejcie and Morgan (1970). The interviews administered to the registered users for domestic water services in Terengganu from eight districts that consist of local residents. The respondents targeted for this study is the head of households who is responsible for water bills every month and they were 18 years old and above. As states by Ahmad (1994), if the respondents were from a group, then the head of the group was selected as the respondent, as the data accumulated from the leader of a group would represent it. The strata used were districts of residence. In each location, the questionnaires were distributed using random survey method.

Each respondent needed to choose from three available options for each of the four attributes. Service option 1 and 2 are the alternatives while service option 3 is the current condition (status quo). The status quo option is provided for respondents who do not want any changes in the water service options described. Three service options for water services from which the respondents were asked to choose the most desirable option shows in Table 4 below.

Based on Table 4, if the respondent chose service option 1 rather than service option 2, that would give the meaning that the respondent are willing to pay a 90% increase instead of a 28% increase in water price in order to have good quality of water, water supply disruption should be once in year and high water pressure. If the respondent chose service option 2, the respondent prefers to have good water quality, frequent water disruption which is a few times a year, low water pressure but would only have to pay 28% increase in water price rather than 90% increase.

Table 5 presents the theoretical expectation of the attributes. There are three variables that are expected to have positive signs which are water quality, water

TABLE 4. Example of choice card given out to respondents

CARD 1	CHOICE 1	CHOICE 2	STATUS QUO
Water quality	Good	Good	Satisfactory
Water disruption	Sometime	Frequently	Frequently
Water pressure	High	Low	Low
Water price	90% increase (RM0.95)	28% increase (RM0.64)	No change (RM0.50)
Choose only ONE	×		

TABLE 5. Attributes and expected sign

Attribute	Descriptions	Expected Sign
Water quality	The quality of water supply at homes expressed in terms of safety for direct human consumption, tasteless, odorless, colorless and comply with the standard drinking water quality	Positive
Water disruption	Frequency of temporary water supply disruptions at homes over the year.	Positive
Water pressure	The condition of water pressure when the water comes out from the tap water.	Positive
Water price	Increase in unit water price charged by the water provider (SATU) over the current price.	Negative

disruption and water pressure. These variables are expected to have a positive impact while the water price is expected to have a negative impact on the willingness to pay for improved water services.

RESULTS AND FINDINGS

SOCIO-ECONOMIC PROFILE OF THE RESPONDENTS

Table 6 presents the results of the socio-economic profile of respondents. There were 384 respondents in the survey where 189 (49.2%) from the total number of respondents were male and 195 (50.8%) were female. The respondents included consumers aged 20 until 70 years old. In terms of income, the majority of the respondents (34.9%) earned monthly income between RM2001 to RM4000. The education level showed that 32.1% of the respondents attained for a diploma or certificate. The highest education level was Ph.D. and Master level with 2.3% while the lowest education level is those with no formal education which is 3.1%. It can be seen that more than half of the respondents having more that one person working in her family members and 42.4% of respondents are working in the government sector.

TABLE 6. Socio-economic profile of the respondents

Socio-economic profile of the respondents	Frequency	Percentage
Gender		
Male	189	49.2
Female	195	50.8
Age (Years)		
20 – 30	85	22.1
31 – 40	101	26.3
41 – 50	146	38
51 – 60	41	10.7
61 – 70	11	2.9
Household Income (RM/Month)		
Less than RM2000	112	29.2
RM2001 - RM4000	134	34.9
RM4001 - RM6000	85	22.1
RM6001 - RM8000	27	7
RM8001 - RM10,000	26	6.8
Education Level		
PhD/Master	9	2.3
Bachelor	104	27.1
Diploma/Certificate	123	32.1
Secondary Level	114	29.7
Primary level	22	5.7
No education	12	3.1
Number of working members (Person)		
1 person	159	41.4
More than 1 person	225	58.6
Type of occupation		
Government sector	163	42.4
Private sector	78	20.3
Businessman	36	9.4
Others	107	27.9

CHOICE EXPERIMENT RESULT

SIMPLE CONDITIONAL LOGIT MODEL

Table 6 presents the estimation of the simple CL model. The variables QUAL2, DIST2 and WPRES2 were significant at 1% level while WPRES3 was significant at the 10% level with the correct expected sign. This indicates that the consumers have adapted to current water quality, water disruption and water pressure but they prefer to have a slight improvement from the current condition so that is why QUAL2, DIST2 and WPRES2 are highly significant at 1% level. In other words, it implies that respondents highly preferred to improve from current condition to second level as compared to level three. The explanation for this is the respondents expect to have an improvement from the current condition but they are not putting a too high expectation for that three attributes. PRICE was significant at the 5% level with an expected negative sign. This specifies that as the price for the water service increases, consumers are less likely to contribute because of the decrease in their utility level. The negative sign in PRICE confirms that increase in water price will make negative contributions to the utility.

CONDITIONAL LOGIT MODEL WITH INTERACTION

The results for interaction model are presented in Table 7. Ten interaction terms were selected. It must be highlighted that the final set of interaction was specified after an extensive testing of the relevant variables and attributes. When the main attributes interact with socio-economic variables, it makes the improvement in model fit. The inclusion of socio-economic variables may provide heterogeneity in choices (Nam & Son 2005) and accuracy in estimation of the model (Rolfe et al. 2000). However, some of the attribute signs and coefficient remain the same as in the basic model but some of it changes. QUAL2 and DIST2 are highly significant with a correct expected sign in basic model, however, both are not significant with incorrect expected sign in the interaction model. WPRES2 are highly significant for both models and it can be explained that water pressure was highly valued by the respondents and they wanted to have an improvement for water pressure from the

TABLE 7. The conditional logit results

Variables	Simple CL Model			CL Model with Interaction Terms		
	Coefficient	Std Error	t-value	Coefficient	Std Error	t-value
QUAL2	2.449	0.285	8.592***	-0.253	1.263	-0.200
QUAL3	-0.246	0.246	-1.001	-1.243	0.338	-3.678***
DIST2	2.841	0.184	15.478***	-0.480	0.578	-0.832
DIST3	-0.097	0.449	-0.217	-2.941	0.666	-4.414***
WPRES2	2.996	0.201	14.914***	2.065	0.730	2.828***
WPRES3	0.680	0.351	1.937*	-1.441	0.498	-2.893***
PRICE	-1.846	0.781	-2.363**	-0.997	0.843	-2.184**
Interaction terms						
QUAL2_EDU				-0.140	0.063	-2.228**
QUAL3_EDU				0.069	0.020	3.384***
DIST3_EDU				0.220	0.037	5.995***
WPRES2_EDU				-0.248	0.037	-6.698***
WPRES3_EDU				0.166	0.028	5.837***
QUAL2_AGE				0.123	0.029	4.239***
DIST2_AGE				0.068	0.017	4.057***
WPRES2_AGE				0.081	0.017	4.699***
DIST2_INCOME				0.311	0.983	3.166***
WPRES2_INCOME				0.707	0.986	2.744***
Number of Observations	1536			1536		
Log-likelihood (LL)	-1208.483			-1134.738		
Log-L function no coefficients	-1233.6659			-1233.6659		
R^2	0.0204			0.0802		
R^2 Adjusted	0.0182			0.0751		

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%

current condition to a better level. It can be supported that, SATU received a high number of complaints regarding water pressure in Terengganu (Malaysia Water Association 2017).

The interaction with education level produces a positive sign to variables of QUAL3_EDU, DIST3_EDU and WPRES3_EDU and significant at 1% level. This indicates that people with high education level prefer to have very good water quality, never experienced with water supply disruption and high water pressure. It shows that they prefer to have an improvement from the current condition to the highest level of improvement for every attributes. As stated by Asthana (1997), Adenike and Titus (2009), Wendimu and Bekele (2011) and Bogale and Urgessa (2012) where education level plays an important role in willingness to pay for improved water services. This is simply because the level of education will affect the identification of water sources, the perception of water quality and reliability of water sources.

As mentioned by Ifabiyi (2011), the role of age is very significant in willingness to pay for improved water services. The interaction with age produces positive signs to a variable of QUAL2_AGE, DIST2_AGE and WPRES2_AGE and significant at 1% level. This defines that older people prefer to have good water quality, less frequency of water disruption and moderate water pressure. It shows that older people prefer to have an improvement from the current condition but then they are not putting a too high expectation on each attribute of water services in Terengganu.

Respondents with higher income take water disruption and water pressure seriously as indicated by positive signs in variables of DIST2_INCOME and WPRES2_INCOME where both are significant at 1%. Income attribute played a role affecting willingness to pay for improved water services and this is showed by Asante et. al (2002) that recognized a relationship between household income and willingness to pay for water services in Ghana.

Based on the results, the CL model with interaction terms has an improved goodness of fit as compared to the basic CL model. It can be seen from the R-square (R^2) value for the basic model and the interaction term has increased from 0.0204 to 0.0802 respectively. Agreeing with Mathew et al. (2019), the inclusion of other variables would increase the R-square (R^2) value. The interaction model has a higher level of model fit with improvements

TABLE 8. Marginal WTP value for basic CL model and interaction model

Variables	Marginal WTP	
	Basic CL model	CL Model with Interaction
QUAL2	-1.327**	-0.253
QUAL3	0.133	-1.243**
DIST2	-1.539**	-0.480
DIST3	0.053	-2.941**
WPRES2	-1.623**	2.066*
WPRES3	-0.368***	-1.442*

Notes: ***Significant at 1%, **Significant at 5%, *Significant at 10%,

in likelihood value which is –1134.738 as compared to –1208.483 in simple CL model. This indicates that the CL interaction model is a more precise model compared to the simple CL model.

CONSUMERS' WTP ESTIMATIONS

The coefficient β can be used to estimate the Marginal Willingness to Pay (MWTP) for each of the non-monetary attributes. It can measure the benefits of an improvement for each attribute from one level to another level. The marginal WTP or marginal rate of substitution indicates the WTP of the respondents according to their preferences (Siebert et al. 2006) and measures the benefits of an improvement of the attribute from one level to another (Latinopoulos 2014). The monetary trade-off between each of the non-monetary attributes (water quality, water disruption, and water pressure) with the monetary attribute is possible to be calculated because water price is included as the price variable for both models. It should be noted that the marginal values related to water price are measured in Ringgit Malaysia (RM). The MWTP can be calculated using the formula of the non-monetary attribute's coefficient over the monetary attribute coefficient:

The MWTP estimation obtained using the coefficients which were generated using the Wald procedure in LIMDEP 9.0, NLOGIT 4.0 are reported in Table 8 and the values estimated vary across the two models. MWTP are the measure of the benefits for an improvement within one attribute from one level to another**.**

Referring to Table 8, the marginal value calculated for QUAL2 is –1.327 in the basic model and –0.253 in the interaction terms. The negative sign in both models indicates that the utility has been reduced. The same thing explains for DIST2 and WPRES3 which have negative sign for both models. The negative signs for QUAL3, DIST3 and WPRES3 in interaction model describe that the utility has been reduced. The marginal value for WPRES2 in basic CL model is –1.623 and 2.066 in interaction model. For the interaction model, consumers are willing to pay an increase of 2.06% for good water quality and this shows that medium water pressure is highly valued by the respondents meanwhile the negative sign in the basic model specifies that the utility has been reduced. It can be explained that each one unit decrease in water pressure has a marginal value of 1.62% of water price for the basic model. The value estimated for QUAL3 and DIST3 in simple CL model had correct expected sign but it was not statistically significant. A probable explanation for this result is that the respondents do not prefer to have very good water quality and have never experienced water supply disruption before.

CONCLUSION

This study contributes to the development of empirical literature on the study of household preferences and willingness to pay pertaining to the issues involving domestic water service. This study also adds to the limited literature on the estimation of economics benefits from improved domestic water services using the CE method mainly on Malaysia population. This study presented an empirical analysis of DCE to estimate the consumers' preferences for domestic water service attribute in Terengganu. The basic CL model revealed that the variables QUAL2, DIST2 and WPRES2 were highly significant at 1% level with correct expected sign. This implies that good quality of water, once-a-year water supply disruption and moderate water pressure are the most preferred attributes by the consumers. For interaction model, it showed four variables that were highly significant (1% level) but only one variable has a correct expected sign which is WPRES2. Other three variables with incorrect expected signs are QUAL3, DIST3 and WPRES3. The variable WPRES2 showed positive expectation sign and this indicates that moderate water pressure is the most preferred by the consumers. DIST2 was not statistically significant and had incorrect expected sign which reveals that the frequency of water disruption (once a year) is not important and not preferred by the consumer.

Results reported in this study are the values that the surveyed households placed on attributes of domestic water service. Findings on the monetary value of the water service attributes will alert the community regarding the importance of conserving water resources. In order to reach the satisfaction of the consumers, this information is essential and beneficial to water provider management to serve as a guideline to improve the water services from the current status quo level to a better service delivery. This study contributes to the recent empirical literature that attempts to study public preference concerning a range of water services related issues. This study does not only provide useful estimates of consumers' willingness to pay for capital and maintenance planning, but it also delivers particular guidance for water providers' operational

to focus on better estimation of water price for a high standard with a new upgraded service in near to medium term. As mentioned by Zaiton et al. (2012), though using WTP for economic valuation cannot provide the exact answers on the valuation of these natural resources, it can still provide a guideline on pricing strategy and provide extra information for management decisions, especially on pricing. This is because pricing is an essential tool of water demand as it can send an influential message to the consumers on the value of water. By moving to a more applicable price structure, it can regulate ineffective levels of domestic water use by changing household water demand. Water price should be structured to encourage conservation of water resources among consumers as there is no substitute for water. Those findings may serve as a reference for sustainable water resources planning aiming at providing cost-effective ways of providing water services at reasonable prices to the consumers. Such guidance will help the service provider to come out with better estimation of water price for upgraded and higher standard services in the near future. This is crucial considering the essentiality of pricing in ascertaining the water demand as it sends an influential message to the consumers on the value of water. Switching to a more applicable price structure as intended by the government to adopt Full Cost Recovery (FCR) approach will recover all related costs when water is delivered to the consumers. Thus, water price should be structured and reviewed to encourage conservation among consumers and simultaneously signals the possibility of higher water price in the future.

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