Model for measuring the effect of incentive schemes, tariff regimes and technological innovations on change of consumer behaviour on energy savings: a study based on Sri Lankan electricity consumers in the domestic sector

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Abstract: The influences of incentives and regulations on changing consumer mindset on efficient usage of technologies, tariff regimes and consumption pattern are evaluated within this study. This research attempts to develop a scientific model with these three independent constructs in the light of two mediating variables. Theory of planned behaviour (TPB), technology acceptance model (TAM), attitude behaviour and consequence (ABC) model and information processing theory (IPT) are used as the existing knowledge. The integrated model is then evaluated, reduced and re-specified using structural equation modelling (SEM) technique. The sample size is 500 domestic consumers. The findings show that existing incentive mechanisms on lower end domestic consumers are ineffective. The effective group is the high-end consumers who consume more than 180 kWh units per month. The model is validated specially with 100 randomly selected consumers in the domestic sector and can be applied as a policy directive on energy conservation in Sri Lanka.

Keywords: energy conservation; incentives; interventions; regulatory framework; structural equation modelling; tariff regimes; technology management.

Reference to this paper should be made as follows: Jayaratne, W., Dasanayaka, S.W.S.B. and Mudalige, D.M. (2021) 'Model for measuring the effect of incentive schemes, tariff regimes and technological innovations on change of consumer behaviour on energy savings: a study based on Sri Lankan electricity consumers in the domestic sector', *Int. J. Engineering Management and Economics*, Vol. 6, No. 4, pp.272–291.

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This paper is a revised and expanded version of a paper entitled 'Model for measuring the effect of utility interventions on change of consumer behavior on energy savings: a study based on Sri Lankan domestic sector' presented at MERCon-2020 Conference, University of Moratuwa, Sri Lanka, 29 July 2020.

1 Introduction and background for the study

Ceylon Electricity Board (CEB) is the government owned electricity provider in Sri Lanka, who is struggling to cater the increasing demand at an affordable cost. In overall, 10%-15% electricity is wasted due to technical and non-technical losses in the national grid in Sri Lanka as in CEB Annual Reports 2013–2017. However, demand for electricity has continuously increased (annually around 5%) and CEB electricity saving stimulus has proven to be ineffective as in CEB Statistical Digests 2013–2017. Further, this phenomenon also indicates that people and industries have not changed their behaviours relating to electricity usage and do not consider electricity conservation as their one of social obligation to combat increasing global warming.

Normally, people would continually engage in a behaviour, if they psychologically feel positive about the outcome of that behaviour as per (Ajzen, 1991). Therefore, this research study aims to theoretically explain why CEB's energy saving stimulus are unable to influence on electricity conservation behaviour among the domestic consumers by testing the mediating effect of consumer motivation and behaviour.

Normally, efficiency involves the cost while conservation involves the behaviour as per Rudin (2000). Electricity conservation creates financial viability and reduces the disastrous Green House Gas (GHG) emission in the long run (Dasanayaka and Jayaratne, 2012).

2 Research gap and the significance of the study

During the failures in major power plants in the system, CEB introduces different energy conservation mechanisms by way of incentive schemes and regulatory framework. However, many consumers do not grab those mechanisms due to various reasons. CEB as the main utility provider of electricity, experiences the problem of bridging the peak energy gap prevailing due to inadequate capacity constraints (CEB Annual Report 2013–2017).

In this case, consumer's awareness and perceived wiliness to adhere to the given mechanism might be insufficient. Documented research (Geller, 2003) showed that there were several determinants with respect to the energy conservation by means of different motivational activities. Some researchers (Goulder and Stavins, 2011) explain that there exist several social and political factors related to energy conservation and furthermore, they explain that administrative and political issues, firm behaviour on different policy instruments and multiple overlapping factors may contribute to the decision on energy conservation (Anthoff and Hahn, 2010). New group of researchers explain that it is difficult to develop, convince and diffuse new policy instruments for different kinds of motivational activities on energy conservation (Gillingham et al., 2012).

Researchers have developed some relationship for demand function of electricity as follows:

$$\log Y = \log(\beta_1 * P) + \log(\beta_2 * I) + \log(\beta_3 * R) + \log(\beta_4 * B) + \varepsilon \quad (1)$$

where

Y electricity demand

P electricity price

I monthly income of the consumer

R cost of other commodity (energy resources)

B consumer behaviours and usage pattern

β_1 price elasticity of demand

β_2 income elasticity of demand

β_3 cross price elasticity of demand

β_4 incentive elasticity of demand

ε another unknown factor

Considering equation (1), it is found that consumer's behaviour (B) effect the energy demand whilst other three factors (P), (I) and (R) all related to tariff regimes also influence the end result. Energy conservation can be achieved by means of changing behaviour. In order to change the consumer behaviour, different intervention mechanisms have been introduced by CEB in time to time.

However, many of such intervention mechanisms have not reach the expected goals by looking at the current level of consumption (CEB Statistical Digest 2013–2017). The theory of planned behaviour (TPB) has significantly been used for systematically identifying the determinants that influence decision making in various behavioural studies including energy conservation, green consumerism, environmental aspects, etc. (Ajzen, 1991; Davis et al., 1989). Accordingly, there exists a knowledge gap for conservation of energy using different intervention to change behavioural aspects in Sri Lanka. The theory of planned behaviour (Ajzen, 1991) stated that a behaviour is obtained by interaction between motivation which can trigger by means of an incentive scheme, and ability to control. The TPB assumes that intension can directly predict the behaviour. Whenever, new technology is introduced to the market, there is certain delay in diffusing same throughout the domain due to the reluctance of consumers to accept the new knowledge. This phenomenon has been fully explained by technology acceptance model (TAM) as in Gillingham et al. (2012) and Davis et al. (1989). Further, according to attitude, behaviour and consequence (ABC) model people will behave according to their attitudes while same can be changed based on the consequences. If the consequence is rewarding it becomes an incentive whilst if it is a punishment it becomes a regulation as per ABC model (Laughery et al., 1994). Further, the information processing theory (IPT) explains how information can be conveyed to human being using five sensors as explain in many religious and psychological findings as in by Guagnano et al. (1995). Using all four existing theories new model is developed in order to explain the human behaviour on energy conservation in presence of different interventions. In this research, what matters is to develop a flow chart which can explain the balancing mechanism of energy demand at peak time by means of conservational aspects. The demand for conservation does not involve any high cost investments. But it needs only limited amount of funds. Especially, within the limit of local investments these mechanisms can be started. According to Laughery et al. (1994), total investment on energy conservation mechanisms is Rs. 1,500 million whereas total requirement for new generation will be several thousand billion. Therefore, conservation mechanism covers distinguish steps with viable interventions. Energy conservation is the saving of energy without wasting whereas energy efficiency is the use of less energy for same kind of work effectively. Approximately, 1.6 billion of world population do not have the privilege of accessing to the national grid connected electricity where as 80 million population of India do not experience the luxury of this versatile energy resource (Harland et al., 2006).

Figure 1 Energy conservation model (see online version for colours)

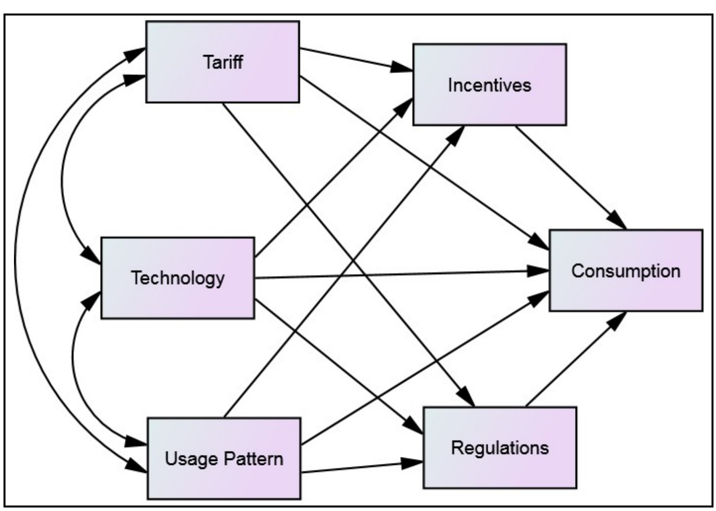


Figure 1 shows the determinants of energy consumption. The major determinants are tariff regime, technology and usage pattern as per Eto et al. (1996). There are two more antecedents namely incentives and regulations. Incentives reward the savings whilst regulations impose legislations to keep the consumer on tract as per Eto et al. (1996). Further, Kano (2013) has found that only 34% of the domestic participants in Japan succeeded in reducing their electricity consumption, and the average reduction rate was – 4.8%. As per Goulder and Stavins (2011), electricity demand can be controlled by changing tariff, introduction of new technology and changing the usage pattern. But authors have only studied the economic feasibility of reduction in carbon emission on electricity generation in Sri Lanka. But not the consumer behavioural part of it. Hence, gap is identified in between energy conservation and changing of consumer behaviour with different interventions. In Kano (2013) and Mizobuchi et al. (2012), authors have measured the possibility of conserving electricity by means of non-structural techniques such as change of consumer lifestyle, long term choices and shifting of comfort zones in terms of moral objectives.

Table 1 Use of electricity 2013–2019 in Sri Lanka

Customer category	*Number of customers – 2013*	*Percentage sales – 2013*	*Number of Customers – 2015*	*Percentage Sales – 2015*	*No. of customers in 2019*	*% sales 2019*
Domestic	4,589,929	33%	4,966,395	33.5%	5,651,452	32.7
Religious	31,627		34,710		40,724	0.6
General	535,267	19%	588,063	19.7%	739,122	21.1
Industrial	53,162	32%	56,681	30.6%	64,241	30.1
Hotel	465	2%	489	1.8%	470	1.9
Government	309	1%	1792	1.2%	4,574	1.4
LECO	1	13%	1	13.3%	1	12.2
Street lamp	1		1		1	32.7
Total	5,210,761	100%	5,648,132	100%	6,500,641	100%

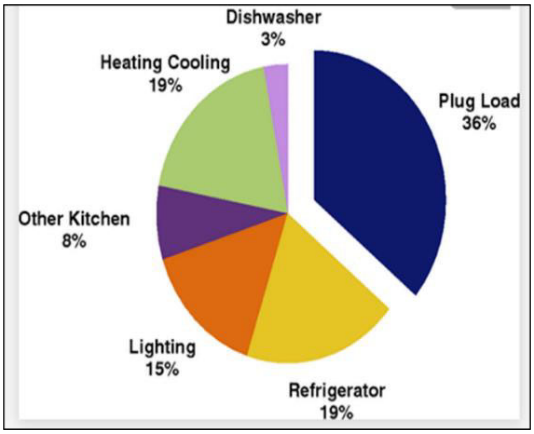
Source: CEB Statistical Digest 2013–2019

By looking at Table 1, it is observed that domestic consumer demand on electricity is getting increased day by day. In 2013, total number of domestic consumers was 4.5 million whereas by 2019, it has become 5.6 million. Accordingly, the consumer demand on electricity increases rapidly (CEB Statistical Digest 2013–2017).

Considering Figure 2, it is found that domestic consumer loading is solely depended on plug load, heating and cooling as in Kano (2013). If we can control these high loads then the energy conservation can be thought of as explain in Kano (2013). According to Kano (2013), Japanese government introduced two kinds of intervention mechanism to curtail higher usage of energy just after the Fukushima disaster.

Table 1 shows the different consumer segments by tariffs category- wise (CEB Annual Report 2013–2017). Very important observation could be found in Table 1 with respect to total energy sales in domestic sector; i.e., the total energy demand 33% in 2013 has risen to 33.5% in 2015 whilst it is at 32.7% in 2019. This is solely due to the increase in consumer number as well as the result of the intervention mechanisms on energy conservation (CEB Annual Report 2013–2017).

Figure 2 Consumer loading on different activities (see online version for colours)



Source: Kano (2013)

3 Research questions and objectives

3.1 Research questions

Research questions are:

1 Why CEB's intervening mechanisms on energy conservation failed prematurely?

2 What is the consumer perception on different intervention mechanisms?

3 What is the influence of intervention mechanisms to domestic sector?

4 What is the mediating effect of interventions?

5 How to derive effective policy mechanism?

3.2 Research objectives

Based on the above research questions the following research objectives are derived:

1 to explore the present situation

2 to explore the consumer perception on different interventions

3 to explore the influence of different interventions on energy saving

4 to explore the mediation effect of behaviour intention with different interventions

5 to develop appropriate policy mechanism on interventions.

4 Literature review

Many studies have shown that various types of incentives are prevailing to motivate consumers to conserve energy around the world (Goulder and Stavins, 2011). Among them, investment subsidies, loan schemes, tax credits and emission allowances are the most popular incentives. More specific studies explain that the available mandatory regulations and incentive schemes must greatly be cost effective in order them to be implemented by the firms (Goulder and Stavins, 2011).

Some researchers have explained that, most intervention mechanisms have not been studied scientifically and comprehensively (Mizobuchi et al., 2012). Many researchers have pointed out that the intervention is composed of six components; Efficiency criteria, size, recipients, form of incentive, eligibility requirements and whether program has exit criteria or continuing with recycling mechanism (Mizobuchi et al., 2012).

Some studies showed that incentives work properly than stringent regulations and therefore, governments need to follow effective incentive mechanisms rather than strict regulations to change the behaviour of public (Rosenberg and Hoefgen, 2009). Furthermore, tariff regimes influence the consumer to conserve energy with different price signals (Ajzen, 1991).

Three intervention mechanisms practice with CEB are the monetary rewards, energy saving technology-based products and systems and regulatory regimes (CEB Annual Report 2013–2017). It has been found that continuous monitoring plays vital role in achieving these desired objectives by Guagnano et al. (1995).

The barriers and difficulties prevailing against the consumer's decision on investment on energy efficient equipment and changing mindset to use them have been researched by studies (Davis et al., 1989). These studies suggest that technological innovation along insufficient to reduce energy consumption but need the change of behaviour too.

As per Abrahamse and Steg (2011) and Arbuckle (1997), this kind of study utilises random sampling technique in order to distribute the uncertainty of perceived behaviours of individual across wider domain. According to Eto et al. (1996), two objectives have been reached with respect to energy conservation by means of behavioural changes namely; "the possibility of sustainable energy consumption in Japan at the individual level; key barriers and drivers to change behaviour for energy conservation". Eto et al. (1996) further explain that there exist structural and non-structural methods of energy conservation. Structural method involves efficiency improvement by means of technology whereas non-structural method involve energy conservation by means of behavioural changes. Even though industrial countries have energy efficient devices still they are still in the problem of energy shortage.

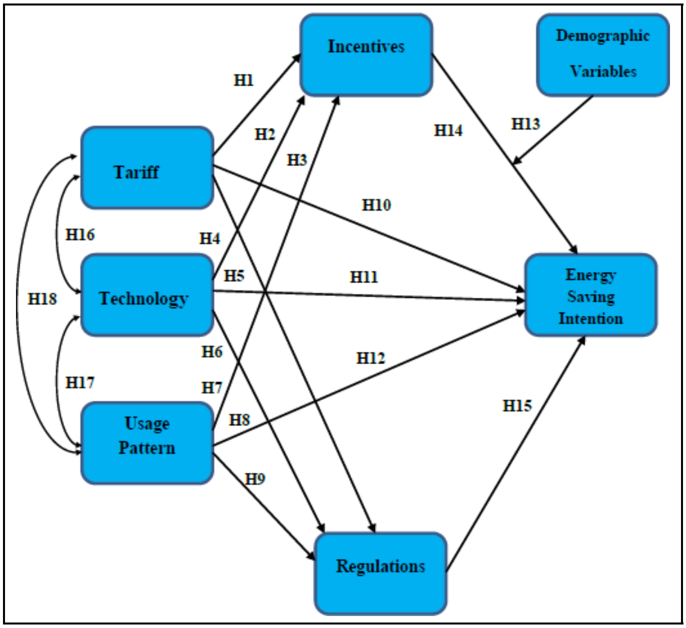
5 Methodology and conceptual model

Since the literature supports the three major components as the determinants of energy conservation which has real knowledge gap, the conceptual model in Figure 3 is developed based on the TPB, TAM, ABC and ITP as explained in literature survey.

5.1 Hypotheses developed

Eighteen hypotheses have been identified within this study. These relationships were identified based on the literature survey.

Figure 3 Conceptual model (see online version for colours)



In this research, positivism, realism and interpretivism are used to study electricity consumer behaviour with respect to different interventions. Structured questionnaire survey and series of face to face interviews used as the main methods of data collection. Basically, this research is initially started with exploratory nature to find out determinants of energy conservation. After that using empirical data which is collected by way of questionnaire survey from random sample of 500 domestic consumers in three major districts namely Colombo, Kalutara and Gampaha districts in Sri Lanka. Then the SMART PLS3 software as in Hair et al. (2011) was used to analyse the relationship between independent, mediating, moderating and dependent variables with 18 hypotheses as shown in Figure 3. The research strategy adopted in this study is that it is started from exploratory method to build up a model to integrate consumer behaviours on different aspects and thereby to measure the performance of the instrument on explanatory means. The mediating effect of consumer behaviour intention on energy conservation is formulated with the principle of observations based on the integrated TPB, TAM, ABC and IPT models through an inductive research process (Attari, 2010). Finally, the new model is re-evaluated with collected user observations and thereby the entire research becomes a mixed method. Sample size is determined by the conceptual model and the scientific tool which is being used to analyse the hypothesised model. As per the SMART PLS3 software requirements (Hair et al., 2011) the sample size should be large enough to get at least ten respondents for one parameter to be estimated in the model. In this context, SEM techniques incorporated with SMART PLS3 software is used to analyse the hypothesised model and accordingly, sample size is determined by the number of parameters in the model. The size of the sample is re- assured with formula which has been accepted by many scholars in recent literature (Hair et al., 2011; Cochran, 1977). In this research, sample size is found to be 500 numbers of domestic consumers which create 38 independent variables of scale category and ten demographic variables of ordinal category which act as moderating factor as identified in the conceptual model. SMART PLS3 model was developed as shown in Fig. No.4. The independent variables are composed of tariff regime (TAR1, TAR2, TAR3 and TAR4), technology {(perceived usefulness UP1–UP10), perceived ease of use PEU1–PEU6)}, usage pattern (UP1–UP4), incentives (INT1–INT4), regulations (REG1–REG4), demographic variables (DEM1–DEM10), behaviour intention as (BI1–BI6). The indicator variables for measuring each latent factor are decided as per Rosenberg and Hoefgen (2009). Moderation effect of demographic variable between incentives (INT) and behaviour intention (BI) is tested as shown in Figure 4. In order to verify the accuracy of the moderation effect sampling with replacement mechanism which is normally identified as the bootstrapping technique which is used to validate the moderation effect successfully. The basic requirements to fulfil the indicator reliability, composite reliability, convergent validity, discriminant validity, etc. are verified in order to ensure the validity of the model prior to do the complete data analysis. Accordingly, as in Abrahamse and Steg (2011), it was found that item reliability > 0.5 was retained, Cronbach's alpha > 0.7, average variance extracted (AVE > 0.5) as in Hair et al. (2011) and Sentosa et al. (2012).

Figure 4 SMART PLS 3 model for domestic consumers (see online version for colours)

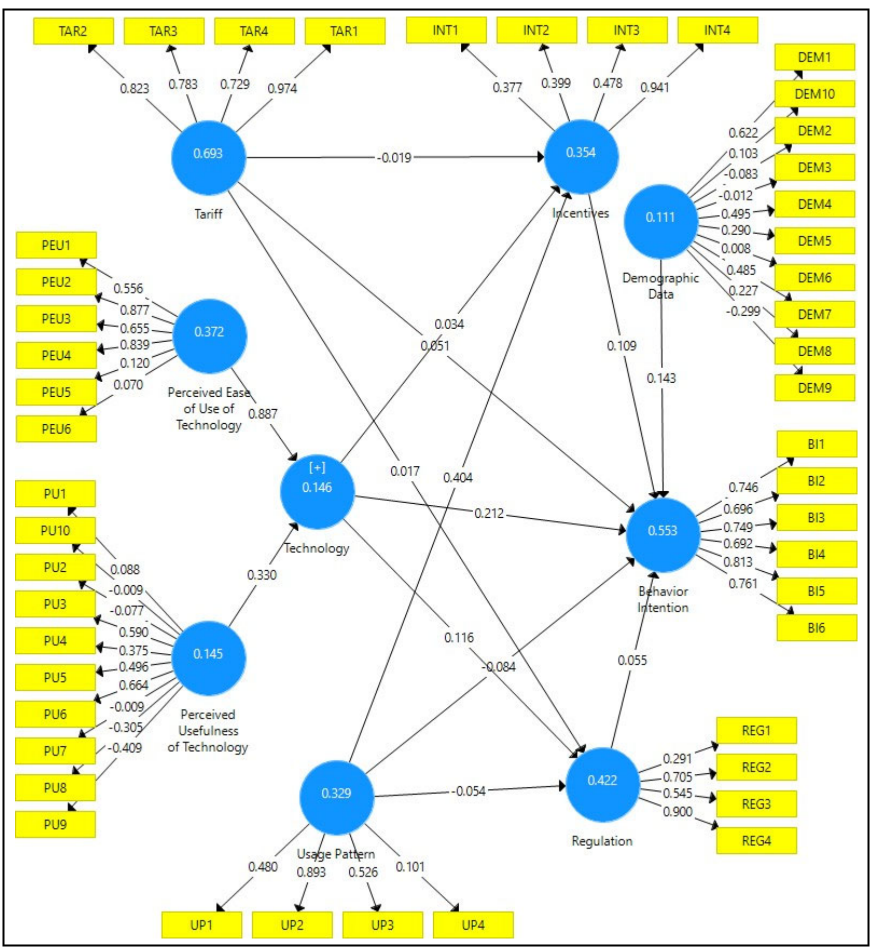
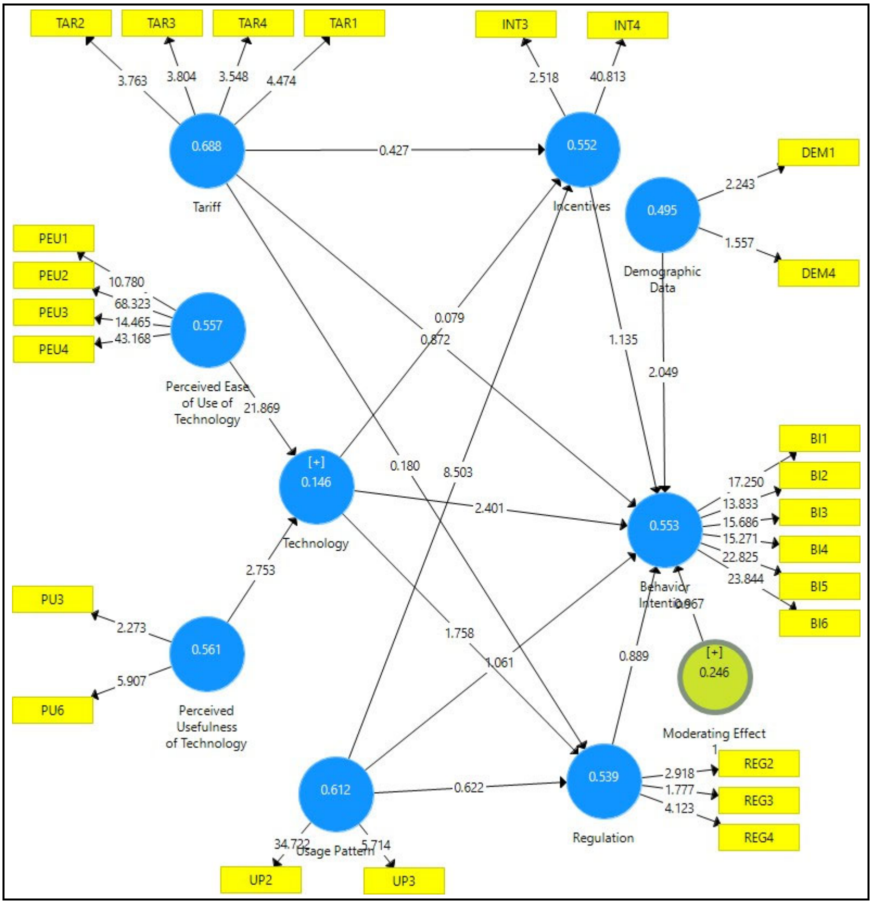


Figure 5 Respecified model with T-values and AVE of construct (see online version for colours)



5.2 Data analysis

Data analysis is based on the output of respecified model as shown in Figure 5. All the indicator loading values represent the values > 0.5 except usage pattern (UP), Incentives (INT) and demographic variables (DEMO). That indicates the reason for the failure of existing incentive mechanisms to match with consumer usage pattern in such a way to change the consumer mindset towards the conservation of energy. The construct reliability values and R square values given in Tables 2 and 3 respectively show the SMART PLS 3 output based on the empirical data gathered within the study. Consumers who uses up to 180 kWh units should be treated with incentives. The consumers living in rented houses and enjoying lesser amounts of units especially up to 90 kWh per month, are having significant correlation with incentive schemes. Those should be treated with incentive schemes. Some regulations over retrofitting mechanism should be there to convert energy saving options while renting of houses with the help of local authority or the utility/government. The consumers who use monthly energy less than 30 kWh have no significant correlation with incentive schemes, tariff regime or regulations. They have to motivate by giving job opportunities to shift their living standard from miserable to comfort zone by the government. Study found that that there exists no mediation effect of consumer behaviour intention over energy conservation with respect to incentives, tariff regime and the regulations whereas the consumers demographic variables act as the moderating variables on changing consumer mindset over conservation. The multi group analysis technique was used to test the model for different demographic variables such as education (DEM4), occupation (DEM5), monthly income (DEM6) and monthly consumption (DEM7). Accordingly, domestic consumer model was grouped according to the monthly energy consumption level as follows; The Likert scale 1-5 is given for different consumption slots as shown below:

- 0–30 kWh: tariff group 1
- 31–60 kWh: tariff group 2
- 61–90 kWh: tariff group 3
- 91–180 kWh: tariff group 4
- above 181 kWh: tariff group 5.

With the multi group analysis techniques available in SMART PLS3, the moderation effect of each consumer group on the relationship of incentives and BI is measured. Accordingly, this facility is used to discriminate the different incentives among different groups of consumption levels (Sentosa et al., 2012).

Table 2 Reliability testing (see online version for colours)

Construct reliability and validity				
	Cronbach's alpha	*rho_A*	*Composite reliability*	*(AVE)*
Behavior_Intention	0.839	0.852	0.880	0.551
Demographic_Data	0.206	0.216	0.712	0.555
Incentives	0.327	0.954	0.672	0.552
Moderating effect 1	0.311	1.000	0.293	0.252
Perceived Ease_of use of technology	0.715	0.749	0.842	0.645
Perceived_Usefulness_of technology	0.595	0.813	0.815	0.692
Regulation	0.606	0.700	0.780	0.547
Tariff	0.882	1.768	0.900	0.695
Technology	0.715	0.746	0.843	0.645
Usage_Pattern	0.427	0.635	0.749	0.612

Note: Relationships highlighted in green colour are statistically significant.

Source: Data analysis

Table 2 shows the Cronbach's alpha > 0.6 (Nunnally, 1970) for major constructs whilst incentives, demographic data and usage pattern have Cronbach's alpha little below the norms. However, as in Hair et al. (2011) and Mizobuchi et al. (2012) further evaluation is made since there exists higher composite reliability, higher average variance extracted (AVE) > 0.5, Rho-A > 0.7 and as a whole which gives significantly a consistent dataset (Sentosa et al., 2012).

It is observed that, dependent variable behaviour intention (BI) is 10.8% represented by the independent variables. The R square value of incentives is 18.6% whilst it is for technology is 95.5%. This means that existing energy conservation is completely depended on the technology. The intervention mechanism such as regulations does not significantly influence the energy conservation in Sri Lanka. The regulations must be stringent enough to move the consumers towards the conservation of energy. The R square value of regulation is 1.1% which is not significant at all to change the consumer mindset towards conservation aspects. It is also observed that incentives and regulations are not known to existing consumers or not cared by individuals. The regulations on energy conservation can play a major role in Sri Lanka. Especially, use of tariff effectively, use of efficient technologies etc. have to be defined by the government regulations. Further, as explain s in Eto et al. (1996), non-structural conservation options play vital role in Sri Lankan energy sector too. R square value 18.6% for incentives explains that the influence of existing incentive mechanisms does not support the entire effort significantly. This is true for the regulations as well. Therefore, what CEB has to do is revisit the existing incentive schemes and regulations and make adverse changes to grab consumer mindset towards the conservation aspects. People will tend to conserve accordingly.

Table 3 R square values in present scenario (see online version for colours)

	Mean, STDEV, T-values, P-values				
	Original sample (O)	*Sample mean (M)*	*Standard deviation (STDEV)*	*T statistics (|O/STDEV|)*	*P values*
Behavior_Intention	0.108	0.135	0.037	2.904	0.004
Incentives	0.186	0.195	0.042	4.440	0.000
Regulation	0.011	0.029	0.017	0.664	0.507
Technology	0.955	0.952	0.007	130.228	0.000

Note: Relationships highlighted in green colour are statistically significant.

Source: Data analysis

CEB introduces different intervention mechanisms to motivate the consumers towards conservation of energy time to time. Recently, one million LED bulbs were distributed among the lowest energy consuming lot. Basically, it focuses on tariff group 1, tariff group 2 and tariff group 3. During this study, objective 1 to 3 in the list of objectives were selected in order to answer this problem.

- *Objective 1*

  Why CEB's intervention mechanisms fails prematurely?

  It is because of the poor representation of those interventions in consumer mind as shown in Table 3. What actions that CEB should initiate is to enhance the R square value of BI. Popularise the intervention mechanisms among all the consumers by way of different information processing techniques as given in IPT by Guagnano et al. (1995). IPT says that in order to transmit information, five sensors must be applied. What are those five sensors? According to IPT, everybody has five sensors in his body: eyes, nose, taste, ears and entire body. Similarly, when a new intervention is going on, utility must stimulate all five sensors of customers by means of awareness campaigns, social media, direct contact, commercial activities such as major subsidies or privileges to first entrants, etc. Giving free samples to test with prior to purchase. Giving continuous technical support and customer care activities, etc. during the phase of introduction. This is what is lagging in CEB. In certain intervention programs, only few people know about it. But the utility's responsibility is to give ample publicity.

- *Objective 2*

  Figure 5 explains the consumer perception on different intervention mechanisms of the utility. Accordingly, path coefficient of PU → BI = 0.369, this indicates that consumer very much concern about the perceived usefulness of available energy saving technologies. Consumers perception on incentives → BI = 0.057, this too indicates that utility's effort on energy conservation by granting different incentives have not become fruitful due to various reasons. However, usage pattern (UP) → incentives (INT) = 0.442, this means that consumer's usage pattern can influence the incentive mechanism. The significance of all these relationships are given in Table 4.

5.3 Hypotheses testing

Table 4 is used to test the hypotheses. Accordingly, Technology has positive impact on BI (H11 becomes true). Incentives have positive impact on usage pattern (H12 becomes true). Demographic variables have moderating impact on the relationship between tariff → incentives (H13: becomes true), tariff → BI (H2: insignificant), tariff → regulation: (H3: insignificant), technology → incentives: (H4: insignificant), technology → BI: (H5: insignificant), technology → regulation: (H6: significant), usage pattern → BI (H8: insignificant), usage pattern → regulation: (H9: insignificant), incentives → BI: (H13: insignificant), incentives → BI: (H14: insignificant), regulation → BI: (H15: insignificant).

Table 4 Significance of relationships of the model and hypothesis testing (see online version for colours)

Mean, STDEV, T-values, P-values					
	Original sample (O)	*Sample mean (M)*	*Standard deviation (STDEV)*	*T statistics (|O/STDEV|)*	*P values*
Demographic_Data → BI [H13A]	0.075	0.087	0.055	1.364	0.173
Incentives → BI [H14]	0.074	0.074	0.067	1.167	0.243
Moderating effect 1 → BI [H13B]	0.106	0.106	0.114	0.989	0.323
PEU_of technology → technology	1.005	1.005	0.003	326.646	0.000
PU_of technology → Technology	-0.005	-0.005	0.004	1.501	0.133
Regulation → BI [H15]	0.061	0.071	0.059	1.039	0.299
Tariff → BI [H2]	0.038	0.027	0.056	0.673	0.501
Tariff → incentives [H1]	-0.021	-0.017	0.051	0.403	0.687
Tariff → regulation [H3]	0.013	-0.008	0.086	0.151	0.880
Technology → BI [H5]	0.099	0.096	0.052	1.909	0.056
Technology → incentives [H4]	-0.015	-0.015	0.050	0.297	0.767
Technology → regulation [H6]	0.144	0.144	0.059	2.450	0.014
Usage pattern → BI [H8]	-0.050	-0.046	0.061	0.814	0.416
Usage pattern → incentives [H7]	0.423	0.424	0.050	8.488	0.000
Usage pattern → regulation [H9]	-0.030	-0.028	0.047	0.637	0.524

Note: Relationships highlighted in green colour are statistically significant

Source: Analysis of data using Smart PLS3 software

Table 5 Hypotheses testing results (see online version for colours)

Hypotheses	*Result*	*Hypotheses*	*Result*
H1	Insignificant	H10	Insignificant
H2	Insignificant	H11	*Significant*
H3	Insignificant	H12	*Significant*
H4	Insignificant	H13	*Significant*
H5	Insignificant	H14	Insignificant
H6	*Significant*	H15	Insignificant
H7	*Significant*	H16	*Weakly significant*
H8	Insignificant	H17	*Weakly significant*
H9	Insignificant	H18	*Weakly significant*

Note: Relationships highlighted in green colour are statistically significant.

Figure 6 Moderation effect of demographic variable on reduced model (see online version for colours)

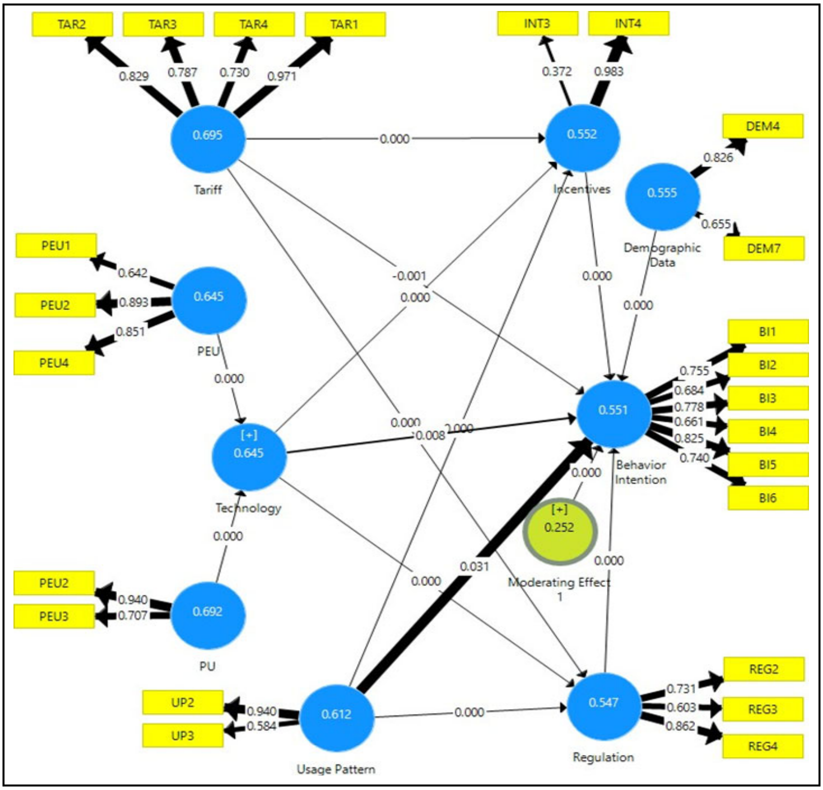


Table 5 gives the correlation among major independent constructs. Accordingly, tariff ↔ technology = 0.053, therefore, H16 = there exists weak correlation among tariff and technology. Technology ↔ usage pattern = 0.048, hence H17 = there exists weak relationship among technology and usage pattern. Similarly, H18 = 0.026 (tariff and the usage pattern retain a weak correlation).

- *Objective 3*

  Objective 3 refers to ascertain the influence of different intervention mechanisms. According to Tables 4 and 5, it is observed that relationships of incentives and regulations on behaviour intention are 0.078 and 0.061 respectively. It shows the poor correlations (0.062 and 0.080) of interventions on behaviour and as a result actual behaviour on energy conservation is very poor. This is the reason for ineffective nature of prevailing interventions on energy conservation in Sri Lanka. The path coefficient of incentives to behaviour intention as in Table 4 is 0.074 whilst the same value for regulation is 0.061. Therefore, objective 3 has reached the conclusion that the influence of existing intervention mechanisms towards energy conservation in Sri Lanka is at a primitive stage and need more development in terms of financial support, tax credits, low interest loan schemes to the customers as well as stringent regulations on the use of efficient devices and effective use of block tariff around the clock.

Table 6 Correlations of latent variables

	Latent variable correlations									
	BI	*DEMO*	*Incentives*	*Moderating effect 1*	*PEU*	*PU*	*Regulation*	*Tariff*	*Technology*	*Usage pattern*
BI	1.000	0.087	0.062	0.019	0.111	0.074	0.080	0.053	0.111	–0.022
DEMO	0.087	1.000	0.108	0.012	0.034	0.028	–0.009	0.008	0.033	0.018
Incentives	0.062	0.108	1.000	–0.035	0.004	–0.005	0.000	–0.011	0.004	0.420
Moderating effect1	0.119	0.102	–0.035	1.000	0.000	–0.009	0.033	0.096	0.000	–0.099
PEU	0.111	0.034	0.004	0.000	1.000	0.860	0.142	0.053	1.000	0.048
PU	0.074	0.028	–0.005	–0.009	0.860	1.000	0.091	0.049	0.858	0.027
Regulation	0.080	–0.009	0.000	0.033	0.142	0.091	1.000	0.020	0.143	–0.023
Tariff	0.053	0.008	–0.011	0.096	0.053	0.049	0.020	1.000	0.053	0.026
Technology	0.111	0.033	0.004	0.000	1.000	0.858	0.143	0.053	1.000	0.048
Usage pattern	–0.022	0.018	0.421	–0.099	0.048	0.027	–0.023	0.026	0.048	1.000

Source: Data analysis

- *Objective 4*

  Objective 4 ascertains the prevailing mediation effect of interventions on change of consumer mindset towards conservation of energy. In this case, direct effect, indirect effect and total effect are measured using the output of the SMART PLS3 software. Accordingly, Table 6 gives the direct effects, indirect effects and total effects of interventions on the change of behaviour intention of domestic consumers towards the conservation of energy in Sri Lanka.

Table 7 Testing of mediation effect of interventions

Specific indirect effects			
	Indirect effects	*Direct effects*	*Mediation exists if direct effect < indirect effect*
Tariff → incentives → BI	–0.002	0.038	No mediation
Technology → incentives → BI	–0.001	0.008	No mediation
Usage pattern → incentives → BI	0.033	0.031	Mediation exists
Tariff → regulation → BI	0.001	0.038	No mediation
Technology → regulation → BI	0.009	0.061	No mediation
Usage pattern → regulation → BI	–0.002	–0.05	Mediation exists

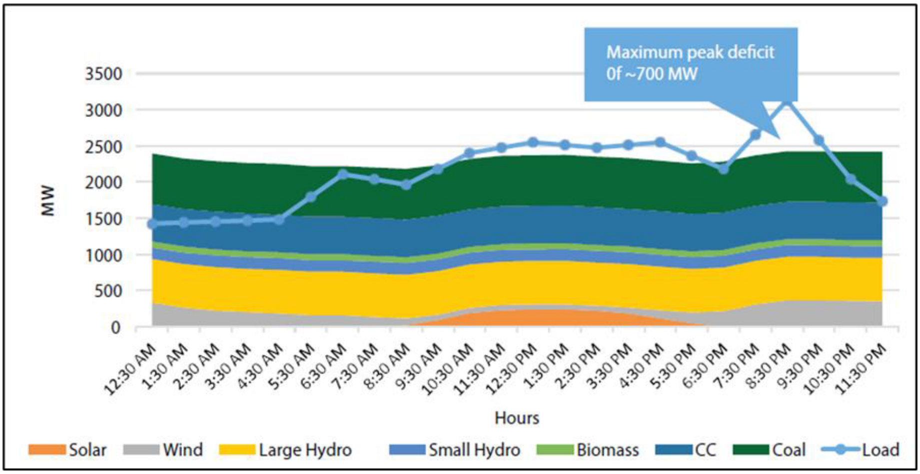
Source: Data analysis

According to Table 6, it is found that mediation of incentives exists between usage pattern and behaviour intention. Similarly, mediation of regulation exists between usage pattern and behaviour intention (BI).

- *Objective 5*

  Objective 5 reserves the necessity of developing a policy instrument on energy conservation in Sri Lanka with the help of findings of this research. Policy directives must be developed in order to fill the prevailing peak demand gap of the country during peak hours especially 6.30 pm to 10.30 pm of every day. Figure 7 shows the existing peak energy demand gap in the country which is about 700 MW as in CEB Annual Report 2013–2017. In order to provide additional requirement during peak hours, it is necessary to put up new power stations of this capacity or curtail the excess usage by means of different intervention mechanisms. According to CEB Annual Report 2018, development of 700 MW of generating station, at least 700 million USD is needed even without the cost of transmission lines. When it considers with the transmission line additional 250,000 USD per km is needed for the construction of transmission line as in Hair et al. (2011). Therefore, conservation of energy will add more value to the national economy when it is compared to the high cost generation solutions. Within the study, it was found that consumer usage pattern can be changed with the introduction of different incentive mechanisms and regulations. Incentive refers, giving something extra to the domestic consumers based on their savings on monthly energy consumption. Different media campaigns can be organised to change the consumer mindset over their usage pattern. Similarly, technological support can be added to make the consumer more conscious on their habitual usage of energy. For an example, motion sensors can be applied to turn on and off the lights whenever the occupant is available. The issue is the initial cost of such devices of which utility should have some form of mechanism to equip their domestic consumers with artificial intelligence. Artificial intelligence can be used to support the change the habitual and perceived behaviours of consumers.

Figure 7 Peak demand deficit of the country (see online version for colours)



Source: CEB Annual Report (2018)

As shown in Figure 7, there exists abandon energy during day time, this excess energy can be utilised for the requirements arising during peak time. For an example, consumer can wash their cloths during day time and iron it at a single occasion even at day time. This can be programmed to perform during the weekend. This should be initiated from the consumer mindset by means of different intervention mechanisms. Regulations can be imposed to introduce different block tariff to different activities. Consumers can be encouraged to shift their activities towards the off-peak tariff. Only challenge is to change the consumer attitude to move away from the comfort zone to conservation mindset. The changing usage pattern by means of continuous awareness programs and incentives are necessary. Policy framework on national energy conservation must be carefully designed with this kind of studies. The best example of issuing LED lamps to the low-end consumers is a totally loss to the organisation as it does not give any return to the organisation as per Table 7 which shows the multi group analysis output of the reduced model with empirical data. When looking at Figure 7, it is clear that existing major issue prevailing in the country. Sri Lanka needs 700 MW of extra capacity to be maintained in order to cater peak energy deficit from 6:30 pm to 10:30 pm every day. The conservation of energy by means of different intervention activities expects to fill this existing peak demand gap as explained in this research. As per Dasanayaka and Jayaratne (2012) and Goulder and Stavins (2011), there exists 850 MW of standby generators in the country. Same can be connected to the system during peak time from 6:30 pm to 10:30 pm if an adequate intervention mechanism is introduced by the government.

Accordingly, the different groups (income level) and groups values (1–5) change the R square value of the dependent variable. That indicates the importance of this kind of model when explaining effectiveness of any intervention mechanism (Hair et al., 2011).

Table 8 Multi group analysis on block tariff

Tariff block	*R-square of [BI]*
0–30 kWh	0.093
31–60 kWh	0.106
61–90 kWh	0.128
91–180 kWh	0.136
Above 181 kWh	0.191

Source: Data analysis

6 Conclusions, recommendations and agenda for future research

CEB introduces different kinds of incentives to encourage customers to conserve electricity in time to time. However, many of these mechanisms have created only expenditure in the long run rather energy conservation. This is because of the unavailability of proper scientific model to measure the behaviour of individual components with respect to the given incentive mechanism. Therefore, the developed new model from this research fills the knowledge gap existing in the body of knowledge. By using this model recently failed many incentive measures such as solar net metering and net plus mechanisms, issuing of LED bulbs to the consumers of below 30 kWh unit consumption can be explained. At different level of incentives converging points of tariff system and the technology input can be predicted and thereby future incentive mechanisms could be evaluated in advance before encountering the premature failures wasting resources etc. The policy makers could get use of this new model as a startup to develop an advance scientific instrument to dispatch different intervention mechanisms effectively. It saves extra money incurring on unprecedented failures already experienced by the utility (Long Term Generation Expansion Plan CEB 2018–2037).

This study only covered the limited consumers of Colombo, Kalutara and Gampaha districts which include high end customers as well as well-educated and higher income group of the country. The result may be diverse if different domains are selected especially in the districts where low income and education levels persist. This reserves for the future research in order to decide different values of incentive levels which would balance the available technology products and the tariff system.

This research covers only the domestic segment of the Western Province (Colombo, Kalutara and Gampaha districts) in the country. This can be extended to other segments of electricity consumers as well. Further, the economics aspects and exit mechanism on these interventions are good agenda for further research.

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