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A review of electricity consumer behavioural change under sustainable energy management scheme

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ABSTRACT

Many authorities launched their energy sustainability plan that involve the sustainable energy management scheme to improve energy efficiency. The sustainable energy management scheme consists of several measures to encourage energy efficiency in three primary energy consumers by pursuing implementation measures in the industrial, commercial, and residential sectors. Meanwhile, energy performance is quantifiable in energy efficiency and energy consumption become one of scheme measure aspects. In this review, the ASEAN Energy Management Scheme (AEMAS) was discussed as a regionally structured training and certification system for ASEAN Energy Managers. Besides that, Energy Management Gold Standard (EMGS) is AEMAS's first regional achievement certification for global excellence in energy management systems. Previous literatures exposed the key to energy efficiency goals is behavioural change, which means individual attitudes affect energy consumption.

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1. INTRODUCTION

Climate change is a new and challenging issue. It is a massive and difficult transformation that will necessitate fundamental and revolutionary improvements in consumer energy management [1]. This points to a massive and transformative boost in energy efficiency [2]. In development country like Malaysia had run into energy consumption demand increased over the past years. Consequently, it was also facing an increasing trend of CO_2 emission from 1980-2016 [3]. Therefore, the growth emission intensity, especially from the energy sector, becomes the country's most concern issue. As a result, the government has committed to reducing greenhouse gas (GHG) emissions intensity of gross domestic product (GDP) by 45% by 2030. Meanwhile, it was compared to the emissions intensity of GDP in 2005, with 35% unconditional and the remaining 10% conditional on receiving climate finance, technology transfer, and capacity building from developed countries. Then, it is critical to examine the relationship between energy consumption, CO_2 emissions, and economic growth to guide policy in energy management alternatives [4].

Furthermore, the industrial sector rated second after the transportation sector and has become one of the largest energy usages. Industries consumes 29.5% of total national energy consumption [5]. Most of the energy used in industry has been derived from fossil fuels, namely coal, oil, and natural gas [6]. The use of fossil fuels in industrial operations generates exhaust emissions, which can raise the concentration of carbon

dioxide (CO_2) and carbon monoxide (CO) gases in the atmosphere. CO and CO_2 gas are components of greenhouse gases (GHG) that harm the environment and living organisms [7]. Increased energy consumption is caused by industrial activity due to economic expansion and inefficiencies in industrial energy use. Higher international oil costs and the negative consequences of industrial operations are driving forces in the industry's implementation of energy efficiency.

Therefore, human involvement is a significant part of reaching sustainable energy goals. At the same time, an exemplary energy management scheme implementation is a priority. Organisations can successfully speed the transition to a cost-effective, dependable, and maintain sustainable energy by investing in renewable energy resources, promoting energy efficiency behaviours, and implementing clean energy technology and infrastructure [8]. Moreover, to achieve sustainable development goals, the residential sector may also practice energy efficiency by involving in a sustainable energy management scheme. these objectives served as the impetus for developing national energy management standards. Scientists and politicians alike have concluded that concentrating on sustainable development goals strategies can help lessen the effects of climate change. Sustainable development goals to improve people's lives while minimising environmental impact are top targets in policy design. Still, it is dependent mainly on the immense task of energy system reforms [9].

Moreover, management of consumption energy significantly impacts the sustainable development of various essential firms, and enhanced energy efficiency is critical. Thus, in Malaysia government undered the Ministry of Energy, Green Technology and Water launched National Energy Efficiency Action Plan (NEEAP) to improve energy efficiency by pursuing implementation measures in the industrial, commercial and residential sectors. Therefore, the sustainable energy management scheme in this plan will determine coordinate energy management in order to ensure energy quality and quantity derived from the energy used are maintained.

The sustainable energy management scheme consists of several measures to encourage energy efficiency in Malaysia's three primary energy consumers. One of the well-known sustainable energy management schemes is Energy Management Gold Standard (EMGS). It was slight growth in higher education. Energy management best practice awards such as EMGS provided many guidelines to organisations achieve and sustain cost savings. Comprehensive energy management strategy training is also provided to the organisation energy manager under this scheme.

The main point is that under a sustainable energy management scheme, personnel and building energy management communities become necessary in energy efficiency measures operations. They were one of the primary electricity consumers in the organisation. How electricity consumer awareness also determines the buildings' energy consumption other than good managing the electrical appliances. Therefore, a review on previous literature on electricity consumer behavioural change throughout sustainable energy management scheme will be discussed in next section. The second part will discuss about the sustainable energy management scheme implementation in Malaysia. The third part will be the previous electricity consumers behavioural studies.

2. SUSTAINABLE ENERGY MANAGEMENT SCHEME IN MALAYSIA

Sustainable energy management is a process of managing the energy consumption in the organisation to assure that energy has been efficiently used. It also covers all elements of energy usage, both technical and non-technical. Energy management must develop energy strategies, objectives, energy targets, action plans, and processes for achieving sustainable energy goals. Energy performance is quantifiable in energy efficiency, energy consumption, and energy use. The organisation's energy performance can be evaluated to its objectives, energy targets, and other energy performance needs. It becomes one of the energy management system components [10].

Therefore, energy efficiency has become one of the significant elements of energy policy [11]. Good energy management with the best energy efficiency practices programme will focus on energy consumption reduction features applied in industrial and commercial sectors and residential in the domestic sectors. In the past decade, the industrial and retail sector is expected to implement measures for improvement in a plant, equipment, processes and energy consumer [12].

2.1. International Organization for Standardization Certification implementation

The International Organisation for Standard (ISO) procedure was introduced under the sustainable energy management scheme purposely to encourage any organisation to best practice energy efficiency towards to standard [13]. Traditional environmental strategies depended on obligatory regulation to cut emissions and the ecological consequences of industry and other polluters. The initiative is an effective instrument for reducing emissions to the air, water, and soil, as well as conserving natural resources and ecosystems [14].

2.1.1. ISO 14001: 2015 environmental management systems

In addition to energy, inefficiency generates high environmental costs. Therefore, standardisation was made to ensure energy was consumed efficiently. These standards certification created based on excellent planning by standards organisations while supporting the synchronisation of good practice worldwide.

Štreimikiene *et al.* [15] stated that ISO 14000 standard indicates the environmental management system requirements and specifies the implementation of the system. Then, the standard was defined as the worldwide management system which explains the organisational structure, planning events, responsibilities, practices, procedures, processes, and resources by preparing, analysing, and maintaining the efficient environmental policy of the organisation. In terms of energy management scheme development, it allows businesses to demonstrate that they operate in accordance with strict ecological standards. In essence, it is the same as the ISO 14001 standard, but with additional measures to improve the environmental condition.

Watson and Emery [16] stated ISO 14001 is a globally recognised international environmental management systems standard in the general category. This standard applies to any organisation operating in any industry area that strives to mitigate the environmental effect of its operations. This standard requires organisations to consider all ecological consequences and associated factors before improving processes in elevated areas. Implementing ISO 14001 principles promotes economic efficacy, offers ecologically friendly conditions, and introduces a substantial competitive advantage worldwide. Organisations chose to apply this new management system willingly and at their own expense because it boosts their export position in a competitive international market [17].

2.1.2. ISO 50001: 2018 energy management

ISO 50001 is standardisation for energy-based practice and based on the energy management system model of continual improvement also used other well-known standards such as ISO 14001. Kanneganti *et al.* [18] discussed that ISO 50001 provides a reasonable basis for improving energy management in industries that have well defined and structured processes. As Figure 1 ISO 50001 indicates a set of criteria for energy usage and consumption, such as measurement, documentation, and reporting, as well as design and procurement methods for equipment, systems, processes, and employees that contribute to energy performance. It is applied to all variables influencing energy performance.

In the United Kingdom, several formal procedures or regulations for energy management improvement. Nevertheless, initiatives such as Energy Savings Opportunity Scheme (ESOS) had expected to bring significant change to these regulations [19]. However, ISO 50001 implementation in Malaysia is offered in regional certification system initiatives. For example EMGS had encouraged the energy consumer to achieve the best energy management standards practice. Besides, ISO 50001 is a standard that increases energy efficiency and improves energy performance [20].

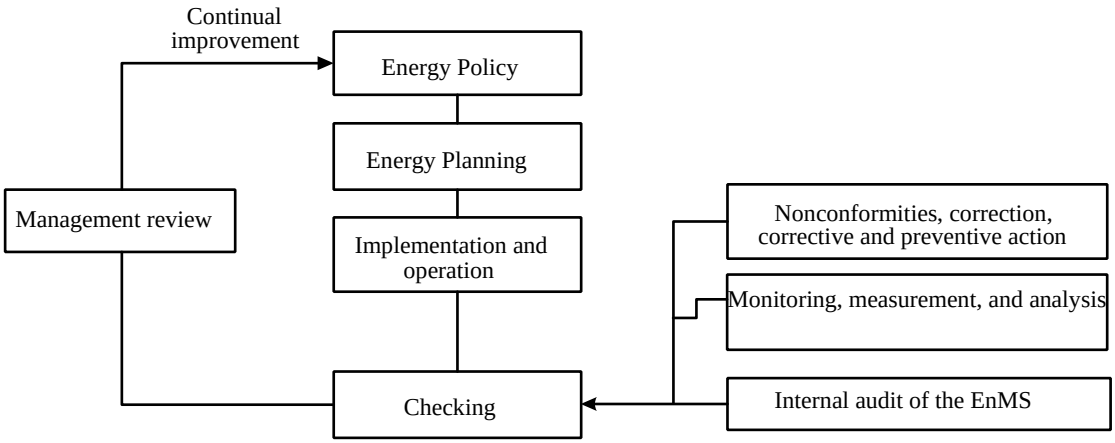

Figure 1. Energy management system model for ISO 50001

2.2. ASEAN Energy Management Accreditation Scheme

Further, energy-saving initiatives have significant importance because of their influence on reducing environmental implications [21]. Thus, ASEAN Energy Management Scheme (AEMAS) was designed under

the steering of the ASEAN Energy Efficiency and Conversation Sub-Sector Network and subsequently endorsed by the ASEAN Minister of Energy Meeting (AMEM).

This is the world's first regional accreditation scheme for energy managers and consumers. Based on Figure 2 show the AEMAS structure, which was previously approved by the European Union as part of the Switch Program. Furthermore, the ASEAN Centre for Energy (ACE) has been established in eight (8) ASEAN Member States: Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Thailand, and Vietnam. AEMAS is also a regionally structured training and certification system for ASEAN Energy Managers.

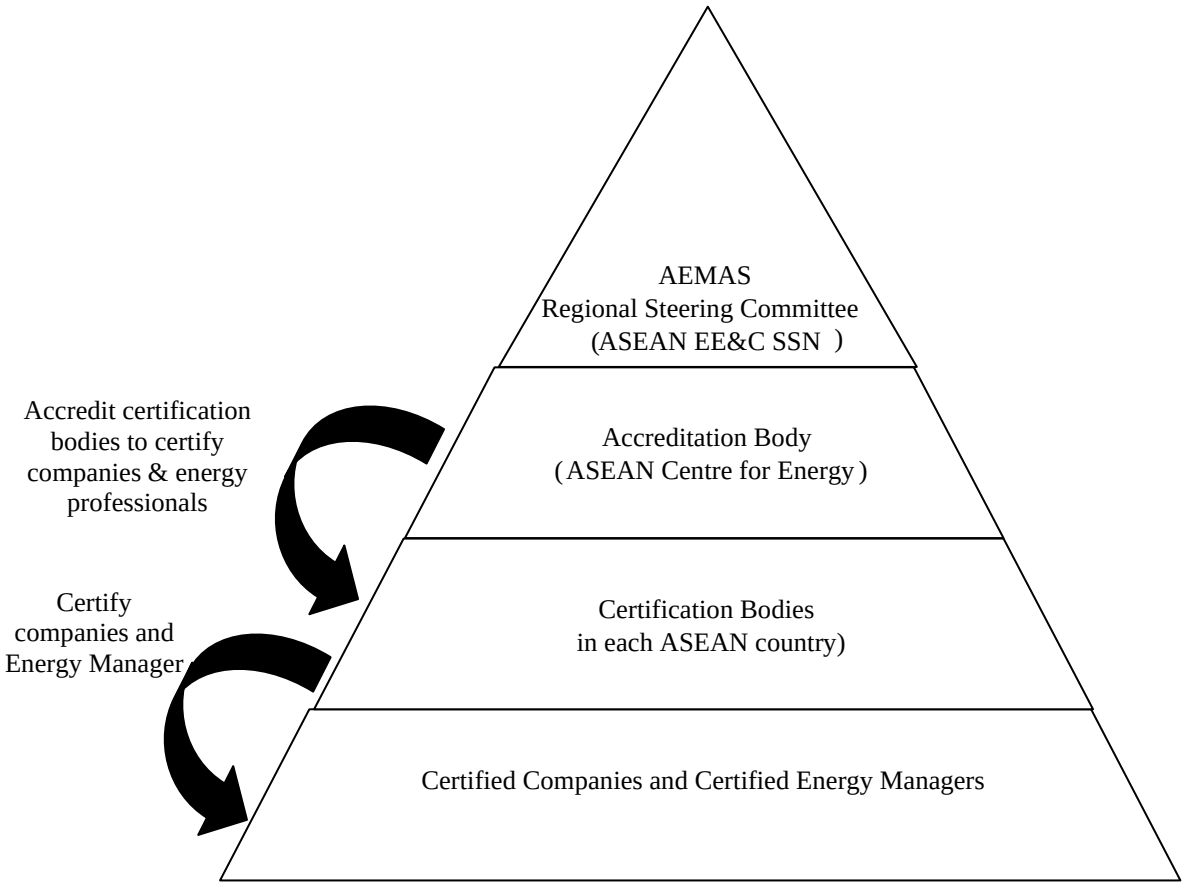

Figure 2. AEMAS structure

GreenTech Malaysia has been responsible for accrediting certification bodies to certify companies and energy professionals in Malaysia. The purpose is to increase the professional standing of certified energy managers in ASEAN. These energy managers will improve their competency by undergoing comprehensive training to develop and implement an effective, sustainable energy framework inside their organisations [22]. This scheme's full training will include all introductory theoretical courses, assessment, personal learning, and energy management practises for Energy Managers. There are two certification levels, Certified Energy Manager (CEM) and Professional Energy Manager (PEM).

This training programme was entirely devoted to management topics. The Suruhanjaya Tenaga also recognises it, and Certified Energy Managers (CEMs) who participate in this initiative are eligible to claim towards becoming Registered Electrical Energy Managers (REEM). As of June 01, 2018, 70 Energy Manager Training Course (EMTC) sessions have been conducted, training over 1315 CEMs [23]. GreenTech Malaysia also has been recognised by the Institution of Engineer Malaysia under their Continuing Professional Development (CPD) for engineers.

2.3. Energy Management Gold Standard

Besides that, AEMAS introduces their second main activity, a certification for energy end-users that undergo AEMAS Certification known as Energy Management Gold Standard (EMGS). Organisation with best practices on energy management will be awarded progressively using three-level certifications under this

regional standard. It is excellence in energy management achievement certification [24]. EMGS is Southeast Asia's first regional achievement certification for excellence in energy management systems globally. Since 2010, Green Tech Malaysia has assessed more than 160 sites, and up to date, reduced than 90GWh electricity per year [25].

Additionally, this process will integrate with standard working procedures which the organisations have to practice the standards to achieve the certification. Therefore, sustainability energy management schemes principles that have been implemented in EMGS are according to the 7 elements of the AEMAS Energy Management Scheme as shown in Table 1. The 7 elements are comprehensive criteria that need to be achieved by the organisation in order to undergo a certification audit [26].

Table 1. The 7 elements of the AEMAS Energy Management Scheme implemented in EMGS

No.	Elements	Criteria
1	Management	i. Energy policy
		ii. Executive management review of energy manager performance
		iii. Energy target and plan
		iv. Planning and allocation of resources
2	Organisation	i. Appoiment of AEMAS CEM
		ii. Energy Manager structure and responsibilities
		iii. Staff competency
		iv. Organisation awareness and accountability
		v. Recognition of energy manager
3	Process	i. Analysis of energy use
		ii. Purchasing and procurement
		iii. Operation control
		iv. Maintenance
		v. Corrective and preventive action
4	Information	i. Document control
		ii. Energy records
		iii. Staff communication
		iv. Report structure
5	Financial	i. Budget management
		ii. Investment
6	Corporate responsibility	i. Regulation compliance
7	Achievement	i. Energy efficiency monitoring
		ii. EnMS internal audit
		iii. Management review
		iv. Energy performance achievement

3. PREVIOUS ELECTRICITY CONSUMERS BEHAVIOURAL STUDIES

Consumers have become increasingly aware of the need for energy conservation during the last decade. For example, global warming awareness, social contact, and environmental behaviour are all possible factors that contribute to high awareness of electricity consumers [23]. Sony and Mekoth [27] found out that the overuse of electricity energy in human activities contributes the global warming. Therefore, electricity consumers behaviours can reduce energy consumption and reduce the environmental impact. Hence, energy consumers have become the core concern of researchers energy consumption studies.

3.1. Conceptual study

A conceptual study in a study review is essential for any research endeavour. The research gaps should be such that, if filled, they will contribute to the advancement of the field of study. Theoretical concepts of electricity consumer behavioural studies will be discussed referred from various works of literature. Paone *et al.* studied that energy usage in residential and commercial buildings is significantly affected by consumer behaviours. Consumers are more likely to reduce their electricity and other energy sources when exposed to consumption history [28]. Koroleva *et al*. [29] points out that the key to energy efficiency is behavioural change. Reduced energy use leads to lower electricity costs and benefits the Earth by reducing CO_2 emissions, making everyone happy. They could reduce emissions by 33%, surpassing a 30% reduction goal set for 2020. It met its carbon reduction target three years early. This accomplishment was made possible in part through the adoption of a behavioural modification programme. An intensive behavioural management programme at another industrial sector business resulted in an annual energy savings of 7%.

Behavioural change programs work in energy conservation [30]. Even if a small company does not hire a subject matter expert to conduct a large-scale campaign, it may be energy-efficient if it has a clear structure, motivated coworkers, and a mechanism to measure the effect [31]. Such actions will benefit the

Earth's ecosystems. Zhang *et al.* [32] also conclude that changes in energy efficiency behaviour affect energy consumption significantly. Thus, energy consumption can be positively affected by consumers energy efficiency actions.

The authors illustrated a theoretical structure in Figure 3 for behavioural-based energy efficiency project influenced performance factors in the industrial sector. Figure 3 shows that employees' behaviour actions cause energy efficiency results. Their motivation initiated their actions [33]. Energy efficiency behaviour also can be affected by increasing knowledge, abilities, skills, and attitude of energy consumers towards energy usage to reduce energy consumption [34]. Reducing energy consumption can be an organisation's sustainable energy management target [35]. This goal setting encourages participants to put in the substantial effort because the organisation's stated goals influence their motivation. Figure 4 depicts the energy management dimensions for energy conservation.

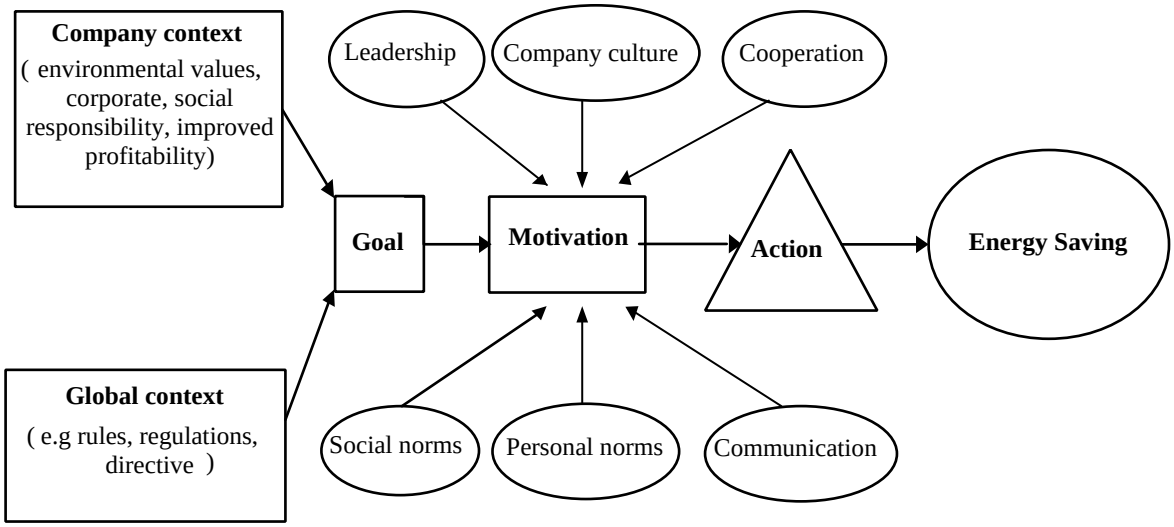

Figure 3. A theoretical framework of factors affecting the performance of a behavioural-based energy efficiency program

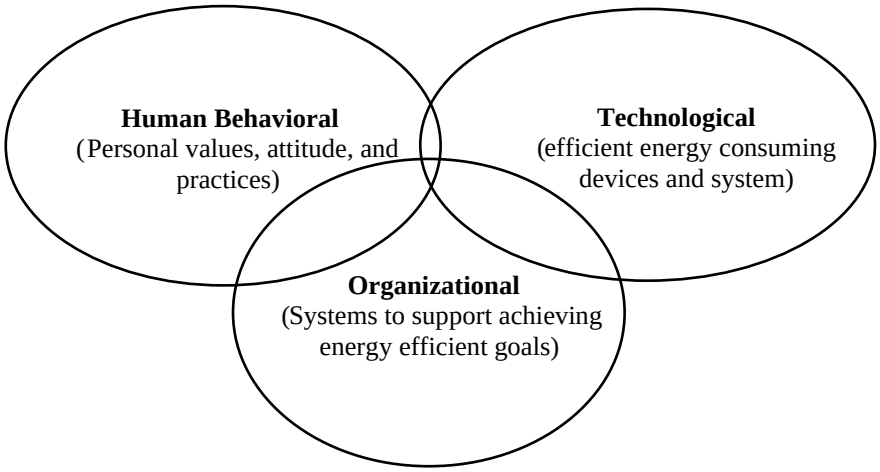

Figure 4. Dimensions of energy management, the low-cost energy conservation measures and behavioural change for sustainable energy management schemes

As shown in Figure 4, successful energy management may be achieved when any firm considers all three aspects, which are technological, organisational, and human behavioural. The maximum impact on energy management is required to address and improve training on behavioural factors, which means that individual attitudes affect their energy consumption [36]. Besides that, consumers behavioural change has also been considered a low-cost option implemented under a sustainable energy management scheme. Ali *et*

al. [37] took research interviews with the subject matter in 2020. The results show in Table 2, a tabulated different several technical and behavioural options in coordinating sustainable energy management schemes.

Table 2. Technical and behavioural options of sustainable energy management scheme

Option	Features	Cost	Tentative payback
Technical	Technology change	High cost	More than 5 years
Technical supported with behavioural	Addition and alterations	Moderate cost	1 to 3 years
Behavioural change	Administrative and corrective actions	Low cost	Less than one year

3.2. Methodological approach

Energy efficiency behaviour is a complicated behaviour that is impacted by various circumstances [38]. In research about energy efficiency behaviour real-time feedback, energy efficiency behaviour is complex because benefits are clearly and immediately visible such as a warm shower. At the same time, this action typically delayed the costs and abstracts, such as an energy bill [39]. Some studies have shown that such behaviours changes may effectively address an individual's views, preferences, and talents. Classification of methodologies by description is presented in Table 3.

Table 3. Classification of methodologies by description

Methodology	Description
Survey	Method of collecting information by asking questions
Case study	It considers describing the overall behaviour of customers in everyday life, not the behaviour of individual members of the organisation.
Pre/post-consumer occupancy	Evaluate consumer behaviour systematically and rigorously after the buildings have been built and some time.

In several studies, the survey method is quite commonly used to study energy consumer behavioural change. A survey investigation is conducted utilising the grounded theory technique. Researchers also considered consumers attitudes and behaviours differ and how would such behaviour emerge in a real-world situation in energy efficiency behaviours analysation. This rationale becomes a qualitative study consideration. It was reported to analyse instances in which stated opinions and behavioural intention change dramatically and when a real-world setting is critical [40], [41].

Generally, the research goal is to determine the meanings that consumers behaviour, mainly their energy efficiency behaviours interact [42]. Thus, researchers choose survey inquiry as it is the most suited. The fundamental phases in survey data analysis are coding the data, combining the codes into more comprehensive categories and themes, and interpreting the results. The study classifies factors of electrical energy saving behaviour into seven categories [43]. Then, policy implications and limits are examined and future research prospects. Results gaps will be discussed in the next section.

Besides that, several researchers used the case study methodology approach to study consumer behaviour. The type of methodology approach is partially similar to the survey method. With the case study method, a logistic regression model-validated using different statistical tests that account for socioeconomic and demographic variables and behaviours. It is also used to capture non-rational influences on consumers choices. The case study method will provide the researcher with exciting insights on the characteristics influencing consumers' decision process when practising energy efficiency, such as purchasing high-label energy efficient electrical appliances [44].

The following method that is used is pre/post-consumer behaviour study. This method has been used to efficiently understand user behaviour and deliver solutions for commercial and residential building energy regulations [45]. From a policy-making viewpoint, the primary obstacle to achieving the intended behaviour is often transmitting the necessary information to the target. Thus, knowledge-based interventions may be given using knowledge-based energy policy instruments that allow or encourage users to change their behaviour voluntarily at the lowest economic and environmental costs potential [46].

3.3. Results debates and conflicts

Electricity consumers psychological and perceptual traits were discovered, including personal convenience, environmental and related energy matters, price concern, personal motivation to save energy, normative effects on behaviour, and self-presentation [47]. Figure 1 shows seven factors of conflicts in electricity energy conservation behavior.

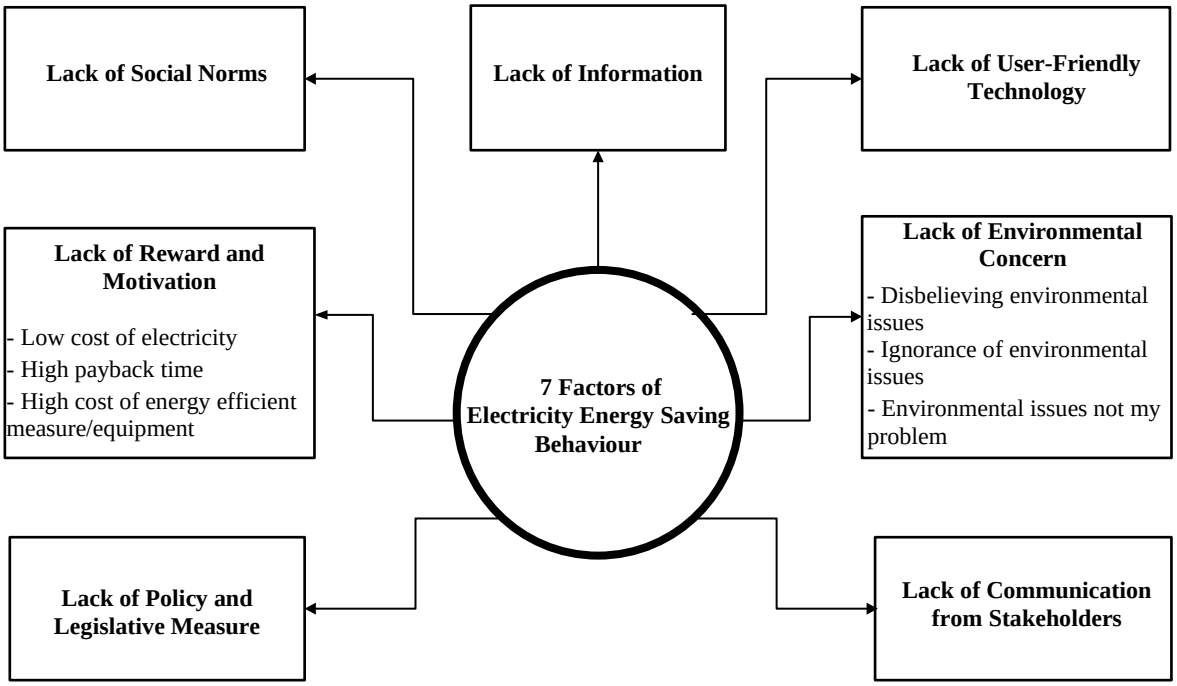

Figure 5. Seven factors of conflicts in electricity energy conservation behavior

Despite varying effectiveness, interventions to encourage energy efficiency behaviours to change among individuals have been implemented. Past research has shown conflicting findings of policy implications effectiveness [48]. The result obtained from a study shows that workers responses through interviews believed that no substantive punitive provisions exist in the absence of severe required legislation. To put it bluntly, the respondents say that tight adherence is inadequate due to a lack of policy and legislative actions [49]. Legislative measures may sometimes coerce specific behavioural patterns out of fear of repercussions. A legal framework may assist electrical energy conservation behaviour [50].

Early literature has shown that people with higher education and income levels are more likely to embrace this energy efficiency measure. Under the banner of behavioural change, Bastida *et al.* [51] conclude that consumer may shift their purchase habits to replace obsolete equipment with energy-efficient appliances. Therefore money is saved. They were changing the washer in a home to one that is more energy efficient. Otherwise, several examples of energy-efficient electrical appliances are even replacing incandescent bulbs with more energy-efficient types.

Additionally, energy efficiency behaviours include actions centred on acquiring energy-efficient technology, scheme, or methods [52]. Meanwhile, due to advancements in technology, energy-saving techniques and equipment are often more expensive than standard ones [53]. If energy saving measures are prohibitively costly, customers will walk out of the programme, especially if the efforts are not long-term reliable.

Individuals' educational attainment influences their electricity use. Meanwhile, the conclusion is questionable. Bertoldi [54], discovered that daily electricity use reduced dramatically when an individual's education level improved . Individuals with a greater level of education utilised less electricity than those with a lower level of education. However, Kostakis [55] found that social individuals' educational backgrounds had no significant effect on power consumption in Greece.

Organisations lack of reward and motivation influenced their employee to perform energy efficiency practices [56]. Despite spending most of their working days in the office, most electricity consumers were unfamiliar with the workings and advantages of the energy management scheme operated [57]. The organisation made no effort to explain, encourage, or reinforce what would have emerged as best practices in terms of working behaviour that decreased energy usage, as would have been the case. Therefore, employees lacked the motivation to change their behaviour to become more energy efficient [58].

4. CONCLUSION

In conclusion, reducing energy consumption can be an organisation's sustainable energy management target. Theoretical concepts of electricity consumer behavioural studies been discussed. The

maximum impact on energy management is required to address and improve training on behavioural factors, which means that individual attitudes affect their energy consumption. Successful sustainable energy management may be achieved when any firm considers all three aspects, which are technological, organisational, and human behavioural. Therefore, the study classifies factors of electrical energy saving behaviour into seven categories.

Moreover, policy implications and limits are examined, as well as future research prospects. The case study method will provide the researcher with exciting insights on the characteristics influencing consumers' decision process when practising energy efficiency. People with higher education and income are more likely to adopt energy efficiency measures. However, due to advancements in technology, some sustainable energy management schemes require techniques and equipment that are often more expensive than standard ones. Thus, electricity consumer behaviours include actions centred on acquiring energy-efficient technology, scheme, or methods.

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