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Organizational level energy conservation and efficiency - a case of public sector organization in Karachi, Pakistan

Anqa min Allah, Jamshaid Iqbal *, Shahid Amjad

Department of Environment and Energy Management, College of Business Management, Institute of Business Management, Karachi Sindh Pakistan

* Corresponding author: Jamshaid Iqbal, Email: jamshaid.iqbal@iobm.edu.pk

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K E Y W O R D S

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A B S T R A C T

Pakistan is facing chronic energy crises since many years. This paper aims to provide an overview of the current status of energy efficiency and conservation practices at organizational level in Pakistan. The first phase of this study evaluates the trends in electricity consumption in selected buildings over the last six years (2017–2022). Subsequently, a survey was conducted in selected buildings to assess employee morale and knowledge of energy efficiency and conservation. Results show an insignificant change in electricity consumption in selected buildings during the past six year's period indicating a poor culture of energy savings in the selected organization. Despite a constant electricity consumption from 2017 to 2022, a significant fluctuation in average billing amounts was observed. This is possibly due to electricity tariff that has continuously been fluctuating since last few years in Pakistan including Karachi. Study reveals that more than 50% of the employees in selected organization were aware about the importance of energy efficiency and conservation however, they rarely practice the energy saving measures during their routine activities. This is perhaps due to the lack of sense of national stewardship among the employees. It was also found that most of the employees of the selected organization are aware and motivated towards the environmental and climate change concerns related to energy production and its efficient use. However, again a small number of employees were found practicing the energy conservation and efficiency measures. According to this study, companies should encourage staff members to save energy by offering frequent trainings and educational opportunities. Additionally, the organizations ought to think about switching to renewable energy sources.

1. Introduction

Energy efficiency and conservation are undoubtedly the important pillars of the sustainable development [1]. Energy efficiency usually focuses on matching input requirements to specific consumption decisions usually done by reducing the power intensive nature of the production process whereas, the energy conservation seeks to reduce the energy consumption by dipping the total consumption of goods and services [2].

Worldwide the buildings consume around one-third of total primary energy resources, making it a prime target for the application of energy-efficiency and

conservation measures. The institutional and commercial buildings, are amongst the sources consuming a huge amount of energy and be the source of carbon emissions [3]. According to an estimate by the 'International Energy Outlook' 2016, globally about 41% of energy is used by the buildings [4].

Simultaneously the global building energy consumption accounts for 30% of CO2 emissions [5]. Over the past two decades, global energy consumption and CO2 emissions have increased dramatically by 49% and 43%, respectively. Current projections indicate that global energy consumption will increase by 2% per year and CO2 emissions will increase by 1.8% [6]. Currently it necessitates the efficient and sustainable use of energy to curtail the carbon emissions and resulting climate change.

Recently the organizations are becoming more interested in learning about employees' energy-use habits. Earlier studies have looked at a few individual-level variables connected to energy-saving behaviours in work environments. [7]. Research finds significant differences in employees' energy conservation behaviours mainly due to their diverse educational and socio-cultural backgrounds. Usually the employees with higher levels of education and working in diverse professional environment are more inclined to energy conservation and environmental protection [8].

Research demonstrates that a large number of organizations are motivated and aware about the long-term benefits of energy conservation and efficiency [9]. However, still a significant proportion is less aware about the efficient use of energy and most of their energy efficiency and conservation efforts are driven by the applicable legal and regulatory requirements [10].

Growing global concern over environmental issues has increased pressure on companies and organizations and increased scrutiny from various stakeholders [11]. Companies increasingly need to innovate by modifying their business models through initiating changes, improvements and replacements in various organizational elements [12].

Energy Conservation is one of the major sustainable practice that companies are adopting [13]. Companies can effectively transition to affordable, reliable, and sustainable energy systems by investing in renewable energy sources, prioritizing energy-efficient practices, and adopting clean energy technologies and infrastructure [14].

Recently the energy-use behaviours of workers and employees is becoming an area of increaseing interest for organizations. Human intervention plays an important role in achieving sustainable energy goals. It is well established that communication and education through behaviour-based energy programs and employees' trainings on their energy behaviours are the effective means to improve the energy efficiency in an organization [15].

Individuals and whole organizations generally do not actively involved in energy conservation and least careful about the environment except having proper awareness of the issue. The Oxford Dictionary delivers a straightforward yet very helpful description of awareness, despite the fact that there are many multifaceted definitions available, mainly in the field of psychology when discussing consciousness. According to this definition, awareness entails knowing something or realizing it; it also refers to being knowledgeable or involved in something. When someone is said to be energy conscious, it shows that they are aware of the nature, characteristics, and composition of energy as well as how to use it less. Additionally, the single person must appreciate the significance of energy saving and be inspired to take appropriate actions. [16].

Pakistan is one of the countries facing worst and persistent energy crises since many decades. During the last several years in Pakistan, the gap between power supply and demand is widening [17]. The energy crises in Pakistan are multidimensional and curtail from several factors such as, shortfall in power generation capacity, circular debt, outdated power infrastructure, lack of diversification in energy mix and dependency on fossil fuels [18].

Pakistan in assistance with foreign organizations have tried to resolve these problems. Among the initiatives are funding new power production projects, enhancing transmission and distribution networks, and looking to attract foreign capital to the energy industry. However, overcoming these obstacles will need consistent work, long-term planning, and regulatory changes [19]. Efforts have been made by the Pakistani government and international organizations to address these issues. Initiatives include investing in new power generation projects, improving transmission and

distribution systems, and seeking foreign investments in the energy sector [20]. However, the resolution of energy challenges requires sustained efforts, policy reforms, and long-term planning.

In Pakistan, at institutional level the efforts for energy conservation are unsatisfactory. Currently there is no unified federal authority which is responsible for energy conservation in all sectors including buildings [21]. Many businesses and institutions in Pakistan are not be fully aware of the paybacks of energy conservation and lack the adequate knowledge about energy-efficient practices and technologies. Most of the institutions in Pakistan find it difficult to carry out energy audits or invest in energy-efficient equipment due to a lack of funding. One major obstacle to adopting energy-saving solutions may be the initial price [22]. Inconsistent energy policies and governance, lack of incentives and resistant to change are also among the key challenges for institutional level energy conservation and efficiency in Pakistan [23].

Expanding energy conservation and efficiency across all sectors nationwide is one of the most cost-effective means of reducing energy imports, trade deficits, and the climb impact of energy [24]. Pakistan regulatory authorities and environmental laws necessitate the businesses to go green to preserve and sustain environment and promote business practices that play a role towards sustainability. To achieve environmental excellence a business should implement green practices like waste management, energy conservation, water conservation, zero paper use, zero plastic use and such environmental beneficent practices that could conserve and sustain resources for future generation [25].

Present study has been designed to evaluate the existing status of energy efficiency and conservation in power sector utility in Karachi. The study evaluates the past trends in energy efficiency in the selected organization and surveys through behavioural analysis, the existing level of awareness among the employees and management. Results of this study would be helpful for future energy planning in Pakistan through providing a useful insight into the energy conservation and efficiency practices and trends at organizational level.

2. Materials and Methods

This study provides the trends of energy efficiency and conservation in three different buildings of an energy organization located in Karachi, Pakistan. Study analysis the past 6-year energy consumption trends and evaluates the awareness level and behavioural attitude of employees towards the energy conservation.

A comprehensive survey of selected buildings was carried out to collect the data about, area and number of rooms in each building, ventilation systems and natural lighting systems along with total number of electricity consuming devices installed such as lights, fans, air conditions, printers, water dispensers, computers/laptops, room coolers, fridges, coffee machines etc. This survey was based on walkthroughs, discussions and interviews with relevant employees and general observation.

To estimate the electricity consumption, the electric meter number and readings for the current month was recorded. The past six years electricity consumption data for selected buildings was measured through consulting past records and collecting bills and metering records from SAP ISU module used for record keeping. SAP was utilized to trace past 5-year consumption record through meter IDs of each building location.

To evaluate the energy conservation and efficiency awareness among the employees, a questionnaire-based survey was conducted in selected buildings. The questionnaire was developed on google forms having 15 number of questions related to the awareness about energy efficiency and conservation among the employees. The survey questions were designed with main focus on understanding the attitude and behaviours of employees towards energy efficient practices at their workplaces. Total 107 responses were received which were analysed using the, IBM SPSS tool based on Value-attitude-Behaviour (VAB) model towards energy conservation (Fig. 1). The main theme of VAB is that people's values shape their attitudes, which in turn shape their behaviours. The VAB framework is widely used in disciplines including psychology, sociology, and organizational behaviour [26]. Through the VAB framework, researchers and policymakers may find it easier to comprehend the values that various

stakeholders have for issues related to energy efficiency. The VAB framework can also be helpful to understand the values of different stakeholders attached to energy-related issues. This is very crucial to develop effective communication strategies and policies that reverberate with various stakeholder groups [27]. At institutional levels, the VAB framework can be used to comprehend the attitudes and values that impact energy-related behaviours. For example, it can help create the focused campaigns that promote energy efficiency and conservation at institutions [28].

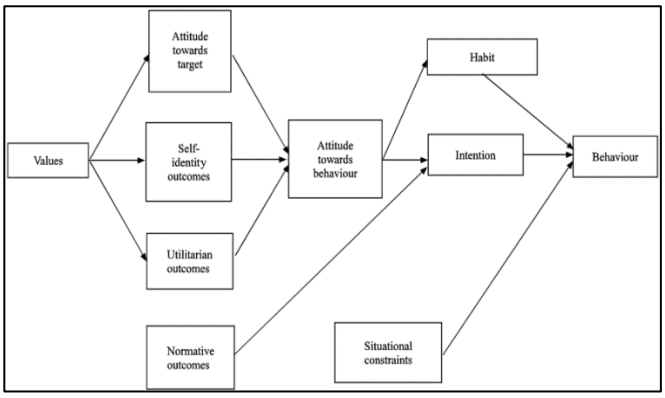

Fig. 1. Value-Attitude-Behaviour Model

Calculation of per day KW hour consumption of each device was done to compare and analyse the consumption trends during the last six years. The energy conservation awareness among employees was analysed using the SPSS tools such as frequency calculation, graphs and charts builder, and cross tab analysis feature of the software. The six years trend in energy consumption was also compared with existing practices adopted by employees and companywide policies and measures implemented for energy conservation and efficiency within the organization. Based on the existing data and analysis, recommendations and suggestions have been made for the future improvements.

3. Results and Discussion

Three office locations located in Karachi were visited comprising an area of approximately 526.71 m² (5,669.48 ft²) with 4 floor and 5 rooms in each floor for building one, an area of about 914.28 m² (9,841.22 ft²), two floors with 4 rooms in each floor for building two and building three has an area of about 3 761.18 m² (8,193.29 ft²) with 5 floors and 7 rooms in each floor.

Fig. 2 represents the six years (2017-2022) energy consumptions in terms of electricity units for selected office locations. It can be seen in Fig. 2 that except for building 2, unit consumption for other two locations have insignificant variation during the six years period. It reflects a relatively poor culture of conservation and efficient use of electricity in selected buildings.

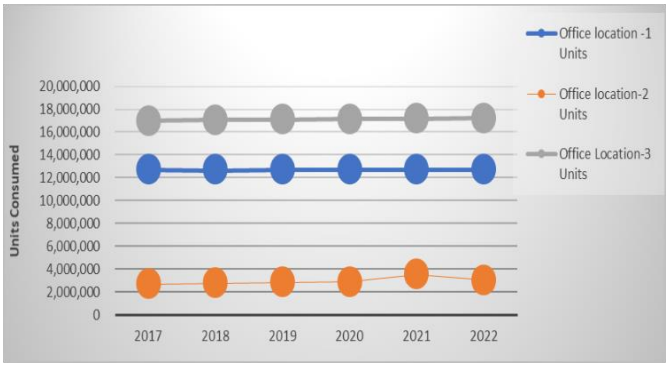

Fig. 2. Electricity units' consumption at selected building during 2017-2022.

Table 1 represents six years of electricity consumption expenditure that indicates an average of PKR 2.57 ± 0.038 million expense at office location 1 and PKR 0.52 ± 0.25 and PKR 3.84 ± 0.02 million at building locations 2 and 3 respectively.

Table 1

Six years electricity consumption expenditure of the selected buildings

Year	Building 1 PKR (million)	Building 2 PKR (million)	Building 3 PKR (million)
2017	2.52	0.22	3.82
2018	2.63	0.26	3.84
2019	2.55	0.44	3.82
2020	2.56	0.67	3.86
2021	2.59	0.71	3.88
2022	2.58	0.82	3.83
Average (± SD)	2.57 ± 0.038	0.52 ± 0.25	3.84 ± 0.02

As represented in Fig. 3, data collected from employees indicates that majority of the population (about 49%) perceives the energy conservation as an important factor and they support from their actions the idea to reduce energy use in their office timings while a negligible percent of employees finds the energy conservation is something not to worry about. About 2% of the employees in selected buildings have the awareness and knowledge about the energy efficiency and conservation however, they believe that this is just an overhyped issue that does not need to be addressed. About 16% employees are neutral about the energy efficiency and conservation i.e. they do not have adequate knowledge about the energy savings and its importance.

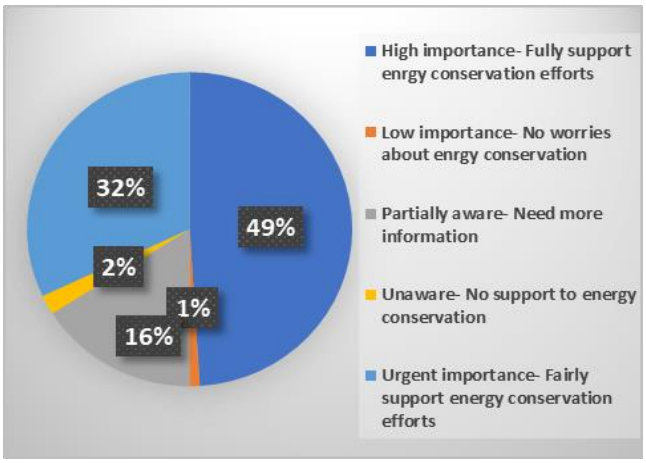

Fig. 3. Perception of energy conservation among employees

It is evident from the Fig. 3 that as a whole majority of employees are aware about and understand the importance of energy conservation practices however, in spite of this electricity unit consumptions did not dropped during the six years period from 2017 to 2022. Therefore, it seems that despite having adequate knowledge and awareness about energy efficiency and conservation, employees do not practice the energy efficiency measure during their routine workings except only 32 % employees who support and participate in energy conservation practices in the selected buildings. This is the national level dilemma of Pakistan that people rarely own the national resources and often a lack of collective thinking and approach is seen among the people throughout the country. Furthermore, many institutions lack the technical capacity and expertise to effectively implement the energy conservation measures as reported by the Ali et al [29].

A cross tab has been developed to match the awareness level of employees with their attitude towards energy conservation that reflects that 73 of the respondents were aware of the cost of single unit of electricity while 20 had no knowledge about the rates per unit electricity. It is to be highlighted that among 73 only 6 individuals have the attitude of closing lights/fans when no one is in the room while 32 had ignorant behaviour towards energy conservation. That indicates the careless behaviour of the employees despite having adequate knowledge and awareness about energy conservation and efficiency at selected buildings.

Similar behaviour was observed in the employees about their practices towards energy devices and it was revealed that majority of the respondents (N=30) were aware of the per unit rate even knowing it doesn't make their practices healthy towards charging of devices. While in total 20 employees were unaware of the cost.

When participants employees were inquired about their behaviour towards switching off the computers when not in used, it is found that 74, 20 and 14 respondents were aware of the rates per unit, were not aware of the rates and have no firm idea about the rate of unit cost respectively. It again reveals the improper attitude of employees that only 4 out 74 have the habit of switching the computers and only 4 people practice the energy saving most of the time while, 31 and 15 never or occasionally practice and care for energy saving respectively.

Table 2

Cross tabs between factors influencing employee's energy saving practices and their awareness level

		Practices to leave lights switched on in rooms					
		Always	Most of the time	Never	Occasionally	Sometimes	Total
Yes		6	5	32	19	11	73
Maybe		0	2	3	3	6	14
No		1	3	5	4	7	20
Total		7	10	40	26	24	107
		Practices to leave the battery charger of an electronic device plugged in once the battery is charge					
		Always	Most of the time	Never	Occasionally	Sometimes	Total
	Yes	5	7	30	15	16	73
	Maybe	0	6	2	1	5	14
	No	0	5	8	1	6	20
Total		5	18	40	17	27	107
		Practices to leave your computer switched on when its not being used					
		Always	Most of the time	Never	Occasionally	Sometimes	Total
Yes		4	4	31	19	15	73
Maybe		0	5	3	5	1	14
No		1	5	8	2	4	20
Total		5	14	42	26	20	107
		Practices to keep electronic devices on standby					
		Always	Most of the time	Never	Occasionally	Sometimes	Total
Yes		3	7	21	26	16	73
Maybe		0	2	3	5	4	14
No		1	8	6	2	3	20
Total		4	17	30	33	23	107

On asking about their attitude towards keeping their devices stand by also supported their lack of practices compliance towards energy conservation and only 10 of the respondents were keeping their devices standby while 97 were either unaware or were aware but doesn't practice keeping stand by devices.

As represented in table 3 majority of the sample population (86.9%) is either very positive – I actively save energy and believe I can make a difference or aware and positive – I think it is important and try to save energy when possible.

When trying to understand how employees behave in energy efficiency and conservation, it is vital to consider a number of factors, such as organizational practices, cultural norms, economic conditions, and awareness levels. Companies and organizations in Pakistan usually have less investments in their employees' education and training about energy conservation. Less stringent regulations from the government also influence the employees' behaviour and compliance with energy saving initiatives in Pakistan [30].

Table 3

General Attitude towards Energy Conservation

Attitude towards energy conservation	Frequency	Percent
Very confident – Actively participate in energy conservation efforts	39	36.4
Conscious and positive – Keep energy conservation at priority	54	50.5
Moderately conscious – Partially participate in energy conservation actions	11	10.3
Impartial – Occasionally participate in energy conservation and efficiency efforts and support actions	2	1.9
Unresponsive – No worries about energy conservation and efficiency	1	0.9
Total	107	100.0

Table 4

Comparing the level of energy conservation motivation and their attitude

Energy Conservation Attitude	Energy Conservation Motivation					
	Climate Change/Environmental sustainability	Saving on Energy bills	Saving on Natural resources	Showing a good example	To Avoid Wastage	Total
Very positive – I actively save energy and believe I can make a difference	20	12	3	3	1	39
Aware and positive – I think it is important and try to save energy when possible	12	33	8	1	0	54
Partly aware – I take some action and occasionally pass on information to others	0	9	2	0	0	11
Neutral – I may occasionally try to save energy when I think about it	0	1	1	0	0	2
Indifferent – It's not something I worry about	0	1	0	0	0	1
Total	32	56	14	4	1	107

Fig. 4 represents the level of awareness about energy wastage and its impact on environment which shows that the employees who are aware of the energy wastage are also aware of its impacts [(N= (13,30), (37,41), (36,25))]. These are classified as; those who actively follow issues and seek out opportunities to learn more, who regularly follow news media and, those who follow current issues and are aware about the current energy conservation and environmental concerns. Other category is of those who are either aware of the debate but are not yet convinced or unaware of the environmental impacts which is found to be [N= (17,9), (4,2)].

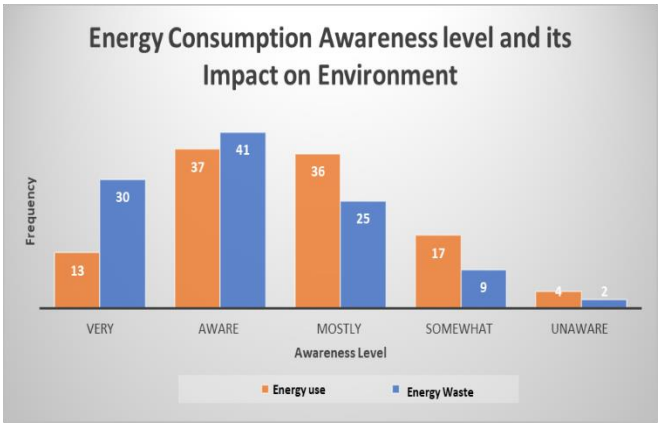

Fig. 4. Comparison of level of energy consumption and awareness of its impact

4. Conclusion

According to the findings of this study, the companies and organizations in Karachi are actively pushing for the adoption and development of an energy-saving culture among their staff members. Over 50% of people who work in offices are aware of the advantages to the environment and economy that come with energy efficiency and conservation. It is unfortunate, though, that the majority of these workers do not incorporate energy efficiency and conservation into their daily work routines. This is mostly due to a lack of a feeling of national ownership and direction. There has been no discernible decrease in the overall electricity usage of the chosen buildings over the past six years, suggesting a real lack of energy efficiency and conservation measures. At the moment, investment in renewable energy is required to implement the most ambitious sustainable business practices. Utilizing renewable energy can drastically reduce a company's carbon footprint, resulting in much more ecologically friendly and sustainable business practices. Energy usage can be greatly decreased by using contemporary approaches like placing post signs adjacent to light controls and putting motion sensors in offices. Employers should create and implement training and educational initiatives for staff members on energy efficiency and conservation as well as environmental concerns related to climate change. Above all, it appears that national stewardship trainings and incentives are very crucial in Pakistan.

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