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ORIGINAL

Factors that affect the consumption of electricity in refrigerators in the Forastero sector, Latacunga Canton, Belisario Quevedo Parish during the period of January-February 2024

Factores que inciden en el consumo de energía eléctrica en refrigeradores en el sector del Forastero, Cantón Latacunga, Parroquia de Belisario Quevedo durante el periodo de enero-febrero del 2024

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ABSTRACT

Introduction: the increase in electricity demand on a global scale implies damage to the Earth's biodiversity. Several Latin American countries experienced a significant economic increase, which generated a greater demand for energy.
Objective: to determine the factors that affect electricity consumption in the foreign sector, Latacunga canton, Belisario Quevedo parish, during the period from January to February 2024.
Method: an observational, descriptive and cross-sectional study was carried out on the factors that affect electricity consumption in the foreign sector, Latacunga canton, Belisario Quevedo parish, during the period from January to February 2024.
Results: 87 % of the total sample have only one refrigerator, 50 % open the door more than five times a day, respondents do not spend time performing the corresponding maintenance for their refrigerator, 100 % do not know the energy efficiency rating of their refrigerators, and indicated that the use of technologies such as programming and energy and temperature savings has a high impact on electricity consumption, which is 75 %.
Conclusions: the critical importance of energy efficiency in the use of refrigerators is highlighted, and the need to raise awareness among users about practices they can adopt to significantly reduce electricity consumption is underlined.

Keywords: Electric Energy Consumption; Energy Efficiency; Household Appliances.

RESUMEN

Introducción: el incremento de la demanda eléctrica a escala global implica el daño en la biodiversidad de la Tierra, varios países de Latinoamérica tuvieron un incremento económico relevante, que generó una mayor demanda de energía.
Objetivo: determinar los factores que inciden en el consumo de energía eléctrica, en el sector del forastero, cantón Latacunga, parroquia de Belisario Quevedo durante el periodo de enero-febrero del 2024.
Método: se realizó un estudio observacional, descriptivo y transversal sobre los factores que inciden en el consumo de energía eléctrica, en el sector del forastero, cantón Latacunga, parroquia de Belisario Quevedo durante el periodo de enero-febrero del 2024.
Resultados: cuentan con un solo refrigerador el 87 % de la muestra total, abren la puerta más de cinco veces al día denotando el 50 %, los encuestados no dedican tiempo para realizar los correspondientes mantenimientos para su refrigerador, no conocen la calificación de eficiencia energética de sus refrigeradores el 100 %, indicaron que el uso de tecnologías como programaciones y ahorros de energía y temperatura hace un alto impacto al consumo eléctrico siendo este el 75 %.
Conclusiones: se destaca la importancia crítica de la eficiencia energética en el uso de refrigeradores, y se subraya la necesidad de concientizar a los usuarios sobre prácticas que pueden adoptar para reducir significativamente el consumo de electricidad.

Palabras clave: Consumo de Energía Eléctrica; Eficiencia Energética; Electrodomésticos.

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INTRODUCTION

With the haste and determination to only achieve profits as demanded by economic models, two elements that are interrelated with the economy have been neglected: society and the environment. This is why the overexploitation of resources has not been respected not only by this generation but has also not thought about or reflected on the progeny of tomorrow, generating socio-environmental conflicts, according to several authors.[1,2,3,4,5]

Several Latin American countries have experienced significant economic growth in recent decades, generating greater energy demand. This increase has been driven by various sectors, such as industry, commerce, and transport, which produce more significant energy requirements, making it difficult for them to increase energy output to meet this demand. Therefore, to meet this increased demand for electricity, most countries have sought to improve energy efficiency. The Latin American Energy Organization (OLADE), in a study for Latin America and the Caribbean, stated that one of the most widely used devices globally and especially at the residential level, is the domestic refrigerator; this is an appliance that operates continuously throughout the year, which is why it implies a high energy consumption in household electricity bills.[6]

Electricity is a key issue in this century. The increase in global electricity demand is damaging the Earth's biodiversity. According to various international reports on residential electricity consumption, the domestic refrigerator is the biggest electricity user in the home, as it operates non-stop, and its energy efficiency has improved significantly as it has become more technologically advanced.[6]

The Ministry of Energy and Non-Renewable Natural Resources (MERNNR) and the Institute of Geological and Energy Research (IIGE) show that electricity consumption per inhabitant increased by 2 % between 2018 and 2019, from 1,488 kWh per inhabitant to 1 517 kWh per inhabitant. It is also important to point out that in the residential sector, some initiatives of the Ministry of Electricity and Renewable Energy (MEER) have been implemented to reduce energy consumption in the homes of Ecuadorian families.[7]

Currently, energy consumption, especially in the context of household appliances, has become critical due to the continuous increase in the global demand for electricity. The environmental impact of excessive energy consumption and the search for sustainable solutions are central issues on the world agenda.

The geographical location of the houses conditions the energy demand of the housing sector in Ecuador; the proportion of electricity consumption of food cooling equipment in Ecuadorian families is 23 % in the coastal region and 14 % in the Andean region. In the country, most households tend to extend the useful life of electrical appliances, which leads to energy consumption, i.e., operating equipment for more extended periods than they were designed for generates a prolonged delay in energy consumption savings.[8]

The issue of energy use, especially in relation to household appliances, has become critically important due to the constant increase in the global demand for electrical energy. The environmental impact associated with excessive energy consumption and the search for sustainable solutions are fundamental issues on the international agenda. It is necessary to create spaces that raise people's awareness of climate change and provide the tools needed for mitigation and adaptation, thus promoting feasible and environmentally friendly solutions in line with the landscape and urban planning of cities in the search for an improvement in people's quality of life.[9]

The population in the Forastero sector tends to extend the useful life of their household appliances, including refrigerators. Although this practice can be considered an initial saving measure, it leads to the prolonged use of devices designed for optimal performance over a limited period. This extension of the valuable life directly impacts the family economy, initially perceived as a savings strategy. However, it increases electricity bills and maintenance costs, thus establishing a causal relationship between the extension of the valuable life and the associated higher expenses.

Identifying and understanding the factors contributing to high consumption lays the foundation for implementing energy efficiency measures that reduce the environmental footprint. The awareness generated by the research can also lead to changes in community behavior, thus contributing to environmental sustainability.

Given the above, this article aims to determine the factors that influence electricity consumption in the sector of the outsider canton of Latacunga, parish of Belisario Quevedo, during January-February 2024.

METHOD

An observational, descriptive, and cross-sectional study was carried out on the factors that affect electricity consumption in the sector of Forastero, canton of Latacunga, parish of Belisario Quevedo from January to February 2024.

To obtain the information, a survey was conducted of refrigerator owners in the area to obtain qualitative information and of electrical energy experts or appliance technicians.

This research would include all refrigerators located in the Forastero sector, Latacunga Canton, Belisario Quevedo Parish, from January to February 2024. The sample, which consists of 8 respondents, would be a representative subset of that population selected to carry out the measurements and analysis necessary to investigate the factors that affect the consumption of electricity in refrigerators.

Measures were taken to protect the participants' privacy and ensure that the data collection was ethical and respectful.

RESULTS

Figure 1 shows that the majority of those surveyed indicated that there are more than three people living in their household, accounting for 50 % of the sample.

	¿Cuántas personas residen en su hogar?			
encuestados	a)Una	b)dos	c)tres	d)mas de tres
1				1
2	1			
3				1
4			1	
5			1	
6				1
7				1
8		1		
total	1	1	2	4

Figure 1. Distribution according to the number of people living in the household.

It is shown that the majority of those surveyed indicated that they have only one refrigerator in their home, accounting for 87 % of the total sample. In contrast, 13 % have three refrigerators in their home. The brand of their refrigerators is other brands, with 50 % favoring this. 25 % of respondents emphasized that their refrigerator model was Whirlpool, and 25 % of respondents noted that the LG brand of their refrigerator was LG. This suggests that most households in the sample have a relatively large number of appliances with brands other than the most common ones.

Figure 2 indicates that 75 % of them have refrigerators that they have owned for more than three years.

	¿Cuántos años tiene su refrigerador?			
encuestados	a)Una	b)dos	c)tres	d)mas de tres
1				1
2				1
3				1
4			1	
5			1	
6				1
7				1
8				1
total	0	0	2	6

Figure 2. Distribution according to the number of years the refrigerator has been in the home

Most surveyed indicated they open the door more than five times daily, accounting for 50 %. 25 % of the sample said they opened the refrigerator door five times. This suggests that most households in the sample open their refrigerator door more than 5 times daily. 50 % indicated that they spend 15 minutes cleaning their refrigerator every month. 25 % of respondents indicated that they spend 10 minutes cleaning their refrigerator monthly, 13 % of respondents indicated that they spend 30 minutes cleaning their refrigerator monthly, and 12 % of respondents indicated that they spend more than 30 minutes cleaning their refrigerator monthly; this shows that there is a sample that cleans their refrigerator for 15 minutes a month, this being the sample of the majority of the population.

Figure 3 shows that the respondents do not spend time carrying out the corresponding maintenance on their refrigerators, suggesting that the total population does not carry out maintenance on their refrigerators.

	¿Cada cuánto tiempo realiza mantenimiento de su refrigerador?			
encuestados	a) Cada dos meses	b) Cada seis meses	c) Cada año	d) No lo hago
1				1
2				1
3				1
4				1
5				1
6				1
7				1
8				1
total	0	0	0	8

Figure 3. Distribution according to how often refrigerator maintenance is carried out.

It can be seen that all respondents do not use implements, equipment, or other external elements to use their refrigerators. This

suggests that the total does not use external elements or third-party equipment to operate the equipment. Respondents do not consider energy efficiency when purchasing a fridge. This indicates that the total number of respondents does not consider outstanding effects on the operation of refrigeration equipment.

Figure 4 shows that all of the respondents who do not know their refrigerators' energy efficiency rating give 100 %.

	¿Conoce la calificación de eficiencia energética de su refrigerador principal?	
encuestados	a) si	b) no
1		1
2		1
3		1
4		1
5		1
6		1
7		1
8		1
total	0	8

Figure 4. Distribution according to knowledge of the energy efficiency rating of the refrigerator

	¿En que medida cree que el uso de tecnologías como la programación de temperatura o el modo de ahorro de energia pueden impactar en la eficiencia energetica de su refrigerador?			
encuestados	a)Alto impacto	b)Regular	c)Medio	d)Bajo impacto
1	1			
2	1			
3	1			
4	1			
5			1	
6				1
7	1			
8	1			
total	6	0	1	1

Figure 5. Distribution according to knowledge about the impact on energy efficiency of technologies such as temperature programming or saving mode.

Not all respondents use the unique features of their refrigerator. This suggests that the total number of respondents do not consider outstanding effects on the operation of refrigeration equipment, giving 100 %. The majority of those surveyed indicated that their perception of the consumption of the refrigeration equipment they own is average, with 75 % indicating moderate energy consumption and 25 % indicating high consumption. This reveals that, in general, the consumption of the equipment does not exceed a perception of concern about high consumption.

In figure 5, the respondents indicated that the use of technologies such as programming and energy and temperature savings has a high impact on electricity consumption, with this being 75 % of the sample.

DISCUSSION

Users can significantly influence the electricity consumption of their refrigerators through more efficient use practices, such as maintaining an adequate temperature, avoiding overloading the fridge, and minimizing the time the door is left open. Furthermore, it is indicated that users believe that the refrigerator operates autonomously and directly, connected directly to the power outlet without requiring other equipment, possibly revealing a lack of knowledge about the actual operation of the appliance and how external factors, such as the location of the refrigerator, the ambient temperature and the quality of the electrical installation, can influence its energy efficiency.

Likewise, it is shown that the majority of users do not defrost their refrigerators regularly, which can lead to the accumulation of ice in the freezer and increase their electricity consumption. The frequency of cleaning varies from every week to every six months, which may indicate a lack of knowledge about the importance of regular maintenance on the refrigerator to guarantee its energy efficiency and prolong its useful life.

It is noted that there are different perceptions about refrigerator energy consumption. Some users consider that their refrigerators have moderate consumption, possibly because they are modern and more efficient models, while others believe that the refrigerator is one of the appliances that consume the most electricity, which may be an erroneous perception.

In terms of the factors that can affect the electricity consumption of refrigerators, it is recognized that temperature settings and door handling can have a significant influence, mentioning that keeping the fridge at its maximum freezing capacity or setting

the freezing volume to the maximum can increase energy consumption, as can leaving the refrigerator door open or setting the temperature freezing at its maximum freezing level.[10]

The results highlight and underline the critical importance of energy efficiency in refrigerators and the urgent need to make users aware of the practices they can adopt to reduce electricity consumption significantly. These results reveal several key aspects:

Adopting simple measures such as maintaining an adequate temperature, avoiding overloading the refrigerator, and reducing the time the door is left open can significantly reduce electricity consumption. Although simple, these practices are fundamental to maximizing the energy efficiency of household appliances.

Many users lack knowledge about how refrigerators work and how external factors can affect their energy efficiency. This highlights the urgent need to educate consumers about these aspects so that they can make informed decisions about how to use their appliances.

A lack of periodic defrosting and regular cleaning can lead to the accumulation of ice and affect heat exchange, which in turn increases electricity consumption. Proper maintenance practices are essential to ensure optimal refrigerator performance.

Users have diverse opinions about the energy consumption of their refrigerators. While some consider that their appliances consume moderately, others believe they consume too much energy. This disparity in perceptions highlights the need for education about the energy efficiency of appliances and how to choose more efficient models.

Electrical energy consumption in homes, mainly when using appliances such as refrigerators, is highly relevant due to its impact on total energy consumption and families' electricity bills. Several factors can influence the energy consumption of refrigerators, and understanding these factors is essential for developing effective energy efficiency strategies.[10]

The use of electrical energy in homes, especially in appliances such as refrigerators, is crucial for modern life. Refrigerators represent a significant part of electrical energy consumption in homes, as they operate continuously to keep food fresh and safe for consumption. This constant demand for energy poses challenges regarding energy efficiency and user costs.[11]

One of the key factors influencing the energy consumption of refrigerators is the ambient temperature. At higher temperatures, refrigerators have to work harder to maintain an adequate internal temperature, which increases their energy consumption. Therefore, placing the fridge in a cool, well-ventilated place can help reduce its energy consumption.[6]

Overloading the refrigerator can also significantly affect its energy efficiency. Overfilling the refrigerator obstructs the air ducts, hindering cold air circulation and increasing energy consumption. Therefore, it is essential to avoid overloading the fridge to allow for proper circulation of cold air.[8]

In addition, door seals play a crucial role in refrigerator energy efficiency. A faulty door seal allows cold air to escape, forcing the refrigerator to work harder to maintain the proper temperature. Therefore, it is essential to regularly inspect door seals and replace them if damaged to prevent cold air loss.

The frequency of opening the door is also an essential factor to consider. Opening the door frequently and leaving it open for long periods makes the refrigerator work harder to recover the internal temperature, which increases its energy consumption. Minimizing the frequency and duration of door openings is advisable to reduce the refrigerator's energy consumption.[6]

Users' concerns about the cost of energy consumption at home vary. Some are concerned about the fluctuation of these costs, while others do not consider it a significant expense. It is essential to raise awareness of the importance of energy efficiency and how usage practices can influence associated costs.

The importance of preventive and corrective maintenance is highlighted, as well as the recommendation to upgrade to newer models that offer significant improvements in energy efficiency. Innovations like inverter compressors and LED lighting systems can translate into long-term savings.

The need to combine everyday practices with technological improvements to achieve greater energy efficiency in refrigerators is emphasized. This results in significant long-term savings for users and a lower environmental impact, highlighting the importance of a comprehensive approach to managing the energy efficiency of household appliances.

Several key factors affect a refrigerator's energy efficiency. The ambient temperature is critical because the higher the temperature, the more work the refrigerator has to do to stay cold, increasing its energy consumption.

Another important factor is overfilling the refrigerator. Overfilling obstructs the air ducts, making it difficult for the cold air to circulate and causing the refrigerator to consume more energy to stay cold. Likewise, a faulty door seal allows the cold air to escape, forcing the refrigerator to work harder to maintain the proper temperature.

How often the door is opened also affects energy efficiency. Opening the door frequently and leaving it open for long periods makes the refrigerator work harder to recover the internal temperature, thus increasing energy consumption.[10]

Finally, proper maintenance is crucial. A poorly maintained refrigerator with dirty coils or a faulty compressor will consume more energy. Therefore, cleaning the fridge regularly and maintaining it properly is essential to ensure its energy efficiency.

It is essential to regularly check the temperature of the refrigerator and freezer with a specific thermometer, keeping the refrigerator between 2-4°C and the freezer at approximately -18°C. It is also necessary to regularly inspect the door seals to ensure they are in good condition and seal properly, replacing them if damaged to prevent the loss of cold air.

To maintain good air circulation and prevent the compressor from overheating, the condenser coils at the back or underneath the refrigerator should be cleaned. It is also essential to ensure that the refrigerator is level so that the door closes properly and there are no cold air leaks, as well as to avoid obstructing the ventilation ducts.[8]

Yes, there are improvements in energy efficiency when certain additional elements are used in the operation of a refrigerator. For example, air circulation fans can improve cold air circulation inside the fridge, reducing the compressor's workload and improving energy efficiency. Voltage regulators can stabilize the power supply, avoiding voltage spikes that can damage the compressor and

reduce efficiency. Programmable thermostats can adjust the refrigerator temperature as needed, thus reducing energy consumption. Temperature and humidity sensors can precisely control these parameters, preventing the refrigerator from operating excessively. In addition, evaporative cooling systems can reduce the compressor's workload by cooling the air more efficiently. It is essential to install these elements correctly and follow the manufacturer's recommendations to ensure their effectiveness and safety.[8]

To improve the efficiency or functionality of a refrigerator, several additional elements can be connected, such as voltage regulators, to stabilize the power supply and protect the fridge from damage due to voltage fluctuations. Programmable thermostats allow for more precise and efficient temperature control. Temperature and humidity sensors automatically adjust the temperature and humidity inside the refrigerator. Air circulation fans improve cold air circulation, reducing the compressor's load. Evaporative cooling systems optimize cooling and reduce energy consumption. In addition, air filters keep the air inside the refrigerator clean and fresh.

CONCLUSIONS

The importance of energy efficiency in refrigerators is emphasized, as is the need to make users aware of practices they can adopt to reduce electricity consumption significantly. Focusing on combining everyday practices with technological improvements to achieve greater energy efficiency in refrigerators will result in significant long-term savings for users and a lower environmental impact.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

CONTRIBUTION OF AUTHORSHIP

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