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ORIGINAL

Factors that influence the consumption of electrical energy in refrigerators, in the sector of the forastero, Canton Latacunga, Parish of Belisario Quevedo during the period 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

This research aims to study the factors influencing electricity consumption in the Forastero sector, located in the Latacunga canton, Belisario Quevedo parish, during the period of January-February 2024. Eight families were selected in this sector, and their electricity consumption was analyzed, especially in relation to the use of refrigerators. The methodology included data collection using a multimeter and interviews with the participants. The results revealed that simple measures such as maintaining a suitable temperature, avoiding overloading the refrigerator, and reducing the time the door remains open can significantly reduce electricity consumption. Likewise, a lack of knowledge among users about the real operation of refrigerators and how external factors can affect their energy efficiency was identified. In conclusion, the importance of education, proper maintenance, and the adoption of more efficient technologies to improve the energy efficiency of refrigerators and reduce environmental impact is highlighted.

Keywords: electrical energy consumption; energy efficiency; refrigerators; Forastero sector; Latacunga; Belisario Quevedo.

RESUMEN

Esta investigación tiene como objetivo estudiar los factores que influyen en el consumo de energía eléctrica en refrigeradores en el sector del Forastero, cantón Latacunga, parroquia de Belisario Quevedo durante enero y febrero de 2024. Se seleccionaron ocho familias en este sector y se analizó

su consumo de energía eléctrica utilizando un multímetro y entrevistas estructuradas. Los resultados mostraron que medidas simples como mantener una temperatura adecuada y evitar sobrecargar el refrigerador pueden reducir significativamente el consumo de electricidad. Además, se encontró que la falta de conocimiento sobre el funcionamiento de los refrigeradores y la falta de mantenimiento adecuado también contribuyen al consumo excesivo de energía. En conclusión, se destaca la importancia de la educación y la promoción de prácticas sostenibles para reducir el consumo de energía eléctrica en refrigeradores en esta comunidad.

Palabras clave: consumo de energía eléctrica; eficiencia energética; refrigeradores; sector del Forastero; Latacunga; Belisario Quevedo.

INTRODUCTION

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

Addressing the high electricity consumption in refrigerators from a community perspective in the Belisario Quevedo parish. Until now, most research has focused on aggregate data at the regional or national level. By studying eight families in a specific sector, the research contributes and provides a detailed understanding of the factors that affect energy consumption in a particular context. This will contribute to general knowledge and offer valuable insights for developing energy efficiency strategies adapted to the specific conditions of this community.

Currently, the issue of energy consumption, especially in the context of household appliances such as refrigerators, has become critical due to the continuous increase in the demand for electrical energy at a global level. The environmental impact of excessive energy consumption and the search for sustainable solutions are central issues on the world agenda. The relevance of the research lies in addressing this problem from a local perspective, analyzing specific behavior in the Belisario Quevedo parish in the El Forastero sector of the Latacunga canton. This approach will provide valuable information on energy consumption practices in particular communities. It will allow for identifying strategies for more efficient and sustainable electrical energy management.

The population of the Forastero sector tends to extend the useful life of their electrical 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 results in increased electricity bills and maintenance costs, thus establishing a causal relationship between the extension of the valuable life and the associated higher expenses.

Despite the obvious excessive costs in the electricity bills for the inhabitants of the Forastero sector, the causal relationship is also related to limited environmental awareness. The high consumption of electrical energy affects family finances and contributes to the deterioration of the local environment, generating a vicious circle.

In the El Forastero sector of the Latacunga canton, the Belisario Quevedo parish has approximately 8,000 inhabitants distributed in 25 neighborhoods. The study will be conducted in the El Forastero sector and will focus on eight families with various electrical appliances. For some time now, the inhabitants of the industry have noticed that their electricity bills are excessive, and there are sudden power cuts and environmental impacts caused by high energy consumption. For these reasons, the

energy consumption of refrigerators will be studied, as they are the products that are in operation all year round and, therefore, the one that consumes the most energy. This led to analyzing the factors that affect the high electricity consumption in refrigerators in the Forastero sector during January-February 2024 to determine and investigate the problems described above.

This study seeks to fill a gap in our understanding of the local factors that contribute to refrigerators' high electricity consumption, focusing specifically on the Forastero sector community. The information obtained will not only be valuable for designing local energy efficiency strategies but will also contribute to raising community awareness of the importance of sustainable practices.

The research significantly reduces expenses by requiring moderate financial resources at an affordable cost. In addition, by focusing on eight families in the Forastero sector, the use of resources is optimized, maximizing the economic efficiency of the research. This specific approach allows for representative results without incurring unnecessary costs.

From a social perspective, the research targets a specific community, such as the families in the Forastero sector. The active participation of the community in the study will not only strengthen the results but also raise awareness about energy consumption and its implications. Feedback from the inhabitants will be essential to understanding local dynamics and designing energy efficiency strategies adapted to their needs.

The persistence of this problem in the Forastero sector is attributed to the lack of specific energy efficiency initiatives and strategies. The lack of information on sustainable practices and the efficiency of household appliances makes it challenging to adopt measures that could counteract the high electrical energy consumption.

The research is based on sound and well-established technical methods for evaluating electricity consumption. In addition, January- February 2024 provides a specific time window to capture meaningful data, considering possible seasonal variations. The choice of this instrument and study period guarantees the reliability and technical accuracy of the research.

From an environmental point of view, the research directly addresses the issue of excessive electricity consumption, which has significant environmental impacts. By identifying and understanding the factors that contribute to high refrigerator consumption, the foundation is laid for implementing energy efficiency measures that reduce the environmental footprint. The awareness generated by the research can also lead to behavioral changes in the community, thus contributing to environmental sustainability at the local level.

This study is expected to yield concise results on the specific factors that affect the consumption of electrical energy in refrigerators. It will provide a basis for developing energy efficiency strategies adapted to the local context of the Forastero sector. The awareness generated by the results can lead to significant changes in the community's daily practices and contribute to a more sustainable use of electrical energy.

General objective

Analyze the factors that affect electricity consumption in the sector of the outsider, canton Latacunga, parish of Belisario Quevedo, from January to February 2024.

What factors affect the consumption of electricity in refrigerators in the sector of the outsider canton of Latacunga, parish of Belisario Quevedo, during January-February 2024?

It is suggested that one of the probable causes in this investigation is that the consumption of electricity in refrigerators is more significant in those that have greater capacity, age, and use and less in those that have better energy efficiency and maintenance in the sector of El Forastero, Latacunga canton, Belisario Quevedo parish during the period of January-February 2024.

METHODS

Research Variables

-Independent variable: Type and characteristics of refrigerators (brand, model, capacity, age, etc.).

-Dependent variable: Electricity consumption of refrigerators.

Table 1. Variable Operationalization Matrix.

Variables	Conceptual definition	Dimensions	Indicators
Electricity consumption in refrigerators.	The amount of electrical energy used by a refrigerator, which it consumes for its correct and appropriate functioning in a given period of time.	Perception of the refrigerator's electricity consumption.	Analysis of the electricity consumed by the element being studied.
Type and characteristics of refrigerators.	Classification and attributes of refrigerators according to their design, capacity, efficiency and age Type of refrigerator according to its shape and size	Refrigerator Design	Identificación del estilo o tipo específico de refrigerador según su diseño externo y distribución interna, categorización del estilo del refrigerador.
		Refrigerator Capacity	Measurement of the internal space of the refrigerator including all compartments, total volume of the refrigerator in liters or cubic feet.
		Refrigerator Energy Efficiency	Identification of the energy rating of the refrigerator according to the manufacturer's label, Energy rating, according to the global standardization A, B, C, for the international system.
		Age of the Refrigerator	Identification of the year in which the refrigerator was manufactured (Year of manufacture of the refrigerator)

		Implementation of additional equipment (devices) for the use of refrigerators	Analysis and identification of the different behaviors when using devices, equipment and machines for the protection, regularization and reduction of electricity consumption that owners employ for their refrigerators.
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Source: Author's own creation.

Research techniques and instruments

The application of techniques for field research involves using specific methods to collect data directly in the environment where the phenomena being studied occur. These techniques are used in various disciplines, such as the social sciences, biology, and geography.

Cross-sectional research

A cross-sectional study is observational in which data is collected from a population at a specific time. In this approach, data is collected simultaneously for all variables of interest without follow-up over time. This means that researchers collect information on the variables of interest simultaneously and do not follow the same participants at different times.

Non-experimental research design

In research with a non-experimental design, the main objective is to describe and understand phenomena as they occur in their natural environment without manipulating variables or controlling experimental conditions.

Demographic variables:

Demographic variables refer to characteristics of the population studied that may influence the phenomenon under investigation.

Table 2. The demographic variables of the research.

Age	Gender	Educational level	Economic income	Household size
It could be relevant if one considers that different age groups may have different electricity consumption habits..	Although it may not be a determining factor in the consumption of electrical energy in refrigerators, some studies suggest that there are differences in consumption patterns between men	People with different levels of education may have different knowledge about the efficient use of energy and, therefore, different consumption behaviors.	Socioeconomic status can influence the ability to purchase more energy-efficient appliances or to be mindful of energy consumption.	The number of people living in a household can affect electricity consumption, as it influences the amount of food stored and consumed, and therefore the use of the refrigerator.

	and women.			
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Source: Author's own creation.

Techniques for the application of field research:

To research the "Factors that affect the consumption of electricity in refrigerators through measurements with the multi-meter measuring instrument, in the sector of Forastero, Cantón Latacunga, Parroquia de Belisario Quevedo during the period of January-February 2024," the following techniques will be applied:

Interviews. Interviews are valuable in research because they allow researchers to explore in depth the experiences and perspectives of participants, which can provide rich and detailed information that complements other research methods. In addition, interviews offer the opportunity to adapt questions according to the participants' responses, which allows for a more complete and contextualized understanding of the subject under study.

Conduct interviews with local refrigerator owners to obtain qualitative information about their usage habits, appliance maintenance, and perceptions of energy consumption.

Interviewing electrical power experts or appliance technicians to obtain technical information and advice.

Applying interviews in research will provide a more complete and accurate understanding of the factors affecting energy consumption in refrigerators. It will also allow you to obtain valuable information directly from users and experts in the field.

•Interview with a family representative and/or refrigerator owner. - Qualitative techniques are used in research to gather information directly from individuals who own and use the refrigerator in question. This interview is conducted to understand the experiences, perceptions, practices, and needs related to appliance use and to obtain detailed information on the factors that may influence electricity consumption.

What are your daily habits when using your refrigerator?

Do you leave the door open for long periods?

How often do you defrost the freezer and clean the inside of the refrigerator?

How do you perceive the energy consumption of your refrigerator?

Are you concerned about the environmental impact and the costs associated with energy consumption?

Do you use any additional equipment with your refrigerator?

Do you think having an old refrigerator increases energy consumption, which is reflected in the electricity bill?

How often do you maintain your refrigeration equipment?

•Interview with technical experts in household appliances. Qualitative techniques are used in research to obtain specialized and detailed information on technical and practical aspects related to household appliances' operation, maintenance, and energy efficiency, including refrigerators. This interview is conducted to obtain expert knowledge on the factors that affect refrigerators' electricity consumption and possible strategies to improve their energy efficiency.

What are the key factors affecting the energy efficiency of a refrigerator?

What are the essential steps that owners should follow for the preventive maintenance of their refrigerators?

How often is it mandatory to perform preventive and/or corrective maintenance on a refrigerator?

Are there specific recommendations for improving the energy efficiency of refrigerators?

Are there specific features in modern refrigerators that contribute to energy efficiency?

Would you recommend upgrading to more recent refrigerator models for efficiency reasons?

Is there any practical advice you can offer owners to reduce the energy consumption of their refrigerators?

Are there any improvements in energy efficiency when using third elements in a refrigerator?

What types of protective equipment would you recommend for refrigerator use?

Surveys. Surveys are a quantitative technique used in research to collect data from a representative sample of a population about their attitudes, opinions, behaviors, or characteristics. In this method, standardized questionnaires are administered to participants, who provide answers to predefined questions about the subject of study.

Design surveys to collect quantitative data on the use of electrical energy in local households.

Including specific questions about the type of refrigerator, frequency of use, defrosting habits, etc.

Surveys are an effective and efficient tool for collecting essential quantitative data on household electricity consumption. They provide valuable information for understanding and addressing the factors that affect this specific aspect.

How many people live in your household?

- a) One b) Two c) Three d) More than three.

How many refrigerators does your household have?

- a) One b) Two c) Three

What is the make and model of your main refrigerator?

- a) Whirlpool b) LG c) Samsung d) Other.

How old is your refrigerator?

- a) One b) Two c) Three d) More than three.

How often do you open the refrigerator door during the day?

- a) Twice b) Three times c) Five times d) More than five times.

How much time do you spend cleaning your refrigerator each month?

- a) 10 min b) 15 min c) 30 min d) More than half an hour.

How often do you maintain your refrigerator?

- a) Every two months b) Every six months c) Every year d) I don't

Do you use external equipment or elements for your refrigerator?

- a) Yes b) No

Have you ever considered energy efficiency when buying a refrigerator?

- a) Yes b) No

Do you know the energy efficiency rating of your main refrigerator?

- a) Yes b) No

Do you use any special features on your refrigerator, such as the energy saving mode or the temperature setting?

- a) Yes b) No c) Sometimes

How do you perceive the energy consumption of your main refrigerator?

a) always b) almost always c) sometimes d) never

Have you noticed any change in your electricity bills related to the use of the refrigerator?

a) Yes b) No c) I haven't noticed

Population and sample

The population in this research would be all the refrigerators located in the sectors of Forastero, Cantón Latacunga, and Parroquia de Belisario Quevedo from January to February 2024. That is all the refrigerators in that geographical area during that period.

The sample would be a representative subset of that population, selected to carry out the measurements and analyses necessary to investigate the factors that affect refrigerators' electrical energy consumption. The sample contemplates analyzing and studying eight families in the sector that meet the requirements, one of which is the main one, to have in their property mainly the equipment to be analyzed for collecting data selected randomly or by some other sampling method.

Aspects of planning data collection

Definition of data collection objectives: It is essential to be clear about the specific objectives expected to be achieved through data collection. In this case, the aim is to identify the factors influencing electricity consumption in the abovementioned sector during the established period.

Sample selection: The target population must be determined, and clear criteria must be established for sample selection. In this case, eight families in the Forastero sector will be studied, so it must be ensured that the sample is representative and allows valid results.

Design of the data collection instrument: An appropriate instrument must be developed to collect the necessary information. In this case, the most efficient data collection techniques mentioned were two simultaneous interviews and a survey directly to the participants.

Planning logistics: It is important to plan how data collection will be carried out, considering aspects such as access to the homes of the selected families, the time needed to collect the data, and any other relevant logistical factors.

Consideration of ethics and privacy: Measures should be taken to protect participants' privacy and ensure that data collection is carried out ethically and respectfully.

Data analysis: A plan must be developed for how the collected data will be analyzed to answer the research questions. In this case, statistical tools can be used to identify the factors that influence electricity consumption in the Forastero sector.

Documentation planning: It is essential to properly document the entire data collection process, including the results obtained and any relevant observations that may arise during the study.

RESULTS

The analysis and interpretation of the surveys carried out as part of the research on the factors that influence the consumption of electricity in refrigerators in the sector Forastero, Canton Latacunga, Parish Belisario Quevedo, during the period January-February 2024, is presented.

Analysis of interviews with the population.

This analysis is based on interviews conducted in the Forastero sector, Cantón Latacunga, Parroquia Belisario Quevedo, during February 2024 to investigate the factors that influence the electricity consumption of refrigerators in this area. The interviews were

conducted with eight members of potential families living in the area, gathering information on their consumption habits, the state of their electrical appliances, and other relevant factors. The results obtained and the conclusions derived from this analysis are presented below to identify possible areas for improvement in the energy efficiency of refrigerators in the area. Forastero.

N°	Question	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6	Participant 7	Participant 8
1	What actions do you take on a daily basis with your refrigerator that could influence its energy consumption?	Keeping the system at a very low temperature can have an influence.	Leaving the refrigerator door open for too long	Overloading the refrigerator with food and keeping it that way for a long time	Adjusting the temperature several times a week, such as raising and lowering the freezing temperature	Leaving the refrigerator door open for long periods of time	Having frostbite is its highest level	Have it operating at maximum as it works harder and will need to cool down more	Keeping the refrigerator at maximum freezing capacity
2	Does any additional equipment complement the operation of your refrigerator?	No, the refrigerator is connected directly to the wall socket.	No, the refrigerator works by itself.	No, the refrigerator uses itself.	No, the refrigerator simply works by itself.	No, the refrigerator simply works like this	It does not use other equipment for operation	No, none of them. They simply work directly from the power socket.	No, none of them. The refrigerator is working fine.
3	How often do you defrost the freezer and clean the inside of the refrigerator?	It does not defrost, cleaning is done every 4 months and according to use.	No, the refrigerator is not defrosted, it is cleaned every 5 months.	It does not defrost, it is cleaned every month	It does not defrost, it is cleaned every week and depending on use.	It does not defrost, cleaning is done every 4 months	It is not defrosted, and it is cleaned every 6 months.	It does not defrost, it is cleaned once every 6 months	It is not defrosted, it is cleaned every month.
4	How do you perceive the energy consumption of your refrigerator?	The refrigerator has moderate consumption because it is modern.	The refrigerator is one of the appliances that consumes the most electricity	The refrigerator consumes moderate energy, neither high nor low.	Usual consumption is between high and medium.	Consumption is high because the equipment is repaired	The refrigerator's energy consumption is moderate-regular.	Moderate consumption, the refrigerator does not consume too much energy	The team's consumption is regular
5	Are you concerned about the environmental impact and the costs associated with energy consumption?	Yes, because it is a monthly expense and a compulsory debit.	It is worrying because it is an expense that is incurred and there are variations.	Not worrying is not something that is greatly appreciated.	No, because it is something he is not so concerned about apart from the other costs.	No, it's not something that greatly affects the household economy	Yes, the costs of energy consumption are a concern because it affects the household economy.	Yes, because it's one more expense apart from all the others that you have on a day-to-day basis.	Yes, because it is just another household expense
6	What do you consider to be the main factor affecting the energy consumption of your refrigerator?	One of the factors is to have the refrigerator at maximum freezing capacity.	Have the freezer on full blast as it would cool more	Leave the refrigerator door open, as it turns on very often	Programming the temperature very cold at its maximum freezing level.	Keeping the refrigerator doors open	Using the refrigerator at maximum freezing power	One of all and especially is to keep the equipment at its maximum freezing point	Fill the refrigerator to its maximum cooling capacity
7	Do you think that having an old refrigerator has an impact on the increase in energy consumption that is reflected in the electricity bill?	It is probable since the technology of ancient times does not have as much control as current technology.	Yes, because an old refrigerator has already been working for a while and a new one hasn't.	Yes, over the years the refrigerator tries to consume more electricity and a new no.	It does have an influence, old refrigerators consume more than current ones due to the components they have.	No, a new refrigerator should work in the same way as an old one.	Yes, a modern refrigerator is much more efficient in its consumption of electricity.	Yes, because a modern refrigerator has components that make it more energy efficient.	Of course, the components of an old refrigerator are not the same as those of a modern one.

Table 3.

Source: Author's own creation.

Table 4.

ANALYSIS AND INTERPRETATION OF RESULTS						
What actions do you take on a daily basis with your refrigerator that could influence its energy consumption?	Does your refrigerator use any additional equipment?	How often do you defrost the freezer and clean the inside of the refrigerator?	How do you perceive the energy consumption of your refrigerator?	Are you concerned about the environmental impact and the costs associated with energy consumption?	What do you consider to be the main factor affecting the energy consumption of your refrigerator?	Do you think that having an old refrigerator has an impact on the increase in energy consumption that is reflected in the electricity bill?
<p>The results suggest that users can significantly influence the electricity consumption of their refrigerators through more efficient use practices, such as maintaining an adequate temperature, avoiding overloading the refrigerator and minimizing the time the door is left open.</p>	<p>The results indicate that users believe that the refrigerator operates autonomously and directly, connected directly to the power outlet without requiring other equipment. This perception could reveal 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..</p>	<p>The results suggest that most users do not defrost their refrigerators regularly, and the frequency of cleaning varies from every week to every six months, depending on the case. This may indicate a lack of knowledge about the importance of regular refrigerator maintenance to ensure energy efficiency and prolong its useful life. Failure to defrost regularly can lead to the accumulation of ice in the freezer, which hinders the operation of the equipment and increases its electricity consumption. On the other hand, the frequency of cleaning influences the efficiency of heat exchange in the refrigerator, which can affect its energy performance.</p>	<p>The results show that there are a variety of perceptions about the energy consumption of refrigerators. Some users consider that their refrigerators have moderate consumption, possibly because they are modern and more efficient models. Others believe that the refrigerator is one of the appliances that consumes the most electricity, which may be a mistaken perception based on factors such as the size of the refrigerator or comparison with other appliances.</p>	<p>The results show that there are different points of view regarding the concern for the cost of energy consumption in the home. Some users perceive this expense as a monthly obligation and are therefore concerned, while others are concerned because this expense can vary, showing sensitivity to possible fluctuations in the cost of energy. On the other hand, there are those who do not consider the cost of energy consumption to be a major concern, either because they do not attach much importance to it or because they believe that it does not significantly affect the household economy. However, there are also those who do see it as an additional household expense and, therefore, it causes them concern.</p>	<p>The results indicate that users recognize several factors that can affect the electricity consumption of their refrigerators, many of which are related to temperature settings and door handling. Some users mention that keeping the refrigerator at its maximum freezing capacity or setting the freezing volume to the maximum can increase energy consumption. In addition, leaving the refrigerator door open or setting the temperature to very cold at maximum freezing can increase the frequency with which the compressor turns on, which also results in higher electricity consumption.</p>	<p>The results indicate that there is a widespread perception that old refrigerators consume more energy than modern models. This perception is based on the idea that old refrigerators lack the technology and efficient components to control energy consumption, compared to more recent models. This opinion is supported by the fact that recent technological advances have made it possible to manufacture more energy-efficient refrigerators, with more sophisticated components and control systems. In summary, these results highlight the importance of considering energy efficiency when choosing a refrigerator, as older models tend to consume more energy and can be more expensive to operate in the long term. They also underline the need to educate consumers about the advantages of modern refrigerators in terms of energy savings and cost reduction.</p>

Source: Author's own creation.

Table 5.

<p>Análisis global</p>	<p>Los usuarios pueden reducir significativamente el consumo de electricidad de sus refrigeradores al adoptar prácticas más eficientes, como mantener una temperatura adecuada, evitar sobrecargar el electrodoméstico y reducir el tiempo que permanece la puerta abierta. Sin embargo, muchas personas desconocen cómo funcionan realmente los refrigeradores y cómo factores externos pueden afectar su eficiencia energética.</p> <p>Además, la mayoría de los usuarios no realizan descongelamientos periódicos ni mantienen una frecuencia regular de limpieza en sus refrigeradores, lo que puede provocar la acumulación de hielo y afectar el intercambio de calor, lo que a su vez aumenta el consumo de electricidad.</p> <p>En relación con la percepción del consumo de energía, hay una diversidad de opiniones entre los usuarios. Algunos consideran que sus refrigeradores tienen un consumo moderado, mientras que otros creen que consumen demasiada energía. Esto resalta la importancia de educar a los consumidores sobre la eficiencia energética de los electrodomésticos y cómo elegir modelos más eficientes.</p> <p>Por otro lado, la preocupación por el costo del consumo de energía en el hogar varía, con algunos usuarios preocupados por su fluctuación y otros que no consideran que sea un gasto importante. Esto destaca la necesidad de concienciar sobre la importancia de la eficiencia energética y cómo las prácticas de uso pueden influir en el consumo de energía y los costos asociados.</p>
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Source: Author's own creation.

Analysis of the interviews with the technician

The present analysis is based on the interview carried out with a technician from the ESPE UNIVERSITY OF THE ARMED FORCES at the Cantón Latacunga headquarters, Belisario Quevedo Parish, in February 2024 to investigate the factors that influence the electricity consumption of refrigerators in this area. The interview was conducted by gathering information on their perceptions and knowledge about the equipment to be studied, the condition of the appliances, and other relevant factors. The results obtained and the conclusions derived from this analysis are presented below to identify possible areas for improvement in the energy efficiency of refrigerators in the sector. Foreigner.

Table 6.

Nº	Pregunta	Técnico	Análisis e interpretación de resultados	Análisis global
1	¿Cuáles son los factores clave que afectan la eficiencia energética de un refrigerador?	<p>La eficiencia energética de un refrigerador se ve afectada por varios factores clave. La temperatura ambiente es fundamental, ya que, a mayor temperatura ambiente, más trabajo debe realizar el refrigerador para mantenerse frío, lo que aumenta su consumo de energía.</p> <p>La sobrecarga del refrigerador es otro factor importante. Al llenarlo en exceso, se obstruyen los conductos de aire, dificultando que el aire frío circule y haciendo que el refrigerador consuma más energía para mantenerse frío. Asimismo, un sello de puerta defectuoso permite que escape el aire frío, lo que obliga al refrigerador a trabajar más para mantener la temperatura adecuada.</p> <p>La frecuencia de apertura de la puerta también afecta la eficiencia energética. Abrir la puerta con frecuencia y dejarla abierta durante períodos prolongados hace que el refrigerador trabaje más para recuperar la temperatura interna, aumentando así el consumo de energía.</p> <p>Por último, el mantenimiento adecuado es crucial. Un refrigerador mal mantenido, con bobinas sucias o un compresor defectuoso, consumirá más energía. Por lo tanto, es importante limpiar regularmente el refrigerador y realizar un mantenimiento adecuado para garantizar su eficiencia energética.</p>	<p>Para mejorar la eficiencia energética de un refrigerador, es importante considerar y controlar estos factores, manteniendo una temperatura ambiente adecuada, evitando sobrecargas, asegurándose de que las puertas estén selladas correctamente, minimizando la apertura frecuente de la puerta y realizando un mantenimiento regular.</p>	<p>Se comprende que mejorar la eficiencia energética de los refrigeradores implica una combinación de prácticas y mejoras técnicas. Comenzando por el control de factores como la temperatura ambiente, la carga adecuada, el sellado de las puertas y la limpieza regular, se destaca la importancia del mantenimiento preventivo y correctivo para garantizar un rendimiento óptimo.</p> <p>Se subraya la relevancia de recomendaciones clave, como la ubicación adecuada, el ajuste del termostato, la limpieza periódica y la inspección de los sellos de las puertas. Se resalta que los modelos modernos ofrecen mejoras significativas en eficiencia, gracias a innovaciones como compresores inverter y sistemas de iluminación LED, lo que se traduce en ahorros a largo plazo.</p> <p>La sugerencia de actualizar a modelos más recientes se respalda en su mayor eficiencia energética y características mejoradas. Finalmente, se enfatiza que la incorporación de elementos adicionales, como ventiladores de circulación de aire y sistemas de enfriamiento por evaporación, puede potenciar aún más la eficiencia energética de los refrigeradores.</p>
2	¿Cuáles son los pasos esenciales que los propietarios deben seguir para el mantenimiento preventivo de sus refrigeradores?	<p>Es fundamental verificar periódicamente la temperatura del refrigerador y el congelador con un termómetro específico, manteniendo el refrigerador entre 2-4°C y el congelador a -18°C aproximadamente. Asimismo, es necesario inspeccionar regularmente los sellos de las puertas para asegurarse de que estén en buen estado y sellen correctamente, reemplazándolos si están dañados para evitar la pérdida de aire frío.</p> <p>Para mantener una buena circulación de aire y evitar el sobrecalentamiento del compresor, se debe limpiar las bobinas del condensador ubicadas en la parte posterior o debajo del refrigerador. También es importante asegurarse de que el refrigerador esté nivelado para que la puerta cierre correctamente y no haya fugas de aire frío, así como evitar la obstrucción de los conductos de ventilación.</p> <p>Por último, se recomienda que un técnico profesional revise periódicamente el refrigerador para detectar y solucionar posibles problemas antes de que se conviertan en fallas mayores.</p>	<p>La importancia de mantener el refrigerador en óptimas condiciones para garantizar su eficiencia energética y buen funcionamiento. Se recomienda verificar periódicamente la temperatura del refrigerador y el congelador, mantener los sellos de las puertas en buen estado, limpiar las bobinas del condensador regularmente y asegurarse de que el refrigerador esté nivelado y sin obstrucciones en los conductos de ventilación. Además, se aconseja que un técnico profesional revise el refrigerador periódicamente para detectar y solucionar posibles problemas.</p>	
3	¿Cada que tiempo es obligatorio realizar un mantenimiento preventivo y/o correctivo a un refrigerador?	<p>El mantenimiento preventivo de un refrigerador se recomienda realizarlo al menos una vez al año para garantizar un funcionamiento óptimo y prevenir problemas futuros. Sin embargo, si el refrigerador muestra signos de deterioro o problemas, como falta de enfriamiento, ruidos extraños o fugas de agua, es recomendable realizar un mantenimiento correctivo de</p>	<p>La importancia del mantenimiento preventivo anual para asegurar el buen funcionamiento del refrigerador y prevenir problemas futuros. También destaca la necesidad de realizar mantenimiento correctivo inmediato en caso de signos de deterioro o problemas,</p>	

		<p>inmediato para evitar daños mayores. En estos casos, la frecuencia del mantenimiento correctivo dependerá de la gravedad del problema y de las recomendaciones del fabricante.</p>	<p>como falta de enfriamiento, ruidos extraños o fugas de agua, para evitar daños mayores. La frecuencia del mantenimiento correctivo dependerá de la gravedad del problema y de las recomendaciones del fabricante</p>	
4	¿Hay recomendaciones específicas para mejorar la eficiencia energética de los refrigeradores?	<p>Para mejorar la eficiencia energética de los refrigeradores, es importante seguir estas recomendaciones:</p> <ul style="list-style-type: none"> Colocar el refrigerador en un lugar bien ventilado y alejado de fuentes de calor. Ajustar el termostato a las temperaturas recomendadas. Evitar sobrecargar el refrigerador para permitir la circulación adecuada del aire frío. Limpiar regularmente las bobinas del condensador, las rejillas de ventilación y las juntas de las puertas. Inspeccionar los sellos de las puertas regularmente y reemplazarlos si están dañados. Descongelar el refrigerador regularmente si no es de descongelación automática. Considerar reemplazar refrigeradores antiguos por modelos más eficientes. Utilizar ajustes de ahorro de energía si están disponibles. 	<p>Se destaca recomendaciones clave para mejorar la eficiencia energética de los refrigeradores:</p> <ul style="list-style-type: none"> Ubicación adecuada y ventilación para reducir la carga de trabajo del compresor. Ajuste del termostato a las temperaturas recomendadas. Evitar sobrecargar el refrigerador para permitir la circulación adecuada del aire frío. Limpieza regular de bobinas del condensador, rejillas de ventilación y juntas de las puertas. Inspección regular de los sellos de las puertas y reemplazo si están dañados. Descongelamiento regular en refrigeradores no automáticos. Considerar reemplazar refrigeradores antiguos por modelos más eficientes. Utilizar ajustes de ahorro de energía si están disponibles. 	<p>Exige gran importancia de un enfoque integral que combine prácticas cotidianas con mejoras tecnológicas para lograr una mayor eficiencia energética en los refrigeradores, lo que no solo resulta en ahorros significativos a largo plazo, sino también en un menor impacto ambiental.</p>
5	¿Hay características específicas en los refrigeradores modernos que contribuyan a la eficiencia energética?	<p>Los refrigeradores modernos cuentan con varias características que contribuyen a mejorar su eficiencia energética. Entre ellas se incluyen compresores inverter, que ajustan su velocidad según la demanda de enfriamiento, iluminación LED de bajo consumo, aislamiento mejorado para reducir la pérdida de frío, sistemas de control de temperatura precisos, funciones de ahorro de energía como modos eco o de vacaciones, y sensores de puerta abierta que evitan la pérdida de frío innecesaria. Estas características hacen que los refrigeradores modernos sean más eficientes energéticamente que los modelos más antiguos, lo que puede resultar en ahorros significativos de energía a largo plazo.</p>	<p>Se resalta que los refrigeradores modernos son más eficientes energéticamente que los modelos antiguos gracias a características como compresores inverter, iluminación LED, mejor aislamiento, control preciso de la temperatura, funciones de ahorro de energía y sensores de puerta abierta. Estas mejoras pueden resultar en ahorros significativos de energía a largo plazo.</p>	
6	¿Recomendaría la actualización a modelos más recientes en refrigeradores por razones de eficiencia?	<p>Si recomendaría la actualización a modelos más recientes de refrigeradores por varias razones relacionadas con la eficiencia energética. Los modelos más nuevos suelen contar con características y tecnologías que los hacen considerablemente más eficientes en el consumo de energía que los modelos más antiguos. Esto puede resultar en ahorros significativos en la factura de electricidad a lo largo del tiempo. Además, los refrigeradores</p>	<p>Se sugiere que actualizar a modelos más recientes de refrigeradores puede ser beneficioso debido a su mayor eficiencia energética. Estos modelos suelen contar con características como mejores sistemas de control de temperatura, aislamiento mejorado y compresores más eficientes, lo que puede resultar en ahorros</p>	

		más nuevos suelen tener mejores sistemas de control de temperatura, aislamiento mejorado y compresores más eficientes, lo que no solo reduce el consumo de energía, sino que también puede prolongar la vida útil del electrodoméstico. Por lo tanto, la actualización a un modelo más reciente puede ser una inversión que se amortice con el tiempo en términos de ahorro de energía y menor costo de mantenimiento.	significativos en la factura de electricidad a lo largo del tiempo. Además, la actualización puede prolongar la vida útil del electrodoméstico y reducir los costos de mantenimiento.
7	¿Hay consejos prácticos que pueda ofrecer a los propietarios para reducir el consumo de energía de sus refrigeradores?	Para reducir el consumo de energía de los refrigeradores, es importante seguir estos consejos prácticos: Ubicar el refrigerador en un lugar fresco y bien ventilado, lejos de fuentes de calor. Ajustar el termostato a la temperatura recomendada (entre 2-4°C para el refrigerador y -18°C para el congelador). Evitar sobrecargar el refrigerador para permitir una circulación adecuada del aire frío. Limpiar regularmente las bobinas del condensador, las rejillas de ventilación y las juntas de las puertas. Inspeccionar los sellos de las puertas regularmente y reemplazarlos si están dañados. Descongelar el refrigerador regularmente si no es de descongelación automática. Considerar reemplazar refrigeradores antiguos por modelos más eficientes energéticamente. Utilizar ajustes de ahorro de energía si están disponibles.	Los consejos prácticos para reducir el consumo de energía de los refrigeradores se centran en la ubicación, el mantenimiento y el uso adecuado del electrodoméstico. Se sugiere colocar el refrigerador en un lugar fresco y bien ventilado, ajustar el termostato a las temperaturas recomendadas, evitar sobrecargarlo, limpiar regularmente las bobinas del condensador y las rejillas de ventilación, inspeccionar y reemplazar los sellos de las puertas si es necesario, y descongelarlo regularmente si no es automático. Además, se recomienda considerar la actualización a modelos más eficientes energéticamente y utilizar ajustes de ahorro de energía si están disponibles. Estas prácticas no solo reducen el consumo de energía, sino que también pueden prolongar la vida útil del refrigerador y disminuir los costos de mantenimiento.
8	¿Existen mejoras en eficiencia energética al uso de terceros elementos en el funcionamiento de un refrigerador?	Si, existen mejoras en la eficiencia energética al utilizar ciertos elementos adicionales en el funcionamiento de un refrigerador. Por ejemplo, el uso de ventiladores de circulación de aire puede mejorar la circulación del aire frío dentro del refrigerador, reduciendo la carga de trabajo del compresor y mejorando la eficiencia energética. Los reguladores de voltaje pueden estabilizar el suministro eléctrico, evitando picos de voltaje que pueden dañar el compresor y reducir la eficiencia. Los termostatos programables pueden ajustar la temperatura del refrigerador según sea necesario, reduciendo así el consumo de energía. Los sensores de temperatura y humedad pueden controlar estos parámetros de manera más precisa, evitando un funcionamiento excesivo del refrigerador. Además, los sistemas de enfriamiento por evaporación pueden reducir la carga de trabajo del compresor al enfriar el aire de forma más eficiente. Es importante instalar estos elementos correctamente y seguir las recomendaciones del fabricante para garantizar su eficacia y seguridad.	La incorporación de elementos adicionales, como ventiladores de circulación de aire, reguladores de voltaje, termostatos programables, sensores de temperatura y humedad, y sistemas de enfriamiento por evaporación, puede mejorar la eficiencia energética de los refrigeradores al reducir la carga de trabajo del compresor y ajustar la temperatura de manera más precisa. Estas mejoras pueden resultar en ahorros significativos de energía a largo plazo, pero es importante instalar y utilizar estos elementos correctamente según las recomendaciones del fabricante.

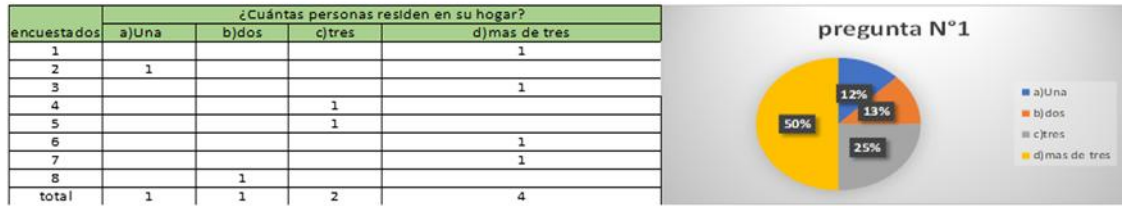
9	¿Qué tipos de equipos de protección recomendaría para el uso de un refrigerador?	Para mejorar la eficiencia o funcionalidad de un refrigerador, se pueden conectar varios elementos adicionales, como reguladores de voltaje para estabilizar el suministro eléctrico y proteger el refrigerador de daños por fluctuaciones de voltaje. Los termostatos programables permiten controlar la temperatura de manera más precisa y eficiente. Los sensores de temperatura y humedad ajustan automáticamente la temperatura y humedad dentro del refrigerador. Los ventiladores de circulación de aire mejoran la circulación del aire frío, reduciendo la carga del compresor. Los sistemas de enfriamiento por evaporación optimizan el enfriamiento y reducen el consumo de energía. Además, los filtros de aire mantienen el aire limpio y fresco dentro del refrigerador.	Se pueden conectar varios elementos adicionales a un refrigerador para mejorar su eficiencia o funcionalidad. Estos incluyen reguladores de voltaje, termostatos programables, sensores de temperatura y humedad, ventiladores de circulación de aire, sistemas de enfriamiento por evaporación y filtros de aire. Estos elementos pueden reducir la carga del compresor, ajustar la temperatura de manera más precisa y mejorar la circulación del aire frío, lo que resulta en un mejor rendimiento del refrigerador.
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Source: Author's own creation.

Analysis of Population Surveys

The present analysis is based on surveys carried out in the sectors of Forastero, Cantón Latacunga, and Parroquia Belisario Quevedo during February 2024 to investigate the factors that influence the electricity consumption of refrigerators in this area. Interviews were conducted with eight members of potential families living in the area, gathering information on their consumption habits, the condition of their appliances, and other relevant factors. The results obtained and the conclusions derived from this analysis are presented below to identify possible areas for improvement in the energy efficiency of refrigerators in the area. Forastero.

Graph N° 1.



Source: Author's own creation.

We can see that most of those surveyed indicated that more than three people live in their household, with 50% in favor of literal d. 12% of respondents emphasize that they live with two and one person, this in literal a and b, and 25% of respondents indicated that there are two people in their household, literal c. This suggests that the majority of households in the sample have a relatively large number of people to whom the study app.

Graph N°2.



Source: Author's own creation.

We can see that the majority of those surveyed indicated that they have only one refrigerator in their home, as is usually the case, with a higher percentage than the literal, which makes up 87% of the total sample, 13% for the literal c having 3 refrigerators in their home and finally zero percent for the literal b. These data make up the total for the entire sample.

Graph N°3.



Source: Author's own creation.

We can see that the majority of those surveyed indicated that the brand of their refrigerator is the same as the literal of other brands, denoting 50% in favor of literal d. 25% of those surveyed emphasize that their refrigerator model is Whirlpool, being literal a and b, and 25% of those surveyed emphasize that the brand of their refrigerator is LG, being literal b. This suggests that the majority of households in the sample have a relatively large number of appliances with brands other than the most common ones.

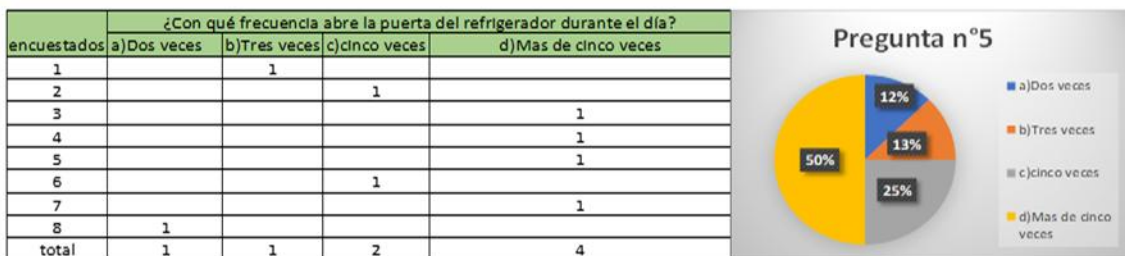
Graph N° 4.



Source: Author's own creation.

We can see that the majority of those surveyed indicated that they have refrigerators that they have owned for more than three years, with 75% in favor of literal d. On the other hand, we have 25% in favor of literal c, with three years, and finally we have two literals with a percentage of 0% each, which are a and b..

Graph N° 5.



Source: Author's own creation.

We can see that the majority of those surveyed indicated that they open the door more than five times a day, with 50% in favor of literal d. 12% of those surveyed open it only once, with literal a, 13% of those surveyed open it only once, with literal b, and 25% of the sample say they open the refrigerator door five times. This suggests that the majority of households in the sample open the refrigerator door more than 5 times during the day.

Graph N° 6.



Source: Author's own creation.

We can see that the majority of those surveyed indicated that they spend 15 minutes cleaning their refrigerator every month, with 50% in favor of option b. 25% of those surveyed indicated that they spend 10 minutes cleaning their refrigerator every month, this being option a, 13% of respondents indicated that they spend 30 minutes cleaning their refrigerator every month, which is option c, and 12% of respondents indicated that they spend more than 30 minutes cleaning their refrigerator every

month, which shows that there is a sample that cleans their refrigerator for 15 minutes every month, which is the sample of the majority of the population.

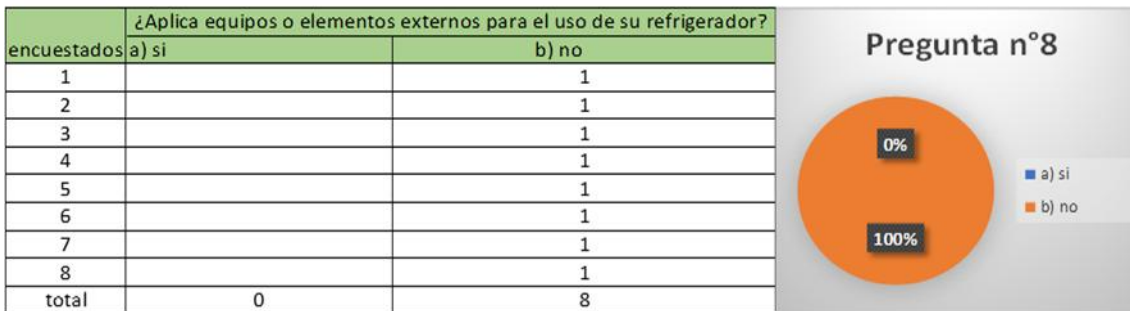
Graph N° 7.



Source: Author's own creation.

We can see that the total number of respondents do not dedicate time to carry out the corresponding maintenance on their refrigerator. This suggests that the total number do not carry out maintenance on their refrigerator. Giving 100% and the totality literal d. This implies that there is a lack of knowledge on the part of the users as to whether or not maintenance should be carried out on their refrigerators.

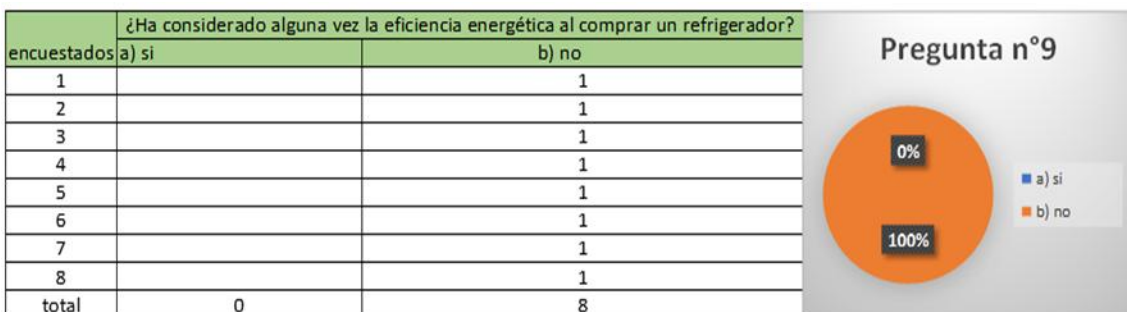
Graph N° 8.



Source: Author's own creation.

We can see that the total of all respondents do not use implements, equipment or other external elements for the use of their refrigerator. This suggests that the total does not use external elements or third-party equipment for the operation of the equipment. Giving 100% and its totality literal b and a null value to literal a which affirms the application of these elements.

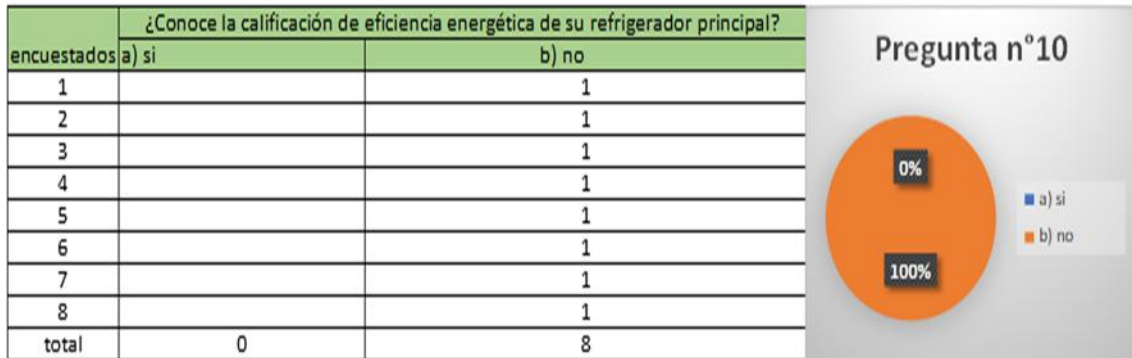
Graph N° 9.



Source: Author's own creation.

We can see that the total number of respondents do not consider energy efficiency when buying a refrigerator. This suggests that the total number of respondents do not consider outstanding effects on the operation of refrigeration equipment. Giving 100% and in its entirety literal b. which there is a total lack of knowledge about the use of refrigerators with energy saving applications.

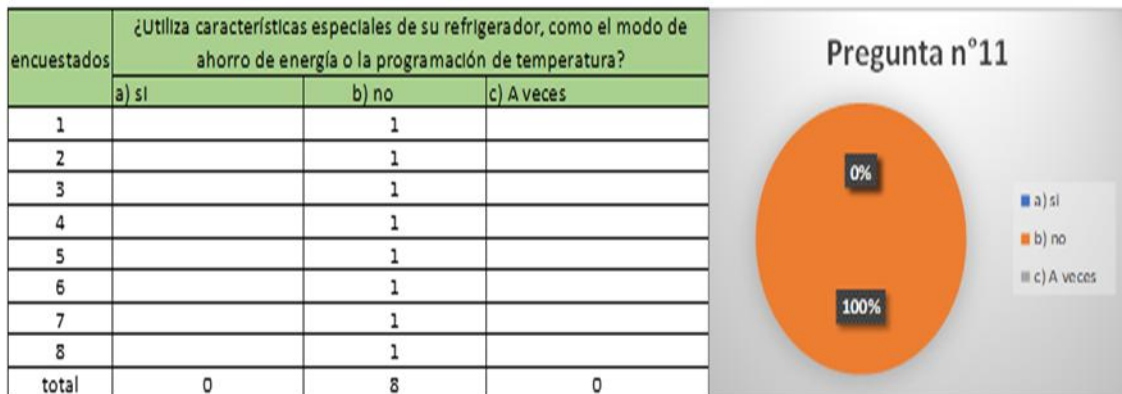
Graph N° 10.



Source: Author's own creation.

We can see that all of the respondents who do not know the energy efficiency rating of their refrigerators give 100% to literal b, which denies knowledge, and 0% to literal a, which affirms this, indicating that the total does not have a great inclination towards knowledge of the functions of their refrigerator and the standards to which the equipment is subject.

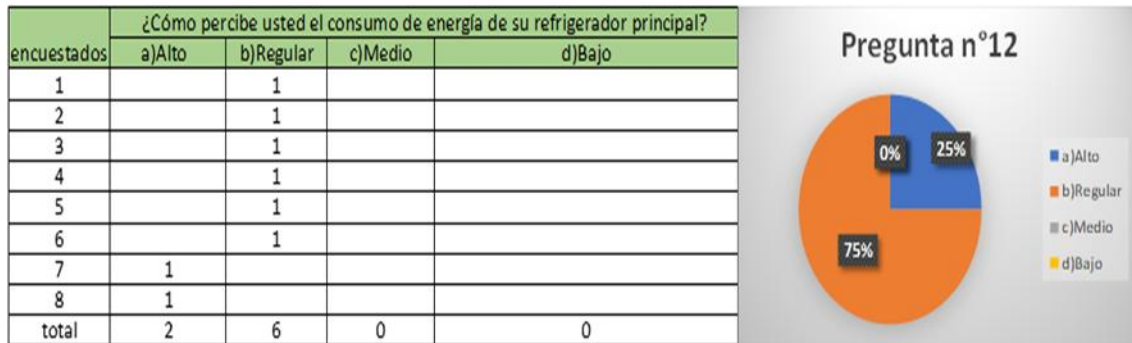
Graph N° 11.



Source: Author's own creation.

We can see that the total of all respondents do not use the special 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% and its totality literal b. which refers to the total ignorance on the part of the users of the equipment and shows in its totality.

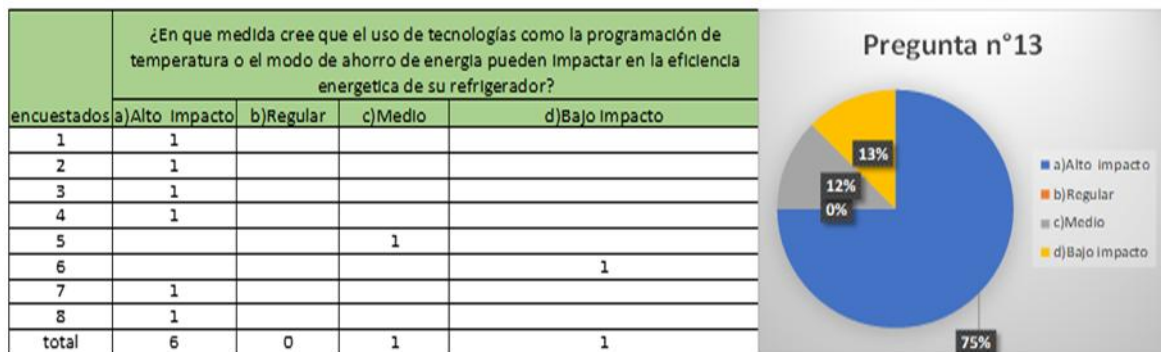
Graph N° 12.



Source: Author's own creation.

We can see that the majority of those surveyed indicated that the perception of the consumption of the refrigeration equipment they own is average, with 75% for literal b, which indicates that there is moderate energy consumption, and on the other hand 25% for high consumption, being literal a and having two values of the literals at zero, revealing that, in general, the consumption of the equipment does not exceed a perception of concern at high consumption.

Graph N° 13.



Source: Author's own creation.

We can see that the majority of those surveyed indicated that the use of technologies such as programming and energy and temperature savings has a high impact on electricity consumption, with 75% of the sample emphasizing literal a, 12% to literal c which says it is a medium range impact and finally literal d, which is 13% which reiterates that it has a low effect when applying the use of technologies to refrigeration equipment, this result emphasizes the aforementioned with programming and savings the use of elements and equipment.

Analysis and interpretation of results between survey and interview

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 it takes for the door to open can significantly reduce electricity

consumption. These practices, although simple, are fundamental to maximizing the energy efficiency of household appliances.

Many users lack knowledge about how refrigerators work and how external factors 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 various opinions about the energy consumption of their refrigerators. While some consider their appliances to be moderate consumers, 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.

Users' concerns about the cost of energy consumption in the 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 the 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 has a lower environmental impact, highlighting the importance of a comprehensive approach to managing the energy efficiency of household appliances.

In conclusion, the results highlight the importance of education, proper maintenance, and the adoption of more efficient technologies to improve the energy efficiency of refrigerators. These actions benefit users in terms of energy and cost savings and positively contribute to the environment.

CONCLUSIONS

Importance of energy efficiency: The critical importance of energy efficiency in the use of refrigerators is emphasized, as is the need to make users aware of practices they can adopt to reduce electricity consumption significantly:

1. Simple practices to reduce consumption: Adopting simple measures such as maintaining an adequate temperature, avoiding overloading the refrigerator, and reducing the time the door remains open can significantly reduce electricity consumption.

2. Need for education: Many users lack knowledge about refrigerators' actual functioning and how external factors can affect their energy efficiency, which highlights the urgent need to educate consumers about these aspects.

3. Importance of maintenance: Regular defrosting and cleaning to prevent ice build-up and ensure adequate heat exchange are emphasized, which helps to reduce electricity consumption.

4. Diversity of opinions on energy consumption: Users have diverse opinions about the energy consumption of their refrigerators, which highlights the need to educate them about appliance energy efficiency and how to choose more efficient models.

5. Concern about the cost of energy consumption: Concern about the cost of energy consumption at home varies among users, which highlights the importance of raising awareness about the importance of energy efficiency and how usage practices can influence associated costs.

6. Importance of maintenance and updating: The importance of preventive and corrective maintenance is emphasized, as well as the recommendation to update to more recent models that offer significant improvements in energy efficiency.

7. Need for a comprehensive approach: Emphasis is placed on the need to combine everyday practices with technological improvements to achieve greater energy efficiency in refrigerators, resulting in significant long-term savings for users and a lower environmental impact.

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CONFLICT OF INTEREST

None.