Competitiveness of the use of solar energy in an educational institution in Santa Marta (North of Colombia)

Competitividade do uso de energia solar em uma instituição educacional de Santa Marta (Norte da Colômbia)

Competitividad del uso de energía solar en una institución educativa de Santa Marta (Norte De Colombia)

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ABSTRACT
The objective was to determine the competitive advantages provided by the use of photovoltaic solar energy in the educational process of an educational institution in the District of Santa Marta, capital of the department of Magdalena in Northern Colombia. Non-experimental, cross-sectional and descriptive study, where the survey technique was applied. The study sample was 120 parents and 10 teachers. The results of the study showed that both teachers and parents have a favorable perception regarding the cost implications experienced by the educational institution based on the use of photovoltaic solar energy, with advantages from an economic point of view as well as in Regarding the added value based on the use of this type of energy, however, this potential is not fully exploited, given that there is a lack of clear knowledge regarding the profiles of the students and their needs according to the educational levels; on the other hand, the educational plan of the institution is not aligned with the care of the environment through the use of renewable energies and the objectives of the use of Photovoltaic Solar Energy are not clear either. On the other hand, the
necesary information and guidance is not provided to teachers to promote the educational process by taking advantage of this energy, nor does it offer training or training for its efficient use.

**Keywords:** photovoltaic energy, educational process, educational institution, solar energy.

**RESUMO**
O objetivo foi determinar as vantagens competitivas proporcionaladas pelo uso da energia solar fotovoltaica no processo educacional de uma instituição educacional do distrito de Santa Marta, capital do departamento de Magdalena, no norte da Colômbia. Estudo não experimental, transversal e descritivo, onde foi aplicada a técnica de levantamento. A amostra do estudo foi de 120 pais e 10 professores. Os resultados do estudo demonstraram que tanto os professores como pais têm uma percepção favorável relativamente às implicações de custos vividas pela instituição de ensino com base na utilização da energia solar fotovoltaica, com vantagens tanto do ponto de vista económico como no que diz respeito ao valor acrescentado baseado sobre a utilização deste tipo de energia, no entanto, este potencial não é totalmente explorado, dado que falta um conhecimento claro sobre os perfiles dos alunos e as suas necessidades de acordo com os níveis de ensino; por outro lado, o plano educativo; da instituição não está alinhado com o cuidado com o meio ambiente através do uso de energias renováveis e os objetivos do uso da Energia Solar Fotovoltaica também não são claros. Por outro lado, não são fornecidas aos professores as informações e orientações necessárias para promover o processo educativo aproveitando esta energia, nem oferece formação ou formação para a sua utilização eficiente.

**Palavras-chave:** energia fotovoltaica, processo educativo, instituição de ensino, energia solar.

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**PALABRAS CLAVE:** energía fotovoltaica, proceso educativo, institución educativa, energía solar.

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1 INTRODUCTION

The implementation of solar energy in educational institutions is presented as a competitive and sustainable alternative to reduce operating costs, improve the environment and promote environmental education among students (Hasapis et al., 2017). So much so that electrical energy costs represent a significant expense for educational institutions (MohdYacoub & Ferreira, 2022). Solar energy can generate substantial savings on the electricity bill, as it reduces or eliminates dependence on the traditional electrical grid (Batlle et al., 2020). The return on investment in a solar energy system can be relatively fast, especially in regions with high insolation (Vieira et al., 2022).

Solar energy is a renewable and clean energy source that does not produce polluting emissions. By using solar energy, educational institutions can significantly reduce their carbon footprint and contribute to the fight against climate change (Tan et al., 2017). Furthermore, solar energy does not require the extraction of fossil fuels, which helps conserve natural resources (Gebreslassie, 2021).

Installing a solar energy system at an educational institution presents a valuable opportunity to educate students about the importance of sustainability and renewable energy. Students can participate in monitoring the performance of the solar system, learn about the benefits of solar energy, and develop environmental awareness (Nhamo & Mukonza, 2016).

Adopting sustainable practices such as solar energy can improve an educational institution's public image and position it as a leader in environmental responsibility. This can attract students, teachers, and families who value commitment to the environment (Gunawan et al., 2023). In the event of power outages, a solar power system with battery storage can provide backup power, ensuring the continued operation of the educational institution. Solar energy systems are generally reliable and require low maintenance, reducing long-term operation and maintenance costs (Esponda & Vera, 2022).

Overall, solar energy offers a competitive proposition for educational institutions seeking to reduce costs, improve their environmental performance, and promote sustainability. The feasibility of solar energy for a specific educational institution will depend on factors such as location, size of the institution, energy consumption, and the initial investment required (Ahamer, 2021). However, the potential benefits of solar energy are significant and deserve careful consideration by educational institutions seeking a more sustainable future (Biancardi et al., 2023).
The decision to implement solar energy in an educational institution should be based on a careful evaluation of the potential costs, benefits, and risks (Сотник et al., 2021). However, evidence suggests that solar energy can be a competitive and sustainable option that offers a number of significant advantages for educational institutions (Berchin et al., 2017).

For its part, Santa Marta, located in the Caribbean region of Colombia, according to Maestre & Julio (2015), enjoys a high potential for solar energy due to its abundant solar radiation throughout the year. This characteristic, added to the growing environmental awareness and the need to reduce operating costs, makes solar energy an attractive alternative for the city's educational institutions. For all of the above, we sought to determine the competitive advantages provided by the use of photovoltaic solar energy in the educational process of an educational institution in the District of Santa Marta, capital of the department of Magdalena in the North of Colombia.

2 METHODOLOGY

The research scheme is non-experimental - transversal, since its variables have not been treated, they were observed in their original character, without carrying out, it is a descriptive exploration since it only seeks to construct a representation that is as complete as possible of the impact of the use of photovoltaic solar energy in the training course as a professional preeminence in the service.

The population and sample consisted of 120 parents and 10 educators from a public secondary educational institution in Santa Marta. This technique was used with the purpose of collecting quantitative, statistical data on opinions, facts, events at school that contribute to the analysis of this research. It is a quantitative instrument that was used to collect and record statistical data on teachers' assessments regarding the competitive advantages and educational process of the institution.

This instrument was made up of structured questions that contributed to the analysis of this research. The analysis of statistical data of the deductions accumulated by the questionnaire applied to educators and parents were presented through tables for the necessary interpretation. The data collected was processed through the SPSS program and the use of the Microsoft Excel program. The intellectual property was respected, the information that has been considered to analyze the current problem, previous works, related theories and conceptual framework, reliability of data and
authenticity, the data obtained in the present investigation will not be altered or manipulated, in other words. They will be interpreted according to reality objectively.

3 RESULTS AND DISCUSSIONS

In relation to the planning of the educational process, it is revealed that there are aspects that are valued positively and others negatively, according to the means of 4 and 3 points. Regarding the favorable aspects, the teachers agree that in the Educational Institution. The intervention of the teachers in the production of the teaching plan is encouraged and that their contributions to the preparation of the training plan are felt, rehearsed and, if applicable, estimated; In another aspect valued favorably, teachers consider that the use of Photovoltaic Solar Energy effectively contributes to better achievement of educational objectives, see Table 1.

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The collaboration of teachers is encouraged in the creation of the instructional plan.</td>
<td>0,5</td>
</tr>
<tr>
<td>My contributions to the preparation of the teaching plan are heard, examined and, if applicable, estimated.</td>
<td>0,8</td>
</tr>
<tr>
<td>The teaching plan of the school It is distributed with care for the environment through the use of renewable energy.</td>
<td>0,8</td>
</tr>
<tr>
<td>The objectives of the use of Photovoltaic Solar Energy in the university corporation are clear.</td>
<td>1,0</td>
</tr>
<tr>
<td>The consumption of Photovoltaic Solar Energy effectively contributes to a better achievement of educational objectives.</td>
<td>0,6</td>
</tr>
<tr>
<td>The school carries out academic skills integrated with Photovoltaic Solar Energy to enhance the education of students.</td>
<td>1,0</td>
</tr>
<tr>
<td>The purposes assumed by the training corporation regarding the use of Photovoltaic Solar Energy in the instructional course are clear.</td>
<td>0,9</td>
</tr>
</tbody>
</table>

Source: Authors

On the other hand, the average of around 3 points indicates that according to the teachers, the teaching plan of the Educational Institution is not included with the care of the environment through the use of renewable energy and they are not calm either. the purposes of the use of Photovoltaic Solar Energy in the educational corporation; Furthermore, it does not carry out dogmatic skills integrated with Photovoltaic Solar Energy to reaffirm the novitiate of the disciples, a situation that is aggravated
because the purposes assumed by the instructional corporation in relation to the consumption of Photovoltaic Solar Energy in the training step are not clear.

In relation to the organization of the educational process, the article demonstrates that, in the opinion of the teachers, in the Educational Institution clarity is acquired in the positions that fall to the educational level; In this institution, there is also the necessary resources to take advantage of the use of Solar Energy, as can be deduced from the averages of around 4 points. On the contrary, the center close to 3 points reveals that the management does not care much about computing with the inevitable resources to develop its educational process, see Table 2.

Table 2. Average rating of teachers for the characteristics of the organization of the educational process

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarity is assumed in the duties that fall to the teaching staff.</td>
<td>0.0</td>
</tr>
<tr>
<td>The school has the necessary resources to take advantage of the use of Solar energy.</td>
<td>0.5</td>
</tr>
<tr>
<td>Management is concerned about providing the necessary resources to develop your educational process.</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Source: Authors

Table 3 also shows that the aspects of the direction of the educational process are not very favorable; Although, the teachers consider that the administration appreciates the work of the I.E. teachers. who make use of solar energy, however, believe that said institution does not offer research and alignment to educators to help the instructive step using photovoltaic solar energy, and does not offer training and/or guidance on the effective management of Solar Energy, as deduced from the average of 3 and 4 points, respectively.

Regarding the control of the educational process, opinions are divided; On the one hand, the average of around 4 points indicates that the release of purposes of the partners in the teaching/learning process is adjusted, although no feedback is provided to teachers on the use of solar energy in the pedagogical summary.

Regarding the programming of the educational process in the Educational Institution, Garrido & Gallo (2020), point out that professional superiority is transcendental and unavoidable to have a reception of insurmountable value before the contenders, to achieve it it is imperative to implement main actions in order to to be more efficient and competitive in the market, while the research carried out at this institution indicates that there are aspects that are valued positively and others negatively, according to the means of 4 and 3 points.
Table 3. Average evaluation of teachers for the aspects of the direction of the educational process

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposes information and alignment to educators to collaborate the masterful process exploiting photovoltaic solar energy.</td>
<td>0,9</td>
</tr>
<tr>
<td>The school delivers preparations and/or rehearsal of the effective use of the Solar energy.</td>
<td>0,9</td>
</tr>
<tr>
<td>The board shows affection for the work of the school teachers making use of solar energy</td>
<td>0,9</td>
</tr>
</tbody>
</table>

Source: Authors

As for the favorable aspects, teachers assume that. The intervention of the didactics is encouraged in the preparation of the training plan and that their contributions are attended to, examined and, if applicable, estimated; In another aspect valued favorably, teachers consider that the use of photovoltaic solar energy effectively contributes to better achievement of educational objectives. It is important to mention that the administrative process begins with planning, which consists of delimiting the course of operation and the intended schedules to achieve the objectives and goals efficiently (Gibellato et al., 2023).

For their part, de Figueiredo et al. (2023), analyze the benefits and threats that come with the application of technologies. Zúñiga points out that making use of solar energy brings with it several competitive advantages, among them the mere fact of satisfying common interest in environmental and social matters, makes many clients see the company as a business that is responsible to society for the sole reason. fact of implementing systems with green technology, positioning the company's name at the highest levels of the market, and contributing to the acquisition of new potential clients.

Meanwhile, the quotients close to 3 points show that according to the teachers, the pedagogical method has not been organized with the care of the environment through the use of renewable energies and the purposes of the consumption of Photovoltaic Solar Energy have not been dissipated either; Furthermore, it does not carry out teaching strategies integrated with Photovoltaic Solar Energy towards the training of students, a situation that is aggravated because the purposes that the foundation has in relation to the use of Photovoltaic Solar Energy are not clear. It should be noted that to achieve improvement in the educational administrative process, the institution's resources must be maximized.

Regarding the characteristics presented by the organization of the educational process, Zúñiga & Viteri (2022) point out that many companies can take advantage of the use of Solar energy and achieve the aforementioned benefits as advantages over their competition and this starts from the administrative functions that are carried out in each organization, for example in the case of a company...
dedicated to the field of education, dependent occupations would be the contiguous of tasks that contribute to improving the educational summary (Berchin et al., 2017). While the study indicates that, in the opinion of the teachers, they know the positions that apply to the teaching staff; In this institution, there is also the necessary resources to take advantage of the use of solar energy, as can be deduced from the averages of around 4 points.

For their part, Paulo & Porto (2018) conclude an analysis of the optimal parameters for the production of electrical energy based on photovoltaic panels; likewise, the user would not be affected in the event of unforeseen outages by the electrical company. In turn, management is responsible for guiding, motivating, involving and holding accountable the institution's collaborators. In that sense, the study carried out in Talara leaves evidence that the aspects of the direction of the educational process are not very favorable; Although, the teachers consider that it shows esteem for the commitment of the I.E. teachers, who use solar energy, however, believe that said institution does not provide information and alignment to the instructions, nor does it offer training on the effective use of solar energy, as deduced from the average of 3 and 4 points, respectively.

Finally, when it comes to controlling the educational process, the opinions in the study are divided; On the one hand, the average of around 4 points indicates that compliance with ideals of the accomplices in the teaching/learning process is valued, although feedback is not provided to teachers on the use of solar energy, which contradicts the concept of control that involves verifying. For their part, Garlet et al. (2020), concludes that the photovoltaic industry in the short term returns all the investment made in its installation through direct and indirect contributions, such as personnel costs, reduced energy dependence on the outside and lower CO2 consumption.

4 CONCLUSION

Regarding the programming of the training step in the educational institution, it was evident that if the contribution of didactics is encouraged in the preparation of the secular plan.

However, currently the didactic design is not rectified with the preservation of the environment through the management of renewable energies and the purposes of the consumption of Photovoltaic Solar Energy in the pedagogical corporation are not clear either; Nor have dogmatic maneuvers completed with photovoltaic solar energy been implemented to affirm the novitiate of schoolchildren. For their part, the particularities that the structure of the training summary displays, the teachers are
clear about the functions that correspond to them, however, the management does not worry much about having the necessary resources to develop their educational process. Regarding the administration of the educational step, aspects are evident that are not very favorable since, although the teachers consider that the management shows esteem for the assignment of teachers who make use of solar energy, however, they believe that said institution does not provide them with the necessary information and guidance to benefit the educational topic exploiting photovoltaic solar energy, and does not provide training and/or preparation for the effective consumption of solar energy. Finally, the compliance with objectives of the co-agents in the teaching/learning process is calculated, however, no feedback is provided to the teachers.
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