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Promoting Energy Efficiency in Panpacific University, Philippines

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Abstract. Panpacific University, located in the northern part of the Philippines, has been active in promoting the United Nations' Sustainable Development Goal No. 7, or the push towards affordable and clean energy, by promoting sustainable energy use through a variety of energy efficiency initiatives. These initiatives include: (a) the University's commitment towards channelling renewable energy through the installation and use of photovoltaics, so that this array of solar panels may generate sufficient energy to become a major contributor in meeting the demand of the school's energy consumption needs; (b) the replacement in the campus buildings of more conventional incandescent or fluorescent light bulbs with lower cost and longer-lasting LED lamps for both greater energy efficiency and lower energy use and maintenance costs; and (c) the setting up of various school guidelines and policies aimed at promoting personal and institutional responsible energy consumption and also at further raising awareness of the need to take a more sustainable approach towards resource use, as well as encouraging further study and discovery in this area. This current report serves to detail the implementation of these initiatives, and the results achieved to date. As the school goes through a restructuring process and installs a newly appointed Sustainability Officer tasked now to oversee these initiatives, a further discussion on the projected targets and potential future directions that these initiatives might take is also in order. It is hoped that this information might be of use for other Higher Educational Institutions in the locality or in the region towards their own energy efficiency efforts.

Keywords:
energy efficiency, HEI, Philippines, renewable energy, SDG7.

1. Introduction

The United Nations set a blueprint - in the form of 17 Sustainable Development Goals - for persons and institutions across the globe to use towards building a more resilient and prosperous world [1]. With just six years remaining before the 2030 target, current progress falls short of what is required to meet the SDGs. The lingering impacts of a variety of crises (such as the COVID-19 pandemic, escalating conflicts, and geopolitical tensions) have been recognized as hindrances to progress; further, without massive investment and scaled up action from various fronts, the achievement of the SDGs remains elusive [2].

Of the various SDGs, the focus of this paper will be on the 7th: Affordable and Clean Energy. The call is to address our long-standing dependence on dwindling and pollutive energy sources; this might be done by prioritizing energy efficient practices, and by accelerating the transition to affordable, reliable, and sustainable energy, through investing in renewable energy resources and/or adopting clean energy technologies and infrastructure [3]. According to the United Nations Environment Programme, energy efficiency translates to finding the most effective and economically advantageous means to provide the services desired by energy users; in other words, it is about determining measures to provide the same (or higher) level of energy services (such as thermal comfort and high-quality lighting) at reduced energy consumption and cost [4]. While the general trend globally on energy efficiency has been progressive, gaps in equitable access remain, particularly between developed and developing countries [2]. It is therefore imperative to redouble one's own efforts in this regard.

The Philippines has long striven to be an active participant in this common global concern. Since the time of the global energy crises of the 1970s, various forms of legislation have been put in place by the national government in view of addressing issues on energy [5]. Most significant of these may be the following: the Presidential Decree of 1977 that created a Department of Energy (DOE), recognizing the importance of having a policy-forming and program-implementing body that works in a comprehensive and integrated way at the national level [6]; the Renewable Energy Act of 2008, through which the government encouraged the development and use of renewable energy sources in order to promote energy self-sufficiency, to lessen reliance on fossil fuels, and to protect the country from global market price fluctuations that affect various sectors of the economy [7]; this is followed about a decade later, in 2019, by the Energy Efficiency and Conservation (EEC) Act, which promotes energy efficiency and conservation initiatives such as load management, and it also reiterates and incentivizes the development and use of renewable energy [8].

Panpacific University is therefore honored to engage in its global and national responsibilities and to join the ranks of Higher Education Institutions (HEIs) across the globe that have embarked on the initiative of promoting sustainability through pursuing greater energy efficiency.

2. Scenario

Panpacific University, formerly Pangasinan Colleges of Science and Technology (PCST), was incorporated in 1992 under Philippine laws as a non-stock, non-sectarian corporation authorized to operate as a school providing secondary, tertiary, graduate and postgraduate courses, and promoting advances in educational research. Particularly, it first offered a handful of programs to just a little over 500 students, in a rented 3-storey building with ten rooms. With the introduction of new academic programs and the achievement of higher accreditation levels, student enrolment significantly increased. The rise in student population and in personnel prompted the expansion of the university's infrastructure to meet the growing educational demands. Currently, the university is located in a 3-hectare campus along McArthur Highway in San Vicente in Urdaneta City, Pangasinan, in the north-western quadrant of the Philippines. The campus features a range of purpose-built facilities designed to enhance learning and student experience, including academic buildings, a mock boat for maritime training, an events center, simulation rooms, laboratories, and a swimming pool. At present, the campus comprises six major buildings: a six-storey Science Building, a six-storey PCST Building for administration, named after the school's core values (Pioneer, Compassion, Service and Truth), a five-storey Padilla Building, a five-storey Academic Building, and a three-storey School of Basic Education (SBE) Building.

The increase in both the population (currently at approximately 3,660 persons) and the infrastructure has led to a significant rise in energy consumption. Realizing both the need for resource use and the need to do so responsibly, the university in 2020 launched its Comprehensive Ecological Sustainability Program, also known as Agenda 20:2020. One agenda item therein is Energy Efficiency, which mandated electricity conservation practices, such as switching off lights, air conditioning units, and electric fans when rooms are unoccupied, observing certain "no aircon days", and maximizing the use of natural lighting and ventilation.

Three years later, in 2023, the university strengthened its commitment to affordable and clean energy by installing solar panels on campus. With its strategic location—characterized by its coordinates (latitude: 15.9698, longitude: 120.5751), its topography (generally flat) and its climate (tropical)—the campus receives abundant sunlight throughout the year, making it highly suitable for solar power generation [9]. It has been noted that insolation in the Philippines is such that there is the potential to generate power to the capacity of 4.5-5.5 kWh per square meter per day or 1862 kWh per square meter per year, and yet at this time, only a very small part of total energy use in the country relies on solar energy [10].

This school year, during Earth Day on April 22 of 2025, the University formally opened its Sustainability Office, which is mandated to provide an integrated, systematic and comprehensive approach to our pursuit of sustainability initiatives.

How Panpacific University has been developing its energy efficiency initiatives is discussed in greater detail below.

3. Implementation

3.1. Renewable Energy: Photovoltaics in PU

The Solar Photovoltaic (PV) System is installed on the rooftop of our three-storey SBE building. The installation utilizes monocrystalline modules comprising 150 cells per panel, with each panel measuring 2187 mm x 1102 mm x 35 mm, and with a maximum power output of 510 Watts per panel. The entire system consists of a total of 198 photovoltaic panels covering a total area of approximately 477.19 square meters, for a combined maximum power output of 99 kW.

This solar PV system is integrated with one grid-tied inverter, specifically the SUN2000-100KTL-M1 model. This is a PV string inverter designed to convert Direct Current (DC) into Alternating Current (AC), which is subsequently fed into the power grid. This particular inverter features several advanced characteristics, such as Smart Air Cooling (which employs intelligent cooling mechanisms that adjust fan speed according to ambient temperature and load conditions, enhancing fan longevity and minimizing maintenance requirements) and Smart PV Module Self-Learning (which makes it capable of automatically detecting and identifying PV module failures, thus facilitating timely rectification and fault management). Such features collectively enhance the efficiency, reliability, and operational lifespan of the rooftop solar PV installation.

Figure 1. The installation of solar PV system on SBE building

The total energy yield from the PV system depends on a number of factors, such as sunlight exposure, panel efficiency, tilt angle, and local weather conditions, and also the efficiency of the energy transfer.

Prior to the installation of the PV system, the University was reliant on the local utility grid - Pangasinan Electric Cooperative (PANELCO) - for our energy needs. They remain, until now, our provider for the school's needs that go beyond what our PV system is capable of producing. The utility grid is provided for by a partner called Masinloc Power, a coal-fired thermal power plant. Thus, while still reliant upon them, to the extent that we can be less dependent on the local utility grid and more reliant on our own PV system, we thereby also are contributing towards the lessening in use of fossil-fuel-driven energy.

Our system being on-grid also allows for surplus electricity generated by our solar panels (that is, energy that exceeds our immediate consumption needs) to flow back into PANELCO's grid, via a typical net-metering arrangement. In this way, we earn credits for this exported energy, reducing future electricity bills and promoting renewable energy use within the community. Let us look at the relevant numbers from the past twelve months (Table 1).

The data from April 2024 to March 2025 highlights notable monthly trends in energy consumption, solar energy production, and renewable energy contribution at Panpacific University. The highest renewable energy percentage was recorded in April 2024 at 40.19%, driven by the highest solar energy yield (13,573.19 kWh) and the largest energy export to the grid (3,850 kWh), indicating optimal solar performance. Similarly, August 2024 also showed a strong renewable share of 40.65%, supported by consistent solar generation. In contrast, October 2024 had the lowest renewable percentage at 24.55% due to the highest total energy consumption (38,932 kWh), which outweighed the moderate solar yield of 9,559.00 kWh. July 2024 registered the lowest total energy use (27,599 kWh), resulting in a high renewable contribution of 39.13%, even with modest solar output. September 2024 experienced the lowest solar yield at 8,610.20 kWh, likely due to unfavourable weather, reducing the renewable share to 29.78%. The cooler dry season towards the last quarter of the year might account for the tendency to lower energy yield and also thus lower use of renewable energy at this period. Overall, the data reflects effective integration of solar energy, with most months maintaining a renewable contribution above 30%.

Table 1. Monthly Energy Consumption, Energy Yield from Solar Panels, Energy Exported Back to the Grid and Percentage of Renewable Energy

Month	Energy Consumed from PANELCO (kWh)	Energy Yield from Solar Panel (kWh)	Energy Exported back to the Grid (kWh)	Total Energy Consumption (kWh)	Percentage of Renewable Energy [%]
April ‘24	23,450	13,573.19	3,850	33,173	40.19
May ’24	23,800	12,975.53	1,050	35,725.53	36.32
June ’24	28,000	12,268.6	1,750	38,518.6	31.85
July ’24	17,150	10,799	350	27,599	39.13
August ’24	19,950	12,943.7	1,050	31,843.7	40.65
September ’24	20,720	8,610.2	420	28,920.2	29.78
October ’24	30,003	9,559	630	38,932	24.55
November ’24	28,000	10,125.8	1,750	36,375.8	27.84
December ’24	27,300	9,579.9	1,400	35,479.9	27.00
January ’25	20,300	10,580.2	2,100	28,780.2	36.7
February ’25	24,500	10,173.2	1,400	33,273.2	30.58
March ’25	24,500	9,956.2	1,400	33,056.2	30.12

The total energy consumption of the school is obtained by adding the energy imported from the local grid to the amount generated by the solar panels, and subtracting the surplus generated by the solar panels and exported back to the grid. The percentage to which our total energy use is now reliant on renewable energy is determined by arriving at the proper proportion of the solar energy produced against its relation to total energy use. The annual numbers are in Table 2.

Earlier published research on the actual use of photovoltaics (as distinct from simulation studies) in schools tended to come from Europe [11, 12, 13, 14, 15, 16], and it is only a bit more recently that work on this by Asian HEIs can be found [17, 18]. We are now proud to join that company. It should be noted that there are all sorts of various factors (e.g., school size, geographic location, administrative objectives) that make comparing numbers across HEIs uninstructive. However, it is also worth noting that our percentage numbers are comparable to that of a similar project also in the Philippines, albeit in a non-academic setting (health sector) [19]. In addition, these numbers well-exceed the recommended target of 20% for renewable energy, as laid out by the EU in its Renewable Energy Road Map [20]; further, it is within the range of the Philippines's own Department of Energy, whose recommended target for renewable energy is 35% for 2030 [21].

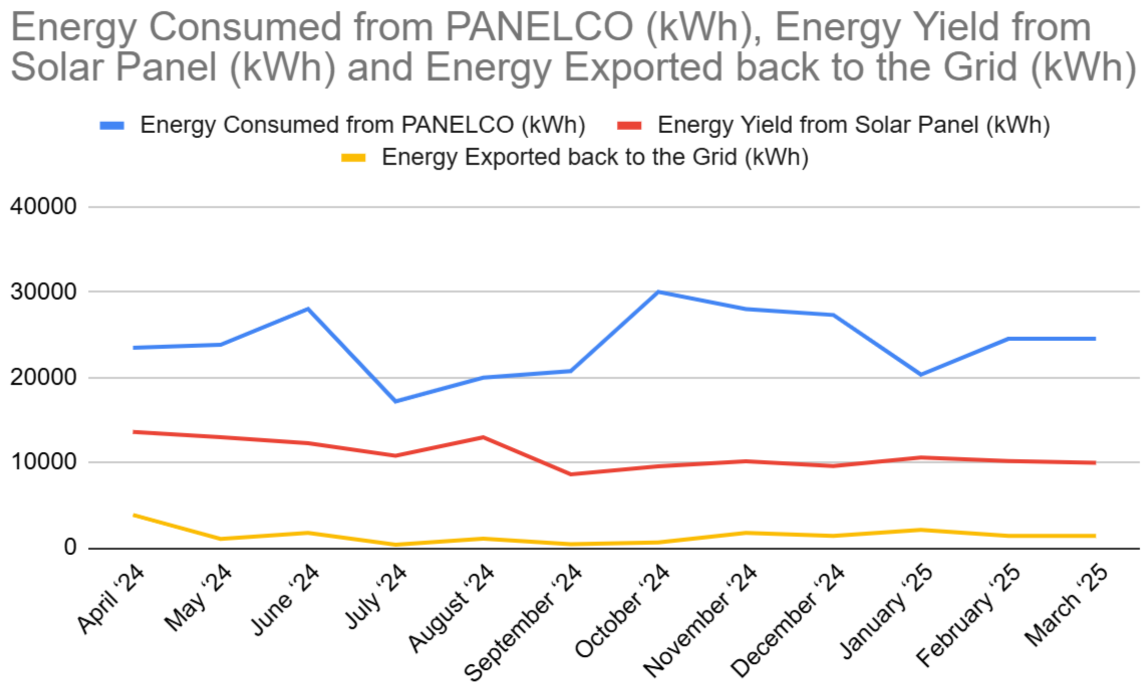

Figure 2. Monthly energy consumption, solar energy yield, and grid export

Table 2. Annual energy consumption, energy yield from solar panels, energy exported back to the grid and percentage of renewable energy

Duration	Energy Consumed from PANELCO (kWh)	Energy Yield from Solar Panel (kWh)	Energy Exported back to the Grid (kWh)	Total Energy Consumption (kWh)	Percentage of Renewable Energy [%]
April '24 to Mar '25	287,763	131,144.52	17,150	401,667.52	32.65

3.2. Transition to LED Lights

A Light-Emitting Diode (LED) is currently recognized as the most energy-efficient, long-lasting, and eco-friendly source of illumination, making it a popular choice for use in HEIs. They consume significantly less energy than traditional lighting technologies. They also last up to 25 times longer than incandescent bulbs, and thus incur lower maintenance costs, despite their higher initial prices. According to the Department of Energy, switching to LED lighting can reduce lighting energy consumption by up to 60–80%, supporting national energy conservation initiatives and lowering carbon emissions [21]. They have the added benefit of producing less heat, which enhances safety by lowering the risk of fire, and for an HEI like Panpacific University, they provide ample lighting and visual clarity with improved Color

Rendering Index (CRI) and are thus in support of teaching, learning and research.

Panpacific University has installed 1,266 LED lights within the campus, completing the institution's shift towards energy-efficient lighting, replacing the more costly incandescent and fluorescent bulbs. Below is a comparison of the difference between the use of LED lamps vs the use of older bulbs, as situated within our specific context: [Assumptions: (a) Usage: 6 hours/day × 365 days = 2,190 hours/year; (b) Electricity Rate: Php (Philippine peso) 6.50 per kWh].

Table 3. Comparison of Energy Consumption and Cost between Traditional 60W Bulbs and 9W LED Bulbs

Category	Traditional Bulb (60W)	LED Bulb (9W)
Power Rating	60 watts	9 watts
Brightness (Lumen)	800 Lm	800 Lm
Usage per Year	2,190 hours	2,190 hours
Energy Consumption per bulb (kWh/year)	131.4 kWh	19.71 kWh
Total Energy Saved (1,266 LED bulbs) (kWh/year)	---	141,399.54 kWh
Electricity Rate	Php 6.50 per kWh	Php 6.50 per kWh
Annual Electricity Cost	Php 854.1	Php 128.42
Annual Savings	---	Php 725.68
Total Annual Savings (1,266 LED bulbs)	---	Php 918,699.89

With a local power tariff of Php 6.50 per kWh and an average daily consumption of 6 hours, each LED bulb saves around Php 725.68 annually in comparison to a 60-watt incandescent light. For the entire university, the use of 1,266 LED bulbs translates into a significant reduction in energy consumption and cost. By replacing traditional 60-watt bulbs with 9-watt LED bulbs, the university is projected to save approximately 141,399 kWh of electricity per year. This reduction in energy usage results in an expected yearly savings of Php 918,710.88 (or approximately €14,500) on electricity costs. This initiative not only supports cost-efficiency but also aligns with the university's sustainability goals by promoting energy conservation and reducing carbon emissions. This also translates into a sizable amount of money that may now be appropriated for scholarships for our more financially challenged students.

3.3. Sustainable Energy Consumption

3.3.1. Guidelines on air conditioner and light use

Panpacific University has moved beyond enjoining its people to be more mindful of their energy use, as had been set in our Agenda 20:2020. It has since set guidelines on air-conditioning and light use that mirror the objectives of the National Energy Efficiency and Conservation Program (NEECP), which aims to make energy efficiency a way of life and includes strategies like promoting energy-efficient technologies and implementing building energy usage standards [8].

The university's practices include: (1) setting air-conditioning units to 24°C [22]; (2) operating them only during peak solar energy production hours (that is to say, between 9:00 AM and 4:00 PM) [23]; and (3) promoting natural ventilation whenever possible.

Likewise, light use is regulated [24]. Lights in classrooms and offices may operate between 6:45 AM to 5:15 PM, and must be turned off during the breaktime of 12:00 NN–1:00 PM in unoccupied areas. Lighting in non-critical areas stays off during weekends and holidays unless needed. Whenever possible, natural lighting when sufficient is deemed preferable. Faculty, staff, and the school’s security teams are all responsible for ensuring compliance.

3.3.2. Guidelines on flexible learning

In 2020, the COVID pandemic provided the reason for Panpacific University to implement a flexible learning modality, in accordance with the government-issued memorandum entitled, “Guidelines on the Implementation of Flexible Learning” [25]. Flexible learning is defined as a teaching approach that allows for flexibility and adaptability with regard to time, place, and audience and through the effective use of technology [26]. To ensure compliance and effective implementation, Panpacific University invested in digital technology such as wider and faster internet, and the use of Learning Management Systems (LMSs), such as Quipper for basic education and Canvas for the higher education programs, and an integrated School Management System, Empowered. Teaching staff have been trained in the utilization of these by the Academics Office and the school’s Knowledge Information and Network System or KINS.

Equipped with the lessons learned from the pandemic and with the objective of reducing energy consumption, Panpacific University continuously implements flexible learning modality in selected courses: for instance, general education courses are delivered in flexible learning mode while institutional courses are taught purely online. Synchronous classes are held from Monday to Wednesday while asynchronous classes are held from Thursday to Saturday. The combination of synchronous and asynchronous classes provides satisfaction to students in terms of pedagogy, students’ knowledge, skills and attitude regarding online learning, interaction, and student engagement [27].

With this learning modality, the number of students being physically inside the school and the number of classrooms being utilized significantly decreased. Consequently, the amount of energy consumed through transportation and through the use of appliances and devices such as air conditioners, fans, lights, and other digital learning equipment dramatically declined. The prioritization and optimization of building use translates into energy conservation [22, 23]. Further, e-learning reduces physical travel which contributes to reducing transport-related carbon emission., as well as helps raise public awareness of environmental issues and the need to reduce energy consumption [28].

3.3.3. Circular and co-curricular activities

As an institution committed to pedagogy, we cannot simply conserve energy ourselves, but must also actively promote and educate towards energy conservation. Panpacific University raises awareness and trains its stakeholders in taking actions towards more sustainable consumption of energy resources. This is done through both curricular and extracurricular activities. The Academics Office ensures that lessons on the Sustainable Development Goals (SDGs) – including SDG 7 Affordable and Clean Energy – are tackled in general education courses such as “The Contemporary World,” “Science, Technology, and Society,” and in the institutional course, “Compassion.” As we understand it in our school, compassion goes beyond caring for other humans right now, but extends to include the environment, and also future generations; it thus involves being responsible stewards of the environment. This ensures that all students acquire a foundational understanding of – and practical knowledge on – energy conservation. Moreover, integrating SDGs can help fulfil the goal of general education courses that are nationally mandated which is to develop well-rounded individuals equipped with intellectual competencies and civic responsibilities [29]. Embedding the SDGs into the curriculum is an effective way to develop responsible global citizens who are not only experts in their fields, but deeply committed to making the world a better place [30].

However, it is not only in the courses that we have academic integration of the SGDs but in our research as well. Through more focused student involvement, there is an increased possibility of practical application of these ideas on renewable energy and energy efficiency through concrete research projects [31]. The works of our students just in the previous academic year include experiments on mechanisms (such as controllers and sensors) that will make for more efficient energy use [32, 33] and also on better ways of generating [34] and utilizing [35] solar energy.

In terms of the involvement of all teaching and non-teaching staff to sustainability initiatives, the Internationalization Office launched the SDG Talks initiative last November 7, 2024, which aims to raise awareness and drive engagement in the attainment of the SDGs. Each administrative office is assigned with a specific SDG and are given the freedom to choose whether to deliver a talk, conduct a panel discussion, or otherwise conduct some activity that promotes understanding, action, or collaboration related to their assigned goal. When the Facilities Office was assigned to discuss SDG 7, they presented practical insights on clean energy solutions and conducted a live demonstration of a Portable Power Station.

Moreover, the university holds its annual Leaders’ Summit as part of its Foundation Celebration where guest speakers share their expertise aligned with the institution’s core values: Pioneer, Compassion, Service, and Truth. In this way the thrust of being compassionate towards the environment is reiterated and reinforced.

Through the learning gained from these curricular and co-curricular activities, stakeholders understand well the principles behind the policies pertaining to energy conservation, making it easier for the administration to implement such policies. Moreover, the learning gained from these initiatives can be applied to the stakeholders’ households and communities, paving a way for more extensive and more collaborative efforts towards sustainable energy consumption.

4. Future Perspectives

Moving forward, Panpacific University will further strengthen and enhance its efforts to advance its energy efficiency initiatives. Aided by learnings from other HEIs, certain enhancements on our initiatives can be further explored.

One of these might be to utilize the energy generated by the solar panels towards promoting the use of electric vehicles and otherwise promoting green transportation, in this way further contributing to the use of renewable energy and the lessening of carbon footprint through a reduction in the use of fossil fuels [36, 37].

Another one would be to expand on the lessons learned from our flexible learning system to apply this to flexibility when it comes to working as well. We are exploring the reduction of the work week from four to five days, along with a lessening of office hours from an 8:00 to 5:00 schedule to a 9:00 to 4:00 schedule, with the system allowing for more remote work and flexibility in delivery of outputs. This work set-up aims to alleviate the burden of daily commuting, provide employees with flexibility and greater personal time, and to better promote a good work-life balance, while contributing to reduced energy consumption and operational costs on campus [38].

Further use of both established and emerging technologies beyond the photovoltaics itself is also worth exploring; one possibility is the use of real-time sensors and digital displays to increase awareness of energy use [23, 39, 40].

Meanwhile, more work can be done in ensuring that our curricular (and co-curricular) push towards energy efficiency is in the right direction. Assessment in the form of periodic evaluations in the classroom or other mechanisms like public consultations on stakeholder engagement outside the classroom are worthwhile activities.

Requiring more strategic and long-term consideration would be exploring the extent to which retrofitting our campus buildings for energy efficiency is a viable option for us. This may include installation of better thermal insulation, window class tints, and redesign of building apertures to optimize natural lighting and ventilation [41]. And speaking of long-term considerations, while the life span for the solar panels is estimated at beyond twenty years, research currently being done regarding that technology's life-cycle - and the attendant issues of disposal and possible pollution - are matters that we should already start looking into as well [42].

As was mentioned earlier, the University formally opened its Sustainability Office just this school year, and it is mandated to provide an integrated and systematic approach to our pursuit of sustainability initiatives. The various possible future ideas for energy efficiency would form part of a more comprehensive and strategic plan in the University's pursuit of sustainability, which would include concerns such as waste management, water conservation, infrastructure development, community development, and more.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Authors Contribution

All authors contributed substantially to the work. **D.P.T.** led the team, supervising and conceptualizing the research project and serving as project administrator; **J.D.P.** contributed to conceptualizing, forming the methodology, and writing/editing; **M.S.** was responsible for formal analysis and writing of the original draft; **M.C.** was responsible for data curation and visualization. All authors reviewed and approved the final version of the manuscript.

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