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Estimation of Energy Utilization Intensity and Its Factors among Municipal Local Government Units in Region 12, Philippines

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Abstract — This study aims to estimate the energy utilization intensity and identify its determinants among municipal local government units of Region 12, Philippines. This study utilized a quantitative-descriptive survey design. It found variation in energy utilization intensity (EUI) across municipalities, with some consuming more energy per square meter than others. MLGUs employed energy-saving strategies like turning off lights and appliances, using energy-efficient equipment, and switching from desktops to laptops. An effective energy monitoring and targeting system for the purpose of energy saving significantly reduces energy utilization intensity at a 10% level based on robust multiple regression analysis.

Keywords — Energy Utilization Intensity, Municipal Local Government Units, Operating Strategies, Robust Regression, Region 12

I. Introduction

The Philippine government has placed a high priority on energy efficiency in response to the increasing energy demand and the projected exhaustion of the Malampaya gas supply by 2024 (Mercurio, 2022; Jose, 2023). The Energy Efficiency and Conservation Act of 2019, together with the National Energy Efficiency and Conservation Plan and Roadmap 2023-2050, requires local government units and all government agencies to enforce energy-saving measures (Rivera, 2021). Implementing initiatives such as energy-efficient lighting has the potential to result in substantial savings of approximately P3.4 billion per year by drastically lowering energy consumption. Nevertheless, the task of persuading the public sector to embrace these measures and cooperate with private energy service providers continues to be a difficult undertaking (Philippine Energy Efficiency Alliance, 2021).

Optimizing energy efficiency is essential for promoting economic growth, mitigating greenhouse gas emissions, and attaining sustainable development objectives, such as the target of doubling energy efficiency by 2030 (Chen et al., 2023). Energy efficiency plays a role in ensuring energy security in the Philippines, which is a net energy importer, due to the combination of

expensive electricity rates and growing demand (IEA, 2019). Advocating for energy efficiency contributes to the overarching objectives of maintaining economic stability, ensuring environmental sustainability, and promoting energy security (Ibrahim & Alola, 2020; Qamruzzaman, 2022).

The results of this study will assist in the supervision of the execution of energy efficiency regulations, strengthening the effectiveness of regulatory initiatives aimed at reducing needless energy use, and optimizing ways to decrease wasteful usage, ultimately leading to cost savings in the operation of government offices. The results will enable regulators to oversee the implementation of the EE&C Act and enhance initiatives to reduce wasteful energy consumption. Moreover, the research can contribute to improving measures of fiscal restraint aimed at decreasing inefficient energy usage and cutting down on operational expenses (as outlined in the National Energy Efficiency and Conservation Plan and Roadmap 2023-2050).

Literature Review

To address the increasing energy consumption in buildings resulting from urbanization and population increase, it is crucial to prioritize energy efficiency to reduce environmental consequences and promote sustainability. This review compiles contemporary studies on energy use in both residential and non-residential buildings, examining approaches to improve energy efficiency and promote sustainability.

In their study, Bahgat et al. (2019) investigated the impact of urban open space design on energy usage in residential buildings in Egypt. The researchers determined the most effective configurations to decrease energy use and enhance thermal comfort, providing practical advice for architects and designers.

On the other hand, Khaliq and Mansoor (2022) highlighted the importance of using insulating materials, implementing enhanced architectural strategies, and adopting modified construction procedures in order to attain optimal energy efficiency. Their research demonstrated that the use of alpolic cladding and double-layered windows increases thermal efficiency by 8%, while cavity wall construction enhances energy conservation by 6%.

Attia et al. (2022) evaluated the energy efficiency of residential structures in Poland, with a focus on promoting awareness and providing easily understandable instructions for effective implementation. They emphasized crucial potential and risks that could hinder the achievement of net-zero emissions. Meanwhile, Farhan et al. (2019) conducted a study on the sustainability of residential dwellings in Kut, Iraq. Their findings indicate that these houses are not environmentally sustainable and significantly depend on artificial energy for heating, cooling, and lighting.

Sholanke et al. (2022) investigated the influence of energy-efficient design solutions on user comfort in mixed-use buildings located in Lagos State, Nigeria. The significance of taking

human comfort into account from the initial design phases and integrating energy-efficient solutions throughout the planning, design, and building processes was underscored.

Bano and Sehgal (2020) evaluated the energy use in government and private office buildings located in Lucknow. The energy performance index (EPI) was calculated for each building, with a focus on identifying variables that contribute to inefficient energy consumption and proposing strategies for achieving consistent energy savings.

In their study, Papadakis and Katsaprakakis (2023) conducted a comprehensive analysis of energy efficiency in non-residential public buildings. They specifically focused on retrofitting measures and examined the various sustainability and economic aspects that influence decisions on retrofits. Their suggestion was to adopt a comprehensive strategy that combines technology advancements with well-informed operational methods.

William et al. (2019) specifically examined the substantial energy requirements of a hospital located in Alexandria, Egypt. A DesignBuilder simulation model was utilised to evaluate various methods for decreasing energy usage. The results demonstrated substantial energy conservation when implementing a Dedicated Outdoor Air System (DOAS).

Alwetaishi (2022) investigated methods to conserve energy in already constructed structures, with a specific emphasis on optimizing the window-to-wall ratio, enhancing thermal insulation, and implementing shading devices. Their investigation indicated that decreasing the ratio of windows to walls and implementing thermal insulation had a substantial impact on energy consumption and thermal comfort in hot areas.

Enhancing energy efficiency in current buildings is vital for addressing climate change and attaining energy self-sufficiency. The Energy Performance of Buildings Directive of the European Union has facilitated these endeavors by establishing mandatory energy efficiency criteria for newly constructed and refurbished buildings (Akram et al., 2022).

Assessing the cost-effectiveness of energy-saving techniques is crucial for companies that need to balance both environmental and financial factors. The research on converting office buildings into Net Zero Energy Buildings (NZEB) emphasizes the significance of a comprehensive and multifaceted strategy to maximize building efficiency (Alajmi et al., 2020). The literature emphasizes the intricate nature of energy efficiency in office buildings, emphasizing the importance of methodical measurement of energy savings, thorough evaluations of strategies for existing buildings, and the incorporation of user behavior factors as crucial areas for future research (Erebor et al., 2021; Šuman et al., 2020; Akram et al., 2022; Azhar et al., 2023).

The literature study emphasizes the significance of employing energy-efficient design solutions to decrease energy consumption and improve sustainability in buildings. Significant energy savings can be realized by implementing modern architectural techniques, enhancing building materials, and incorporating novel technologies. These studies offer significant insights

and ideas for architects, designers, and legislators that seek to improve energy efficiency in the built environment.

II. Methodology

This study utilizes a descriptive-quantitative design to determine the energy utilization intensity (EUI) of municipal government offices in Region 12, Philippines, and evaluate the factors that affect it. All 45 municipal local government units (MLGUs) in Region 12 were taken, encompassing four provinces: Cotabato, Sarangani, South Cotabato, and Sultan Kudarat. Cities within the region were deliberately omitted in order to maintain consistency and uniformity of sampled offices. The main data was gathered through a checklist that assessed energy management techniques, adherence to government rules (Freedom of Information (FOI) compliance, Budget Utilization Rating (BURS) for 2023, International Standard Organization (ISO) certification) and other attributes of the MLGUs, including building size, age, design, and the quantity of different types of air-conditioning systems, fans, vehicles, computers, personnel and clients served. The financial data was obtained from budget or accounting offices, while data on employees, air-conditioning units, and environmental elements were acquired from HRMDO, general services offices, and the internet, respectively. The data was analyzed using descriptive statistics and robust regression analysis. The EUI was determined by dividing the total energy usage (total electricity costs and total fuel costs for January 2024) by the floor area of the MLGU. A map showing the spatial distribution of Energy Utilization Intensity (EUI) among Municipal Local Government Units (MLGUs) was created using Q-GIS. Robust multiple regression was used to determine the elements that influence EUI. Statistically, the model is expressed as: $EUI_i = \beta_0 x_0 + \beta_1 x_i + \beta_2 x_2 + \beta_3 x_3 + B_4 x_4 + B_n x_n + \varepsilon_i$ where EUI is the energy utilization intensity (in pesos/sqm/January 2024) of the given MLGU; β_0 *to* B_n are regression coefficients and x_0 *to* x_n are independent variables and ε_i denotes the error term.

III. Results and Discussion

Characteristics of Municipal Local Government Units in Region 12

Table 1 presents a descriptive analysis of the attributes of municipal local government offices in Region 12, Philippines. These attributes include the dimensions, structure, age, height, workforce size, clientele, heating, ventilation, and air conditioning systems, vehicles, adherence to ISO standards, compliance with Freedom of Information (FOI) regulations, efficiency in budget utilization, and allocation of national taxes. These characteristics provide essential information about the local government infrastructure and how it affects energy efficiency.

In Region 12, the average size of municipal offices is 1,924.64 square meters, with a range of sizes from 254.86 square meters to 6,300 square meters. The representation of building design is predominantly determined by the number of floors, typically averaging at 2.31 floors. The majority of offices consist of two floors (55.56%), while a significant portion have three floors (33.33%).

The mean age of municipal offices is 26.5 years, ranging from the most recent, which is six months old, to the oldest, which is 74 years old. Older constructions may necessitate increased upkeep and may lack the energy efficiency of more recent ones. The mean altitude of municipalities is 133.6 meters above sea level, with Lake Sebu having the highest elevation at 730.3 meters and Kalamansig having the lowest at 5.6 meters. This variation in elevation highlights the geological diversity of the region. The average number of employees in the municipal offices of Region 12 is 319.64, with Maasim having the highest number and Bagumbayan having the lowest. In January 2024, the mean number of clients serviced was 1,006.62, with President Quirino having the highest number and Bagumbayan having the lowest number. Just 13.33% of workplaces adhere to the FOI Act, which promotes transparency and accountability. However, none of them are certified under ISO standards, which have the potential to enhance operational efficiency and optimize energy usage. The average budget utilization rates in 2023 were 91.96%, suggesting a high level of efficiency in carrying out projects and plans. Palimbang, Tulunan, and Banisilan had full budget utilization of 100%, whilst Makilala had the lowest utilization rate of 79%. Pikit was allocated the largest national tax amount of 578.32 million pesos for 2024, followed by Polomolok with 531.29 million, while Tantangan earned the smallest portion at 115.25 million.

Table 1. Characteristics of Municipal Local Government Offices in Region 12, Philippines.

Variables	Frequency (N=45)	%	Min	Max	Mean
Building Size (total floor area in sqm)			254.86	6300	1924.64
200 to 1410	19	42.22			
1411 to 2621	13	28.89			
2622 to 3832	10	22.22			
3833 to 5043	2	4.44			
5044 to 6300	1	2.22			
Building Design (Number of Floors)			1	5	2.31
1 floor	4	8.89			
2 floors	25	55.56			
3 floors	15	33.33			
5 floors	1	2.22			
Building Age (in years)			0.6	74	26.5
0.5 to 15	15	33.33			
15.1 to 30	12	26.67			
30.1 to 45	10	22.22			
45.1 to 60	5	11.11			
60.1 to 75	3	6.67			
Elevation of Municipality (in MASL)			5.6	730.3	133.6
Number of Employees			109	890	319.64
Clients served last January 2024			50	7887	1006.62

Heating, Ventilation, & Airconditioning System (HVAC)					
Number of Aircons					
Split type			1	52	21.54
Door type			0	62	7.61
Window type			0	99	20.88
Number of electric fans			0	103	31.64
Average HVAC System Efficiency			3.9	4.88	4.41
Number of Vehicles			5	182	69.35
Compliance to ISO	0	0			
Compliance to Freedom of Information (FOI)	6	13.33			
Budget Utilization Rate (in % in 2023)			79	100	91.96
National Tax Allocation for 2024 (in Php)			115,250,738.00	578,324,052.00	318,410,294.93

Actual Electricity and Fuel Consumption of Municipal Local Government Units

Energy is operationally defined in the study as the sum of actual electricity costs and actual fuel costs of the MLGUs in the region. The electricity consumed per kilowatt hour was computed from the electricity costs for January 2024 by the respective MLGUs divided by the power rates for low voltage or public buildings for the same period. The power rates were taken from the respective electric cooperatives per province for January 2024. However, the most recent power rates available for Sultan Kudarat was July 2023, so this data was used to compute for the actual consumption in kwh for Sultan Kudarat municipalities. Power rates vary per province with North Cotabato electric cooperative having the most expensive rate at Php10.4454/kwh and PPALMA electric cooperative having the cheapest power rate at Php 7.7914/kwh. The lowest energy consumer per sqm is Lambayong in Sultan Kudarat province at Php115.80/sqm. On average, municipalities in the region spend Php2,239.16/sqm on energy.

On average, MLGUs consume 49,605.44 kWh of electricity in the region with Surallah in South Cotabato province having the lowest consumption. The highest consumers of electricity can be found on the same province with Polomolok consuming 182,827.13 kWh followed by Tupi at 150,076.75 kWh.

In terms of fuel consumption, the MLGUs in the region spend an average of Php1,541,602.23 for January 2024 with Sto Nino in South Cotabato having the lowest spending for fuel for January 2024. Biggest spenders for fuel is in Cotabato province particularly Kabacan at Php19,802,243 followed by Columbio in Sultan Kudarat Province at Php10, 751,950.83. The large spending of some municipalities could be attributed to varying prices of fuel in the provinces and as well as the number of efficient vehicles used which is not anymore covered in the study. Furthermore, electricity consumption of MLGUs in the region is estimated at 603kwh/sqm per year which is beyond the 200 kwh/sqm/year set by the ASEAN Energy Awards for energy efficient

offices. This finding suggests that MLGUs, on average, in the region are not yet energy efficient. This further implies a thorough study on other factors not covered in the study such as specific building designs (wall to window ratio, insulation, building envelop among others) and occupant behavior.

Table 2. Actual electricity and fuel consumption of MLGUs in Region 12.

Municipality	Actual electricity Consumption in kwh January 2024	Actual fuel consumption (in pesos for January 2024)
Bagumbayan	42,208.61	512,920.00
Lambayong	24,991.19	112,344.76
Isulan	74,467.11	5,258,727
Esperanza	53,216.26	2,845,762.64
Palimbang	25,099.23	726,845
Columbio	41,208.23	10,751,950.83
Kalamansig	50,040.95	2,224,378.30
President Quirino	35,688.07	195,897.29
Lebak	40,643.48	175,221.58
Lutayan	27,507.78	510,300
Senator Ninoy Aquino	19,345.35	207,332
Sto Nino	37,441.20	94,367.00
Tantangan	46,258.25	260,451.66
Surallah	15,495.42	651,453.55
Norala	25,129.06	201,190.17
T'Boli	39,670.52	428,693.22
Polom olok	182,827.13	846,211.36
Lake Sebu	20,827.36	361,040.98
Tampakan	55,463.35	276,554
Banga	21,293.16	516,658.77
Tupi	150,076.75	700,403.46
Malapatan	53,363.81	630,174
Alabel	42,690.91	580,671.18
Kiamba	71,222.16	854,126.09
Maasim	77,341.89	547,536.65
Malungon	52,426.77	514,852.03
Glan	65,844.77	1,567,823.16
Maitum	31,240.54	163,801.82
Magpet	33,337.93	1,683,437
Makilala	30,822.44	454,276.08
Tulunan	55,643.46	1,310,919.50
Pigkawayan	79,484.30	258,805.32
Pikit	58,952.72	96,546
Kabacan	55,055.79	19,802,243
Antipas	24,742.87	612,847.53
M'lang	46,743.06	612,952
Arakan	28,017.67	500,000
President Roxas	32,948.74	617,513.53
Aleosan	58,825.98	873,942.33
Midsayap	79,927.87	619,820
Alamada	26,836.58	604,665
Banisilan	22,312.11	1,142,756.80
Carmen	58,576.46	850,567.93
Libungan	47,031.15	358,612.26
Matalam	69,956.38	6,254,507.78

Mean	49,605.44	1,541,602.23
Max	182,827.13	19,802,243.00
Min	15,495.42	94,367.00

Energy Utilization Intensity of MLGUs in Region 12

Figure 1 addresses the objective on energy utilization intensity of Municipal Local Government Units in Region 12. The energy utilization intensity (EUI) is derived from the sum of the electricity costs and fuel cost for the period (January 2024) divided by the building size (in square meters). The formula on energy utilization intensity by Bakar et al. (2014) was adopted.

A map was shown to present the distribution of energy utilization intensity per sqm in Region 12. As the color gets redder or darker, the more energy is utilized or consumed in pesos per square meter. Findings show that relative to other provinces, Saranggani municipalities (at the bottom portion of the map) generally have lower energy consumption per sqm with expectedly the most progressive municipality Alabel being the largest consumer of energy in the said province. Notable municipalities with biggest energy consumption can be observed in municipalities of Kabacan (Php40,112.40/sqm), Matalam (Php9,887/sqm), Tupi (P7,409.07/sqm), Columbio (Php6,678.96/sqm) and Kalamansig (Php5,944.80/sqm) which are found in Cotabato, South Cotabato and Sultan Kudarat provinces, respectively.

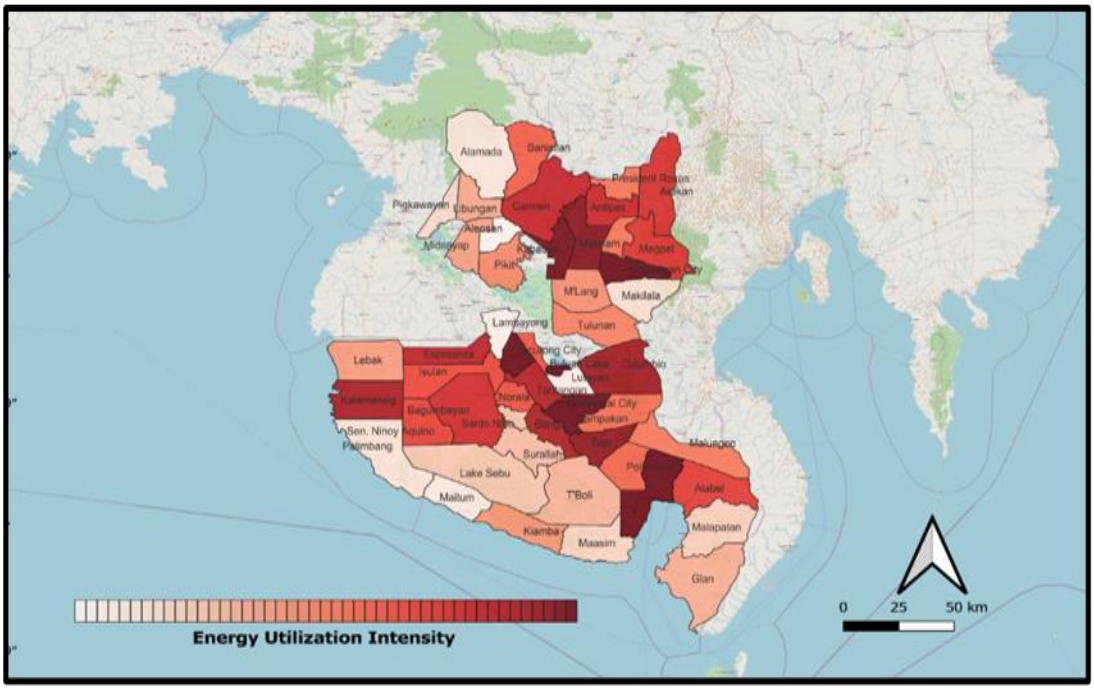

Figure 1. Energy utilization intensity of Municipal Local Government Units in Region 12.

Operating Strategies or Measures of Municipal Local Government to Conserve energy

The operating methods for energy conservation employed by Municipal Local Government Units (MLGUs) in Region 12 of the Philippines are displayed in table 2. When not in use, 100% of MLGUs turn off lights and appliances. This is a simple yet efficient method of energy conservation. According to a Department of Energy (DOE) study, energy usage in buildings can be greatly decreased by taking easy steps like shutting off lights in empty rooms. However, in the study of Zhu et al. (2021), building occupants are not particularly concerned with lighting systems, suggesting that it is possible to save energy by reducing the lighting needs in certain non-essential locations of a building. The study further reveals that the rise in energy consumption can be attributed to the use of additional personal appliances, inefficient air conditioning practices, and inadequate ventilation during summer.

Meanwhile, an effective energy monitoring and targeting system is in place among 68.89% of MLGUs. This means that they can monitor their energy consumption and pinpoint areas for improvement as a result. Energy monitoring systems should be installed in all buildings, according to DOE recommendations. Approximately, 73.33% of MLGUs acquire energy-efficient equipment and technologies for their offices. This is an effective and sustainable approach to decrease energy usage over an extended period of time. The Department of Energy (DOE) in the Philippines has implemented several programs and efforts to encourage the adoption of energy-efficient products.

Majority (62.22%) of Municipal Local Government Units (MLGUs) have transitioned from using desktop computers to utilizing laptops. Laptops generally consume lower amounts of energy compared to desktop PCs. The Environmental Protection Agency (EPA) advises businesses and organizations to substitute desktop computers with laptops or other energy-efficient devices, as this consumes lesser energy. A respectable energy audit and certain energy-saving measures have been put in place by more than half (53.33%) of MLGUs. An extensive evaluation of a building's energy consumption is called an energy audit. It can identify areas of energy waste and provide targeted recommendations for increasing efficiency. MLGUs can receive assistance from the DOE through energy audit programs and resources.

About their building services systems, 53.33% of MLGUs have scheduled routine maintenance schedules. Maintaining these systems on a regular basis can guarantee smooth operation. For building owners looking to maintain the optimal operation of their HVAC systems, the Association of Energy Engineers (AEE) suggests creating preventative maintenance. Moreover, only 28.89% of MLGUs provides an easy-to-read manual or operating instructions for their HVAC systems. In addition, almost half (48.89%) of Municipal Local Government Units (MLGUs) indicate that the entirety of their lighting fixtures are composed of Light Emitting Diodes (LEDs). LEDs are a very energy-efficient kind of lighting, surpassing the energy efficiency of ordinary incandescent bulbs. The Department of Energy (DOE) advises Municipal Local Government Units (MLGUs) to transition to LED lighting to conserve energy.

A myriad number of literatures also pointed out that significant energy savings can be achieved when organizations practiced a combination of energy management measures (operating

strategies). For instance, Digitemie and Ekemezie (2024) emphasized that Building Energy Management Systems (BEMS) optimize energy efficiency and promote sustainability in buildings by monitoring and regulating services such as HVAC and lighting. The essential elements consist of sensors, controllers, and user interfaces, which enhance the functioning of the system and minimise energy usage and expenses. BEMS also enhances occupant comfort and productivity. Although there are significant initial expenses and difficulties in integrating, the progress in IoT and cloud computing is increasing the availability of BEMS. Future trends encompass the incorporation of artificial intelligence (AI) (Merabet et al., 2021; Lee, D., & Lee, S. T. 2023) and machine learning to enhance energy conservation and optimise building efficiency. The implementation of Building Energy Management Systems (BEMS) is crucial to minimize energy use and promote the creation of healthier indoor environments.

Table 2. Operating strategies in conserving energy by Municipal Local Government Units in Region 12

Practices	Freq (N=45)	%
Turn off lights and appliances when not in used.	45	100
Have an effective energy monitoring and targeting system for the purpose of energy saving	31	68.89
Have carried out a decent energy audit of the building or premises and implemented some energy conservation measures for the purpose of energy saving	24	53.33
Have planned regular maintenance program, easy-to-follow inspection manual in maintaining good efficiency of the building services system.	24	53.33
Have easy-to-follow manual detailing the operation methods, instructions, and standard control settings for HVAC services equipment	13	28.89
Procure energy-efficient products and energy-saving technologies for the office.	33	73.33
All lights are LEDs and energy efficient.	22	48.89
Switch from desktop computers to laptops, as laptops use less energy	28	62.22

Factors Affecting the Energy Utilization Intensity of MLGUs in Region 12

The study tested the effect of MLGU characteristics and their operating strategies in managing or conserving energy against energy utilization intensity of MLGUs in the region. Prior diagnostic tests were done to ensure the reliability and validity of the model used in the study and check if the assumptions for Ordinary Least Squares (OLS) are met. A test for multicollinearity was done first using the Variance Inflation Factor (VIF). The VIF values of the independent variables in the study ranges from 1.82 to 6.23 with average temperature showing the largest VIF indicating high correlation with some predictor variables, however, the mean VIF is only 2.79 implying that most of the predictors used in the study do not pose significant multicollinearity

issues. A hettest was also analyze to check for heteroskedasticity. Heteroskedasticity measures if the errors have constant variances. The resulting Breusch-Pagan / Cook-Weisberg test for heteroskedasticity is significant suggesting the presence of heteroskedasticity in the residuals of the regression model. If this is not corrected, it will lead to unreliable hypothesis tests. To address this issue, a robust standard errors is applied to the regression model in the study leading to the use of robust multiple regression analysis.

Findings show in table 3, that only the variable OS2 significantly affects the energy utilization intensity of MLGUs in Region 12 at 10%. This implies that when MLGUs have an effective energy monitoring and targeting system for the purpose of energy saving, energy utilization intensity will decrease by 42,905.4 pesos per square meter. Hercegová et al. (2021) supported this finding and stressed that energy monitoring and targeting systems help companies spot inefficiencies and places where energy may be saved which has impact on energy use. Organizations can efficiently minimize energy wastage by focusing on specific areas for improvement, such as scheduling equipment usage optimally or fixing equipment faults. As a result, activities become more efficient and sustainable as the intensity of energy use decreases. However, this energy management measure has an opposite result to the implementation of an ISO 14001 as an energy management measure. The study of Jeong and Lee (2022) indicates that implementing ISO 14001, a prominent Environmental Management System (EMS) standard, leads to a decrease in energy efficiency of 6%–12% compared to not using it, despite significantly lowering pollutants. Nevertheless, this compromise can be mitigated by implementing superior quality management capabilities, indicating that organizations can achieve a harmonious equilibrium between environmental performance and energy efficiency by enhancing their quality management procedures.

Although only one factor is found to statistically influence energy utilization intensity in the study, the resulting R-squared value of 0.6288 suggests that the predictors used in the model can explain 62.88% of the variations in energy utilization intensity of MLGUs in the region at a 1% level. Hence, the study is 99% confident that the factors can explain the degree of energy consumption among the studied offices. Factors that are not significant, on the other hand, failed to explain significantly the variations of the energy utilization of the government offices in the study.

Table 3. Factors Affecting Energy Utilization Intensity among MLGUs in Region 12.

Energy Utilization Intensity	Coefficient	Standard Error	T	P>|t|	[95% Conf.	Interval]
OS2	-42905.4*	21521.73	-1.99	0.06	-87798.95	1988.145
OS3	-4945.86	12133.14	-0.41	0.688	-30255.14	20363.42
OS4	16711.52	13023.17	1.28	0.214	-10454.34	43877.38
OS5	14030.92	16007.95	0.88	0.391	-19361.08	47422.92
OS6	-17262.68	11666.34	-1.48	0.155	-41598.23	7072.877
OS7	-17857.95	13089.9	-1.36	0.188	-45163	9447.096
OS8	12867.72	15580.39	0.83	0.419	-19632.41	45367.85
Average Temp (in deg Cel)	6465.635	6652.685	0.97	0.343	-7411.622	20342.89
Average rain (in cm)	24066.56	35429.47	0.68	0.505	-49838.02	97971.14
No. Split type aircon	252.1945	625.3404	0.4	0.691	-1052.243	1556.632
No. Door type aircon	695.2938	478.8024	1.45	0.162	-303.4705	1694.058
No. window type aircon	-483.9787	300.4674	-1.61	0.123	-1110.743	142.7852
No of elect fans	96.7825	316.8112	0.31	0.763	-564.074	757.639
No of computers	-1.187937	50.80793	-0.02	0.982	-107.1714	104.7955
BURS	1415.436	1075.408	1.32	0.203	-827.8248	3658.697
FOI	22931.29	17986.24	1.27	0.217	-14587.36	60449.93
HVAC Efficiency	-47298.79	29781.1	-1.59	0.128	-109421.1	14823.5
Clients served	-7.18791	5.803104	-1.24	0.23	-19.29297	4.917152
Total No of employees	-10.30719	46.36894	-0.22	0.826	-107.0311	86.41671
National Tax Allocation	62.15421	65.95527	0.94	0.357	-75.42608	199.7345
Building Age	326.3812	318.1854	1.03	0.317	-337.342	990.1044
Building Size	-0.8291094	6.653659	-0.12	0.902	-14.7084	13.05018
No of Floors	14603.54	11556.33	1.26	0.221	-9502.53	38709.62
Elevation (in masl)	-15.63753	40.53787	-0.39	0.704	-100.198	68.92298
constant	-107470.4	279895.2	-0.38	0.705	-691321.7	476380.8
Prob > F = .0051						
R-squared=0.6288						
Root MSE = 28210						

IV. Conclusion

The study emphasizes the possibility of achieving substantial reductions in energy consumption in municipal local government units (MLGUs) in Region 12 by using an energy management systems (operating strategy). A highly effective energy monitoring and targeting system is found to be a significant factor and is crucial for discovering inefficiencies and optimizing equipment utilization, hence reducing energy consumption and decreasing expenses. This study highlights the need of implementing extensive energy-conservation strategies and technologies, such as routine maintenance of HVAC systems and the utilization of energy-efficient equipment, to improve energy efficiency in government offices. The results illustrate that by

prioritizing certain areas for enhancement, MLGUs can possibly attain significant energy conservation and foster more sustainable and streamlined operations.

To further develop upon these findings, it is advised that MLGUs in Region 12 improve their energy monitoring systems to consistently monitor energy consumption and detect any areas of inefficiency. Scheduling regular maintenance for HVAC systems is recommended to optimize efficiency, while investing in energy-efficient lighting, appliances, and equipment is encouraged to reduce long-term energy use. In addition, conducting training sessions to raise staff understanding about energy conservation methods helps promote the adoption of more sustainable behavior. Adhering to energy efficiency laws and investigating renewable energy sources, such as solar power, will bolster sustainability initiatives. It is advisable to participate in collaboration and benchmarking with other MLGUs (Municipal Local Government Units) in order to exchange best practices and consistently enhance energy management methods. MLGUs can attain substantial cost savings, improve energy efficiency, and contribute to wider sustainable development objectives by using these measures.

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