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RESEARCH ARTICLE

THERMAL COMFORT AND ENERGY RESILIENCE OF URBAN HOUSEHOLDS FACING CLIMATE CHANGE: A CASE STUDY IN DAKAR

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Abstract

In the context of accelerated climate warming and rapid urbanization, the thermal comfort of urban households is a major issue for energy sustainability and quality of life. This article analyzes the perceptions and thermal adaptation strategies of households in Dakar, an emblematic city of sub-Saharan Africa. Based on a quantitative survey conducted among 354 residents across the five departments of Dakar, we examine energy practices, housing conditions, and motivations related to energy consumption.The results reveal that while 66.1% of households report being generally comfortable, nearly 29% experience recurrent thermal discomfort. The preferred strategies are opening windows (95.8%) and using fans (91%), while air conditioning remains marginal (18%). The reduction in energy consumption is primarily motivated by economic reasons (61.9%), although environmental concerns are growing (48.3%). The structural limitations of housing, particularly insufficient thermal insulation, exacerbate household vulnerability. The discussion places these results in an international comparative perspective, highlighting the specificities of Dakar compared to other African and Asian cities. The study underscores the need to align public policies, technical innovations, and community practices to promote sustainable and equitable thermal comfort.

Introduction:-

Climate change intensifies heat waves in urban areas, increasing the vulnerability of populations and the pressure on energy systems. The building sector, accounting for over 40% of energy consumption in Senegal (Figure 1) [1], is particularly affected. The capital, Dakar, illustrates these dynamics, with accelerated urban density and population growth.

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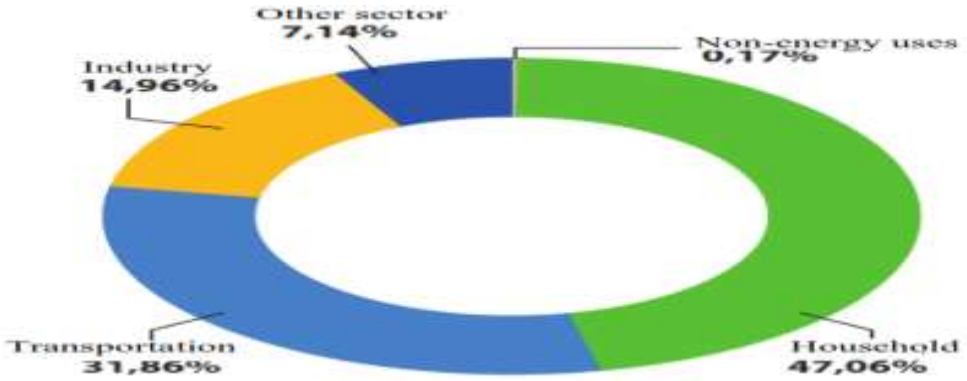

Figure 1 : Consumption by sector in 2018 [1].

Residential energy demand, driven by thermal comfort needs, is expected to more than double between 2013 and 2030 (Figure 2) [2]. This trend, coupled with the high dependence of the tertiary sector on air conditioning (Table 1), underscores the urgency of developing strategies that reconcile energy efficiency, thermal comfort, and sustainability [3].

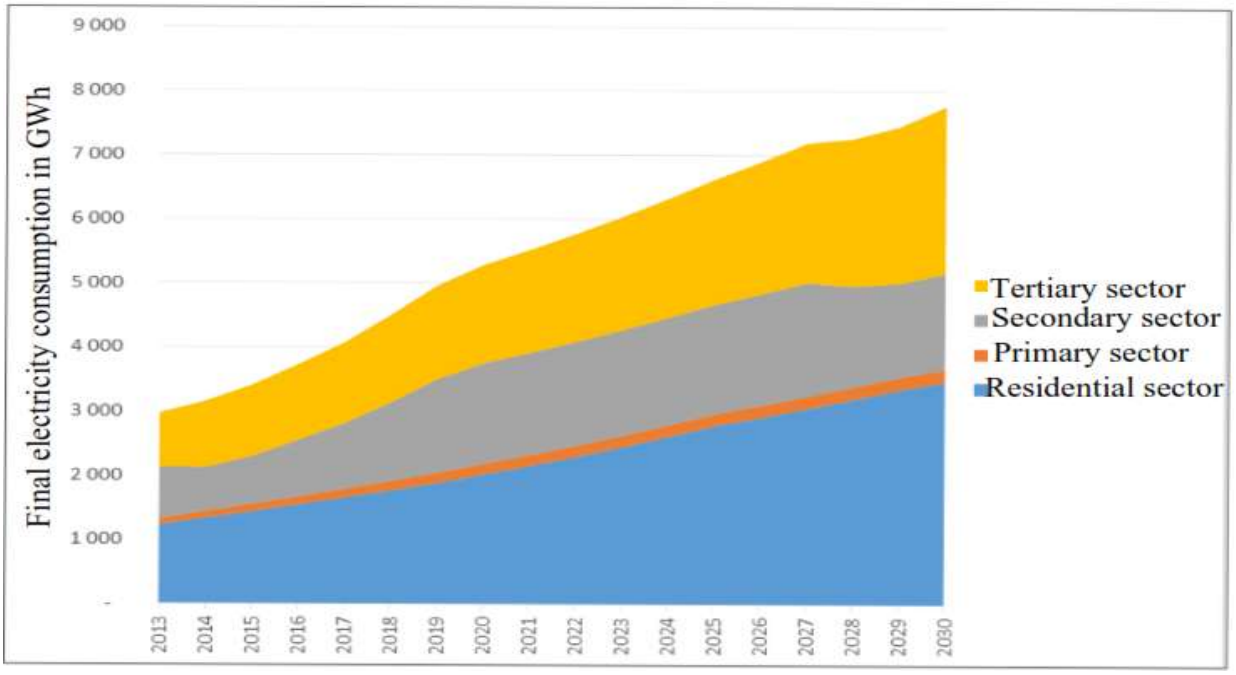

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Figure 2 : Projection of electricity consumption by sector [2].

Table 1: Share of air conditioning consumption in the public sector by building function [4].

Type of building	Share of electricity consumption from air conditioning in the energy balance (%)
Administrative buildings	18 % - 60 %
Schools, colleges, and high schools	1 % - 30 %
Health centers	10 % - 55 %
Training centers	3 % - 5 %
Universities (administrations and lecture halls)	15 % - 44 %
Student residences (U residences and university restaurants)	1 % - 13 %
Leisure centers and theaters	1 % - 5 %

Moreover, there is a strong correlation between electricity consumption and outdoor temperature (Figure 3) [5], exacerbating household vulnerability. This research aims to fill the gap in local empirical studies on the perceptions and thermal adaptation strategies of urban households in Dakar.Likewise, the energy sector in Senegal is under significant pressure, both in the building and transportation sectors, which also represent a substantial share of demand [6].

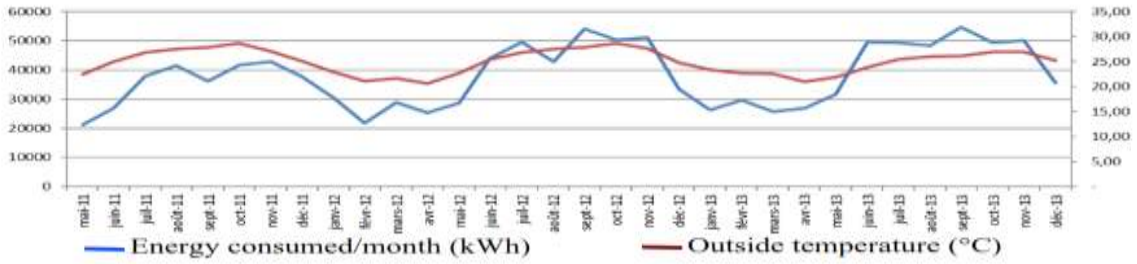

Figure 3 : Correlation between electricity consumption and outdoor temperature [5]

Theoretical Framework:-

Thermal comfort is defined as the state of satisfaction of an individual regarding their thermal environment [7]. It depends on both objective factors (temperature, humidity, ventilation, materials) and subjective factors (perceptions, habits, social practices). In industrialized countries, technological solutions dominate (insulation, air conditioning), whereas in sub-Saharan Africa, practices remain predominantly passive and behavioral. This makes households particularly vulnerable to prolonged heatwaves.

Methodology:-

The study is based on a quantitative survey conducted from March to May 2024 among 354 residents of the five departments of Dakar (Dakar, Pikine, Rufisque, Guédiawaye, Keur Massar). Stratified sampling took into account income, density, and type of housing. A structured questionnaire collected data on ventilation practices, household appliances, electricity bills, and perceptions of thermal comfort. The data were analyzed using SPSS, employing descriptive and multivariate methods (correlations, regressions).

Results:-

The main results are presented below:

Respondent Profile:

The majority of participants are young adults (16-30 years: 75.1%). Young households show a strong tendency towards cohabitation. Presence at home varies between weekdays and weekends (Figure 4).

- **Perception of Thermal Comfort:**

66.1% of residents report feeling comfortable, while 28.8% report discomfort. The kitchen is perceived as the hottest room, while the living room is seen as the most temperate (Figure 5).

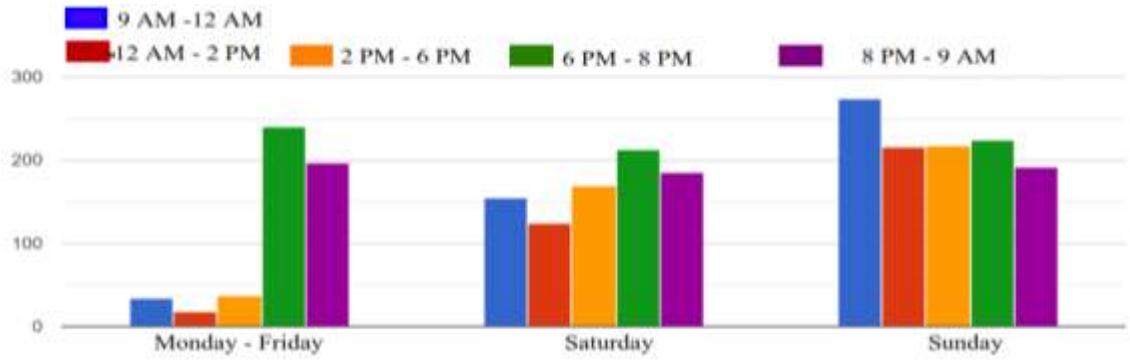

Figure 4: Presence in Households by Hour and Day of the Week
(Source: Survey Data)

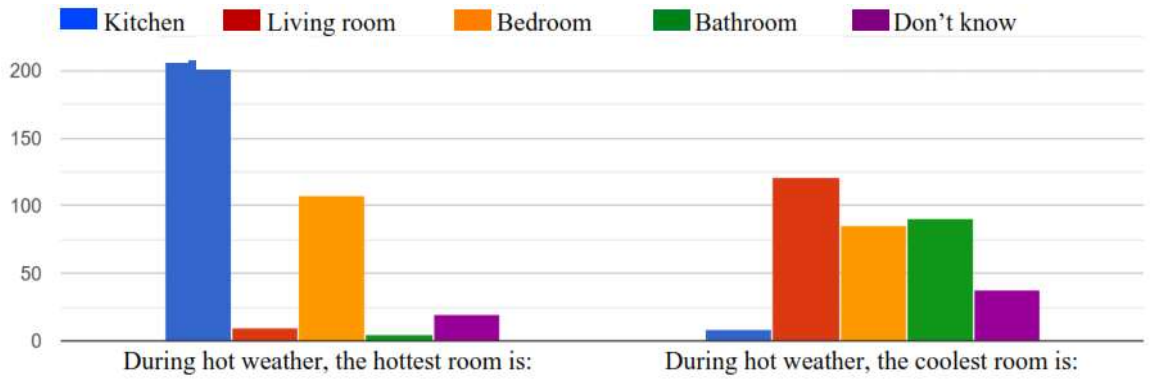

Figure 5 : Experience on Room Temperatures During Heat Periods
(Source: Survey Data)

Adaptation Strategies:
Households prioritize opening windows (95.8%, Figure 6) and using fans (91%). Air conditioning remains marginal (18%). Adaptation practices also include solar protections (65.3%, Figure 7) and clothing choices (63%, Figure 8).

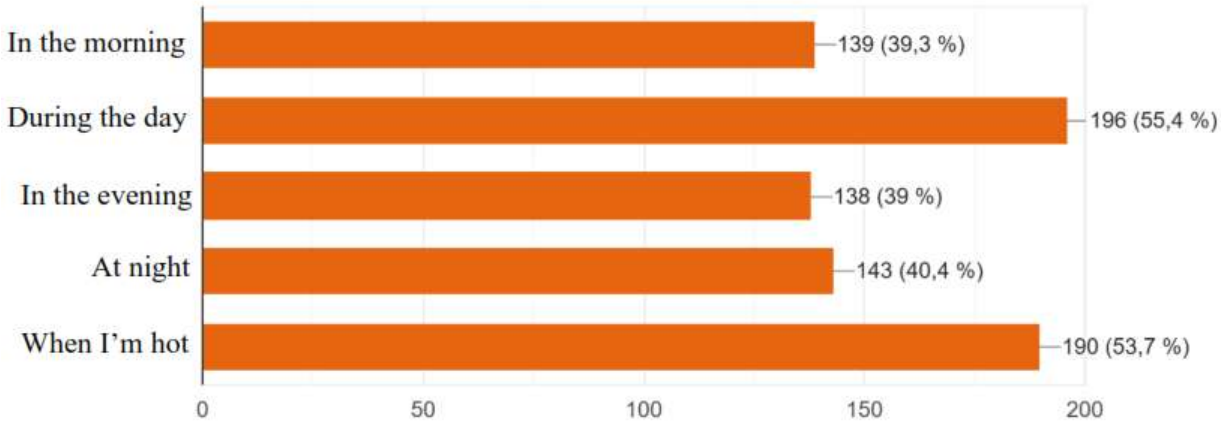

Figure 6 : Times of the Day When Windows Are Opened to Cool Down
(Source: Survey Data)

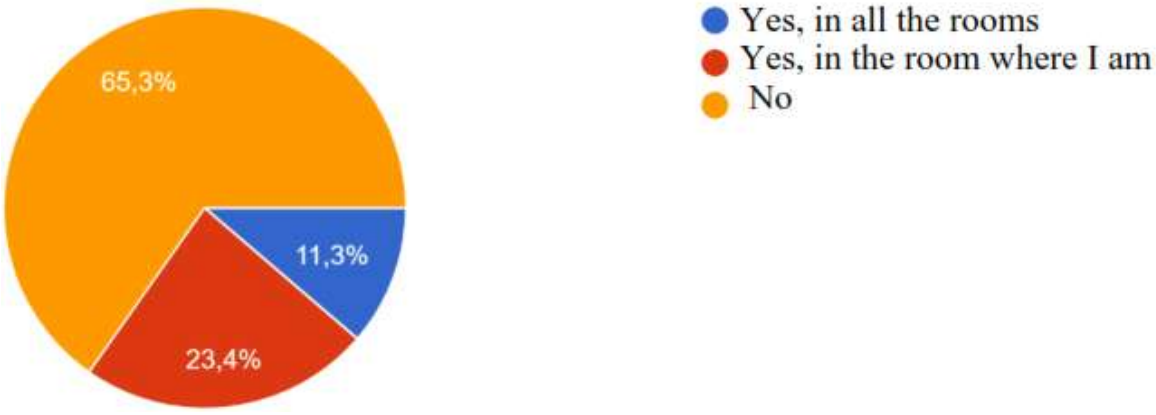

Figure 7 : Use of Solar Protections to Shield Against Heat
(Source: Survey Data)

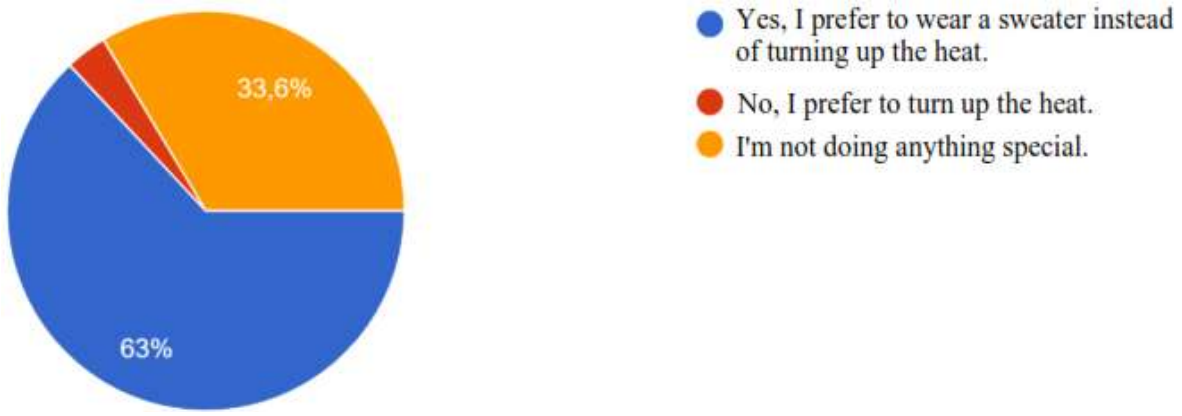

Figure 8 : Clothing Adaptation According to the Season Inside the Home (Source: Survey Data)

Economic and Environmental Considerations:

The reduction of energy consumption is primarily driven by economic reasons (61.9%, Figure 8), while environmental concerns are also increasing (48.3%).

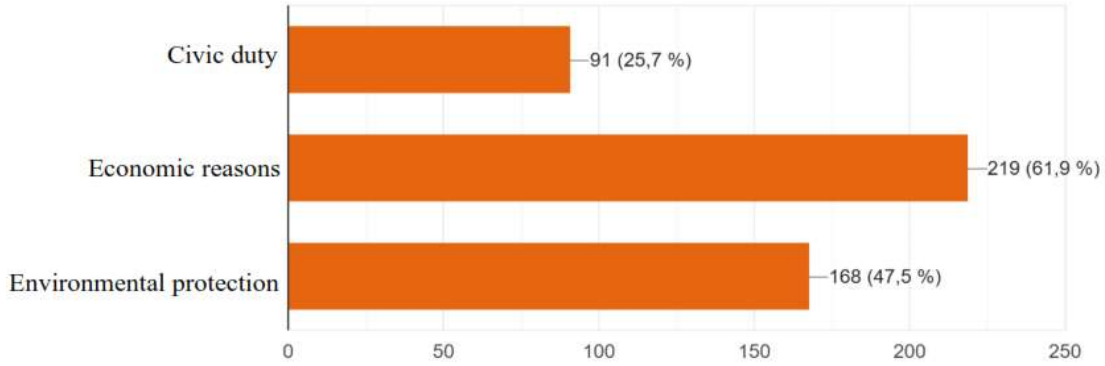

Figure 8 : Motivations for Reducing Energy Consumption (Source: Survey Data)

Discussion:-

The results confirm the predominance of natural and low-cost strategies, in line with Econoler (2019) [4], which highlights the low penetration of air conditioning in Senegal. However, this reliance on natural ventilation underscores the vulnerability of low-income households, whose homes suffer from insufficient insulation [8][9]. In comparison, studies conducted in South Africa and India show a more pronounced adoption of mechanical solutions when income is higher and public policies support energy efficiency [10][11].Economic sensitivity clearly dominates energy behaviors in Dakar, but there is a growing openness to environmental concerns. This reflects a similar dynamic observed in Accra and Nairobi, where households associate climate adaptation with rationalizing energy expenditures. Finally, the lack of ambitious public policies to support appropriate building standards, energy efficiency, and green infrastructure increases the vulnerability of urban households [12][13]

Conclusion and Perspectives:-

This study highlights the diversity of thermal adaptation strategies among households in Dakar, revealing significant social and economic inequalities. It emphasizes the need to integrate public policies, technical innovations, and community practices within a vision of urban sustainability.

To maximize urban energy resilience, we recommend:

- Establishing minimum standards for insulation and natural ventilation;
- Providing financial incentives for the use of insulating materials and energy-efficient equipment;
- Promoting eco-friendly neighborhoods that incorporate energy efficiency from the design stage;
- Conducting widespread awareness campaigns on sustainable energy practices.

Future research perspectives include thermal modeling of housing, prospective analysis of consumption profiles based on climate scenarios, and experimenting with innovative low-cost solutions for vulnerable households.

Références:-

1. SIE Sénégal, rapport bilans énergétiques des années 2017 et 2018, 2019.
2. AEME (2015). Stratégie de Maîtrise de l'Energie du Sénégal (SMES).
3. PED (juin 2021). Bâtiment et énergie : Analyse du secteur du bâtiment au Sénégal.
4. ECONOLER (2019). Opportunités d'efficacité énergétique dans le secteur public du Sénégal.
5. EMASOL (2015). Pré-diagnostic de 10 bâtiments publics. PERACOD/GIZ, AEME et BMN.
6. Tchanche, B. (2017). Energy consumption analysis of the transportation sector of Senegal. AIMS Energy, 5(6), 912-929.
7. de Dear, R. J., & Brager, G. S. (2013). Field studies on human thermal comfort — An overview. Renewable & Sustainable Energy Reviews, 26, 16-30.
8. ANSD (2013). Recensement Général de la Population et de l'Habitat, de l'Agriculture et de l'Élevage (RGPHAE).
9. Diouf, G., Diallo, O., Bal, H. M., Touré, P. M., & Gaye, S. (2020). Improving the Thermal Comfort of a Building by Adding a Layer of Straw. Journal of Building Construction and Planning Research, 8(3), 193-202.
10. Tchanche, B. (2021). Energy Supply and Consumption in Senegal. In Sustaining Tomorrow via Innovative Engineering. World Scientific.
11. International Energy Agency (IEA). (2023). Senegal 2023 – Energy Policy Review.
12. Niang, S. A. A., et al. (2023). A Tale of Sustainable Energy Transition Under New Fossil Discoveries: The Case of Senegal. Sustainability, 16(23), 10633.
13. Wai, C. Y., Tariq, M. A. U. R., & Muttil, N. (2022). A Systematic Review on Urban Green Infrastructure for Thermal Comfort. Water, 14(16), 2496.