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Ergonomics of domestic building structure on occupants' health

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Abstract

This research looks into the connection between building design and the health of its occupants. There is probable effect of noble or lowly building edifice on the comfort, aesthetic, psychology and euphoria of occupants in terms of topography, dimension, colour and temperature of the building. A careful inspection, application and adherence of various factors on ergonomics of domestic buildings will have a positive ripple effect on occupants' health and elongated lifespan. Building stakeholders are to enforce compliance to standards and ensure strict monitoring of domestic building through establishing of policies to as to achieve a comfortable and a healthier end user.

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Keywords: building; comfort; health; policies; temperature

1. Introduction

Ergonomics is a design practice that takes human comfort into massive cognizance. Every designer intuitively factors ergonomics; however, they need the principle to get it achieved. Ergonomics and sustainable development are closely needed in every dimension of human endeavours. Ergonomics focuses on meeting present needs while sustainable development focuses on meeting both needs and preventing its damage to future generation (Radjiyev et al., 2015). Researchers pointed attention on the problem of selective ergonomics such as the neglect of construction workers who make the egronomy of building works (Sass and Smallwood,2015). The construction workers span well above 350 million people who are mainly manual labourers (Eaves et al., 2016) and are faced with health, financial and safety challenges (Biswas et al., 2016; Golabchi, 2018). Other challenge they face are unsafe act,

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unsafe working conditions, insufficient tools, poor safety know-how and poor work plan (RatriParida and RadipKumarRay, 2015; Okoye et al., 2016). The aim of this article is to advocate for adherence to standards in design of domestic building in harmony with the utmost health of occupants.

1.1. Building design standard

Building design is a key indicator of the mental, social and psychological wellbeing of a person and a nation. In its design, building experts consider building energy reduction in its plan (Ruparathna et al.,2016; Boeck et al., 2015; Roh et al., 2016). This approach can be incorporated from scratch or retrofitting an existing building (Trencher et al., 2016; Wu et al., 2016; Penna et al., 2015). Technological goal tends towards zero building energy consumption (Chastas et al., 2017; Cui et al., 2017) and reduction in emission in building sectors (Dirisu et al., 2017; Dirisu et al., 2018). To further actualize energy reduction, it is important to appraise the material make up of building materials before commencing the project through the process of life cycle assessment (Rashid and Yusoff, 2015; Dirisu et al., 2018; Oyekunle et al., 2018). Additional effort to accomplish this objective was presented by Iturriaga et al., (2018) through applying a programming model to track and curtail energy consumption at design decision making stage. Other expert included emergency exit in the design of buildings (Olander et al., 2017).

1.2. Building Design Overview in Nigeria

Developing countries are faced with the problem of implementing policies that are especially meant for the well-being of the masses due to human factor constraints (Akinlabi, 2016) and shortage of advanced instrument to achieve it. The problem this poses to end users is the use of substandard method and materials in building structures. kitchen is spotted as the often visited structure by female folks, as such its design should be comforting and should give inspiration when cooking. The head room is specified as not less than 2.2m from the ceiling. Other dimensions such as the area and width were not specified since it isn't considered as a habitable area (Nigerian Building Code, 2006). There should be serious consideration for kitchen dimension especially for female folks due to their constant visit to this section of the home in the update of the Nigerian building code. There were proposed tools designed to enable Nigerian Building code more feasible by Amasuomo et al. (2017). Akanni et al., (2015) proposed that the environmental factors have to be investigated when embarking on building projects such as undue interruption of the projects by miscreants which can in turn impair the technical dedication to the optimal efficiency of delivery of the building job. A look into the internal enclosure of the building, the available oxygen level will influence the health and performance of the occupants, especially at classrooms (Ogbonda and Ji, 2017). The question of using pet bottles as wall structure in replacement of brick will be the comparison of oxygen availability since the former have insignificant pore size compared to the latter. Research work on the utilization of pet bottles for building structure are ongoing (Mokhtar et al., 2015).

There are recommendations for reduction in energy consumption of buildings by authors for Nigeria (Geissler et al., 2018; Kawuwa 2015; Akadiri 2015) which will include proper material selection, orientation of the building with respect to solar energy and employing energy saving measures in the design plan (Mohammed and Abbakyari, 2016).

2. History and health effect of poor domestic building construction

Domestic building construction cannot take place without the consideration of various factors that might have harmful effect on the occupant's wellbeing (Macintyre, S., et al, 2002). Meanwhile, some owners due to profit, do not consider this fact. A case study is a residential building in Ota, Ogun State Lagos where the kitchen dimension is 1.11m x 1.55m as against 1.2m x 2.75m. This generates smoke and heat while cooking, reduces comfort in the entire building, minimized degree of freedom of the body, as well as promote health issues like fatigue, lethargy and irritability due to drop in oxygen level. Some adverse effect can also include asthma, autism and even cancer in children (Zhang, J., & Smith, K. R. ,2003)., see Fig. 1.

Fig. 1. Residential building in Ota

3. Ergonomics and Sustainability

The term sustainability has been well addressed by various authors and can be summarized as design that meet both present and future needs without distressing the ecosystem and the environment (Roger and Patrick, 2013). Moray (1995) and Moray (2000) projected in the mid 90s that there will be increased pollution with population explosion and declining social amenities, therefore the term global ergonomics which is referred to as sustainable development should be addressed rather than location specifics. Global ergonomics addresses global problems which in return solves local concern. It is a concerted effort made by various researchers and stakeholders in resolving human and ecosystem issues (Thatcher *et al*., 2018; Street, 2018; Munguía, 2018 and Naeini 2019). In 2008, the International Ergonomics Association (IEA) authorized the formation of a Human Factors and Sustainable Development Technical Committee, envisioned to advance a global link of specialists in the fields of ergonomics and human factors and sustainability (Haslam and Waterson, 2013). The call for a sustainable future has become the caption of most international conference proceedings which is greatly commendable.

4. Recommendation

Local Government in Nigeria should be actively involved in enforcing building structure to standard since this arm of Government seem to be close to the populace. The enforcement will be more viable when policies are established and certified professionals are integrated into their Department. This principle is practiced in Israel (Goulden et al., 2015).

A critical review of the dimension of kitchen in the Nigerian building code is paramount to the health of female folks who often spend more duration here in getting things done for the home.

Conclusion

An updated standard material, the Nigerian Building Code, is necessary for the welfare of end user in buildings. Empowerment of regulatory bodies and firm penalties for defaulters of standard design procedures will curtail health issues in buildings. It is necessary to canvass for a sustainable ergonomics and compliance by designers and manufacturers should be entrenched so that end users are fulfilled health wise. This can be achieved by its awareness communications through international conferences, standard organizations and seminars.

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Reference

[1] Akanni, P. O., Oke, A. E., & Akpomiemie, O. A. (2015). Impact of environmental factors on building project performance in Delta State, Nigeria. HBRC Journal, 11(1), 91-97.
[2] Akinlabi, O. M. (2017). Do the police really protect and serve the public? Police deviance and public cynicism towards the law in Nigeria. Criminology & Criminal Justice, 17(2), 158-174.
[3] Akinsola, S. I., Issa, I. O., Adegoke, M. A., Ojo, V. O., & Alabi, A. B. (2016). Characterization of Low Carbon Steel Bar Used For Reinforcing Animal House Building. FUTY Journal of the Environment, 10(1), 11-19.
[4] Alaidroos, A., & Krarti, M. (2015). Optimal design of residential building envelope systems in the Kingdom of Saudi Arabia. Energy and Buildings, 86, 104-117.
[5] Amasuomo, T. T., Atanda, J., & Baird, G. (2017). Development of a building performance assessment and design tool for residential buildings in Nigeria. Procedia engineering, 180, 221-230.
[6] Biswas, G., Bhattacharya, A., & Bhattacharya, R. (2017). Occupational health status of construction workers: A review. International Journal of Medical Science and Public Health, 6(4), 669-675.
[7] Brunoro, C. M., Bolis, I., & Sznelwar, L. I. (2018). Building Sustainable Organisations: Contributions of Activity-Centred Ergonomics and the Psychodynamics of Work. In Ergonomics and Human Factors for a Sustainable Future (pp. 191-210). Palgrave Macmillan, Singapore.
[8] Chastas, P., Theodosiou, T., Kontoleon, K. J., & Bikas, D. (2017). The effect of embodied impact on the cost-optimal levels of Nearly Zero energy buildings: A case study of a residential building in Thessaloniki, Greece. Energies, 10(6), 740.
[9] Colclough, S., Mernagh, J., Sinnott, D., Hewitt, N. J., & Griffiths, P. (2019). The Cost of Building to the nearly-Zero Energy Building Standard: A Financial Case Study. In Sustainable Building for a Cleaner Environment (pp. 71-78). Springer, Cham.
[10] Cui, Y., Yan, D., Hong, T., & Ma, J. (2017). Temporal and spatial characteristics of the urban heat island in Beijing and the impact on building design and energy performance. Energy, 130, 286-297.
[11] Dale, A. M., Jaegers, L., Welch, L., Gardner, B. T., Buchholz, B., Weaver, N., & Evanoff, B. A. (2016). Evaluation of a participatory ergonomics intervention in small commercial construction firms. American journal of industrial medicine, 59(6), 465-475.
[12] Dirisu, J. O., Asere, A. A., Oyekunle, J. A., Ajayi, O. O., Afolalu, S. A., Joseph, O. O., & Abioye, A. A. (2017). Comparison of the elemental structure and emission characteristics of selected PVC and non PVC ceiling materials available in Nigerian markets. *International Journal of Applied Engineering Research*, *12*(23), 14755-14758.
[13] Dirisu, J. O., Oyedepo, S. O., Fayomi, O. S. I., Okokpujie, I. P., Asere, A. A., Oyekunle, J. A., & Abioye, A. A. (2018). Effects of Emission Characteristics on Elemental Composition of Selected PVC Ceiling Materials. *Materials Focus*, *7*(4), 566-572.
[14] Eaves, S., Gyi, D. E., & Gibb, A. G. (2016). Building healthy construction workers: Their views on health, wellbeing and better workplace design. Applied ergonomics, 54, 10-18.
[15] Goulden, S., Erell, E., Garb, Y., & Pearlmutter, D. (2017). Green building standards as socio-technical actors in municipal environmental policy. Building Research & Information, 45(4), 414-425.
[16] Haslam, R. and Waterson, P., (2013) . Editorial: Ergonomics and sustainability. Ergonomics, 56 (3), pp. 343-347.
[17] Iturriaga, E., Aldasoro, U., Terés-Zubiaga, J., & Campos-Celador, A. (2018). Optimal renovation of buildings towards the nearly Zero Energy Building standard. Energy, 160, 1101-1114.
[18] Lützkendorf, T., Foliente, G., Balouktsi, M., & Wiberg, A. H. (2015). Net-zero buildings: incorporating embodied impacts. Building Research & Information, 43(1), 62-81.
[19] Macintyre, S., Ellaway, A., & Cummins, S. (2002). Place effects on health: how can we conceptualise, operationalise and measure them?. Social science & medicine, 55(1), 125-139.
[20] Mokhtar, M., Sahat, S., Hamid, B., Kaamin, M., Kesot, M. J., Law, C. W., ... & Sim, V. J. L. (2015). Application of plastic bottle as a wall structure for green house.
[21] Moray, N. 1995. “Ergonomics and the Global Problems of the Twenty-first Century.” Ergonomics 38: 1691– 1707.
[22] Moray, N. 2000. “Culture, Politics and Ergonomics.” Ergonomics 43: 858– 868.
[23] Munguía Vega, N. E., Flores Borboa, V. S., Zepeda Quintana, D. S., & Velazquez Contreras, L. E. (2018). Assessing the effectiveness of integrating ergonomics and sustainability: a case study of a Mexican maquiladora. *International Journal of Occupational Safety and Ergonomics*, 1-10.
[24] Naeini H.S. (2019) Towards Quality of Life Through the “ErgoSustaiNomics” Approach. In: Bagnara S., Tartaglia R., Albolino S., Alexander T., Fujita Y. (eds) Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018). IEA 2018. Advances in Intelligent Systems and Computing, vol 825. Springer, Cham

[25] Ogbonda, U. J., & Ji, Y. (2017). A critique of the ventilation system used for public schools around gas flaring sites in the Nigeria Niger Delta area. Healthy Buildings 2017 Europe.
[26] Ojoko, E. O., Abubakar, H. O., Ojoko, O., & Ikpe, E. O. (2016). Sustainable Housing Development In Nigeria: Prospects And Challenges. Journal of Multidisciplinary Engineering Science and Technology, 3, 4851-4860.
[27] Okoye, P. U., Ezeokonkwo, J. U., & Ezeokoli, F. O. (2016). Building construction workers' health and safety knowledge and compliance on site. Journal of Safety Engineering, 5(1), 17-26.
[28] Olatunji, S. O., Olawumi, T. O., & Odeyinka, H. A. (2016). Nigeria's public procurement law–Puissant issues and projected amendments. Public Policy and Administration Research, 6(6), 73-85.
[29] Oyekunle, J. A. O., Dirisu, J. O., Okokpujie, I. P., & Asere, A. A. (2018). Determination of Heat Transfer Properties of Various PVC and Non-PVC Ceiling Materials Available in Nigerian Markets. *International Journal of Mechanical Engineering and Technology (IJMET)*, *9*(8), 963-973
[30] Park, H. S., Ji, C., & Hong, T. (2016). Methodology for assessing human health impacts due to pollutants emitted from building materials. Building and Environment, 95, 133-144.
[31] Radjiyev, A., Qiu, H., Xiong, S., & Nam, K. (2015). Ergonomics and sustainable development in the past two decades (1992–2011): Research trends and how ergonomics can contribute to sustainable development. Applied ergonomics, 46, 67-75.
[32] Rashid, A. F. A., & Yusoff, S. (2015). A review of life cycle assessment method for building industry. Renewable and Sustainable Energy Reviews, 45, 244-248.
[33] Reiss, J. (2014). Energy retrofitting of school buildings to achieve plus energy and 3-litre building standards. Energy Procedia, 48, 1503-1511.
[34] Roger H. & Patrick W. (2013) Ergonomics and Sustainability, Ergonomics, 56:3, 343-347, DOI: 10.1080/00140139.2013.786555
[35] Sass, C., & Smallwood, J. (2015, August). The role of ergonomics in green building. In Proceedings of the 19th Triennial Congress of the IEA, Melbourne (pp. 9-14).
[36] Sass, C., & Smallwood, J. (2016). Green building and construction worker Ergonomics: a pilot investigation. Ergonomics SA: Journal of the Ergonomics Society of South Africa, 28(2), 28-48.
[37] Street, B. P. (2018, June). Ergonomics as the Common Denominator and Vital Condition to Achieve Sustainability of Buildings of Different Types on Example of Two Built Projects. In *Advances in Human Factors, Sustainable Urban Planning and Infrastructure: Proceedings of the AHFE 2018 International Conference on Human Factors, Sustainable Urban Planning and Infrastructure, July 21-25, 2018, Loews Sapphire Falls Resort at Universal Studios, Orlando, Florida, USA* (Vol. 788, p. 387). Springer.
[38] Thatcher, A., Waterson, P., Todd, A., & Yeow, P. H. (2018, August). The Way Forward for Human Factors/Ergonomics and Sustainability. In *Congress of the International Ergonomics Association* (pp. 616-625). Springer, Cham.
[39] Trencher, G., Broto, V. C., Takagi, T., Sprigings, Z., Nishida, Y., & Yarime, M. (2016). Innovative policy practices to advance building energy efficiency and retrofitting: Approaches, impacts and challenges in ten C40 cities. Environmental Science & Policy, 66, 353-365.
[40] Ugochukwu, S., Akabogu, S., & Okolie, K. (2015). Status and perceptions of the application of building information modeling for improved building projects delivery in Nigeria. American Journal of Engineering Research (AJER), 4(11), 176-182.
[41] Ukah, A. (2016). Building God's City: the political economy of prayer camps in Nigeria. International Journal of Urban and Regional Research, 40(3), 524-540.
[42] Zhang, J., & Smith, K. R. (2003). Indoor air pollution: a global health concern. British medical bulletin, 68(1), 209-225.