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A REVIEW: HARNESSING THE POSITIVE IMPACT OF GREEN BUILDING MATERIALS ON INDOOR TEMPERATURE

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ABSTRACT

Implementing environmentally friendly construction materials has emerged as a potential strategy to regulate indoor temperature sustainably. This is in response to the growing concerns on the comfort of interior spaces and the effects of climate change. Sustainable building methods and green building materials capacity to regulate interior temperature are becoming more widely recognized, but their effectiveness and practicality are still unclear. Many studies have explored the thermal characteristics of individual green building materials, but there is a lack of research on how these materials collectively affect indoor temperature control. This article clarifies the beneficial effects of green building materials on indoor temperature regulation by conducting a systematic literature review. This study aims to thoroughly understand how green building materials influence the dynamics of interior temperature by methodically discover, analyse, and synthesize pertinent research data. The methods for harnessing the positive impact of green building materials on indoor temperatures, such as the selection of high-quality green materials, high-performance insulating materials, high thermal mass materials and strategic placement are studied through the literature review. The results of this research do not only enhance *comprehension on the influence of green building materials will have on the development of sustainable building design and construction methods in the future, but also provide practical insights for architects, policymakers, and researchers interest in sustaining building design. This study underscores the significance of promoting research and lobbying for legislative support to speed up the use of green building materials and drive the shift towards a more sustainable built environment.*

Keywords: *Indoor temperature, Sustainable, Thermal performance, Green material, Insulation*

INTRODUCTION

Built environment has greatly influenced environmental sustainability, human health, and well-being. For instance, the interior temperature of a building is one of the most important factors in terms of occupant comfort, productivity, and energy consumption, among other elements of building design and construction. The envelope of a structure is essential to achieve optimal energy conservation (Zhang et al., 2013). It plays a critical role in delaying the effects of outside temperature changes, which substantially influences in maintaining comfortable indoor thermal conditions. This study aims to ascertain the potential beneficial impact of green building materials on interior temperature management. This research will show how sustainable materials may improve energy efficiency, interior comfort, and building environmental effects by analysing their thermal qualities and advantages. Lakatos (2022) stated that the components with low thermal conductivity decrease the amount of heat transferred from the inside of a structure to its outside. Besides, conventional construction materials frequently have poor thermal performance, which causes interior temperature swings and a greater need for mechanical heating and cooling systems. On the other hand, by utilizing natural characteristics to control the dynamics of interior temperature, green building materials provide a viable way to lessen these difficulties. Somasundaram et al. (2020) stated that in glazed, green-certified office buildings in Malaysia with double low-emissivity (Low-E) glass keeps interior air temperature within the Malaysia Standard's 23–26 °C range. In addition, other green building materials like BIO-GREEN PANELS effectively decrease the expenses associated with heating and cooling buildings, while minimizing carbon emissions (Almusaed et al., 2023).

Characteristics of Green Building Materials Review

A wide variety of goods and materials that are distinguished by their energy efficiency, environmental sustainability, and health advantages are collectively referred to as "green building materials." These materials can be categorized based on their composition, thermal conductivity, and embodied energy. Marwa et al. (2018) stated that utilizing environmentally conscious and less harmful materials, reducing resource consumption, increasing energy efficiency, and promoting occupant wellness are all tenets of the green construction concept. According to Kubba (2012), green material does not harm the environment. He considers the health of building inhabitants by way of indoor air quality. According to a study conducted by Balaban and Puppim de Oliveira (2017), green buildings can achieve greater levels of indoor environmental quality (IEQ) than conventional structures, which in turn leads to improved health for occupants and enhanced user satisfaction.

This green material is typical of materials with strong thermal inertia, such as stone, brick, and concrete, which can absorb, retain, and release heat to maintain a steady temperature within. Other than that, insulation materials, such as cellulose, fiberglass, and foam, minimize thermal losses and increase energy efficiency by reducing heat transmission through walls, roofs, and floors. Using insulation materials for opaque facades can enhance buildings thermal and acoustic performance (Aksamija, 2016). Other researchers stated that effective thermal insulation in a building may result in a reduction of around 65% in energy use (Blom et al., 2010). By reducing the thermal bridges inside their envelopes (Phase Change Materials - PCMs) materials store and release latent heat through reversible phase changes. They include salt hydrates, bio-based polymers, and paraffin wax. As a result, they are effective in moderating variations in indoor temperature. In addition, several certification bodies exist, including REACH, Construction Product Regulation (CPR), Building Research Establishment Environmental Assessment Methodology (BREEAM), and Leadership in Energy & Environmental Design (LEED) (Alsharif & Tong, 2019). These regulatory authorities ensure that the construction supply chain adheres to the legal, technical, and environmental criteria of green building.

Green Building Materials' Effects on Thermal Performance Review

Green building materials improve thermal performance. This can be achieved by adding phase change capabilities, increasing thermal mass, and improving insulation. These materials improve interior comfort levels, lessen the need for heating and cooling, and minimize temperature extremes. Moreover, their sustainable features support occupant well-being and environmental preservation. According to research conducted by Ferrandez-Garcia et al. (2020), the thermal conductivity of recycled textile fibers (e.g., jute fiber recovered from old jute sacks) is comparable to that of one or more of the materials as mentioned earlier, with values ranging from 0.031 to 0.140 W/(m·K). As a result of their ability to improve shading and thermal insulation of external walls in a cost-effective and environmentally friendly way, green wall systems are seen as a key way to stop buildings from losing energy because of their structure and the thermophysical properties of their walls (Balaban & Puppim de Oliveira, 2017).

According to Han et al. (2017), to mitigate the energy consumption and pollutants associated with conventional cement, a team of researchers from Michoacan University of San Nicolás de Hidalgo in Mexico devised a unique cement that harnesses solar energy during daylight hours and releases it at night. Other researchers, Guna et al. (2021), adding coir and wool reinforcement to gypsum will enhance its thermal and acoustic qualities, while also lowering costs and converting a significant percentage of the material into biodegradable ceiling tiles, which will lessen its environmental impact and support green building initiatives.

METHODOLOGY

A systematic literature review addressed the research questions and fulfilled the research objectives on the positive impacts of green building materials on indoor temperature regulation through a systematic gathering and integration of scholarly information. For this study, authors had comprehensively searched two prominent databases, the article selection process included identifying studies from 25 Scopus publications and 17 Web of Science articles. Following a screening procedure that included keywords such as title and abstract relevance, failure to meet inclusion requirements, and unavailability of full-text publications, as a result, only 15 articles or journals were deemed appropriate to investigate the potential of green construction materials in improving indoor temperature.

This analysis focused on material produced between 2016 and 2024 to include the most recent advancements and novel perspectives in the subject. The selection of these platforms was based on their extensive coverage of engineering, environmental science, and policy studies, which offer a diverse and important collection of material necessary to the research. The search approach used a mixture of carefully selected keywords: "beneficial effects of green building materials on indoor temperature," and "positive impact of green building materials on indoor temperature." To improve the green building materials, this research included a strategy for maximizing the beneficial effect of these materials on interior temperature, while excluding criteria that did not give a clear analysis and conclusion as a barrier to boost green building materials. The beneficial effect can be enhanced by promoting research, fostering collaboration, and advocating for legislative support to expedite the adoption of green building materials and facilitate the transition towards a more sustainable built environment.

FINDING

Numerous techniques should be addressed during the design, construction, and operation stages to maximize the beneficial influence of environmentally friendly building materials on the dynamics of the temperature within the structure. The previous literature review in Table 1 provides a holistic overview of harnessing the positive impact of green building materials on indoor temperature.

Table 1. Method in Harnessing the Positive Impact of Green Building Materials on Indoor Temperature on Reviewed Literature Review

Method to harnessing the positive impact of green building materials on indoor temperature	Authors	Contextual Scope
Selection of High-Quality Green Materials	Majumder, A.; Canale, L.; Mastino, C.C.; Pacitto, A.; Frattolillo, A.; Dell'Isola, M. (2021)	Utilizing green materials for construction may effectively retain heat and contribute to environmental sustainability.

	Liu, L. and Zhai, Y. (2022)	Green materials have an extended useful life, are environmentally friendly when used, and can be recycled and reused twice without adding to pollution levels.
	Schiavoni, S., D'Alessandro, F., Bianci, F. & Asdrubali, F. (2016)	Green materials must include non-thermal properties such as water vapor permeability, fire resistance, sound insulation, and environmental and human health effects.
		Green building materials provide appropriate performance and longevity, necessitating less upkeep, decreasing the extraction of raw materials, pollutants produced during production and usage, and energy consumption.
Selection of High-Performance Insulating Materials	Cascone, S. M., Cascone, S. & Vitale M. (2019)	Cork acoustic insulation panels provide better thermal insulation than plasterboard.
	Almusaed, A., Almssad, A., Alasadi, A., Yitmen, I. & Al-Samaraee, S. (2023)	The natural plant fibers in BIO-GREEN PANELs efficiently impede heat flow between a building's interior and exterior because of their low thermal conductivity and limited heat conduction capabilities.
	Okonta, D. E. (2023)	Effective insulation plays a role in maintaining a pleasant interior environment, minimizing the build-up of heat inside, and constructing fabrics with insulation helps lessen the cooling burden.
	Asim, M., Ghulam, U., Jamshaid, H., (2019)	Thermogravimetric investigation showed that RC made of Jute, Sugarcane, and Basalt fibers had superior thermal stability than ordinary concrete up to 50°C, making it a good fit for the environment of South Asian nations.
	Follmi, D., Corpel, L., Solcerova, A. & Kluck, J. (2023)	The energy costs for heating and ventilation may be reduced by the additional water storage layer in blue-green roofs that act as insulation, lowering the building's temperature in the summer and keeping it warm in the winter.
	Zilberberg, E. Trapper, P., Meir, I. A. & Isaac, S. (2021)	Incorporating insulation leads to a substantial decrease in operating energy use and also minimizing the relative influence of non-insulated thermal mass in the building envelope.

High Thermal Mass Materials and Strategic Placement	Almusaed, A., Almssad, A., Alasadi, A., Yitmen, I. & Al-Samaraee, S. (2023)	Compared to straw bales or clay bricks, the natural plant fibres used to make BIO-GREEN PANELs have a greater thermal mass, making them a better insulator.
	Wang, H., Chiang, P., Cai, Y., Li, C. Wang, X., Chen, T., Wei, S. and Huang, Q. (2018)	Smart windows may selectively absorb or reflect heat radiation from the outside environment and stop interior heat diffusion because they are made of transparent materials like glass, substrate, and dimming materials.
	Alsuhaibani, A. M., Refat, M. S., Qaisrani, S. A., Jamil, F. Abbas, Z. Zehra, A. f, Baluch, K., Kim, J. and Mubeen, M. (2023)	Those with larger thermal mass or buffering capacity have been shown to retain more heat compared to those with lower thermal mass.
	Sharaf, F. (2020)	The high thermal mass building materials, such as clay bricks, help maintain a comfortable interior within the range of human thermal comfort.
	Reilly, A. and Kinnane, O. (2017)	The high thermal mass structures in building envelopes are more effective in hot regions than cold ones, affecting operating energy.

DISCUSSION

To improve indoor temperature regulation and amplify the positive impact of green building materials, the focus discussion was on selecting high-performance insulating materials, high thermal mass materials with strategic placement, and high-quality green materials.

Selection of High-Quality Green Materials

This phrase underscores the significance of selecting environmentally friendly materials of superior quality for construction. Materials with certification and standards involved selecting environmentally friendly construction materials based on their thermal qualities, influence on the environment, and conformity with the project's needs. Findings of an experiment by Majumder et al. (2021) showed that new materials from locally grown natural and recycled materials can keep heat in well. According to Liu and Zhai (2022), the objective of manufacturing green building materials is to enhance the quality of life for people. This necessitates that these materials have a prolonged lifespan and do not generate any pollution throughout their use. It can be recycled and reused twice without generating any pollution during the manufacturing process. The use of long-lasting materials reduces the need for frequent replacements and repairs. Materials that are used for thermal insulation and have low densities are characterized by high porosity, which helps the efficacy of the insulation the materials provide (Martinez et al., 2024).

Ensuring that materials do not release any dangerous VOCs (Volatile Organic Compounds) or other contaminants, as stated by Schiavoni et al. (2016), when selecting an insulator, thermal performance is not the only factor to consider. Building materials are beginning to adopt a more holistic approach that takes into account non-thermal characteristics such as water vapor permeability, resistance to fire, sound insulation, and environmental and human health impact. Other than that, utilizing materials derived from recycled items, such as recovered wood or recycled metal, aids in mitigating the environmental footprint. Choosing locally produced green building material that takes less energy to make and easy to transport and make it low embodied energy, is essential.. Guna et al. (2021) proposed that incorporating coir and wool into gypsum walls would enhance thermal and acoustic characteristics, lower costs, increase biodegradability of a significant portion of the gypsum ceiling tiles, reduce environmental impact, and support green building efforts. By strategically employing environmentally friendly materials, these advantages can improve the indoor and outdoor environments.

Selection of High-Performance Insulating Materials

Selection involves finding thermally insulating materials that reduce heat transmission between indoor and outdoor surroundings. To minimise heat transmission and maintain stable interior temperatures, it is recommended that walls, roofs, and floors be insulated with materials with high R-values, such as cellulose, fiberglass, or spray foam. The material thermal conductivity coefficient (λ) must be less than 0.1 W/m k, in order to be considered thermally insulated. Cellulose insulation from recycled paper has a high R-value and is ecologically beneficial. The panel made from crushed coconut peels, with a thermal conductivity of 0.054 W/mK, is well-suited for use as insulation in walls and ceilings. This made it a practical and environmentally friendly option for sustainable construction materials (Cascone et al., 2019). In a study by Almusaed et al. (2023), the natural plant fibers in Bio-Green Panels effectively inhibit heat movement between the inside and outside of a building owing to their low thermal conductivity and limited heat conduction capabilities.

Besides, effective temperature control means better insulation makes HVAC systems work and reduces the load, which means they use less energy and release fewer greenhouse gases. This enhances a building's comprehensive energy efficiency evaluation and may assist in obtaining certifications such as LEED or Passive House. In addition, proper insulation can contribute to preserving a comfortable indoor environment and reducing internal heat accumulation (Okonta, 2023). As Okonta's study in 2023 showed, building fabrics with insulation helps lower the cooling load, which runs from 371.14 kWh in January to 1297.91 kWh in May and adds up to 10,152.92 kWh per year compared to the case where the fabrics weren't insulated.

High Thermal Mass Materials and Strategic Placement

Selecting materials of having a high thermal capacity need to be considered. The materials are capable of absorbing and retaining significant quantities of thermal energy. To stabilize interior temperatures, it is advisable to use concrete, brick, and stone to absorb and slowly release heat and strategically place materials with high thermal mass in locations. In addition, do ensure the location get direct sunlight during the day to collect heat, which may then be released at night. Due to the higher thermal mass of Bio-Green Panels' natural plant fibers provide superior insulation compared to straw bales or clay bricks since they can efficiently absorb and retain heat energy (Almusaed et al., 2023).

Simply employing these materials is insufficient; they must be carefully arranged to maximise their efficiency in temperature control. According to Reilly and Kinnane (2017), high thermal mass structures in building envelopes are more efficient in warmer climates than cold ones as it impacts operational energy. Utilising orientation and window positioning do guarantee that these materials get the most favourable sun exposure. Smart Windows composed of glass or other transparent materials, such as substrate and dimming material, can selectively absorb or reflect the heat radiation of the outside world and prevent internal heat diffusion (Wang et al., 2018). Alsuhaibani et al. (2023) stated in their study that materials with greater thermal mass or buffering have been shown to hold more heat than materials with less thermal mass.

CONCLUSION

This comprehensive systematic literature review shows a considerable number of studies conducted to improve the effectiveness of using green building materials. Ultimately, the careful choice and purposeful utilization of superior green materials, high-performing insulating materials, and materials with high thermal mass greatly improve the control of interior temperatures, energy efficiency, and overall sustainability. Adopting these materials and processes supports environmental objectives and helps in the creation of pleasant, healthy, and long-lasting living spaces. By giving priority to materials that provide thermal efficiency, durability, minimal environmental impact, and health advantages, the construction sector may transit towards more sustainable methods that are advantageous for both inhabitants and the earth. To speed up the use of green building materials and make the most of their ability to improve the temperature inside, future studies should focus on creating novel environmentally friendly construction materials that are more cost-effective, long-lasting, and have improved thermal qualities. Besides that, the performance evaluation by conducting exhaustive performance assessments and simulations to measure the influence that environmentally friendly building materials have on the dynamics of the temperature within the building under various circumstances, is important. Lastly, policy support should include establishing certification programs, financial incentives, and building rules to encourage the use of environmentally friendly building materials in construction projects.

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AUTHOR CONTRIBUTIONS

All authors contributed to the research design, the literature review screening, and the write-up of this article on harnessing the positive impact of green building materials on indoor temperature. The literature review from Scopus and WOS, data screening, and tabulation were undertaken by the authors from University Teknologi MARA. All authors have read and approved the final manuscript.

A CONFLICT OF INTEREST

The authors declared there was no conflict of interest.

REFERENCES

Aksamija, A. (2016). Design methods for sustainable, high-performance building facades. *Journal of Advance in Building Energy Research. 10*(2), 1–23. Retrieved September 23, 2015, from doi:10.1080/17512549.2015.1083885

Almusaed, A., Almssad, A., Alasadi, A., Yitmen, I. & Al-Samaraee, S. (2023). Assessing the role and efficiency of thermal insulation by the "BIO-GREEN PANEL" in enhancing sustainability in the Built Environment. *Journal of Sustainability, 15*(13). Retrieved July 1, 2023, from doi:10.3390/su151310418.

Alsharif, H. Z. H. & Tong, S. (2019). Green product innovation strategies for environmental sustainability in the construction sector. *Journal of Contemporary Research in Social Science, 1*(6), 126-135, from doi:10.33094/26410249.2019.16.126.135.

Alsuhaibani, A. M., Refat, M. S., Qaisrani, S. A., Jamil, F., Abbas, Z., Zehra,

A. F., Baluch, K., Kim, J., & Mubeen, M. (2023). Green buildings model: Impact of rigid polyurethane foam on the indoor environment and sustainable development in the energy sector. *Heliyon, 9*(3), e14451. https://doi.org/10.1016/j.heliyon.2023.e14451

Asim, M., Ghulam, U., Jamshaid, H., Raza, A., Tahir, Z. U. R., Hussain, U., Satti, A. N., Hayat, N., & Arafat, S. M. (2019). Comparative experimental investigation of natural fibers reinforced lightweight concrete as thermally efficient building materials. *Journal of Building Engineering,* 31, 101411. https://doi.org/10.1016/j.jobe.2020.101411

Balaban, O.; Puppim de Oliveira, J.A. (2017). Sustainable buildings for healthier cities: Assessing the co-benefits of green buildings in Japan. *Journal of Cleaner Production*, 163, S68–S78. Retrieved October 1, 2017, from doi:10.1016/j.jclepro.2016.01.086.

Blom, I.; Itard, L.; Meijer, A. LCA-based environmental assessment of the use and maintenance of heating and ventilation systems in Dutch dwellings. *Building and Environment, 45*(11), 2362–2372. Retrieved November 2010, from doi:10.1016/j.buildenv.2010.04.012.

Borja Martinez, Virginia Mendizabal, M. Blanca Roncero, Ernest Bernat-Maso, Lluis Gil (2024). Towards sustainable building solutions: Development of hemp shiv-based green insulation material. *Journal of Construction and Building Materials, 4*(414). Retrieved February 2, 2024, from doi:10.1016/j.conbuildmat.2024.134987.

Cascone, S. M., Cascone, S. & Vitale M. (2019). Building insulating materials from agricultural by-products: A review. *Journal of Sustainability in Energy and Building,* 163, 309–318. Retrieved October 27, 2019 from doi:10.1007/978-981-32-9868-2_26.

Fares, A. I., Sohel, K., Al-Jabri, K. S. & Al-Mamun, A. (2021). Characteristics of ferrochrome slag aggregate and its uses as a green material in concrete- a review. *Journal of Construction and Building Materials,* 294, 123552–124152. Retrieved August 2, 2021, from doi:10.1016/j.conbuildmat.2021.123552.

Ferrandez-García, M.T.; Ferrandez-Garcia, C.E.; Garcia-Ortuño, T.;

Ferrandez-Garcia, A.; Ferrandez-Villena, M. (2020). Study of waste jute fiber panels (Corchorus capsularis L.) agglomerated with portland cement and starch. *Polymers, 12*(3), 599. Retrieved March 4, 2020, from doi:10.3390/polym12030599.

Follmi, D., Corpel, L., Solcerova, A. & Kluck, J. (2023). Influence of blue-green roofs on surface and indoor temperatures over a building scale. *Journal of Nature-Based Solutions*, 4, 100076. Retrieved December 2023, from doi:10.1016/j.nbsj.2023.100076.

Guna, V., Yadav, C., Maithri, B. R., Ilangovan, M., Touchaleaume, F., Saulnier, B., Grohens, Y. and Reddy, N. (2021). Wool and coir fiber reinforced gypsum ceiling tiles with enhanced stability and acoustic and thermal resistance. *Journal of Building Engineering,* 41, 102433. Retrieved September 2021, form doi:10.1016/j.jobe.2021.102433.

Han, B., Zhang, L., Ou J. (2017). *Smart and multifunctional concrete toward sustainable infrastructures.* Springer.

Hao Wan, H., Chiang, C., Cai, Y., Chunhui, L., Wang, X., Chen, T., Wei, S. & Huang, Q. (2018). Application of wall and insulation materials on green building: A review. *Journal of Sustainability, 10*(9), 3331. Retrieved September 18, 2018, from doi:10.3390/su10093331.

Kubba, S. (2012). *Green building materials and products*. In Handbook of green building design and construction (2nd ed., pp. 227–311). Elsevier.

Lakatos, A. (2022). Novel thermal insulation materials for buildings. *Journal of Energies, 15*(18), 6713. Retrieved September 14, 2022, from doi:10.3390/en15186713.

Liu, L. & Zhai, Y. (2022). Application of lightweight thermal insulation building materials for green building design. *Journal of Chemistry,* 2, 1-7. Retrieved September 2022, from doi:10.1155/2022/7044427.

Majumder, A.; Canale, L.; Mastino, C.C.; Pacitto, A.; Frattolillo, A.; Dell'Isola, M. (2021). Thermal Characterization of Recycled Materials for Building Insulation. *Energies, 14*(12), 3564. Retrieved June 5, 2021, from doi:10.3390/en14123564.

Martinez, B., Mendizabal, V., Roncero, M. B., Bernat-Maso, E. & Gil, L. (2024). Towards sustainable building solutions: Development of hemp shiv-based green insulation material. *Journal of Construction and Building Materials*, 414, 134987. Retrieved February 2, 2024, from doi:10.1016/j.conbuildmat.2024.134987

Mattoni, B.; Guattari, C.; Evangelisti, L.; Bisegna, F.; Gori, P.; Asdrubali, F. (2018). Critical review, and methodological approach to evaluate the differences among international green building rating tools. *Journal of Renewable Sustainable Energy Reviews, 82*(1), 950–960. Retrieved February 2018, from doi:10.1016/j.rser.2017.09.105.

Mayhoub, M. M. G., Sayad, Z. M. T., M. Ali, A. A. M., & G. Ibrahim, M. (2021). Assessment of green building materials' attributes to achieve sustainable building facades. *Journal of Building Energy, Physics, Environment, and Systems, 11*(10), 474. Retrieved October 14, 2021, from doi:10.3390/buildings11100474.

Okonta, D. E. (2023). Investigating the impact of building materials on energy efficiency and indoor cooling in Nigerian homes. *Journal of Energy, 9*(9). 1-15. Retrieved September 2023, from doi:10.1016/j.heliyon.2023.e20316.

Reilly, A. and Kinnane, O. (2017). The impact of thermal mass on building energy consumption. *Journal of Applied Energy,* 198, 108-121. Retrieved July 15, 2017, from doi:10.1016/j.apenergy.2017.04.024.

Schiavoni, S., D′Alessandro, F., Bianci, F. & Asdrubali, F. (2016). Insulation materials for the building sector: A review and comparative analysis. *Renewable and Sustainable Energy Review*, 62, 988-1011. Retrieved September 2016, from doi:10.1016/j.rser.2016.05.045.

Sharaf, F. (2020). The impact of thermal mass on building energy consumption: A case study in Al Mafraq city in Jordan. *Cogent Engineering, 7*(1), 1-8. Retrieved August 13, 2020, from doi:10.1080/23311916.2020.1804092.

Somasundaram, S., Chong, A., Wei, Z. & Thangavelu, S.R. (2020). Energy saving potential of low-e coating based retrofit double glazing for tropical climate. *Journal of Energy and Buildings,* 206, 109570.

Retrieved January 1, 2020, from doi:10.1016/j.enbuild.2019.109570.

Wang, H., Chiang, P., Cai, Y., Li, C. Wang, X., Chen, T., Wei, S. and Huang, Q. (2018). Application of wall and insulation materials on green building: A review. *Journal of Sustainability, 10*(9), 3331. Retrieved September 18, 2018, from doi:10.3390/su10093331.

Zhang, Y.; Chen, Q.; Zhang, Y.P.; Wang, X (2013). Exploring buildings' secrets: The ideal thermophysical properties of a building's wall for energy conservation. *International Journal Heat Mass Transfer,* 65, 265–273. Retrieved October 2013, from doi:10.1016/j.ijheatmasstransfer.2013.06.008.

Zilberberg, E. Trapper, P., Meir, I. A. & Isaac, S. (2021). The impact of thermal mass and insulation of building structure on energy efficiency. *Journal of Energy and Buildings, 241*(10), pp. 110954. Retrieved June 15, 2021, from doi:10.1016/j.enbuild.2021.110954.