Innovation Balancing Enterprise Capabilities and Local Technological and Consumer Requirements

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Abstract: This paper explores the development of an innovative skylight solution adapted for the Sri Lankan market, focusing on the transfer of corporate insights from temperate to tropical climates. It highlights the collaborative efforts with GOODLITE to optimize design, materials, and technology for tropical conditions. The study identifies key challenges such as high humidity, intense solar heat, and heavy monsoonal rains, and proposes solutions like the TropiLite Skylight. Overheating is an evident challenge that needs to be addressed when introducing western designed solutions from cooler climates into new markets characterized by higher solar exposure and more intense temperatures. By offering innovative solutions to address overheating, GOODLITE could unlock new market opportunities and drive growth by adapting to local climate challenges while staying true to their core values and preserving the unique qualities of their products that set them apart in a competitive global landscape. The research emphasizes the importance of modular and customizable designs to cater to diverse economic segments, ensuring affordability and functionality. This study also investigates useful strategies that could be used to introduce a foreign product into a new market by leveraging localized marketing, strategic partnerships, and product adaptations to meet regional needs. However, for long term success, the local ecosystem must also evolve, developing the necessary infrastructure, technical skills, and maintenance capabilities to support and sustain the introduction of such products. Hence, the study leverages on GOODLITE's expertise in skylights and roof window innovation and brings forward the experience in bringing market adapted solutions to new markets to ensure the proposed solution is suitable. The study demonstrates how strategic adaptations can address local climatic and market needs, paving the way for a scalable solution that could be used in tropical regions across the world. Through entrepreneurship, the introduction of a new skylight product to a foreign market aims to address specific consumer needs by offering a climate adapted solution.

Keywords: Innovation, Entrepreneurship, Skylight, Localized Adaptation, Tropical Climate.

1. Introduction

The global construction industry is undergoing a pivotal transformation, driven by the urgent need for sustainability, climate resilience, and market specific innovation. Innovating for sustainability means creating durable, climate resilient solutions that deliver long term value to stakeholders while addressing global environmental and social challenges and reducing reliance on disposable consumption (Chabowski, B.R. et. al, 2025). Skylights and roof window systems are seen as key enablers of green building practices. By enhancing the inflow of natural light, promoting passive ventilation, and reducing reliance on artificial lighting and mechanical cooling. Integrating innovation early in building design, particularly in optimizing window systems enables energy efficient, cost-effective solutions that enhance thermal performance, occupant comfort, and environmental sustainability in response to climate and health challenges (Ma, Q. et. al, 2025). The development of skylight solutions reflects the complex reality of sustainable transitions while embodying innovative solutions for tropical climates, it also highlights the disparities and challenges that developing nations face in balancing resource limitations with global sustainability expectations (Dsilva, J. et. al, 2025). While these products have seen success in temperate regions, their effectiveness does not always translate seamlessly across geographic and climatic boundaries. Furthermore, wellbeing has been validated as an importance since there has been a change of lifestyle among urban dwellers, especially in medium- to high-income groups, who tend to spend more time indoors nowadays (Ahmed, K. S., 2003). These changes are likely to contribute to increased use of air conditioning and thus higher energy use.

This paper focuses on regions characterized by Tropical climate conditions such as Sri Lanka, which present a distinct set of environmental challenges that complicate the adoption of skylight and roof window technologies developed for other climates. High humidity, persistent solar radiation, heavy monsoonal rainfall, and elevated ambient temperatures impose significant demands on building materials (Jayawardena et al., 2024). This demands specialized design considerations that address not only performance and durability, but also user comfort and safety. Furthermore, technological innovations have to be an integral aspect of the entire concept development. Especially to prevent water leaks, which is a common issue in regions with heavy rainfall (Ratnaweera & Hestnes, 1996). The paper explores the case of the TropiLite Skylight, an innovative solution that can be used as a blueprint to similar markets. The TropiLite represents a compelling model of how global firms such as GOODLITE which has been taken as the main company of focus for this study could leverage their technological expertise while engaging in meaningful partnerships with local actors to create context sensitive products.

The TropiLite case thus serves as a practical example of sustainable innovation adapted for emerging markets, offering insights into the strategic fusion of global innovation and local adaptation. Lastly, it is valuable to realise that companies such as GOODLITE could transform climate challenges into opportunities for innovation and resilience, aligning with strategies that leverage environmental imperatives to drive sustainable growth (Rani, S.Y. et. al, 2025).

2. Literature Review

Understanding the interaction between architecture and climate is essential in tropical regions such as Sri Lanka, where high temperatures, humidity, and intense rainfall shape the built environment. Sri Lanka, specifically Colombo, offers a representative case due to its hot-humid climate, dense urbanization, and associated environmental pressures. Other regions that share maritime-tropical climatic similarities with Sri Lanka (Jayawardena et al., 2024), including Southeast Asia (Thailand, Malaysia, Indonesia), parts of Central America (Costa Rica, Panama) and tropical islands such as the Maldives, faces comparable challenges (Beck, H. E. et al., 2018). The implications are both architectural and social, 99% of the tropical population resides in developing countries, with significant growth expected by 2050 (United Nations DESA, 2019; State of the Tropics Report, 2014). Aligned with Adenle et al. (2015), this work acknowledges the importance of innovation diffusion in addressing climate challenges. Overheating in tropical dwellings reduces indoor comfort, raises energy demands, and exacerbates health risks. Passive design strategies, including optimal orientation, thermal mass, cross ventilation, and external shading are vital in mitigating overheating. Window orientation along east-west axes and shaded facades limit solar gain (Zune et al., 2021; Farrokhirad et al., 2024). Over glazing poses risks, increasing internal heat loads and glare. Thus, careful sizing and placement of skylights become critical. The A/V (area to volume) ratio also influences thermal performance, compact structures fare better in minimizing surface heat transfer (Rob et al., 2024). Findings from Ghosh and Gomes (2020) support these approaches, identifying natural ventilation and daylighting as essential for comfort and efficiency in Sri Lankan homes. Additionally, Mlakar and Štrancar (2011) and Bruno et al. (2017) emphasize the risk of overheating even in passive buildings, reinforcing the relevance of shading, glazing, and thermal mass solutions. Furthermore, from a human context of wellbeing, lighting influences not only energy efficiency but also circadian rhythms, mental health, and safety. Natural lighting reduces the need for artificial light and has therapeutic effects, improving mood and concentration (Van Bommel & Van den Beld, 2016). Design tools like the Daylight Factor (DF) and GOODLITE Daylight Visualizer help assess performance in residential settings (Dolnikova et al., 2020). Ventilation is equally crucial. Natural ventilation reduces reliance on air conditioning but must be protected from outdoor pollutants and insects.

Sri Lanka's Urban Development Authority outlines building regulations for light, ventilation, and room height, yet lacks specific codes for skylights. This regulatory gap highlights the need for market specific innovations aligned with global standards. International codes like EN 12207 (airtightness), EN 14449 (laminated safety glass), and ASTM E331 (water resistance) offer benchmarks for tropical performance. Roof windows present a viable solution for enhancing daylight and ventilation, particularly in rooms with limited wall space. However, tropical climates demand careful material selection. Anodized aluminum provides lightweight strength and corrosion resistance, while uPVC offers affordability and thermal efficiency. Laminated low-E glass helps manage solar heat gain, glare, and UV exposure (Sinha & Kutnar, 2012; Farrokhirad et al., 2024). Material innovations discussed by Wielage et al. (2008) and Moghaddam et al. (2021) support the use of anodised aluminum and modern glazing technologies to withstand tropical humidity and sunlight. Modular product design, as explored by Psomas et al. (2017), allows customisation and market flexibility for mass or premium consumer segments. Finally, integrating smart technologies such as rain sensors, automated ventilation, and solar powered actuators can optimize energy use and user comfort in skylights. These innovations reflect a shift toward responsive environments where users control and interact with building systems for improved wellbeing and efficiency (Hansen et al., 2013; Psomas et al., 2017). In Sri Lanka, the introduction of modular, scalable, and intelligent roof window systems offers a pathway for climate adaptive, consumer centered innovation. Innovation diffusion principles (Adenle et al., 2015) and entrepreneurial localisation strategies support this adaptive and inclusive innovation journey.

3. Methodology

This research adopted a mixed methods approach of both quantitative and qualitative, to ensure a comprehensive understanding of both consumer needs and expert perspectives regarding skylight solutions suitable for tropical climates, particularly in Sri Lanka. This was combined for context specific and innovation driven product development process. Quantitative data were collected through an online consumer survey, distributed to 270 Sri Lankan homeowners and prospective homeowners across various income brackets, the flexibility to carry out the data collection remotely made this method appropriate for this study. The survey explored demographic profiles, housing preferences, window usage behavior, material and technology choices, climate adaptation challenges, and willingness to invest in skylight products. For qualitative insights, semi-structured interviews were conducted with two Sri Lankan architects and two civil engineers, selected for their experience in tropical construction environments. These expert interviews explored technical feasibility, design integration, material suitability, regulatory factors, and cultural preferences. In addition, in-depth interviews were held with an innovation and a material & technology expert from GOODLITE, to validate technical decisions, assess design concepts, and evaluate potential testing methods. Interviews were conducted online using Microsoft Teams, recorded, transcribed using AI tools, and analyzed using thematic analysis to extract key themes and recommendations. Carrying out expert Semi-Structured Interviews (SSI), allowed for follow up queries to be performed and for open ended exploration to take place, which helped to improve the data-richness (Wilson, C., 2014; Adams, W. C., 2015). A case study approach centered on Colombo (Sri Lanka) was adopted to focus on real world applicability, this gave opportunities to develop suitable theories by the application of in-depth insights from the knowledge base and the environment. The study was further guided by a dual framework methodology combining the FuGle Innovation Process Model and Design Thinking (Louw et al., 2018; Carlgren, L. et al., 2016; Buhl, A. et al., 2019), ensuring structured innovation with user centered design principles. These frameworks enabled iterative ideation, conceptualization, and refinement of a skylight solution.

4. Case

GOODLITE, a multinational company, pioneered the modern roof window by combining daylight and ventilation in a compact, functional design. GOODLITE has maintained a strong focus on enhancing the quality of indoor environments through innovation in roof windows, skylights and sun tunnels. Their signature product model represents decades of iteration and market adaptation. With global reach across Europe, North America, and Asia. Adapting to tropical markets like Sri Lanka introduces new challenges. Unlike Japan, Sri Lanka's climate requires a bottom-up redesign, consistent with insights from innovation diffusion theory (Adenle et al., 2015). Furthermore, business capability mapping enables companies like GOODLITE to identify bounded innovation capabilities and strategically pursue commercial or cooperative transactions to complement them. This approach aligns internal capability diagnostics with adapted external partnerships, driving innovation through targeted resource and knowledge exchange (da Silva Nascimento, L. and Zawislak, P.A., 2023). This is essential in adapting to new markets that require products to fit local needs. In addition, global entrepreneurship thrives when it balances local adaptability with cross-border collaboration, and emerging markets can harness this synergy by building entrepreneurial cultures that are agile, innovative, and globally connected (Emma, L., 2025). This is critical for GOODLITE to make a seamless entry into a new emerging market such as Sri Lanka.

Balancing global innovation with local adaptation is essential for GOODLITE to remain competitive and responsive in diverse markets. This approach, often referred to as "glocalization," emphasizes the importance of adapting global strategies to fit local contexts, ensuring that innovations resonate with regional needs and preferences (Barakat, L. et. al, 2025). In terms of local context, in this study Colombo is the focus area, it is the commercial capital city of Sri Lanka, exemplifies both the challenges and opportunities for sustainable skylight design. The central business district (CBD) suffers from poor ventilation and low natural light due to urban congestion and shadowing from tall buildings; the outskirts maintain more breathable residential layouts. Sri Lanka's architectural tradition emphasizes passive cooling and ventilation. Historic and vernacular structures utilized high pitched roofs, shaded eaves, and natural materials to manage solar gain and humidity. However, globalization led to widespread use of energy intensive materials and solutions, including extensive glazing and air conditioning (Ratnaweera & Hestnes, 1996).

Temperatures in Colombo average 28–31°C year-round, with high humidity and distinct monsoon seasons bringing heavy rainfall (Sri Lanka Department of Meteorology, 2024). The city experiences sharp fluctuations in sun hours throughout the year, from 9 hours in January to nearly zero in May. Peak rainfall occurs in May and

October, each receiving over 300 mm. These conditions demand skylight systems that can manage solar gain, allow ventilation, resist moisture ingress, and withstand intense UV exposure. The city's location in the wet zone of Sri Lanka means it receives over 2,500 mm of rain annually, with additional inter-monsoonal rains offering intermittent but intense downpours. The urban middle and upper-middle class in Sri Lanka prioritize visual comfort, thermal regulation, and modern aesthetics. Market dynamics show the dominance of SMEs in the construction sector, limited access to advanced training, and inconsistent recognition of sustainable building practices. Regulations by the Urban Development Authority (UDA) and Colombo Municipal Council stress the importance of natural light and ventilation but lack specific guidelines for skylights. Urbanization has amplified the heat island effect and increased cooling loads, reinforcing the value of passive lighting and ventilation.

5. Findings

This study presents a data-driven approach to designing the TropiLite Skylight by aligning climatic realities with consumer preferences in Sri Lanka. Colombo's tropical environment is marked by high temperatures (28°C–31°C), humidity (73%–87%), and intense rainfall necessitates skylights that are waterproof, UV protected, impact resistant, and mosquito proof. Features such as StormSafe Glass, EPDM drainage, and insect proof ventilation address these challenges. Consumer insights show strong demand for skylights that are stylish, durable, and functional. Most respondents were young professionals (67.4% aged 25–34), many of whom were homeowners with moderate to premium incomes. Most preferred single-family homes (57.8%) and favored a blend of Western and Sri Lankan architectural styles (52.6%). Key functional priorities included natural light (91.5%), ventilation (84.4%), weather resistance (83.7%), and durability (82.6%), alongside a preference for low maintenance (79.6%) and customizable solutions whether manual or automated depending on budget. These findings emphasize the importance of localized, modular innovation that balances design, climate adaptation and affordability.

6. Skylight Solution for Tropical Climates

Innovative product design that aligns with emerging market needs is crucial for GOODLITE aiming to achieve sustainable growth and maintain a competitive edge in today's dynamic business environment (Shehab, S. et. al, 2025). By integrating customer insights, market research and advanced technologies, GOODLITE could develop and offer products that not only meet current demands but also anticipate future trends, ensuring long term success keeping in mind their goal of mass volume sales as a key driver.

6.1 TropiLite Skylight

With support from GOODLITE experts, a new product concept, the TropiLite Skylight has been developed through an iterative design process that incorporated insights from potential end users and in-depth climate analysis. Several concepts were proposed, but the most viable solution that was attractive to have as an initial market offering was chosen. While GOODLITE's existing range of center-pivot windows, solar-powered skylights, and smart ventilation systems serve temperate regions effectively, these models were not fully suited to Colombo's unique tropical climate. As a result, the TropiLite Skylight emerged as a purpose-built innovation, reflecting a strategic departure from product adaptation to a regionally embedded design approach. Developed in alignment with the Fugle Method, focusing on Function, Usability, Goal, Limitations, and Evolution, the TropiLite Skylight is a modular and scalable product that supports a range of consumer budgets and roof types. Its design evolution was guided by GOODLITE's global mission to deliver daylight and fresh air into buildings while rooting innovation in the specific socio-economic and climatic conditions of Colombo.

The study has identified key enablers that offer potential solutions to address the challenges specific to tropical regions. These enablers demonstrate how skylights, originally designed for temperate climates, could be adapted to suit tropical conditions. **Figure 1** illustrates these enablers.

6.2 Skylight Innovation Enablers - Temperate to Tropical Climates

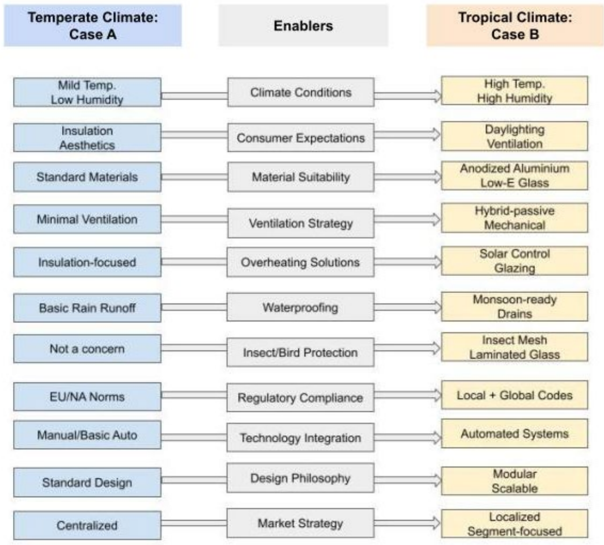

Figure 1: Transition from Temperate to Tropical Skylight Innovation: Enablers (Self-developed by Author)

The development of the TropiLite Skylight followed a human centered design approach using design thinking. In the Empathy phase, field research identified issues like overheating, poor ventilation, and limited passive cooling. The Define stage clarified goals such as weather resilience, affordability, modularity, and architectural fit. During Ideation, key innovations including TropicFrame, SunGuard Glazing, AeroFlow Ventilation, and RainGuard Drainage were conceptualized. The Test phase will include performance evaluations under simulated monsoon conditions, solar heat gain analysis, and wind load assessments. The final design combines essential components such as TropicFrame, SunGuard Glazing, RainGuard Drainage, StormSafe Glass, and UVDefender coating with optional features like AeroFlow Ventilation (manual/automated), CoolShade System (internal/external blinds), and RainShield Sensors for automatic rain response. Based on expert and user feedback, EPDM seals, impact resistant glass and weatherproof coatings, ensuring durability, comfort and smart functionality. The main features are shown on the TropiLite concept model in **Figure 2** below.

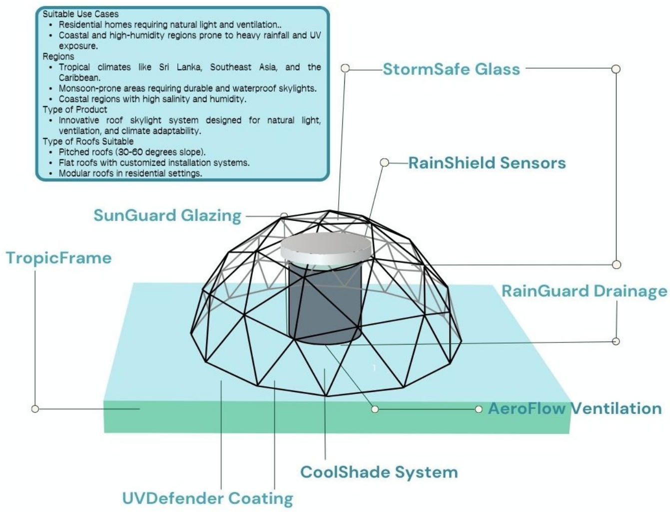

Figure 2: TropiLite Skylight (Self-developed by Author)

7. Discussion

Developing a roof window solution for Sri Lanka required a fundamental rethinking, rather than retrofitting a temperate climate design for tropical use, this study adopted a bottom-up, context driven innovation transfer strategy. This is because innovation can be costly, apart from certain R&D efforts, absorbing external knowledge through technology transfer is considered an alternative method to support innovation (Wang, Y. et. al, 2025). The hot-humid urban climate of Colombo comes with distinct architectural challenges such as high solar radiation, humidity, and intense seasonal rainfall (Jayawardena et al., 2024; Beck et al., 2018). Colombo, with its dense population of middle to high income urban dwellers, served as an ideal testbed for this study. The consumer insights obtained from 270 survey respondents confirmed strong preferences for natural light (91.5%), passive ventilation (84.4%) and stylish design, showing a clear market opportunity for skylight solutions. These insights align with the importance having daylighting and ventilation in tropical residential architecture (Ghosh and Gomes, 2020). The design of the TropiLite Skylight was supported by Design Thinking and the Fugle Innovation Process Model (Carlgren et al., 2016; Louw et al., 2018), promoting an iterative and empathetic development with direct target consumer input. The TropiLite Skylight integrated passive design principles vital for tropical comfort. Overheating is a major challenge in tropical architecture, mainly due to the excessive glazing and poor ventilation (Mlakar & Štrancar, 2011; Bruno et al., 2017). To avoid these risks the skylight was designed with shading features to control daylight penetration and also manage the solar heat gain. The use of laminated low-emissivity (low-E) glass in the SunGuard Glazing system reduces glare, blocks UV radiation and prevents indoor overheating (Farrokhirad et al., 2024). Furthermore, every building reflects unique and customized characteristics shaped by consumer, social and cultural preferences inherited from ancestral traditions, this emphasizes the need for design and material choices that respect and integrate these local values (Gurupatham, S.V. et. al, 2024). Hence it was crucial in addressing Colombo's coastal and humid climate. The TropicFrame, built from anodized aluminum, offers corrosion resistance and long-term durability, which are local requirements that had to be fulfilled (Wielage et al., 2008; Moghaddam et al., 2021). In addition, the AeroFlow Ventilation system enhances cross-ventilation while including insect proof mesh to protect against vector-borne diseases like dengue (Messina et al., 2014; Puppim de Oliveira et al., 2011). The modular product architecture enables customization across budget levels and housing types. This supports the principles of inclusive innovation and entrepreneurial localization strategies essential for tropical market diffusion (Adenle et al., 2015). To protect the product's key innovations, especially the features, having Intellectual Property Rights (IPR) frameworks are crucial. Legal tools such as patents, trademarks, design rights and NDAs with partners are recommended to prevent imitation and secure competitive advantage (Narwaria et al., 2024). These protections are important as Sri Lanka is envisioned not only as a domestic market but as a strategic blueprint that could be used to enter other maritime tropical regions such as Southeast Asia and Central America (Beck et al., 2018).

8. Conclusion

Technological innovation serves as a critical differentiator for multinational companies like GOODLITE, particularly in the context of emerging markets where climate specific demands and consumer aspirations are rapidly evolving. This collaborative, research-based initiative aimed to develop a skylight product suited for the Sri Lankan market by synthesizing localized consumer insights with GOODLITE's global design and engineering capabilities. The study led to the conceptualization of the TropiLite Skylight, a purpose-built solution adapted for tropical climates, with Colombo as the primary case study. A bottom-up innovation strategy was adopted, resulting in the TropiLite Skylight, featuring TropicFrame for structural durability, SunGuard Glazing for thermal control, RainGuard Drainage for waterproofing, and CoolShade for improved occupant comfort. These design elements directly address core challenges such as overheating, poor ventilation and insufficient daylight, as identified by both consumers and professionals. To secure long-term competitiveness, GOODLITE must complement product innovation with robust Intellectual Property Rights (IPR) strategies. These legal tools can help safeguard proprietary technologies as the company scales its offerings to similar tropical markets. In addition, strategic partnerships and knowledge exchange with local actors can support smoother market penetration and after sales support. However, this study presents certain limitations. The primary focus on Colombo, while representative, may not capture regional diversity across Sri Lanka or other tropical contexts. Similarly, expert interviews, though insightful, were limited in number and could benefit from broader stakeholder inclusion, such as regulators and builders. The product's performance, although conceptually validated, awaits empirical testing under real world climatic conditions. Future research should prioritize prototyping and field testing of the TropiLite Skylight under varied tropical weather scenarios to validate durability, thermal performance and user experience. In conclusion, the TropiLite Skylight shows how climate adapted, consumer driven innovation, rooted in interdisciplinary collaboration can result in context specific solutions that support comfort and strategic growth in emerging tropical markets.

Ethics Declaration

This study has kept all stakeholders anonymous and no data is presented making stakeholders identifiable.

AI Declaration

Artificial intelligence tools, including language models provided by OpenAI for language proofing. In addition, the semi-structured interviews were transcribed using AI tools.

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