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A Proposed Thinking Strategy as an Approach for Glazing in Hot Regions

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Abstract

Oftentimes, architects opt to utilize largely glazed facades to convey contemporary values through their designs of different buildings. Despite the appealing aesthetics of these approaches, utilizing glazing in hot regions presents various climatic challenges due to its inherent detrimental thermal characteristics. Furthermore, designers may ignore newly developed materials and techniques that can mitigate the negative impact of glazing. The study's goal is to present a thought strategy as an approach to encouraging the inclusion of climate-responsive concepts as part of the glazing design process. The approach is based on the rational and critical exploration of conventional and innovative glazing methods. Through this thought strategy, designers can gain a deeper understanding of the impact of glazing choices on buildings' performances, especially in hot regions, and allow for a thorough evaluation of both traditional and innovative glazing methods, allowing designers to select the most climate-responsive, comfortable, and environmentally friendly options. The outcome serves as an adjunct to traditional thinking during or after the glazing design process. The proposed strategy is also ideal for expert assessment and optimization of glazing in hot regions, in addition to fostering a shift towards more environmentally conscious glazing practices tailored for hot-region glazing designs.

Keywords: Hot regions; Glazing; Design process; Architectural thinking.

1. Introduction

The creation of climate-sensitive housing is an inherent human nature. Ideally, designers adopt such values by utilizing local knowledge and resources for creating buildings that strongly address the climatic issues of their geographic location and optimally suit the surrounding environment [1–5]. However, achieving this is exceedingly challenging in hot regions; Designing thermally pleasant buildings that have high-quality indoor air, with little energy use, under the harsh micro-climate conditions of these regions requires special considerations[6–9]. Yet, vernacular architecture cleverly addresses this by introducing passive concepts such as the design of compacted urban fabrics, minimalistic exterior openings, shading devices, orientation, courtyards and using traditional clay bricks [10, 11, 2, 12]. Unfortunately, the vernacular and regional architectural identity can be overridden by new modern trends in certain cases, in a desire to comply with the worldwide architectural attitude, creating a globalized architectural form that overlooks the local climate situation [1, 8, 13]. For example, contemporary development in Middle Eastern countries often outputs wide streets and standalone buildings in opposition to the traditional compacted streets and conjoined buildings[14].In response, research attempts to revive the traditional climate-responsive methods in a suitable functional and aesthetic manner [5, 15–19].

The design of largely glazed facades for buildings located in hot regions is another prominent example of disregarding climate conditions due to contemporary architecture[20, 21].It is tempting for designers to increase glazed areas in office building facades to convey a modern aesthetic appearance and deliver a sense of connection with the outdoor environment [21–23]. However, this approach is problematic in hot regions; the glazed façade area is considered a vulnerable thermal spot as it allows for solar radiation and heat to penetrate through. Consequently, the amount of energy required to cool the inside of the building is significant, straining energy resources[24, 20, 25] as the amount of penetrating solar radiation transmittance is directly dependent on design aspects, such as glazing area, orientation, and thermal insulation characteristics, which can allow for up to 85% of the incident radiation to penetrate [26, 20, 27, 28].Also, the glare resulting from excessive sun rays can be discomforting for the building's users[29, 30, 21, 31, 32], in addition to the exterior reflectiveness of the glass that affects the surrounding adjacent area [21].The lack of natural airflow is also a highly disadvantageous aspect of fixed glazing systems that can result in an intensification of overheating issues [33–36].Furthermore, the aesthetic values of glazing are not always in compliance with the surrounding architectural identity which can convey a sense of alienation[20, 37–39].

Despite the mentioned possible negative impact of utilizing glazing in hot areas, it is possible to achieve comfortable indoor environments with limited energy requirements with the emergence of new concepts and technologies[6, 28, 40–43]; Concepts such as the combination of photovoltaic cells have emerged with the purpose to compensate for the additional energy usage due to glazing and allow for vacuum-based installation method that reduce heat gain [44–46, 46]. Similarly, the addition of heat-regulating materials to glazing [47, 47–49] and the introduction of glass coatings [50–52] are equally advantageous. More commonly, the employment of shading devises, above, beside, or overlapping the glazed area, is a successful method to counter the detrimental aspect of glazing [53–56]. It is advantageous to integrate protection from solar exposure by pairing devices like moveable shutters, external blinds, and smart material systems with glazing systems[57, 14]. These devices can also mimic the appearance of most architectural styles which allows for better integration with the surrounding environment [14].Based on this, it is evident that careful consideration must be put in place when utilizing glazing in hot regions.

2. Aim and novelty

The literature mentioned earlier points to the problematic nature of utilizing large glazed facade areas in hot regions. Yet designers remain persistent in pursuing such architectural approaches. New advances in construction and materials can contribute to mitigating the negative impact of glazing and promoting its positive attributes. The thought process of façade designers should incorporate such techniques, a frequently overlooked step. Accordingly, the study's goal is to effectively promote the design of environmentally-suitable glazing systems through influencing designers' trends and preferences. Hence, the study aims to provide a novel thinking strategy for glazing design in hot regions that considers climate-responsive principles as an effective approach, which acts as a complementary aid to the conventional design process of glazing. Also, the proposed strategy consequently promotes the adaption of architectural disciplines dedicated to hot-region glazing designs. Accordingly, the strategy is ideal for the guiding consultants/experts targeting to enhance the conceptual design projects. The thinking strategy is based on the logical and critical analysis of common techniques pertaining to glazing system design and measures relating to hot climates.

3. Methodology and scope

The current study employs both, the descriptive and analytical approach; This mixed methodology couples literature survey with logical reasoning and informed analysis. Literature abundantly describes the principles and characteristics of designing glazing systems. Accordingly, rational analysis is utilized to screen this generic knowledge to produce a focused scheme pertaining to the thought process of glazing design in hot regions, considering the climate-responsive challenges and requirements of these regions. As Figure 1 shows, the first step is to explore relevant literature, focusing on techniques related to hot-region glazing. The acquired information is critiqued, where possible, to highlight the realistic possible measures based on the mentioned techniques for managing hot regions. Then, each determined measure is categorized based on its relation to the appropriate phase of design or construction. Based on this, the proposed thought strategy is formulated, which aims to prioritize achieving a comfortable interior environment through passive methods. It is important to note that the scope of the study is limited only to basic glazing techniques, despite the availability of other high-performance intricate facade systems, such as smart and kinetic shading systems. This is due to the complexity of such systems, which requires independent research suitable for future research. Besides, basic manners of glazing techniques seem to be, so far, most common in oppose to complex facades. Furthermore, due to the architectural nature of the study, inherently multi-disciplinary aspects such as cost are excluded and dedicated to future research.

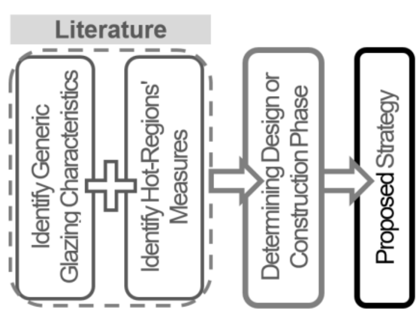


Figure 1: steps to formulating the proposed strategy.

4. Mitigation of solar exposure

Solar exposure is an inherently significant issue in hot regions; Exposure results in excessive heat which impacts the indoor environment and strains HAVC systems. In the case of glazing, this is of critical importance; as heat permeates the glass it will be reflected back and retained inside the building, an effect commonly known as the greenhouse effect. This is not desirable in hot regions. Contrarily, solid façade components allow for good insulation and reduce the impact of exterior temperature variations[14]. Hence, many considerations must be put in place to mitigate these effects as follows:

4.1. Orientation

The building's orientation will affect the exposure of certain facades to direct sun light thus impacting the influence of window and openings on the interior environment[58, 59]. While designers could opt to utilize various types of exterior shading devices, a well-oriented building could reduce the need for such devices. Hence, the building's overall thermal performance, HVAC, and operating costs can be reduced through orientation [22, 60]. In fact, buildings with façades adapted to specific orientations are more likely to be low-energy and low-carbon[14, 61].Therefore, it is prudent to adopt a design strategy where glazing is limited in sun-facing façades to minimize exposure. Alternatively, strategies can allow for buildings with main façades that welcome sunlight and other secondary façades that block it, thus adding directionality to interacts with the surrounds[14].

4.2. Glazing-to-wall ratio

In general, the ability of standard glazing options to mitigate heat transfer is much lower compared to solid walls; In fact, windows can allow for up to five times or more penetration of heat [62]. Hence, as the area of the glazed section of a façade increases, the heat transfer through is increased in addition [22, 28, 60, 63, 64]. It therefore falls upon the designer to create a good balance between an aesthetically pleasing design and a moderate glazing area. Logic dictates that facades exhibiting prolonged solar exposure are designed with minimal glazing-to-wall ratios [62], which is recommended to be decreased by as much as 10% in some cases [65], to reduce the degree of penetration gained through the glazed areas, and vice versa. Contrarily, the glazing-to-wall ratio in shaded facades, should exceed 40% to rely on daylight as the main source of lighting [66].

4.3. Shades, louvers, and setbacks

The application of well-designed shades and vertical louvers adjacent to glazed façade areas allows for additional shielding from sun rays, thus reducing heat gains[67, 68]. Such devices can be calculated based in the location of the building and the façade's orientation[22].This is also true for prominent setbacks of the glazed areas as it inflicts similar effect to the devices mentioned earlier. Historic and contemporary architecture is able to provide a wide variety of designs that allow for shading glazed façade areas. Recent manufacturing technologies have produced efficient perforated metal curtain-wall veils that shade facades in a way similar to the traditional Middle Eastern "Mashrabiya" device. Similarly, horizontal light shelves allow for sufficient penetration of diffused daylight into the building. Additionally, coupling devices such as movable shutters, external blinds, and roller Blind systems with glazing systems is beneficial for introducing additional protection against exposure. A notable advantage of such systems is that the degree of shading can be manipulated, whether manually or automatically, to suit the degree of light penetration required. Furthermore, there is great potential to customize the aesthetic appearance of these devices to perfectly suit the buildings' design[14]. **Error! Reference source not found.** shows examples of effective shading methods. Hence, it is logical to rely heavily on such recent trends of shading strategies in addition to resurrecting traditional methods of in hot regions' glazing.

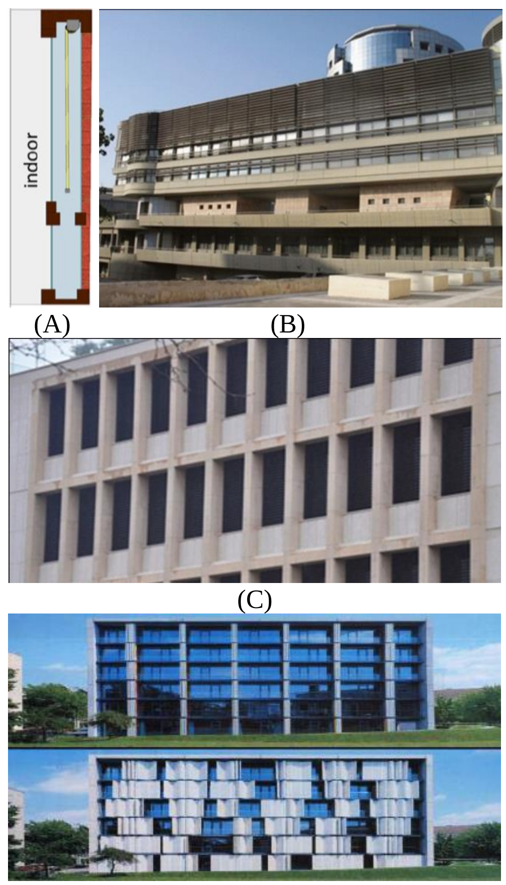


Figure 2: Examples of shading devices: (A) Cross-section showing a roller sheet placed inside window[68]; (B) Horizontal shades over glazed area [69]; (C) Vertical louvers [69]; (D) Moveable and tiltable shutters electronically manipulated according to requirements [70].

5. Glazing characteristics

The thermal performance of glazing systems can be influenced by multiple factors other than its area; hence, designers must take these factors into account to allow for additional mitigation of solar exposure. The following presents some of these factors:

5.1. Glass thickness

The thickness of glass panes affects two aspects of glazing, namely: the heat conduction and the visual transmittance[71, 72].It is crucial to balance these aspects by utilizing the appropriate thickness. Naturally, this will vary from one location to another based on the prevailing amount of solar radiation. However, glass with thicknesses over 12 mm has generally been found to exhibit a substantial reduction in heat conduction [73], as such it is recommended.

5.2. Glass visual transmittance

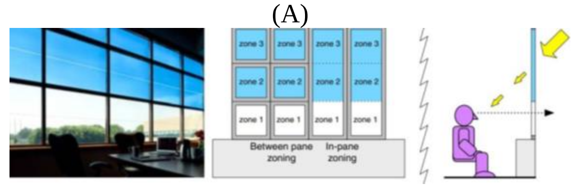
As light passes through the glass panes of the glazing system, a portion of it is obscured. The percentage of passing light is referred to as visible transmittance. Naturally, increased transmittance results in enhanced daylight penetration, thus reducing the demand for artificial lighting[73]. This factor is determined by many characteristics, such as the number of panes, tinting and coatings[74]. Clear glass typically has a visible transmittance of 90% and highly reflective glass of 10%, whereas, double-glazing exhibits a transmittance of 70-80%[73, 75]. While the penetration of day lighting is advantageous, it must be considered carefully as excess day lighting could increase solar heat loads resulting in additional reliance on HVAC systems[76, 77].

5.3. Glass coatings

The glazing panels are responsible for transmitting solar energy through the building. Hence, it is important to carefully select the appropriate type of glazing panels, especially in hot regions, as it is one of the main defenses against excessive heating and can form a low-cost simple method of heat control[14, 78, 79]. Fortunately, many coatings are available that reduce the transmissibility of the glass panes, block UV rays, and transmit visible light, which are selected based on the building's location, climatic requirements, and budget [22, 80, 80, 50]. Many forms of coating can be applied to glazing systems, such as the examples presented in the following:

- Low-emissivity coating: these coatings allow glass to acquire superior thermal performance, with low-costs and weight, by reducing emittance[81–83]. They are created by applying certain additives to molten glass or utilizing soft silver-based surface coatings and transparent metallic layers to create lower emissivity while enhancing transparency[84–87]. For retrofitting purposes, the coatings can be adhered, in the form of polymeric films, to the interior surfaces of existing windows, which is considerably lower in costs and produces lower environmental impacts[88–91].
- Thermochromic glazing: this is a passive technique in which glass surfaces are coated with certain thin polymeric films or inorganic coatings. As a result, the glass is able to change from clear to tinted states, while preserving a degree of transparency. The change between the clear and colored states is triggered by changes in temperature due to a gradual change in the material's nanostructure, causing the transition [92–94].Figure 3(A) shows an example of thermochromic glazing in a test facility.

(A)



(B)

Figure 3: Examples of coatings: (A) Thermochromic coating [106]; (B) Manipulation of the properties of electrochromic glazing to suit building's users [93].

- Photochromic glazing: similar to the previous, the glass is able to transition from clear to tinted. However, the change is triggered by absorption of specific wavelengths of solar radiation[95, 96, 96]. Accordingly, the physical properties of the coating material, such as the refractive index, solubility, viscosity, and wettability, play a role in its effectiveness[97, 98]. Such coating can by created by embedding photoactive materials or dispersion of photosensitive particles[50]. The reduction in solar penetration can potentially allow for up to 4.1% energy savings [99].
- Electrochromic glazing: this type allows for color changes. However, the changes are triggered on-demand by an electric current passing through the glass panes[100–102]. This ability allows electrochromic glazing to be more practical as the buildings users could optimize the timing, degree,

and location of light obscuring properties, as seen in Figure 3(B).

- Photovoltaic glazing: this glass appears transparent, however, its inner structure changes when exposed to certain light wavelengths resulting in enhanced light reflection. This lead to reduced solar gains in addition to generating a small electric current that can contribute to the building's power requirements [103–105].

5.4. Reflectance and color

The building's ability to absorb heat is greatly influenced by color; As commonly known, dark colors absorb more heat than bright colors due to reflecting less solar radiation[10, 107]. Therefore, in a hot environment, increasing reflecting surfaces is an advantageous passive method to decrease the heat absorbed by the building's components and the penetration of heat through window. Yet, it is important to consider the surrounding buildings; introducing highly-reflective glazing may be beneficial for the buildings users, but can also negatively impact other buildings' users as the reflected light causes undesirable glare or focuses light rays. Anti-reflecting coatings can be applied in such cases [50].

5.5. Air tightness

Constructing airtight glazing is of paramount importance to prevent unintentional airflow, especially in regions known for strong seasonal winds; Any leakage could negatively impact the buildings' indoor environment, thus resulting in issues such as thermal discomfort, acoustic disturbances, undesirable odor, diminished air quality, and increased energy consumption[108, 109]. Also, possible vibrations in the glazing units and mold formation could potentially compromise the buildings' integrity[22]. Therefore, it is important to examine sensitive locations within the glazing system during and post-construction; namely panel joints, wall-window connections, and service openings. The use of sealing materials is also highly favorable.

5.6. Moisture control

Many hot areas exhibit significant rainfall, which is a primary source of moisture penetration through building envelopes. This occurs due to small gaps in the glazing system or a lack of sealants. In addition, condensation and vapor diffusion also contribute to elevated indoor moisture levels [22, 110, 111]. Naturally, moisture can cause thermal discomfort [111–113], extensive structural and aesthetic damage,[114] and significant health concerns [115]. However, measures can be taken to mitigate the effect of moisture, which include: a) the employment of protrusions such as balconies and shading devices to counter rainfall; b) the accurate usage of sealants in joints; c) rain drainage systems; and d) the utilization of vapor retardation methods.

6. Multi-pane glazing

In principle, multi-pane glazing consisting of two, three, or more overlaying facades offers a thermal buffer zone that can mitigate changes in temperature between the building's exterior and interior[116, 117].For instance, studies report that utilizing a double-pane instead of a standard pane can reduce energy consumption by up to 72.6% of façade related energy usage and reduce heat gains by 12% [24, 118]. Many design variations of this principle have been created and widely utilized. The mentioned designs vary in many aspects, such as the buffer zone's depth and used the types of materials. Also, the interior façade may be fully or partially glassed, sealed, or have operable windows which are motorized, or manually controlled. The buffer zone provides a perfect location for installing blinds and shading mechanisms [14, 119]. The buffer zone is also optimal for introducing transparent thermal insulations, gases, and even vacuumed spaces, resulting in exceedingly superior insulation [117, 120–122]. Figure 4 displays the cross-sections the highlight the manufacturing method of examples of the mentioned multi-pane glazing systems. This seems very suitable to hot regions as they form a passive method of mitigating solar exposure with minimal costs. It is important to mention that these methods are very successful to the extent that studies recommend that dedicated disciplines of engineering should be concerned with double glazing.

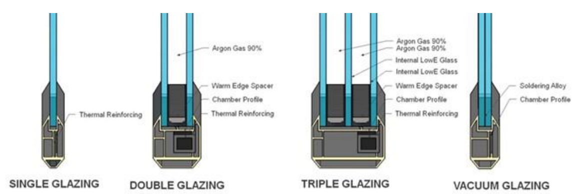


Figure 4: Cross-section of multi-pane glazing systems, adapted from [73]

7. Post-construction considerations

As the construction phase of a façade concludes, various façade components, including glazing, are expected to be in perfect functional and structural condition[123]. However, as time elapses, certain aspects of the façade will degrade due to exposure and other factors[22]. Such degradation could result in the glazing system failing in terms of optimal performance. Furthermore, the degradation can result in large financial losses, aesthetic failures, and a possible risk of injury. Hence, steps must be put in place to reduce the degradation of glazing or prolong its life span, which are legally mandatory in some countries [124]; Routine inspections should be carried out in order to detect any faults or degradations as early as possible. The construction drawings or documents are first reviewed to understand the original design of the glazing system. Then, a visual inspection is carried out in appropriate weather conditions to compare the actual status of the glazing system with the original design [125, 126]. Obvious deterioration, such as cracks and displaced elements, is easily noticed. Other issues may not be as easily noticeable, such as concealed cracks or yet-to-occur degradation. As such, a more thorough inspection is required using a variety of techniques, such as thermal imaging or laser scanning. A report of the detected issues is compiled and utilized to manage the required maintenance[22]. Accordingly, immediate corrective measures are taken to address the detected issues in the form of repair, rehabilitation, or strengthening[23, 125]. It is important to note that maintenance efforts must be carried out within an appropriate time frame. Unnecessarily postponing maintenance can lead to increased costs and additional laborious maintenance processes [22].

Another integral part of maintenance is cleaning the glazing system, which is vital to achieving an optimal aesthetic appearance. Many factors, such as the building's purpose, location, and weather, often determine the frequency of cleaning. For example, many hot climates are accompanied by desert conditions, such as those in Middle Eastern countries, which result in the accumulation of sand or dust that obscures the transparency of glazing systems. Hence, a lack of cleaning can hinder the functionality of the glazing system. More importantly, cleaning also has an advantageous impact on durability as it contributes to eliminating pollutants such as Sulphur and acid rain contaminants, thus mitigating degradation. Examples of the various cleaning processes include chemical, non-chemical, water, abrasive, and hybrid approaches which are carried out taking the façade's materials in mind.

8. Glazing design strategy

The mentioned earlier displays generic design details and general characteristics of glazing. Yet, designing glazing systems in hot regions requires special consideration to overcome climatic and regional challenges, which are also deeply discussed. Based on this, it is possible to highlight the unique region-specific considerations and propose a complementary thinking strategy for designers to employ, in addition to conventional thinking, when designing glazing in hot regions in order to create glazing systems that are not only aesthetically pleasing but also energy efficient and comfortable. It is important to point out that the proposed strategy is not a substitute for the standard design process; rather, it functions as a checklist utilized to further optimize the typical design outcomes. Specifically, the strategy is ideal for aiding façade glazing consultants they may be employed to enhance the architectural design of a project after or during design, which is a practice the study targets to promote.

The proposed strategy aims to allow designers to determine the appropriate glazing characteristics to employ, based on the requirements of their project. However, to formulate the proposed strategy, it is imperative to correlate the measures taken to optimize glazing to the appropriate design or construction phase, in order to limit waste in time or resources. Hence, as presented in Table 1, the appropriate phase of the design or construction for each characteristic is identified (denoted by ✔). In addition, stages where it is possible to re-design or change the glazing characteristics, for further optimization, are identified (denoted by ■). The corresponding section within the present study for each glazing characteristic is also mentioned.

Table 1: appropriate phases for determining glazing measures.

Characteristic	Orientation	Glazing ratio	Shading devices	Glass thickness	Glass type	Coatings	Reflectance	Air tightness	Moisture control	Pane count	Maintenance
Study section	4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	5.6	6	7
Conceptual design	✔	✔	✔	■							
During construction			■	✔	✔	✔	✔	✔	✔	✔	
Initial operation				■	■	■	■	■	■	■	✔
Operational stage				■	■	■	■	■	■	■	■

✔ *denotes optimal stage for determining measure.*
■ *denotes staged where further optimization is possible.*

In detail, the proposed thinking strategy comprises of four stages, after or during the initial buildings design process as follows:

- Stage 1: focuses on gathering and analyzing the conceptual design of the building with emphasis on the glazed façade areas. The purpose of this is to infer means to further optimize the glazed areas by

a) detecting design flaws; b) promoting design advantages; c) determining climate and regional responsive measures. The goal of this stage is to highlight the design's requirements, in the mentioned context, and accordingly make informed comprehensive design notions.

- Stage 2: aims for utilizing the previous information to optimize the conceptual design and formulate actual design modifications that address the responsive requirements determined earlier.
- Stage 3: aims to further echo the design's responsive requirements through the technical detailing of the glazing systems. A process which will require the consultation of other experts and obtaining manufacturing information.
- Stage 4: aims to create a post-construction maintenance plan to ensure the sustainability of the glazing system and to minimize the impact of the natural surrounding hot environment.

The process shown in **Error! Reference source not found.** highlights the proposed staged strategy mentioned earlier. To further clarify this strategy, Table 2 illustrates the proceedings of hypothetical example created by the author. The example assumes that a conceptual design of a project in a hot region is created, and the glazed areas of the facades require optimization to enhance the indoor thermal environment. Accordingly, glazing-related decisions are made in light of the proposed strategy.

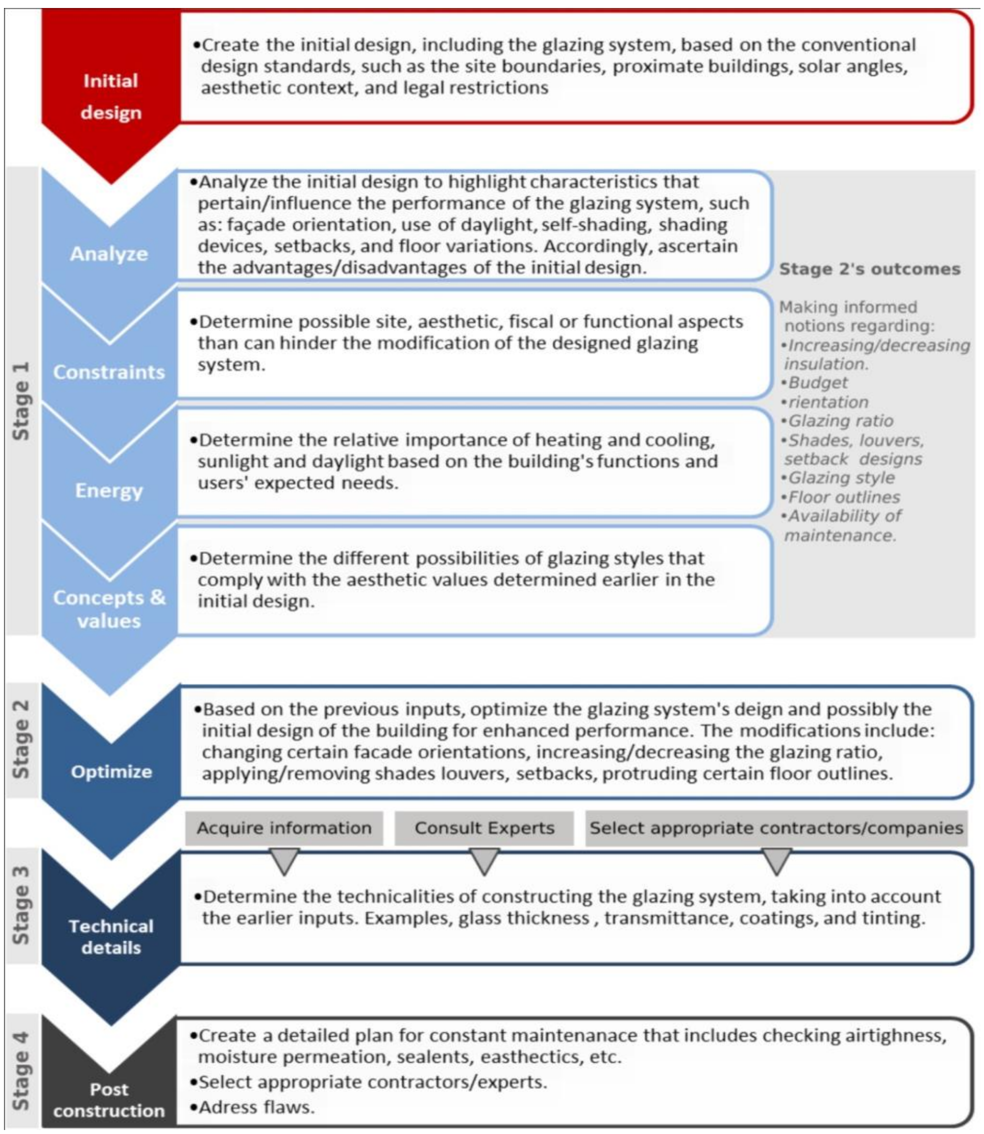


Figure 5: The proposed complementary thinking strategy for glazing in hot regions.

Table 2: Hypothetical example of the proposed strategy complementing a conceptual design.

	* **Pre-implementation of the strategy, the initial conceptual design is reviewed**
Stage 1	analysis is performed to deduce the following notions:
Identifying Issues constraints, and preferences	→ *The glazed areas are unprotected against solar exposure* → *Facades A, B…etc. are problematic due to facing intense direct solar exposure and glazing-to-wall ratio is high.* → *Façade C is exposed to moderate solar exposure.* → *Facades E, F…etc. are partially protected with surrounding shading devices.* → *Façade G is partially protected with surrounding shading devices, but required daylight.* → *The budget allows for further modifications, up to an amount of X$.* → *The building's style is contemporary architecture.*
Stage 2	the glazing system is optimized accordingly
Defining optimal generic solutions to issues	→ *Facades A, B…etc. are coupled with double-glazing in addition to frontal perforated shading veil-style cladding, in a contemporary style.* → *Facades C…etc. is coupled with double-glazing only.* → *Facades E, F…etc. are enhanced with photochromic coatings.* → *Façade G is enhanced with low-emissivity coating to allow daylight.* → *Deliberate with designers/owners/users to orient Block X of the building 30° to the north to optimize the glazing's orientation without impacting function or design.*
Stage 3	technical details are specified, after surveying/consulting experts
Set detailed technical specifications	→ *Glass thickness will be 12 mm.* → *Double-glazing will be type X with sealants of type, types Z will be disregarded due to expenses.* → *The veil-style cladding will be manufactured from X.* → *Photochromic coatings will be type Z.* → *Review alternative/companies/vendors to ensure modifications are within budget.*
Stage 4	A maintenance plan is devised
Determining future maintenance plans	→ *Maintenance for facades A, B … etc. will be conducted on 6-month bases, due to many perishable elements.* → *Maintenance for facades E, F … etc. will be conducted annually.* → *Section X, Y, and Z of the glazing will be checked every two months.*

9. Conclusions and recommendations

The present study has shown that glazing systems, if not well designed, can pose a climatic threat to building users, despite their advantageous aesthetic values. The study has also demonstrated that glazing's characteristics may play a significant role in its environmental and physical performance. To this end, the study has highlighted common and innovative measures that allow designers to decrease solar penetration, heat gain, and reliance on HVAC, in addition to increasing insulation. This is carried out to enable designers to utilize glazing systems to contribute to a more sustainable and comfortable indoor environment.

The knowledge portrayed in the study is utilized to formulate a comprehensive thought strategy that pertains to all of the building stages, from conceptualization to operation, which is based on a rational and critical examination of glazing systems' properties. The proposed strategy consists of four stages that revolve mainly around analyzing the building's thermal glazing requirements and appropriately addressing them. This output facilitates the role of both designers and specialized consultants in terms of optimizing conceptual glazing designs and determining the most suitable materials and technologies to utilize. More importantly, the strategy ensures the full consideration of all related possibilities in this regard. Furthermore, the suggested strategy encourages the adaptation of architectural disciplines focused on hot-region glazing designs.

Based on the study, designing glazing in hot regions should entail many special considerations to mitigate the effects of harsh weather conditions and create comfortable and sustainable indoor environments, as glazing systems are considered sources of exposure to the exterior environment. Accordingly, the study offers many recommendations that fall into the realm of both design and technical implementation, as follows:

A. Designers must carefully consider influential design aspects of glazing systems, such as manipulating the buildings' orientation and changing the area of glazing. In this context, the following is recommended:
   - Strategically positioning buildings to maximize shade, minimize direct sunlight exposure, and reduce excessive heat gain.
   - Incorporating shading devices and louvres to enhance energy efficiency and block unwanted solar radiation.
   - Considering the size and shape of the glazing area to balance between the desire for natural light and the need to minimize heat gain.
   - Utilizing advanced glazing technologies, such as low-emissivity coatings and double-glazed windows, in order to significantly reduce heat transfer through the glazing.

B. The technical specifications of glazing systems, such as material selection and coating application, must be meticulously determined. This is crucial to ensuring the optimal performance of the glazing system in terms of energy efficiency and thermal comfort. This process should take into account factors such as:
   - Insulation properties.
   - Sealing techniques and prevention of air leakage.
   - Durability.
   - Visual aesthetics.
   - Coating application and specifications.
   - Proper installation and execution.

C. Glazing measures should not be individually implemented; rather, the use of multiple conjoined measures is imperative to obtain optimal effectiveness; These measures complement one another to enhance insulation properties and reduce heat transfer, resulting in an improved building envelope.

D. Building operators must keep a vigilant eye on the utilized glazing system through a rigorous maintenance plan that allows for constant monitoring and flexible adjustments. This ensures that the climatic and aesthetic properties of the glazing system are in continuous prime condition. Besides, it is possible that investing in ongoing maintenance can reduce running costs, prolong longevity, and improve compliance with environmental standards.

E. Designers, consultants, and operators should utilize the proposed thought strategy offered by the present study, or other similar strategies, to ensure that all aspects of glazing systems are fully considered.

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