From Character to Parameter: A Review of Regional Saudi Architecture and a Performance-Anchored Framework for Applying the Saudi Architecture Characters Map

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Abstract

Since the Saudi Architecture Characters Map was launched in March 2025, the façade of a new building in Makkah is no longer a matter of taste between the architect and the owner. The map divides the Kingdom into 19 regional characters, each applied through a traditional, transitional or contemporary approach, and compliance is now checked at the building permit stage. The risk seen in daily practice is formal compliance: the same air-conditioned concrete box with large glazed façades, covered at permit stage with a skin of wood substitutes and decorative screens that do no environmental work. This review brings together published evidence on the climatic performance of regional Saudi elements, the identity debate in Saudi and Gulf cities, and the codes and digital tools that act on new façades. The evidence shows that the rawshan cuts peak solar gain sharply but does not replace air conditioning in a hot and humid summer, that thick earthen walls lower peak demand without cooling a house on their own, and that Saudi architects themselves rank climate response above copying traditional forms. The character guidelines and the energy code (SBC 602) are checked in two separate routes that never meet. The paper therefore proposes the Performance-Anchored Character Translation (PACT) framework, which turns the descriptive guidelines into five families of measurable design parameters, including a new indicator for cleaning and maintenance access, and tests every option against thermal, daylight and authenticity anchors. A worked example for a two-storey villa and a research agenda close the paper.

Keywords: Saudi Architecture Characters Map; regional architecture; vernacular architecture; architectural identity; design guidelines; rawshan; parametric design; daylight; building energy performance

1. Introduction

Before the Saudi Architecture Characters Map, designing a façade in Makkah was a matter of taste between me and the owner, as long as we respected the setbacks and the permitted heights. Today, the first question when any new file is opened is: in which zone does the site fall, and which character is required? The map was launched on 16 March 2025 [1,2]. It names 19 regional characters, and each can be applied through a traditional, a transitional or a contemporary approach; the contemporary approach is expected to cover about 80% of new projects [3]. Compliance is part of

the building permit [3,4], and Makkah is one of the four cities of the first phase [3]. In Jeddah, the Hejazi coastal guidelines are now mandatory for new residential permits and façade renovations, with fines for offices, contractors and owners [5].

The risk I see every day is formal compliance. The same concrete box is designed as before, air-conditioned and with large glazed façades, and then a skin of wood-plastic composite (WPC) frames and decorative screens is fixed to it only to get the file past the reviewer. These elements do no environmental work. The building receives approval because it carries the image of the character, while the climatic logic that produced that image is lost. This concern is not new. Saudi institutions have encouraged regional identity since the 1980s [6], and Gulf and Saudi projects have often borrowed the image of the vernacular without its logic [7,8].

The existing research does not answer this problem because it is detached from the reality of permits. Energy studies measure the performance of the rawshan, the mashrabiya or the mud wall in isolation from municipal requirements [9–12]. Identity studies speak a theoretical language that does not help the engineer who works with the numbers of the building code [13,14]. The character guidance describes the regions in words and images, while the energy code for low-rise housing, SBC 602, works with numbers [15].

The aim of this paper is to bring the two tracks into one practical framework. The descriptive guidance of the map is turned into clear numbers, so that a traditional element placed on a façade can be shown to shade and serve the building and not to sit there as decoration only. To support this, the paper (1) sets out the policy facts of the map, (2) reviews the measured performance of regional Saudi elements, (3) summarises the identity debate in Saudi and Gulf cities, (4) examines how the current instruments and digital tools act on new façades, and (5) proposes the PACT framework with a worked example.

2. Review Method

This is a structured narrative review. A narrative design was used because the sources mix field monitoring, building simulation, surveys and policy documents, which cannot be pooled statistically. Literature searching was assisted by a generative AI tool, as stated in the Declarations; every source was checked by the author.

Scoping search. The open bibliographic index OpenAlex was searched through its public API. Four core phrases were searched in titles and abstracts together with the terms Saudi OR Gulf: “vernacular architecture” (78 records), “traditional architecture” (112), “architectural identity” (43) and “urban identity” (38). The counts were last checked on 10 November 2026. Together the four queries returned 271 records before de-duplication, 246 of them from 2000 onward (Figure 1).

Targeted searches. Further OpenAlex queries covered single elements and regions: mashrabiya OR rawasheen with Saudi OR Jeddah (17 records); Najdi OR Hijazi with architecture OR building (100); Asir OR Aseer OR Abha with architecture OR vernacular (89); Ahsa OR Hofuf with architecture OR houses (39); Salmani OR Salmaniah with architecture (8); mashrabiya with daylight OR energy (80); and parametric OR generative with “vernacular architecture” (82). Relevant records were screened by title and abstract and followed by backward citation tracking.

Inclusion. Peer-reviewed sources with a registered DOI were included when they dealt with regional Saudi or Gulf architecture, its performance, its identity, or the tools that translate it into new design. Each DOI was checked against its Crossref record, and a source was used only when its abstract could be read. Policy facts were taken only from official or news pages. The final base is 35 peer-reviewed sources and nine official or news pages.

Limitations. Only one bibliographic index was searched. The detailed guideline handbooks on the official portal were not reviewed; the analysis of the guidance rests on the portal pages and their published descriptions.

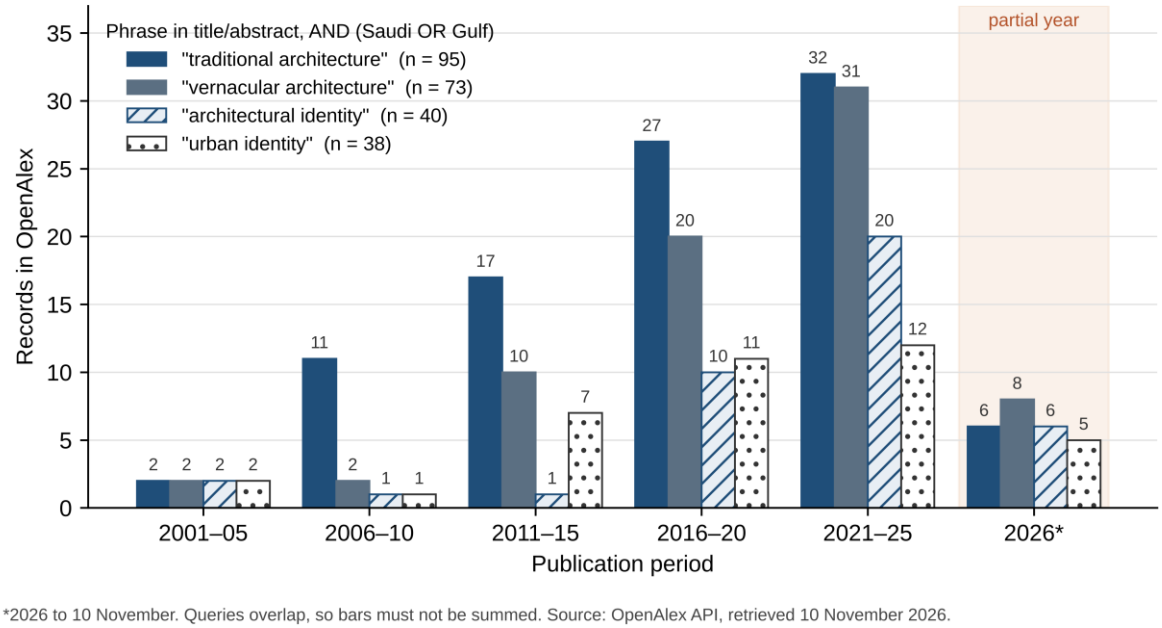


Figure 1. OpenAlex records combining Saudi OR Gulf with four core phrases in title or abstract, by publication period (2001–2026). Queries overlap and should not be summed. Retrieved 10 November 2026; 2026 is a partial year.

The number of records in 2021–2025 is the highest of any five-year period for all four phrases, and 188 of the 246 records since 2000 appeared from 2016 onward. The field was already growing before the map was launched.

3. Policy Context of the Characters Map

Table 1 lists the main policy facts that a designer in the first-phase cities now works with.

Table 1. Policy facts of the Saudi Architecture Characters Map.

Item	Fact	Source
Launch	16 March 2025	[1]
Characters	19, not tied to administrative boundaries	[1,2]
Approaches	Traditional (historic sites), transitional (around historic districts), contemporary (about 80% of new projects)	[3]

Item	Fact	Source
Regulating plans	Levels 1–3: Level 1 traditional only; Level 3 allows all three approaches (Yanbu extract, 2024)	[16]
Scope today	Commercial projects of any height, government and major projects, residential villas	[3]
First phase	Makkah, Al-Ahsa, Taif and Abha	[3,17]
Expected impact	More than SAR 8 billion to GDP and more than 34,000 jobs by 2030	[2]
Jeddah mandate (2026)	Hejazi coastal guidelines mandatory for new residential permits and façade renovations; fines of SAR 1,000–5,000 for design offices, SAR 2,000–10,000 for supervisors and contractors, SAR 100–500 for owners	[5]
Earlier instrument	King Salman Charter for Architecture and Urbanism, 1 December 2021	[18]

The permit route works as follows in practice. The owner contracts a licensed engineering office through the Balady platform. The office prepares the drawings and designs the façades according to the zone of the plot on the regulating plan. After submission, the façades are referred to the design studio of the Saudi Architecture Support Center [17]. From my own dealings with it, the review there is mainly visual and advisory. If the reviewer finds that the façade lacks the features of the character, the request is not rejected; it is returned to the office with notes, such as changing the colour shades, adding claddings that imitate local materials, or making the façade divisions clearer. The designer revises and resubmits until the permit is issued. This matches the published description that non-compliant designs are returned with notes rather than rejected [3].

What is good in the current guidelines is their flexibility. They follow geography and climate rather than administrative boundaries, and the three approaches open the door to modern materials at a reasonable cost. What is missing is a numerical ruler. The guidelines explain the character in words and images and leave the judgement to the eye of the reviewer, with no direct numerical link to the energy and daylight calculations. The Hejazi coast page, for example, describes rawasheen, coral stone, white plaster and geometric ornament, but gives no ratios for openings or projections [19]. An earlier assessment of the King Salman Charter reached a similar conclusion: its values were sound but did not reach the level of detailed implementation criteria [14].

4. Evidence on the Climatic Performance of Regional Elements

Table 2 summarises the measured and simulated evidence by character group.

Table 2. Measured or simulated performance of regional Saudi elements.

Character group	Element	Study type	Main result	Source
Hejazi Coast (Jeddah)	Coral-stone walls, night ventilation (house of 1856)	Field monitoring, Dec 2021–Aug 2022	Thermal mass steadied indoor air; night ventilation lowered indoor temperature	[9]
Hejazi Coast (Jeddah)	Mashrabiya with evaporative add-ons	Field experiment, two rooms	Outdoors 40–41.6 °C; closed screen 35.4–35.8 °C; wetted cloth 33.8 °C; comfort only 1–9 a.m.	[20]
Hejazi Coast (Jeddah)	Rowshan, six opening sizes	Simulation and CFD	Noon indoor temperature −15 to −22% (Nov–Apr, north side); comfort in 42.3% of annual hours with a 5 × 5	[21]

Character group	Element	Study type	Main result	Source
			cm grid	
Western region	Traditional mashrabiya	Thermal simulation	Peak solar gain −77.8%; operative temperature −14%; monthly cooling −5.7%; daylight factor +35.5%	[10]
Makkah, Jeddah, Riyadh, Al-Baha	Rawshan blind thickness	Calibrated simulation, genetic algorithm	Energy saving 3.6% (Makkah, Riyadh) to 16.6% (Al-Baha) with sufficient useful daylight	[11]
Five Saudi climates	Adobe walls, mashrabiya, courtyard	Calibrated simulation	Adobe −6% annual and −19% peak electricity; mashrabiya −4% and −3%; courtyard no saving	[22]
Central Najdi (Ushaiger)	Thick mud-brick walls	Pilot monitoring, Aug–Sep 2025	Walls damped part of the daily swing; unoccupied rooms stayed very hot; infiltration drove humidity	[23]
Central Najdi	Courtyard house	Ethnography, six houses	Courtyard is the social and environmental centre of the house	[24]
Abha Highlands / Asir	Mud house vs concrete-block house	Field measurement, interviews	Mud house performed better; passive strategies also helped the concrete house	[12]
Jazan region (Tuhama, mountains, Farasan)	Compactness, height-to-width, window-to-wall ratio	Morphological analysis, 12 buildings	Mountain houses taller and less open; Farasan houses more open	[25]
Al-Ahsa Oasis, Al-Qatif Oasis, East Coast	Courtyard houses	No performance study found	Evidence gap	Section 8

4.1 The rawshan

The rawshan is excellent at breaking direct sun and reducing peak heat. The reported cut in peak solar gain reaches 77.8% [10], and noon indoor temperature fell by 15–22% in the mild months [21]. Its effect on annual energy is modest in hot cities such as Makkah and Riyadh (3.6%) and larger in the highlands (16.6% in Al-Baha) [11]. In the heat and humidity of summer it cannot replace the air conditioner: even with wetted cloth, the room was comfortable only between 1 and 9 a.m. [20]. Its real role today is therefore to take load off the air conditioning at midday and to allow natural ventilation in winter and spring.

4.2 Earth walls and the courtyard in Najd

Thick walls delay the arrival of heat and lower the peak in electricity use, by 19% in a calibrated model [22]. They do not cool the house on their own if hot air leaks in: in Ushaiger, infiltration rather than wall thickness controlled the indoor conditions, and the unoccupied rooms stayed very hot in August [23]. The courtyard is a wonderful element for privacy and family life [24,26], but it saved no energy in a modelled air-conditioned house [22]. In my view, it can only help if it is shaded and its proportions are studied with care.

4.3 Asir, Jazan and the highlands

The milder climate of the mountains lets passive solutions work better. The same rawshan saved 16.6% of energy in Al-Baha against 3.6% in Makkah and Riyadh [11], and in Asir the traditional mud house performed better than an adjacent concrete-block house [12]. The Jazan study showed that the form of the traditional building, its height and its share of openings, is a direct geometric translation of the climate of its area [25]. This is the idea on which the framework in Section 7 is built.

4.4 The modern villa and large glazing

Cooling takes more than 70% of residential electricity use in the Kingdom [27]. In Makkah, the biggest mistake we make is to imitate large glazed façades. In a modelled villa, smaller windows combined with insulation and shading cut cooling energy by 68%, more than two thirds [27]. For school classrooms in Saudi climates, a glazing-to-wall ratio of about 10% has been recommended, with south and east orientations gaining most heat [28].

4.5 Daylight

Our problem under the sun of Makkah is not a lack of light but glare and heat. When we enlarge the glazing without shading, the residents close the curtains and live on electric lamps at noon. When we cover the façade too heavily with rawasheen, the rooms become dark. We need to balance useful daylight against shading. Dynamic, climate-based metrics such as useful daylight illuminance and spatial daylight autonomy are better suited to this than the static daylight factor [29], and the rawshan can be optimised to keep useful daylight while saving energy [11].

5. Identity in Saudi and Gulf Cities

What convinced me most is a 2026 survey of 132 Saudi architects in private, government and academic practice. They ranked climate response as the first identity strategy (relative importance index 0.85), followed by local cultural values (0.84), and placed the direct copying of traditional forms near the bottom [13]. This shows that the practising architect sees identity in the honesty of the building with its environment, not in copying the past. Other Saudi studies point the same way: projects that use vernacular principles gained public acceptance [30], while revivals in Riyadh that focus on visual form have been criticised by design teachers [8].

The Gulf experience teaches an important lesson. Souq Waqif and Souq Al Wakrah in Qatar work well for pedestrians [31], yet they have been criticised for using traditional motifs as a stage set for visitors [7]. The wind towers of Dubai, which arrived through trade in the early twentieth century, became a modern symbol of the city [32]. When such towers and motifs turn into closed symbols with no function, we have made a theatrical decoration and lost the essence of architecture. Table 3 summarises these positions.

Table 3. Positions in the identity debate and what they mean for the map.

Position	Example	Source	Meaning for the map
Restoration and continuity	Gulf restoration; Qatari souqs	[31,33]	Learn from documented local buildings first
Critique of pseudo-	Souq Waqif, Souq Al Wakrah	[7]	Guard against façade-only compliance

Position	Example	Source	Meaning for the map
heritage			
Changing symbol	Dubai wind towers	[32]	A symbol can keep its image and lose its function
Regionalism at city scale	"Big Regionalism" in Dubai	[34]	Massing and urban form belong in the character
Climate before image	Survey of 132 Saudi architects	[13]	Performance should be part of compliance
Values without criteria	King Salman Charter assessment	[14]	Indicators make review consistent

Makkah has its own story. The old building regulations focused on investment and the number of floors and neglected identity, until the city filled with blank masses that do not resemble it [35]. The real heritage of Makkah, down to its finest plant motifs [36] and the details of its rawasheen [37], combined spiritual meaning with daily function: privacy, ventilation and shade.

6. Two Separate Reviews and the Tools That Could Join Them

Imagine a new villa in Jeddah or Makkah. The office places a large glazed opening on the first floor and fixes wooden rawshan-shaped cladding next to it on the solid wall, then paints the façade pearl white and sand. The design passes the studio, because the reviewer sees the features of the Hejazi character. In the parallel track, the office submits the SBC 602 energy calculation and passes it with insulated blocks and double glazing. The building passes both tests and receives its permit, yet neither review asks whether the rawshan actually sits in front of the glass to shade it at peak hours, or whether it lets enough daylight into the room behind it. Table 4 shows why: the instruments regulate different things.

Table 4. Instruments acting on a new Saudi façade.

Instrument	What it regulates	Form of the rule	Linked to performance?	Source
King Salman Charter (2021)	Values	Principles	Indirectly	[14,18]
Characters Map guidelines (2025)	Exterior design	Descriptions, images, studio review	No performance test on the pages reviewed	[3,19]
Regulating plans	Which approach applies where	Levels 1–3	No	[16]
Jeddah mandate (2026)	Residential façades	Elements, materials, palette, fines	Ventilation and shade named as aims	[5]
SBC 602	Envelope and systems	Numeric requirements	Yes, energy only	[15]

Codes on building form work best when they fix a few essentials clearly and leave the rest to design judgement [38,39]. The tools to join the two reviews already exist. In engineering practice we rely mainly on Revit for building information modelling (BIM), which can be linked to visual programming in Dynamo, or to Grasshopper with the Ladybug and Honeybee tools for energy and daylight simulation. Libraries of smart heritage objects for Hijazi and Najdi elements have been built [40,41], new rawashin designs have been generated by machine learning [42], and parametric models linked to simulation allow many options to be tested early [43,44]. With such libraries, Revit

can read the schedules of areas and openings to compute the window-to-wall ratio of each façade, count the share of elements that really shade against those fixed on blank walls through element tagging, and run a quick shoebox simulation of a room to produce one numerical report showing that the façade achieves both identity and efficiency.

7. The Performance-Anchored Character Translation (PACT) Framework

PACT turns a regional character into five families of design parameters (P1–P5) and tests every option against three anchors (A1–A3) (Figure 2). In my view the framework is practical because it reduces the character to five clear groups and only three tests, without complication. Its most important part is the authenticity anchor (A3), because it immediately reveals any element placed as a decorative skin on a blank wall. I add one indicator to the original set: cleaning and maintenance access for screens and rawasheen (P3.4), because deep screens in our dusty climate turn into a visual and environmental burden if the designer gives no practical way to clean and maintain them.

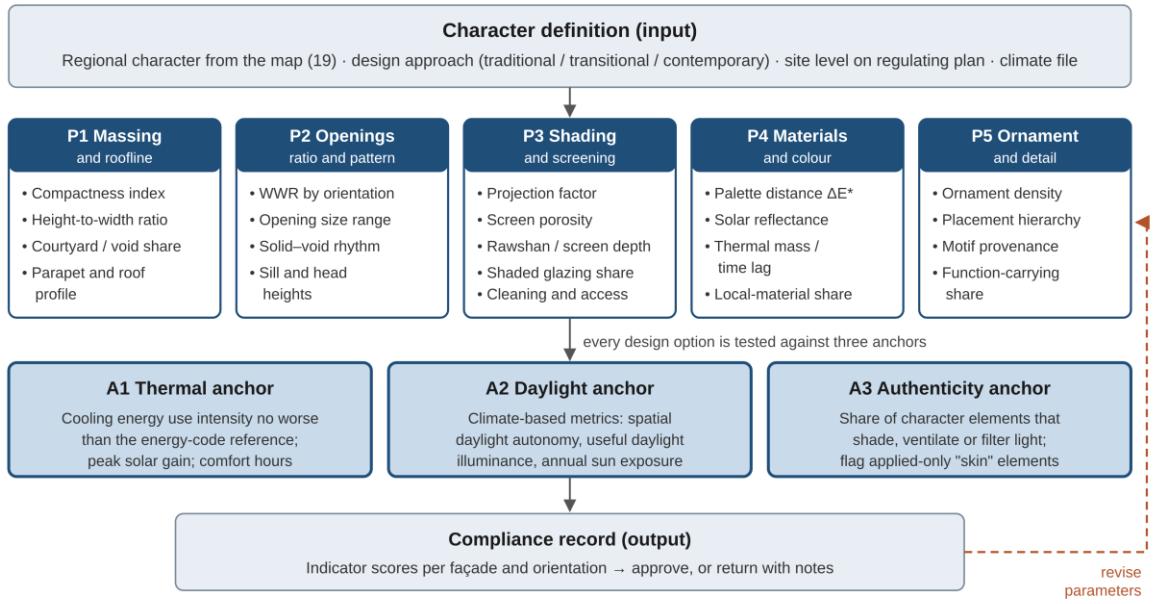


Figure 2. The Performance-Anchored Character Translation (PACT) framework. Five parameter families (P1–P5) translate a regional character into measurable design variables; three anchors (A1–A3) test every option before it enters the compliance record.

Table 5. Proposed PACT indicators (for calibration, not adopted standards).

Code	Indicator	How the target is set	Source
P1.1	Compactness index	Band from a measured sample of local buildings	[25]
P1.2	Height-to-width ratio	Band from local sample; higher in mountain types	[25]
P1.3	Courtyard or void share	Present where the character has courtyards; not counted as energy saving unless shaded	[22,24]
P2.1	Window-to-wall ratio by	Upper limit set by A1; south, east and west most critical	[27,28]

Code	Indicator	How the target is set	Source
	orientation		
P2.2	Opening size range	Within the range of the local sample	[25]
P3.1	Projection factor	Set by solar geometry at design hours	–
P3.2	Screen porosity	Balance between solar gain and daylight	[10,11]
P3.3	Shaded glazing share	Share of glazing in shadow at summer design hours	–
P3.4	Cleaning and maintenance access (new)	Target to be set in calibration with maintenance teams	Author's proposal
P4.1	Palette distance	Within tolerance of the character palette	[5]
P4.2	Solar reflectance and thermal mass	Consistent with A1	[22]
P5.1	Ornament density	Band per character and approach	–
P5.2	Function-carrying share	Share of character elements that do environmental work; above half for transitional and contemporary approaches	Author's proposal
A1	Cooling penalty	Cooling energy no worse than the SBC 602 reference of the same building	[15]
A2	Daylight and glare	Useful daylight illuminance, spatial daylight autonomy, annual sun exposure	[29]
A3	Applied-only flag	Elements with no environmental role are reported, not banned	Author's proposal

The anchors are relative, not absolute: A1 compares the design with the same building designed to the code, which is fair across climates. Decorative elements remain allowed, since ornament carries its own cultural meaning [36]; the framework only makes their share visible to the reviewer.

7.1 Worked example

When I explain the framework to a new engineer in the office, I take a two-storey villa in the contemporary Hejazi approach. We do not start by fixing decoration on the façade. First, in Revit, we set the massing and its proportions so that the building is compact, and we choose light colours such as pearl white and the sandy tones of Manqabi stone to reflect the sun (P1, P4). Second, we reduce the windows on the west and south as much as possible and open the large windows to the north (P2). Third, we place the contemporary projections and screens, the rawasheen, directly in front of the large windows, and we run one main room through a quick simulation with Dynamo and Ladybug to check two things: that the screen breaks the midday sun and reduces the cooling load, and that the room still receives natural light without glare (P3, A1, A2). If we want a decorative band at the entrance as an aesthetic touch, the model accepts it, as long as most of the other character elements on the façade work and shade (P5.2, A3). Finally, the model produces a ready table that we attach to the permit, and it convinces the studio reviewer from the first submission.

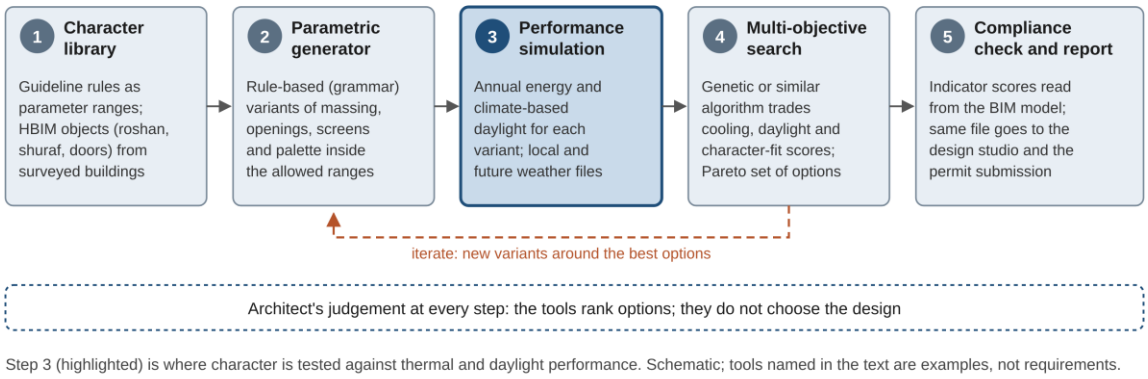


Figure 3. A computational workflow for PACT: character library, parametric generator, simulation, multi-objective search and a compliance report read from the same model.

8. Research Gaps

Three gaps matter most in my view, and practice adds a fourth.

1. **Regions without performance data.** No performance study was found for the Al-Ahsa Oasis, Al-Qatif Oasis or East Coast characters, although Al-Ahsa is in the first phase of mandatory application.
2. **Two separate review tracks.** The façade is checked visually in the design studio and thermally under the building code, with no link between the two (Table 4).
3. **Post-occupancy evaluation.** After the Hejazi character became mandatory in Jeddah [5], and as it spreads in Makkah, the real effect on electricity bills and on residents' satisfaction should be measured against ordinary buildings.
4. **Durability of substitute materials and life-cycle cost.** Projects today use WPC wood substitutes, glass-fibre reinforced concrete (GRC) sections and modern paints to imitate rawasheen and stone. No study measures how these materials behave thermally and visually after five or ten years of exposure to the sun, dust and coastal humidity of Makkah and Jeddah, or whether they become a thermal and maintenance burden on the owner.

9. Conclusions

The traditional architecture of the Kingdom's regions was never a set of shapes for decoration. It was a set of intelligent solutions for living with a harsh climate. If the Saudi Architecture Characters Map is treated as a visual checklist inspected by eye and separated from the energy code, our cities will fill with concrete boxes wearing false heritage masks. The solution is to link the form of the façade to its environmental performance through simple numerical criteria, so that new buildings carry our identity and serve their occupants at the same time. The PACT framework and its indicators are proposals; their bands should now be calibrated on measured samples of each character and tested on pilot projects in the first-phase cities.

Declarations

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References

1. Saudipedia. Saudi Architecture Characters Map. Online (accessed on 6 November 2026).
2. Asharq Al-Awsat. Crown Prince Launches Saudi Architecture Characters Map. 17 March 2025. Online (accessed on 6 November 2026).
3. Saudi Architecture (Development Authorities Support Center). Saudi Architecture Portal: Design Guidelines, Design Approaches and Frequently Asked Questions (trial version, updated 2 September 2026). Online (accessed on 6 November 2026). (In Arabic)
4. Al-Watan. Compliance with the Saudi Architecture Design Guidelines and Building Permits. 17 April 2025. Online (accessed on 6 November 2026). (In Arabic)
5. Gulf News. Saudi Arabia Makes Hejazi Coastal Design Mandatory for Jeddah's New Homes and Renovations. Updated 1 October 2026. Online (accessed on 6 November 2026).
6. Alzahrani, A. Understanding the role of architectural identity in forming contemporary architecture in Saudi Arabia. *Alex. Eng. J.* **2022**, 61, 11715–11736. https://doi.org/10.1016/j.aej.2022.05.041
7. Dabaieh, M.; Sakr, M. The illusion of heritage: Critiquing pseudo-earthen vernacular architecture in Qatar. In *Proceedings of the HERITAGE2025 International Conference on Earthen & Vernacular Heritage Conservation, Adaptive Reuse & Urban Regeneration*; 2025. https://doi.org/10.4995/heritage2025.2025.19189
8. Yun, S.H.; Yi, T.Y. Architectural design studio works exploring archetype based on ecological sensibilities from experiencing Najdi architecture of At-Turaif Town and modern Riyadh. *Buildings* **2024**, 14, 3671. https://doi.org/10.3390/buildings14113671
9. Basunbul, A.I.; Braham, W.W. Climate responsive lessons from an architectural and ethnographic study of Hijazi traditional dwellings in Jeddah, Saudi Arabia. *Front. Built Environ.* **2023**, 9, 1127615. https://doi.org/10.3389/fbuil.2023.1127615
10. Taki, A.; Kumari, H. Examining Mashrabiya's impact on energy efficiency and cultural aspects in Saudi Arabia. *Sustainability* **2023**, 15, 10131. https://doi.org/10.3390/su151310131
11. Alelwani, R.; Ahmad, M.W.; Rezgui, Y.; Alshammari, K. Optimising energy efficiency and daylighting performance for designing vernacular architecture—A case study of Rawshan. *Sustainability* **2025**, 17, 315. https://doi.org/10.3390/su17010315

12. Mohamed, M.; Klingmann, A.; Samir, H. Examining the thermal performance of vernacular houses in Asir region of Saudi Arabia. *Alex. Eng. J.* **2019**, 58, 419–428. https://doi.org/10.1016/j.aej.2019.03.004
13. Abdelqader, A. Assessing regional identity strategies in contemporary Saudi architecture: A survey-based study of professional architects. *Mater. Res. Proc.* **2026**, 72, 64–74. https://doi.org/10.21741/9781644904336-7
14. Mashary Alnaim, M.; Abdulfattah Bay, M. Regionalism indicators and assessment approach of recent trends in Saudi Arabia's architecture: The Salmaniah architectural style and the King Salman Charter initiatives as a case study. *Ain Shams Eng. J.* **2023**, 14, 102144. https://doi.org/10.1016/j.asej.2023.102144
15. Abdou, S.; Mohsen, O.; Abd El Fattah, A.; Asif, M. Aligning national building codes with energy rating systems for sustainable residential development: A policy-driven performance analysis. *Smart Sustain. Built Environ.* **2026**, 1–27. https://doi.org/10.1108/sasbe-07-2025-0407
16. Saudi Architecture (Development Authorities Support Center). Regulating Plan for Yanbu, Rev. 1.0 (extract), March 2024. Online (accessed on 6 November 2026).
17. Okaz. The Saudi Architecture Characters Map: 19 Architectural Styles and Three Design Approaches. 21 March 2025. Online (accessed on 6 November 2026). (In Arabic)
18. Saudipedia. King Salman Charter for Architecture and Urbanism. Online (accessed on 6 November 2026).
19. Saudi Architecture (Development Authorities Support Center). Hejazi Coastal Architecture: Design Guidelines Page (updated 21 December 2025). Online (accessed on 6 November 2026). (In Arabic)
20. Bagasi, A.A.; Calautit, J.K. Experimental field study of the integration of passive and evaporative cooling techniques with Mashrabiya in hot climates. *Energy Build.* **2020**, 225, 110325. https://doi.org/10.1016/j.enbuild.2020.110325
21. Mezaien, A.A.; Baltazar, J.-C. Potential regenerative impact of implementation of cultural vernacular elements (Rowshan) in Jeddah, Saudi Arabia. *Energies* **2024**, 17, 1995. https://doi.org/10.3390/en17091995
22. Alrashed, F.; Asif, M.; Burek, S. The role of vernacular construction techniques and materials for developing zero-energy homes in various desert climates. *Buildings* **2017**, 7, 17. https://doi.org/10.3390/buildings7010017
23. Mazzetto, S.; Alnaim, M.M. Thermal performance of earthen architecture in Ushaiger, Saudi Arabia: A pilot digital-twin feasibility study. *Sustainability* **2026**, 18, 3634. https://doi.org/10.3390/su18073634
24. Alnaim, M.M. The typology of courtyard space in Najdi architecture, Saudi Arabia: A response to human needs, culture, and the environment. *J. Asian Archit. Build. Eng.* **2024**, 23, 91–110. https://doi.org/10.1080/13467581.2023.2229399
25. Mezaien, A.A. Environmental–morphological influences on vernacular dwellings in the Jazan region, Saudi Arabia: Compactness, vertical proportion, and façade permeability. *Saudi J. Appl. Sci. Technol.* **2026**, 3. https://doi.org/10.63908/rfy4pb60
26. AL-Mohannadi, A.S.; Furlan, R. The spatiality of the vernacular courtyard house in the Arabian Gulf region. *Heritage* **2025**, 8, 268. https://doi.org/10.3390/heritage8070268

27. Rodrigues, L.; Cherian, B.A.; Tokbolat, S. Reducing cooling energy demand in Saudi Arabian residential buildings using passive design approaches. *Buildings* **2025**, 15, 1895. https://doi.org/10.3390/buildings15111895
28. Alwetaishi, M. Impact of glazing to wall ratio in various climatic regions: A case study. *J. King Saud Univ. Eng. Sci.* **2019**, 31, 6–18. https://doi.org/10.1016/j.jksues.2017.03.001
29. Reinhart, C.F.; Mardaljevic, J.; Rogers, Z. Dynamic daylight performance metrics for sustainable building design. *LEUKOS* **2006**, 3, 7–31. https://doi.org/10.1582/LEUKOS.2006.03.01.001
30. Alnaim, M.M.; Alnaim, M.A. Integrating vernacular architecture into contemporary urban regeneration: Heritage, identity and modernization in Saudi cities. *Land* **2026**, 15, 494. https://doi.org/10.3390/land15030494
31. Khan, A.H.; Major, M.D.; Tannous, H.O.; Paquet, T. Tradition, transformation, and re-creation in two marketplaces: Souq Al Wakrah and Souq Waqif, Qatar. *Habitat Int.* **2021**, 116, 102438. https://doi.org/10.1016/j.habitatint.2021.102438
32. Assi, E. Layers of meaning and evolution of cultural identity: The case of wind towers in Dubai. *Conservation* **2022**, 2, 38–50. https://doi.org/10.3390/conservation2010004
33. Mazzetto, S. Heritage restoration as a tool to promote architectural identity in the Gulf regions. *Preserv. Digit. Technol. Cult.* **2018**, 47, 3–11. https://doi.org/10.1515/pdtc-2017-0015
34. Wilson, M. Vertical landscraping, a big regionalism for Dubai. *Int. J. Urban Reg. Res.* **2010**, 34, 925–940. https://doi.org/10.1111/j.1468-2427.2010.01007.x
35. AL-Zahrani, M.A.M.; Shawky Abou Leila, M.M. Strengthening the architectural identity of Makkah Al-Mukarramah's buildings: An assessment of the impact of laws and regulations. *J. Umm Al-Qura Univ. Eng. Archit.* **2022**, 13, 37–61. https://doi.org/10.1007/s43995-022-00002-0
36. Alghamdi, N.A.; Al-Ashwal, N.T. Reviving architectural ornaments in Makkah: Unveiling their symbolic, cultural, and spiritual significance for sustainable heritage preservation. *Buildings* **2025**, 15, 1681. https://doi.org/10.3390/buildings15101681
37. Alhuseini, M.F.; Altammam, G.A.; AlSehaimi, B.R.; Bettaieb, D.M.; Alawad, A.A.; Tarim, K.J. Conceptual inspiration from heritage: The design philosophy surrounding the Saudi Arabian Rowshan. *City Territ. Archit.* **2023**, 10, 20. https://doi.org/10.1186/s40410-023-00204-6
38. Talen, E. Design by the rules: The historical underpinnings of form-based codes. *J. Am. Plann. Assoc.* **2009**, 75, 144–160. https://doi.org/10.1080/01944360802686662
39. Carmona, M. Design coding and the creative, market and regulatory tyrannies of practice. *Urban Stud.* **2009**, 46, 2643–2667. https://doi.org/10.1177/0042098009344226
40. Baik, A.; Boehm, J. Hijazi architectural object library (HAOL). *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.* **2017**, XLII-2/W3, 55–62. https://doi.org/10.5194/isprs-archives-xlii-2-w3-55-2017
41. Baik, A. Najdi architecture in HBIM for sustainable conservation. *J. Umm Al-Qura Univ. Eng. Archit.* **2026**, 17, 148–168. https://doi.org/10.1007/s43995-025-00227-9
42. Bagido, R. Generating new Arabic letters-Rawashin design using GAN. In *Proceedings of the 2022 Fifth National Conference of Saudi Computers Colleges (NCCC)*, 2022; pp. 186–192. https://doi.org/10.1109/nccc57165.2022.10067330

43. Touloupaki, E.; Theodosiou, T. Performance simulation integrated in parametric 3D modeling as a method for early stage design optimization—A review. *Energies* **2017**, 10, 637. https://doi.org/10.3390/en10050637
44. Caetano, I.; Santos, L.; Leitão, A. Computational design in architecture: Defining parametric, generative, and algorithmic design. *Front. Archit. Res.* **2020**, 9, 287–300. https://doi.org/10.1016/j.foar.2019.12.008