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Measuring Structural Environmental Awareness in Iraqi Architecture through AHP and Climatic Analysis

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ABSTRACT

In many cases, the quality of the environment in Iraqi architecture is judged from the formal reading and the presence of what is inherited from the vocabulary is considered evidence of awareness of the environment. In this paper, an alternative criterion, structural criterion, is proposed and made measurable. The five criteria: Passive Climatic Response, Contextual and Urban Integration, Environmental Perception, Material and Resource Logic, and Structural Integration of Environmental Function are weighted using Analytic Hierarchy Process (AHP) and based on the solar geometry of Baghdad (33.3° N) for the development of a Structural Environmental Awareness Index (SEAI). Using the normalised geometric mean, the criterion weights were obtained from a reciprocal matrix with a consistency ratio of CR = 0.008. The building evidence is rated on a five-level evidence scale and added together to form an index with a 0–100 scale. It's used on two buildings in Baghdad, which respond to the same climate in different ways, and on opposite principles, fifty years apart: the Central Post Office by Rifat Chadirji (1975), which blocks the radiation but lets the diffuse light and air through, and the Central Bank of Iraq by Zaha Hadid Architects, which shades the glazing and carries the load with its structural exoskeleton. The Post Office obtained SEAI = 95.4 and the Central Bank SEAI = 85.9, which was maintained in all ten weight perturbations and under equal weights. On structural integration, the two works get the same score, which means that the screen and the exoskeleton are structurally similar and that environmental awareness is a structural principle and not a period style. This margin is primarily on material and resource logic, when structure, mass and enclosure is released simultaneously by means of load-bearing masonry. The numerical values are a demonstration of the instrument and need to be confirmed by the expert elicitation and dynamic simulation before making inferential claims.

1. Introduction

Economy of a building does not come from one single apparatus. This comes from the interplay of orientation, massing, structural depth, envelope configuration, thermal mass, openings, shading, ventilation paths, material sourcing, and the inhabitability and maintenance of a project. These interactions are significant in Baghdad: buildings have to deal with the long duration of intense solar radiation, extremely high summer temperatures, dust, water scarcity, and a sporadic power supply which can render mechanically dependent buildings unusable at the very time they are needed for cooling. In such situation, the choice of shading a façade structure and not merely mechanically is not

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style but an environmental, and, in the end, social choice.

An analysis of the environment in local architecture has, however, been often produced as a formal reading centered on the identification of the inherited vocabulary: the courtyard, the screen, the arch, etc. as evidence of an awareness of the environment. This conflation is not dependable in either direction. A courtyard that is culturally legible but environmentally inert may be one that does not respond to the local microclimate with proportions, surfaces and ventilation paths, while a building without any inherited motif may be able to exclude solar radiation precisely through the structure alone. The difference between the two is not the representation of the element, but if an environmental function is integrated in the building.

Qualitative judgements of this sort can be disciplined using the Analytic Hierarchy Process (AHP) developed by Saaty which translates qualitative comparisons into explicit weights, and provides a formal test of internal consistency [1]. AHP has been used to evaluate building systems and of architectural design quality, and the most beneficial aspect of using it is the transparency: criteria are compared two at a time, matrices can be reviewed by other people and the impact of any one preference can be tested using sensitivity analysis [2,3]. Obviously there are a number of drawbacks to this: the weights are still judgemental, with the clarity of the criteria and the evidential basis of the scores dictating whether the result is defensible or not.

In this paper the authors suggest the use of Structural Environmental Awareness Index (SEAI) for Iraqi architecture and apply it on two buildings in Baghdad. Structural environmental awareness is used in a very exact way: an environmental function which is discharged by the load-bearing or fabric-forming elements of the building without being added. For structural to have any meaning, the screen wall must carry load and must filter radiation; the exoskeleton must stiffen a tower and shade its glazing; an applied motif which does not perform any thermal work is not structural. The index is meant to distinguish between the two.

Four questions are addressed in the study. Firstly, what are the criteria that should be used to determine the environmental awareness of the architecture of a hot-arid Iraqi city? Second, how can AHP give defensible weights to those criteria and how is the consistency of the weights tested? Third, how to make use of the solar geometry and climatic regime of Baghdad to make the scoring of individual buildings base on the facts and not impression? Fourth, does the final composite index make meaningful distinctions between two buildings which respond to the same climate, but in different ways and at different times؟

The contribution is methodological in nature and is interpretive too. Most of the works on climate-responsive design in Iraq simply set thermal facts without sensitivity to how the facts should be used to weight design priorities and most of the multi-criteria assessments simply set the weights without any climatic sensitivity. The two are linked through a framework presented here: The preference is determined through solar geometry and thermal evidence documented from these geometry; the weighting is determined through AHP; and the sensitivity analysis reveals the extent of the conclusions if one preference is discarded. The two buildings, the Central Post Office (1975) designed by Rifat Chadirji and the Central Bank of Iraq (1982) designed by Zaha Hadid, are chosen because they deal with the same climate by means of divergent technical solutions, and because they were designed fifty years apart, thus providing a test to see if environmental sensitivity is a style or a structure.

2. Literature Review and Conceptual Background

2.1 Environmental awareness in architectural decision-making

Architectural environmental awareness can be described as the ability to identify the environmental impacts of the design, to transfer that understanding into the physical aspects of the design and to maintain that design through its use. Such awareness is not synonymous with an environmental technology, nor a traditional element. A shading device to an inherently bad orientation does not make it good; a motif added to a sealed, mechanically-cooled envelope does not make it cooler.

The concept developed out of climatic design in which Olgyay saw the climatic needs of a region as a primary influence for architectural form and suggested the systematic extortion of built form from bioclimatic needs of a region [4]. McHarg took the argument one step further, from the building to the territory, suggesting that design should be done in harmony with natural systems, not in opposition to them [5]. The discourse of sustainability then expanded to resources, energy and life cycle, as well as international assessment systems like LEED and BREEAM codifying this broadening into families of measurable criteria in the areas of site, energy, water, materials, and indoor environmental quality [6,7]. The systems provide the terminology for contemporary assessment, but direct translation to a particular climatic and constructional context is not straightforward, as the relative importance of their criteria is not constant across climates.

Life-cycle thinking takes assessment beyond operational performance. Materials have energy and emissions embedded in their extraction, manufacturing, transport, construction, maintenance and replacement and the general procedure for defining functional units, boundaries, inventories and interpretation are given by ISO principles of life-cycle assessment [8,9]. Recent comparative studies show that vernacular building methods can still have a life-cycle advantage over current methods in similar contexts, something directly relevant to the present case where a tradition of masonry buildings with a high thermal mass is pitted against a tradition of concrete-and-glass buildings.

The story is completed by indoor environmental quality. Adaptive comfort research indicates that building occupants can accept a larger indoor temperature range when their indoor environment follows the outside climate and when they can exert some control over their environment [11] and reference procedures to thermal environmental conditions are included in standards [12]. However, in an extreme summer climate, there are physiological limits to adaptive tolerance and passive strategies cannot be called upon to excuse unsafe interiors; the only conclusion that can be drawn is that the envelope must do more, not the occupant must endure more [10].

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2.2 Climate-responsive architecture in Iraq and the logic of the vernacular

The urban building forms a unified system of environmental elements: narrow streets with shade, the internal courtyard, high thermal mass walls, summer rooms that are partially underground, opening with screens and recesses, and the seasonal movement from one part of the section of the house to the other. Fathy himself resumed this repertoire as a template for an architecture based on its place, and then he laid out the physical principles on which its performance depends — that of solar exclusion, thermal delay, pressure-driven airflow and evaporative potential — in a form designed to be reinterpreted rather than duplicated [13,14].

The physical claim is backed up by empirical work. Experimental and simulation studies in the climate of Baghdad reveal that the shading level provided by a courtyard is not merely a function of the existence of the courtyard as a type, but depends on the geometric parameters of the courtyard [15] while in thermal optimisation in traditional houses in hot arid climate, it has been found that night ventilation in conjunction with thermal mass provides measurable cooling, and that the dimensions of the courtyard and the rooms surrounding it have significant influence on the performance [16]. The ventilated interior courtyards have proved to enhance the thermal performance of houses in hot-arid regions [17] and the courtyard configuration has been studied and found to be favourable for mid-rise buildings in similar climates [18]. Throughout this literature, there is the constant assumption that the value of the traditional element to the environment depends on its geometry and its connection with ventilation, that is, its logic, and not its recognisability.

This conclusion is in line with critical-regionalism approach. Frampton challenged a regionalism that was limited to scenographic signs and called for a rootedness that was tectonic and topographic, one that was realized through structure, light and climate, but not through the image of the surface [19]. Norberg-Schulz was interested in the disclosure of the character of a place by the building and not in the reproduction of the place's motifs [20]. From within Iraqi practice, Chadirji called for a rooting that reinterprets the local element through contemporary modes of production that upholds its logic but discards its literal image [21]. The current system implements this collective attitude: it evaluates the work performed by an element and not the tradition it evokes.

The perceptual aspect of environmental awareness also exists. Environmental-psychology research demonstrated that perception is an active process whereby people create an image of their surroundings and imbue it with meaning [22]; Lynch related the quality of an urban environment to its ‘legibility' [23] and Rapoport that built form is determined not just by climatic determinism but also by cultural and perceptual factors [24]. So it can be an environmentally competent but perceptually mute building or a perceptually rich but environmentally inert building. Only a thermal index would miss the first failure, only a legibility index would miss the second. The hierarchy below shows both of them.

2.3 AHP in architectural and sustainability assessment

AHP is a process that breaks the decision down into a hierarchical structure, asks for judgment using a bounded ratio scale, and then uses the scale to develop priorities from a reciprocal matrix and also checks for the coherence of the judgments by calculating a consistency ratio [1]. In the built environment it has been applied to the weighting of the basis criteria for the selection of intelligent building systems [2] and to structure the assessment of architectural design where it's shown to produce results similar to those of conventional assessment, but was measurable, gradable and separately reportable by individual assessors [3]. These properties are the ones because of which it has been adopted here: the weighting of the environmental criteria in architecture is unavoidably a matter of judgement – and the merit of AHP is not that it eliminates judgement, but that it makes it inspectable and testable.

2.4 Research gap

Two body of works thus lie side by side without touching each other. Climate responsive studies in Iraq have been getting increasingly precise in defining the behavior of courtyards, mass and ventilation under the radiation and temperature regime of Baghdad, but they have not expressed the criteria of the environment in relation to the completed work. Multi-criteria assessments on the other hand provide weighting procedures but they are often adjusted to generic or imported priorities. The instrument proposed below is designed to fill this gap in a single, very clearly defined climatic context and to be applied to two buildings, with opposite environmental strategies, historically distant.

3. Research Methodology

3.1 Research design

The study is a comparative, criteria-based assessment utilizing a mixed approach in five stages: building the hierarchy of assessment criteria from the literature; determination of the weights of assessment criteria using AHP and consistency test; climatic analysis of the study area to set a physical basis for the measurement of the evidence; measurement of the evidence of each case against the evidence scale using documentary sources; and calculating the composite index and sensitivity analysis. The scores are based on documented evidence and not on impression, and the protocol is defined in such a way that an expert panel can duplicate or update the weights and the scores.

3.2 Case selection

Three criteria were used for the selection of two buildings in Baghdad: the two buildings have the same climatic setting to prevent the differences in performance being blamed on differences in climate; the two buildings adopt technically opposed environmental strategies, one passive and masonry, the other parametric and framed; and the two buildings are roughly 50 years apart, in order to test whether there is a period-bound environmental awareness. The first is the Central Post Office in Baghdad by Rifat Chadirji (1975), which is based on a load-bearing screen wall, courtyard organisation and local brick of high thermal mass [21]. The second one is the Central Bank of Iraq by Zaha Hadid Architects, which is a tower located at the bank of the Tigris; the façade of this tower is wrapped with a structural exoskeleton of solid and open elements who shade the glazing and the section is opened with a central atrium [25,26].

3.3 The criteria hierarchy

Based on the literature reviewed in Section 2 and being adapted to the hot-arid Iraqi environment, five main criteria were determined. These are all operationally defined - meaning the score can be related to an observable aspect of the building and not to a general impression:

Table 1. Criteria hierarchy and operational definitions.

Code	Criterion	Operational definition
C1	**Passive climatic response**	Solar exclusion on all exposures, including the low-angle east–west condition; daylight without direct gain; ventilation paths; thermal mass and time-lag
C2	**Contextual and urban integration**	Relation of mass to site, river frontage and urban fabric; scale gradation; contribution to shading and microclimate of adjacent space
C3	**Environmental perception and experience**	Legibility of the environmental logic in ordinary experience; rootedness of the sensory environment in the local climate
C4	**Material and resource logic**	Suitability and locality of materials; embodied burden; durability; number of functions discharged per material
C5	**Structural integration of environmental function**	Whether the environmental device carries load or forms fabric, as against being applied to a structure that performs no environmental work

C1 is deliberately separated from C5 by the hierarchy. A building can be a response to climate by the addition of devices (scoring good on C1 and poor on C5), or by incorporating an environmental function into the building. The difference is the analytical heart of the instrument, because it is precisely that difference that a formal reading of tradition can't make.

3.4 Mathematical formulation

Let $A = [a_{ij}]$ be an $n \times n$ positive reciprocal matrix, where a_{ij} denotes the importance of criterion i with respect to criterion j, and $a_{ji} = 1/a_{ij}$, $a_{ii} = 1$. The geometric-mean estimate for criterion i is $g_i = (\Pi_j a_{ij})^{(1/n)}$ and the normalised priority is $w_i = g_i / \Sigma_i g_i$. The mean of $(Aw)_i / w_i$ is used to make an estimate of λ_{max}. The consistency index and the consistency ratio are used to check consistency:

$$CI = (\lambda\_max - n) / (n - 1)$$

$$CR = CI / RI, \;\; \text{with } RI = 1.12 \text{ for } n = 5$$

Judgements are accepted when CR ≤ 0.10 [1].

A raw score x_bk is given for each building b and criterion k on a five-point evidence scale: x_bk = 0 if feature is absent or harmful to the environment; x_bk = 1 if feature is minimal; x_bk = 2 if feature is basic; x_bk = 3 if feature is good practice; x_bk = 4 if feature is advanced practice. The raw scores are translated to percentages using p_bk = 25 x_bk. The Structural Environmental Awareness Index for building b is the sum with weights:

$$SEAI\_b = \Sigma\_k \; (W\_k \times p\_bk), \;\; \text{with } \Sigma\_k \; W\_k = 1, \;\; 0 \le SEAI\_b \le 100$$

The criterion-level profile is reported along with the composite score. A minimum-performance rule is used, the building may not be considered as having high structural environmental awareness if it scores less than 50 % on C1 (passive climatic response) or C5 (structural integration) regardless of the total. This helps to avoid compensation: a good perception or context might mask the envelope, which does no thermal work.

3.5 Climatic analysis of the study setting

The scores for C1 are related to the solar geometry of Baghdad (latitude 33.3° N), thus determining the physical challenge that any façade in the city must face. The sun's elevation at local noon is about 80.2° at the summer solstice, 56.7° at the equinoxes, and 33.2° at the winter solstice. Two consequences follow. First, a shallow horizontal projection can easily exclude the high sun of summer (full shading of an opening at midday requires a depth of projection of d = h / tan(80.2°) = 0.18 x h). Second, and more challenging, horizontal devices can't block the low morning and afternoon sun on east and west, and either vertical screening, deep recessing or a shade layer that creates a 3D effect is needed. The low-angle east–west condition, rather than the high-angle noon condition, is therefore the most important one to consider when judging a façade strategy in Baghdad.

Table 2. Solar geometry of Baghdad (latitude 33.3° N).

Season	Declination δ	Solar altitude at noon (33.3° N)
Summer solstice	+23.45°	**80.2°**
Equinox	0°	**56.7°**
Winter solstice	−23.45°	**33.2°**

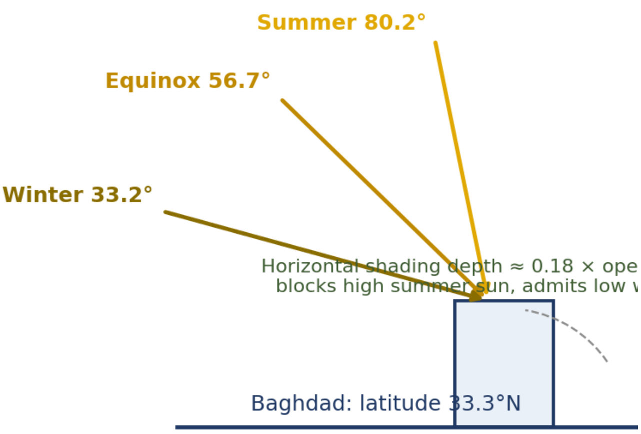

Figure 1. Solar geometry of Baghdad (33.3° N) and the shading task. Original analytical diagram.

This geometric reference is supplemented by the thermal behavior of the local repertoire documented. Geometric parameters of a courtyard govern the shading level in the courtyard in Baghdad [15], thermal optimisation of traditional houses in hot-arid region demonstrates that night ventilation with thermal mass can yield measurable cooling [16] and the ventilation of courtyards enhances the thermal performance of hot-arid houses [17]. These and the geometry provide the physical reference on which each case is scored on C1.

3.6 Scoring protocol and evidence base

Each criterion is marked based on the documentary evidence of the building configuration. The evidence base for the Central Bank is the design documentation published by the architects, and the technical description of the completed structure [25,26] The evidence base for the Central Post Office includes the architect's own description of his approach and the known features of the work [21]. When it is not possible to confidently score a song using the documentary evidence provided, it is scored as provisional and the appropriate evidence requirement is indicated in Section 7.

3.7 Validity, reliability, and sensitivity

Content validity is based on the drawing of the criteria from literature reviewed and the operational definition in Table 1. The consistency of the weights is checked by using the consistency ratio. One-at-a-time sensitivity analysis is used, where each criterion weight is perturbed by 25 % (+/-25 %), renormalised, and then examined for robustness of the outcome, as is an equal-weights scenario that discards the AHP priorities. To see if a comparative conclusion is specific to the weighting used or, holds over the range of reasonable weightings.

4. Results

4.1 Priority structure and consistency

On Saaty's 1–9 scale, pairwise comparisons were conducted and the criteria most directly related to physical environmental performance were given priority. The resulting reciprocal matrix is shown in Table 2 and the priority vector obtained from it is shown in Table 3.

Table 3. Reciprocal matrix of pairwise comparisons (Saaty 1–9 scale).

	C1	**C2**	**C3**	**C4**	**C5**
C1	1	2	3	4	1
C2	0.50	1	2	3	0.50
C3	0.33	0.50	1	2	0.33
C4	0.25	0.33	0.50	1	0.25
C5	1	2	3	4	1

Table 4. Derived criterion weights, priority vector and consistency test.

Criterion	**Weight W_k**	**Share**
C1 Passive climatic response	**0.320**	32.0 %
C2 Contextual and urban integration	**0.184**	18.4 %
C3 Environmental perception	**0.109**	10.9 %
C4 Material and resource logic	**0.068**	6.8 %
C5 Structural integration	**0.320**	32.0 %
λ_max = 5.036 | CI = 0.0091 | RI = 1.12 | CR = 0.008 (≤ 0.10, accepted)		

The largest eigenvalue estimate was λ_max = 5.036, giving CI = 0.0091 and, with RI = 1.12, a consistency ratio CR = 0.008. As CR is less than or equal to 0.10, the judgements are consistent and the weights are accepted [1]. The passive climatic response is valued at 0.320, the structural integration at 0.320, the contextual integration at 0.184, the perception at 0.109 and the material and resource logic at 0.068.

4.2 Case A — the Central Post Office (Rifat Chadirji, 1975)

The wall is the environmental action of the Post Office. The screen is a load bearing element, which at the same time rejects radiation, diffuses the daylight, reduces glare and allows air to flow through the depth of the façade; it is not an element hanging from a wall but the wall itself that has been perforated. The screening layer being in three dimensions and with depth caters for the low angle east–west condition that a horizontal projection would not have been able to. The courtyard organisation provides a shaded, ventilated volume in the section, while the local brick gives thermal mass, whose delay characteristics are exactly what the local repertoire of documented night-ventilation performance depends on [15,16,17].

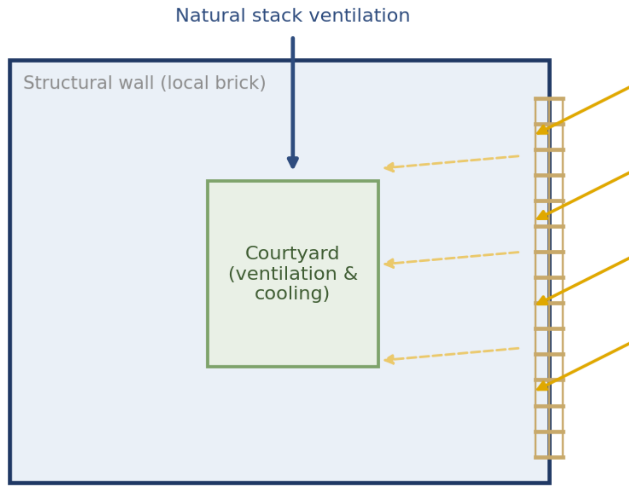

Figure 2. Environmental logic of the Central Post Office: load-bearing screen wall and courtyard. Original analytical diagram.

The following scoring was used. C1 = 4 (advanced practice): the envelope simultaneously offers solar exclusion, daylight diffusion and ventilation, and takes into account the strict requirements of the low-angle condition. C2 = 3 (good practice): the building is linked to the urban fabric, but its connection with the broader urban ecology is not recorded in as much detail as at the level of the C2 sub-criteria. C3 = 4: building as perceptual identity by environmental device, legibility of climatic logic in experience. C4 is the 4: local brick, low embodied burden, durability. C5 = 4: the structure is the environmental function.

4.3 Case B — the Central Bank of Iraq (Zaha Hadid Architects)

The environmental approach of the Central Bank is also transmitted through structure, albeit in another way. The exoskeleton is a load-bearing lattice of alternating solid and open elements wrapped around the façade, which shades the double glazing, filters the solar gain and creates a gradation of light into the interior, with the central atrium acting to funnel daylight into the interior of the plan. Like the Post Office, the shading layer is three dimensional and able to catch the low angle east–west sun. The mass changes to meet the limitations of the site and the podium provides a relationship between the tower and the river frontage [25,26].

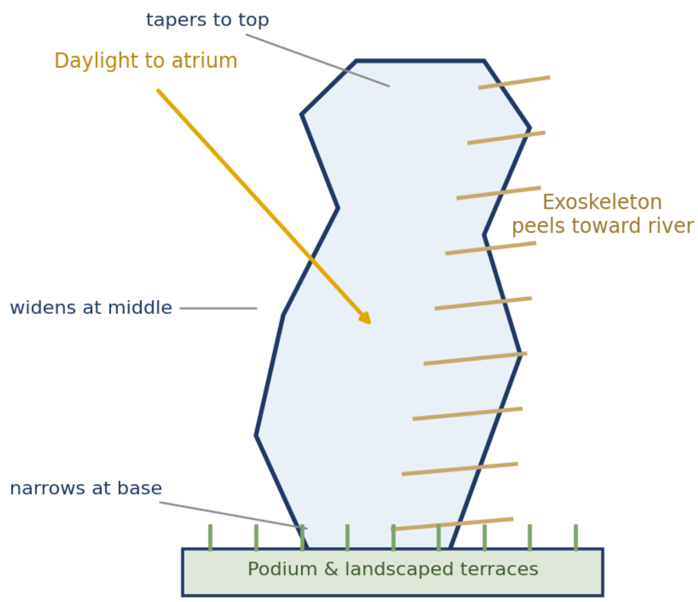

Figure 3. Central Post Office, Baghdad (Rifat Chadirji). *Source: Rifat Chadirji Archive — Archnet* https://www.archnet.org/collections/1218

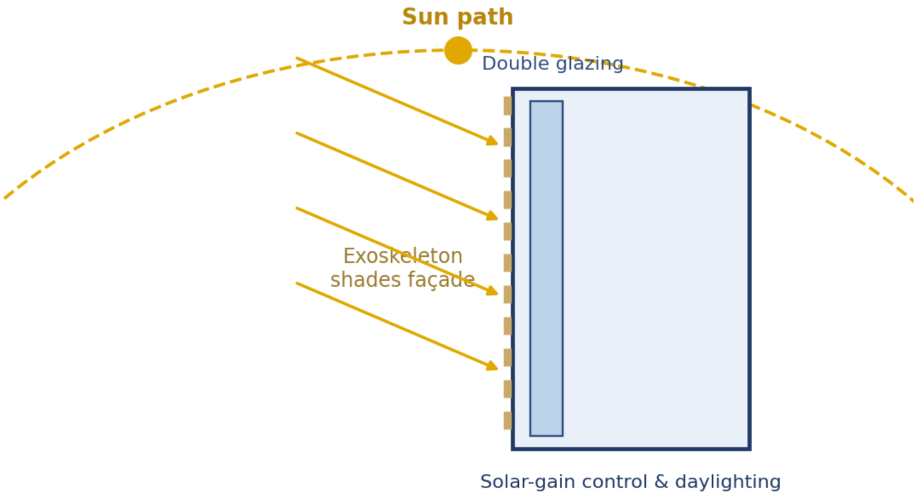

Figure 4. Massing and river relationship, Central Bank of Iraq. Original analytical diagram.

The following scoring system was used. C1 = 3 (good practice): exoskeleton actually functions for solar control and the atrium provides daylighting, but the envelope is still largely glazed and mechanical cooling is required to the same degree as the passive case. C2 = 4: The mass, podium and terraces have an established documented relationship with the river frontage and the surrounding fabric. C3 = 3: The building is more legible as an event on the river, but less so in its environmental logic compared to the Post Office. C4 = 2 (basic compliance): the embodied burden of reinforced concrete and glass is greater than load bearing brick despite the use of local concrete capacity. C5 = 4: One element takes care of the shading and load-bearing functions.

4.4 Composite results

The composite index reported in Table 4 is the result of applying the weights in Table 3 to the scores in Sections 4.2 and 4.3.

Table 5. Composite SEAI scores and criterion contributions for the two cases.

Criterion	W_k	x	$W_k p$ (PO)	x	$W_k p$ (CB)	Δ
C1 Passive climatic response	0.320	4	32.0	3	24.0	**+8.0**
C2 Contextual integration	0.184	3	13.8	4	18.4	**−4.6**
C3 Environmental perception	0.109	4	10.9	3	8.2	**+2.7**
C4 Material and resource logic	0.068	4	6.8	2	3.4	**+3.4**
C5 Structural integration	0.320	4	32.0	4	32.0	**0.0**
SEAI (0–100)	**95.4**		**85.9**	**+9.5**		

The Central Post Office score is SEAI = 95.4, and Central Bank score is SEAI = 85.9 (on a scale of 0-100). Both are above the high thresholds for structural environmental awareness and both meet the minimum performance requirement of Section 3.4 (neither is below 50 % on either C1 or C5). The two buildings' separation is 9.5 points, 8.0 on C1 and 3.4 on C4, partly attributable to the Central Bank's bonus of 4.6 on C2. Both works are the same on C5.

4.5 Sensitivity analysis

The values of each criterion weight were changed by +25% and –25% and the remaining weights re-normalized, resulting in ten scenarios, with the equal weights scenario also calculated. This ranking did not vary in any of the perturbations considered, nor in the equal weights case, where the scores are 95.0 and 80.0. The result does not change when passive climatic response is down-weighted 25 % or up-weighted, although the margin varies, respectively, to 8.2 points or 10.6 points. The comparative conclusion is not therefore any product of the specific priority vector used.

Table 6. One-at-a-time sensitivity analysis of the criterion weights.

Scenario	SEAI Post Office	SEAI Central Bank	Leading case
C1 × 0.75	95.0	86.8	Post Office
C1 × 1.25	95.7	85.1	Post Office
C2 × 0.75	96.4	85.2	Post Office
C2 × 1.25	94.5	86.5	Post Office
C3 × 0.75	95.3	86.2	Post Office
C3 × 1.25	95.5	85.6	Post Office
C4 × 0.75	95.3	86.5	Post Office
C4 × 1.25	95.5	85.3	Post Office
C5 × 0.75	95.0	84.7	Post Office
C5 × 1.25	95.7	86.9	Post Office
Equal weights (AHP discarded)	95.0	80.0	Post Office

5. Discussion

5.1 The screen and the exoskeleton as functionally cognate devices

The margin between the two buildings is not as important as the fact that they agree on C5, for which they both get a 4. A surface-applied screen wall, as in 1975, and the exoskeleton of the contemporary tower are, environmentally, cognate devices: a three-dimensional layer which carries load and excludes radiation in a single wave. Although the technologies are different, in one case perforated load-bearing masonry, the other a fabricated structural lattice, the environmental logic is the same and it is the logic, not the technology, that the index registers. It is in this sense that here environmental awareness is revealed to be a structure and not a style.

The finding also provides an operational interpretation of the critical-regionalist approach. The dichotomy between a tectonic and a scenographic regionalism [19] that Frampton has drawn is frequently cited but seldom quantified. It is measurable here: C5 is whether the environmental function is given up by the fabric, and an applied motif, regardless of its traditionalism, is scored as 0 or 1, whereas a structurally integrated device is scored as 4. It is the instrument which separates rootedness from resemblance – requirement of critical-regionalist position, which a formal reading of tradition could not give.

5.2 The material advantage of the passive case

The central bank's main weakness is on C4 where it has scored 2 compared to 4 for the Post Office. This is not something that happens as a by-product. In addition to providing structure, thermal mass and enclosure, load-bearing brick has a low embodied burden and a long life, while a concrete and glass tower has to provide these functions in the additional materials with a higher embodied burden and relies on mechanical systems to provide the thermal function that mass provides. This reading [10] is corroborated by comparative life cycle studies, which report a benefit for vernacular over contemporary construction methods, and the adaptive-comfort studies as well: a building that has an interior temperature that varies with the outdoor climate has a wider range of tolerable conditions, while a sealed and glazed interior has a smaller range of tolerable conditions [11, 12]. This discrepancy is not just a carbon accounting issue, it is a question of whether a building is habitable when its cooling plant shuts down, given an intermittent electric supply in a city.

The importance in today's practice is not a reversion to masonry building, a system which is neither programmatic nor structurally available at the scale of a national bank. That the passive logic—mass where possible, depth in the shading layer, daylight without direct gain, and an envelope that diminishes the cooling load before the plant is sized—should be extrapolated to contemporary structural systems, as the exoskeleton shows is possible.

5.3 The perceptual dimension

The distinction between the two cases lies on C3 (4 as opposed to 3) and it is instructive. The environmental device is also the visual identity of the building; the screen is what one sees, and what one sees is what does the thermal work, so that the climatic logic is legible in ordinary experience, at the Post Office. The exoskeleton also appears in the Central Bank, but its environmental role is not so easy to read, but rather is part of a formal language, the main reference of which is the movement of the river. Environmental perception is an active construction that is made by the observer [22,23,24] and a building, whose environmental logic is legible, does a second kind of work: it teaches the climate to its users. This is a criterion where the local tradition, even when re-interpreted but not copied, has an advantage which can not be reduced to thermal performance.

5.4 Methodological reflection

The stability of the ranking obtained under all the perturbations, including the complete omission of the AHP weights, suggests that the conclusion is more a result of the score profile than of the weights. This is a good attribute because it implies that the instrument is not simply re-stating the analyst's previous biased choice of criteria. It also restricts claims that can be made, however. The weights dictate the size of the margin and diagnostic profile, not the direction of the margin, and a different expert panel may reasonably have come up with a different size margin. What matters with the AHP layer is not the outcome, but rather the basis of the outcome is made inspectable.

6. Implications for Practice and Education

Three implications follow. The test given by the criterion of structural integration (C5) can be applied to the design proposal at an early stage and will not allow the exchange of image for performance: what does the environmental device carry and what does it exclude; and if the motif is applied, it fails the test, no matter its cultural pedigree. The cognate status of the screen and the exoskeleton suggest that the passive repertoire can be applied to framed construction, but the shading layer must be given depth and be made structural instead of applied. The two cases combined show that the study of the local tradition is not a memorative skill for architectural education, but a physical skill: what is to be learnt is the geometry of what is not the sun at 33° and not the pattern of perforations.

7. Limitations and Future Research

The study has a number of limitations as well as areas requiring further research.

These results have four caveats that each represent a next step. First, the scores are imposed by the analyst, not elicited from a panel; whilst the criteria are operationally defined, an expert-elicitation exercise with architects, building-services engineers and environmental specialists would enable the scores to be elicited and inter-rater agreement to be reported. Second, the weights are based on only one reciprocal matrix: if several experts' matrices were used, then the priority vector could be aggregated by the geometric mean and consistency of each matrix could be separately reported. Third, the C1 scores are based on solar geometry and published thermal literature on the local repertoire, not on simulation of the two specific buildings, although dynamic thermal and daylight simulation of both envelopes, based on measured weather data from Baghdad, would provide a performance figure to replace the evidence scale judgement and is the most valuable single extension of this work. Fourth, the sample consists of two buildings carefully chosen for their contrast, providing the discriminating power of the instrument but not the distribution; to extend the set to include a larger sample of Iraqi buildings, including some intermediate cases where an inherited motif is used but without structural significance, would test the validity of the C1–C5 separation across the spectrum.

Hence the numerical values given in Section 4 should be understood not as a validated measurement of the two buildings but rather as a demonstration of the instrument. They have internal consistency and are traceable to their evidence but are still to be confirmed through expert elicitation and by simulation.

8. Conclusion

This paper has constructed an index for structural environmental awareness of the Iraqi architecture, based on AHP weighting and climatic reference based on the solar geometry of Baghdad, and applied it to two structures responding to the same climatic conditions but by the use of conflicting technical means, fifty years apart. The weights showed good internal consistency (CR = 0.008). The Central Post Office achieved SEAI = 95.4 and the Central Bank of Iraq SEAI = 85.9, the ranking stayed stable when all the weights were tested in perturbations modes and even when they were completely removed.

Three conclusions follow. Structurally defined environmental awareness is not a feature of a period, not a feature of a style, but of the load-bearing screen of 1975 and of the present's structural exoskeleton: both score equally on the criterion that counts - environmental awareness. The benefits of the passive case are mainly material and material logic as the thermal mass serves three purposes simultaneously and as the building can be used even in the event of a failure of mechanical cooling. The difference the instrument can make – between the rootedness of the environment as opposed to the resemblance of an image applied to it – is measurable which means that the critical-regionalist requirement for rootedness instead of resemblance can be used as a criterion and not just a preference in architectural evaluation.

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