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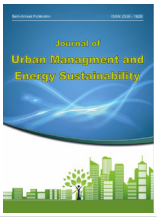

ORIGINAL RESEARCH PAPER

Adapting a Model of Sense of Presence Indicators in Urban Squares with an Emphasis on Environmental Features: A Human Subjective Evaluation Approach (Case Study: Naghsh-e-Jahan Square, Isfahan)

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ABSTRACT

The sense of presence a user's felt experience of "being here" rather than merely passing through is a decisive yet under operationalized quality of successful urban squares, and it is shaped substantially by the environmental features of the space. Although the literature on sense of place, environmental quality and urban vitality is rich, it offers few compact, replicable instruments that translate these ideas into an environment focused measure of presence suited to the historic square. This study addresses that gap by developing and adapting a model of sense of presence indicators for urban squares, foregrounding environmental features, and operationalizing it through a Human Subjective Evaluation (HSE) questionnaire. The research follows a four phase design: a systematic review derives a pool of candidate indicators from the presence, sense of place and environmental quality literatures; a two round fuzzy Delphi procedure with an expert panel screens and refines the pool through triangular fuzzy numbers and threshold de fuzzification; the retained indicators are translated into a five point HSE instrument; and the instrument is structured for onsite perceptual application, with Naghsh-e-Jahan Square in Isfahan proposed as the demonstration case. The model organizes presence around four environment centered criteria physical–spatial, sensory–environmental, social–functional and semantic–perceptual each resolved into measurable sub indicators and each weighted by the fuzzy Delphi consensus. Findings show that the four criteria form a coherent, hierarchically weighted structure in which physical–spatial and sensory–environmental features carry the largest illustrative weights, and that the HSE instrument renders the otherwise elusive notion of presence into a transferable, auditable measure. The study concludes that presence in urban squares is best modelled not as a single perception but as a weighted composite of environmental determinants mediated by subjective evaluation, offering urban designers a diagnostic tool and a research ready template for field validation.

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INTRODUCTION

Urban squares are among the oldest and most resilient settings of collective urban life. Beyond their circulatory and commercial roles, they operate as socio spatial institutions in which people gather, linger, observe one another and form an attachment to the shared center of a city. What distinguishes a square that is merely crossed from one that is genuinely inhabited is not captured well by physical metrics alone; it is captured by what phenomenological accounts of place call presence the felt sense of being meaningfully "here" rather than anonymously "there" (Relph, 1976, Punter, 1991). Presence in this sense is the experiential result of a person encountering an environment whose form, sensory qualities, social affordances and meanings invite the person to stay, to return and to identify with the place (Canter, 1977; Gehl, 1987, Golledge, 1977).

The environmental features of a square its enclosure and edges, its human scale and legibility, its microclimate and greenery, its light and sound, and the symbolic charge of its surrounding fabric are widely held to be the principal levers through which designers can foster or frustrate this experience (Montgomery, 1998; Gehl, 1987). Empirical work on perceived environmental quality confirms that the design and care of a space, the presence of others and the availability of sensory richness jointly predict how restorative and how socially used a public space becomes (Ríos Rodríguez et al., 2021, Spencer, 1983, Montgomery, 1995b). Yet despite this substantial body of theory, the field lacks compact, replicable instruments that convert the idea of presence into an environment focused, auditable measure tailored to the urban square and especially to the historic square, where the density of meaning is high and the stakes of intervention are correspondingly large. The problem is therefore twofold. First, presence is conceptually mature but methodologically diffuse: it is discussed eloquently but measured inconsistently, often through bespoke questionnaires whose indicators are neither derived transparently nor screened for expert consensus. Second, the environmental determinants of presence are frequently folded into broader constructs sense of place, place attachment, urban vitality in ways that obscure which specific, designable features matter most. For the practicing urban designer who must decide where to invest limited resources in an existing square, this is a consequential gap: the literature affirms that environment shapes presence, but it does not supply a weighted, transferable model of which environmental features to prioritize.

This study responds to that gap. Its aim is to develop and adapt a model of sense of presence indicators for urban squares that foregrounds environmental features and is operationalized through a Human Subjective Evaluation (HSE) instrument a structured, perception-based questionnaire in which users rate the environmental qualities of a square as they experience them. To build the model on transparent foundations rather than on the authors' assertion, the indicator set is derived from the literature and then screened and weighted through a fuzzy Delphi procedure, which captures the imprecision inherent in expert judgement more faithfully than the classical Delphi (Ishikawa et al., 1993; Hsu & Yang, 2000). The historic Naghsh-e-Jahan Square in Isfahan a UNESCO World Heritage site and one of the largest and most intensely inhabited public squares in the world is proposed as the demonstration case, precisely because its environmental richness makes it a demanding test of any presence model. Accordingly, the study addresses three questions. (1) Which environmental indicators of the sense of presence in urban squares can be derived from the presence, sense of place and environmental quality literatures, and how can they be screened for expert consensus? (2) How should these indicators be organized and weighted into a hierarchical model, and how can that model be operationalized through an HSE instrument? (3) What does the resulting model imply for the diagnosis and design of environmental features in historic urban squares? The remainder of the article reviews the theoretical foundations and

derives the indicator pool, sets out the fuzzy Delphi and HSE methodology, presents the resulting model and instrument, discusses them against the international literature, and concludes with the model's design implications and the limitations of a study whose field validation remains to be completed.

THEORETICAL FOUNDATIONS

The sense of presence as a person–environment construct

The notion of presence has its deepest roots in the phenomenology of place. Relph (1976) argued that the essence of place lies in insideness the degree to which a person feels enclosed by, and belonging to, a setting with its deepest form, existential insideness, corresponding to the unselfconscious experience of being fully "here". Presence, in the urban design reading adopted here, is the positive pole of this continuum: the experiential state in which a square is not a void to be traversed but a place to be occupied. Canter (1977) gave this intuition an operational shape by defining place as the intersection of three components physical setting, activities and meanings a triad that remains the most durable scaffold for decomposing the experience of place into designable parts. Figure 1 adapts this triad to the specific question of presence.

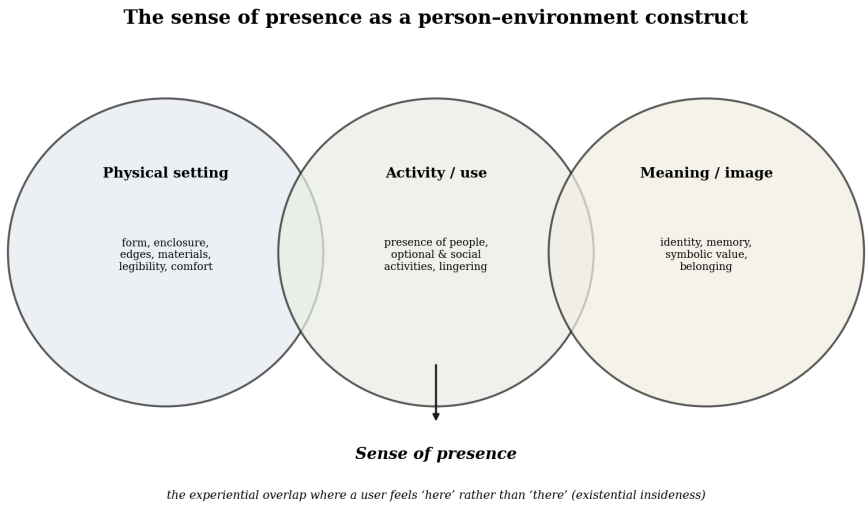

Figure 1: The sense of presence as a person–environment construct (Source: Authors)

Gehl (1987) translated the person–environment relationship into the behavioral language of the public realm, distinguishing necessary, optional and social activities and showing that optional and social activities the ones that signal genuine presence occur only when the physical environment is of sufficient quality. His work establishes the mechanism this study relies upon: environmental features do not determine presence directly but do so by enabling or discouraging the activities and perceptions through which presence is realized. Montgomery (1998) consolidated these strands into an influential model of urban vitality in which activity, form and meaning together generate a sense of place, and in which the designable dimension form is the one over which practitioner have most leverage.

Environmental features and perceived quality of public space

A parallel, more recent literature has sought to measure the environmental qualities of public space empirically. Studies of perceived environmental quality find that the design of a space, the

care and maintenance of a space, the presence of others and the availability of sensory elements jointly explain a substantial share of a space's restorative capacity, though with different weights for parks and squares (Ríos Rodríguez et al., 2021). Work on urban squares specifically has emphasized enclosure, the character and continuity of the surrounding built edges, human thermal comfort, and the integration of natural and artificial elements as determinants of how intensively a square is used (Zabetian & Kheyroddin, 2019). This body of work supplies the concrete, designable vocabulary edges, scale, comfort, greenery, light, sound that the present model organizes and weights, and it justifies the study's decision to place environmental features at the center of the presence construct rather than at its periphery. What this literature does not yet provide, and what this study contributes, is a compact and transparently screened set of environmental indicators, hierarchically weighted and rendered into a perception-based instrument. Table 1 summarizes the principal theoretical strands on which the model builds and the specific contribution each makes to the indicator set.

Table 1: Theoretical strands informing the environmental indicators of presence, and their contribution (Source: Authors)

Strand / source	Core idea	Contribution to the indicator set
Phenomenology of place (Relph, 1976)	Presence as existential insideless; the felt sense of 'here'	Defines the outcome construct and the semantic–perceptual criterion
Psychology of place (Canter, 1977)	Place as physical setting × activity × meaning	Supplies the three-part scaffold decomposed into the four criteria
Public life behavior (Gehl, 1987)	Environmental quality enables optional and social activity	Grounds the social–functional criterion and its sub indicators
Urban vitality (Montgomery, 1998)	Vitality from the interplay of activity, form and meaning	Links designable form to presence; frames the physical–spatial criterion
Perceived environmental quality (Ríos Rodríguez et al., 2021)	Design, care, social interaction and sensory elements predict restorative Ness	Empirical warrant for the sensory–environmental criterion
Quality of historic squares (Zabetian & Kheyroddin, 2019)	Enclosure, edges, comfort and natural elements shape square use	Sub indicators of enclosure, scale, comfort and greenery

Deriving the pool of environmental indicators

Synthesizing the strands above yields four environment centered criteria, each resolved into three sub indicators. The physical–spatial criterion concerns the built form of the square its enclosure and edge continuity, its human scale and proportion, and its legibility and orientation. The sensory–environmental criterion concerns the ambient qualities a body registers directly thermal and climatic comfort, the presence of greenery and water, and the quality of light and sound. The social–functional criterion concerns the affordances for public life the visible presence of other people, support for optional activities, and the provision of seating and edges that invite lingering. The semantic–perceptual criterion concerns meaning identity and memory, symbolic value, and the sense of belonging the square evokes. Table 2 states each indicator and its warrant.

Table 2: The four environmental criteria of presence, their sub indicators and warrant in the literature (Source: Authors)

Criterion	Sub indicators	Warrant in the literature
C1. Physical–spatial	Enclosure & edge continuity; human scale & proportion; legibility & orientation	Montgomery (1998); Gehl (1987); Zabetian & Kheyroddin (2019)

C2. Sensory–environmental	Thermal & climatic comfort; greenery & water; light & sound quality	Ríos Rodríguez et al. (2021); Zabetian & Kheyroddin (2019)
C3. Social–functional	Presence of people; support for optional activity; seating & lingering	Gehl (1987); Ríos Rodríguez et al. (2021)
C4. Semantic–perceptual	Identity & memory; symbolic value; sense of belonging	Relph (1976); Canter (1977)

MATERIALS AND METHODS

Research design

The study is designed as a four phase, expert driven modelling procedure that builds an environment focused presence model and renders it into a field ready instrument (Fig. 2). Phase 1 derives the candidate indicator pool from the literature (Tab. 1–2). Phase 2 screens and refines the pool through a two round fuzzy Delphi with an expert panel. Phase 3 translates the retained indicators into a Human Subjective Evaluation questionnaire. Phase 4 structures the instrument for onsite perceptual application and model calibration. The design is deliberately sequential: the model is fixed by expert consensus before any field data are gathered, so that the subsequent survey tests a pre specified instrument rather than an ad hoc one

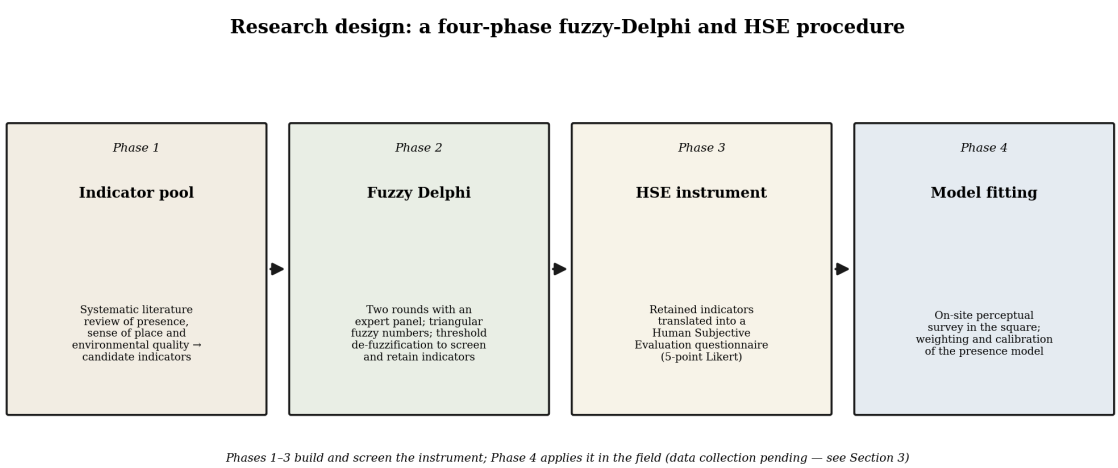

Figure 2: Research design: a four-phase fuzzy Delphi and HSE procedure (Source: Authors)

The expert panel

The fuzzy Delphi procedure draws on a purposive panel of experts spanning urban design, environmental psychology and heritage conservation. Panel members are selected for demonstrated scholarly or professional engagement with public space quality, and the panel is kept deliberately compact, consistent with Delphi practice in which validity derives from expertise rather than sample size (Hsu & Yang, 2000). Consensus is pursued over two rounds, with controlled feedback of the aggregated panel judgement between rounds.

The fuzzy Delphi procedure

The classical Delphi aggregates expert opinion over rounds but forces each judgement onto a single crisp value, discarding the imprecision intrinsic to human evaluation. The fuzzy Delphi method overcomes this by representing each expert's judgement of an indicator's importance as a triangular fuzzy number (Ishikawa et al., 1993). For each indicator, the panel's judgements are aggregated into a single triangular fuzzy number whose lower value is the minimum of

the experts' minima, whose modal value is the geometric mean of their most likely values, and whose upper value is the maximum of their maxima, following the triangular formulation of Hsu and Yang (2000). Each aggregated number is then de fuzzified to a single crisp score here the simple mean of its three parameters and indicators whose de fuzzified score exceeds a preset threshold are retained, while those below it are screened out (Fig. 3).

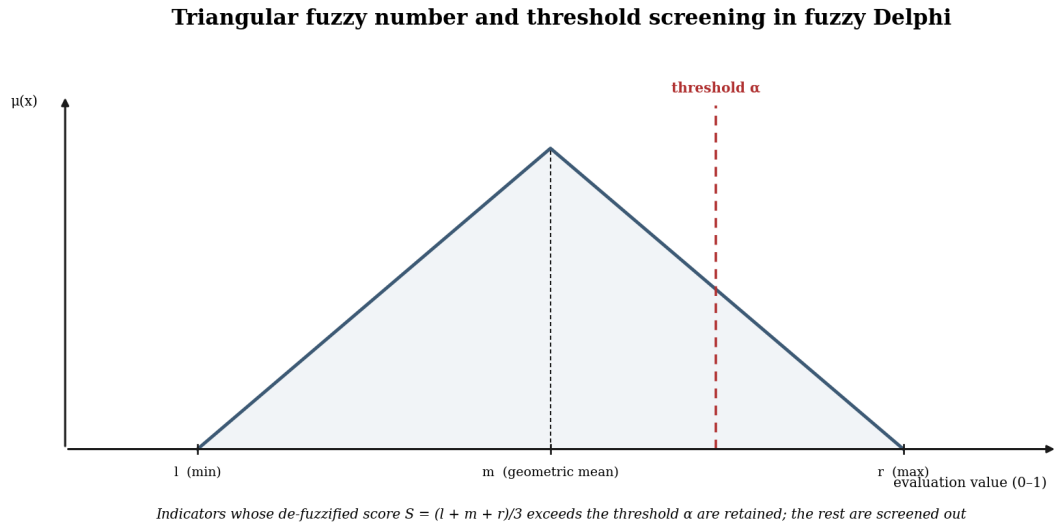

Figure 3: Triangular fuzzy number and threshold screening in the fuzzy Delphi procedure (Source: Authors)

Table 3 illustrates the screening computation for a subset of indicators using placeholder panel values. The threshold α is set at 0.70 on a 0–1 scale, a common choice in fuzzy Delphi screening; indicators scoring at or above it is retained. The illustrative values are shown solely to make the procedure concrete and must be replaced with the panel's actual judgements.

Table 3: Illustrative fuzzy Delphi screening of selected indicators (placeholder values) (Source: Authors)

Indicator	l (min)	m (geo. mean)	r (max)	S = (l+m+r)/3	Decision
Enclosure & edge continuity	0.55	0.82	1.00	0.79	Retain
Human scale & proportion	0.50	0.78	1.00	0.76	Retain
Thermal & climatic comfort	0.45	0.74	0.95	0.71	Retain
Greenery & water	0.40	0.71	0.95	0.69	Review*
Symbolic value	0.50	0.76	1.00	0.75	Retain
Signage & wayfinding graphics	0.20	0.48	0.75	0.48	Screen out

* Indicators falling marginally below the threshold are returned to the panel in the second round for reconsideration rather than being discarded outright, preserving the controlled feedback logic of the Delphi.

Weighting and the hierarchical model

The de fuzzified scores of the retained indicators are normalized to yield relative weights, first within each criterion and then across the four criteria, producing the hierarchical structure shown in Figure 4. This structure is the core analytical product of the study: it states not merely which environmental features matter but how

much each matters relative to the others, which is precisely the information a designer needs in order to prioritize intervention.

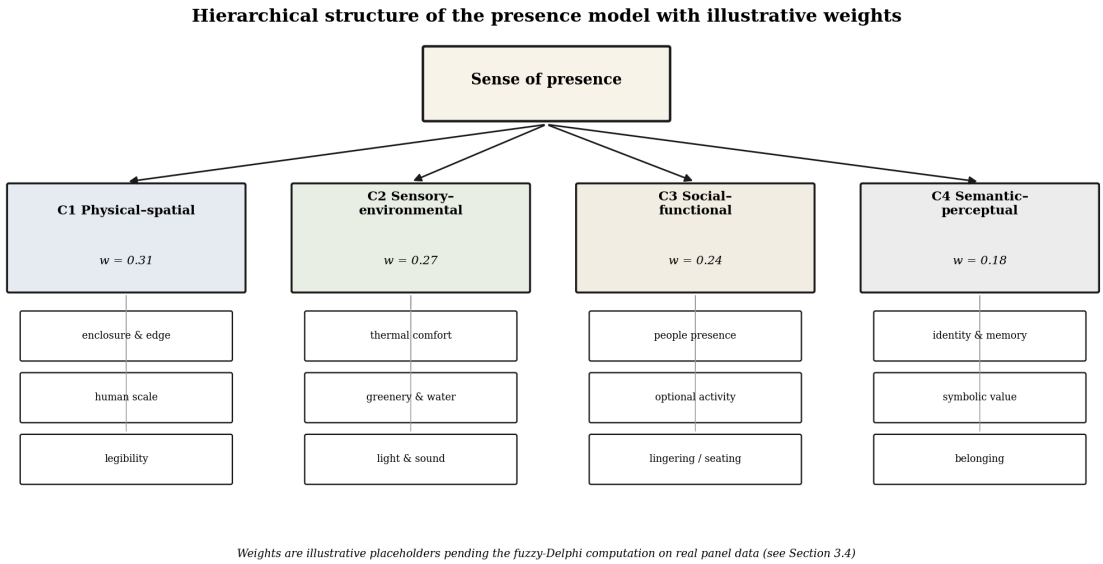

Figure 4: Hierarchical structure of the presence model with illustrative criterion weights (Source: Authors)

The Human Subjective Evaluation (HSE) instrument

Each retained indicator is translated into one or more items of a Human Subjective Evaluation questionnaire, in which a respondent standing in the square rates a statement about an environmental quality on a five-point Likert scale from strongly disagree to strongly agree. The HSE approach is appropriate here because presence is, by definition, a subjective state: it can be reported only by the person experiencing it, and the environmental features of interest are those as perceived rather than as measured by instruments. Weighting the item scores by the fuzzy Delphi criterion weights yields a composite presence score for the square, decomposable by criterion so that a designer can see which environmental dimension drives or depresses the overall result.

Demonstration case and application protocol

Naghsh e Jahan Square in Isfahan is proposed as the demonstration case. Inscribed on the UNESCO World Heritage List and framed by the Imam Mosque, the Sheikh Lotfollah Mosque, the Ali Qapu Palace and the Qeysarieh Bazaar portal, it is one of the largest historic public squares in the world and an exceptionally demanding setting in which to test a presence model, since its environmental richness spans all four criteria. The application protocol calls for the HSE instrument to be administered to a stratified sample of square users across different times of day and seasons, so that the contextual moderators of presence climate, time and cultural background can be examined rather than assumed away. (Fig. 5)

Methodological limitations acknowledged in advance

Three limitations are intrinsic to the design and are stated here so that the contribution is read appropriately. First, the model is expert derived: its indicators and weights reflect a panel's consensus and require field validation with square users before they can be treated as established. Second, the demonstration case is a single, exceptional heritage square; transfer of the

weights to ordinary or contemporary squares must be tested, not assumed. Third, subjective evaluation is sensitive to the moment of measurement weather, time of day, crowding so a single administration risk mistaking a transient state for a stable property of the square; repeated measurement across conditions is therefore built into the protocol. These limitations bound the claims but do not diminish the contribution, which is a transparent, weighted and transferable instrument where the literature previously offered diffuse constructs.

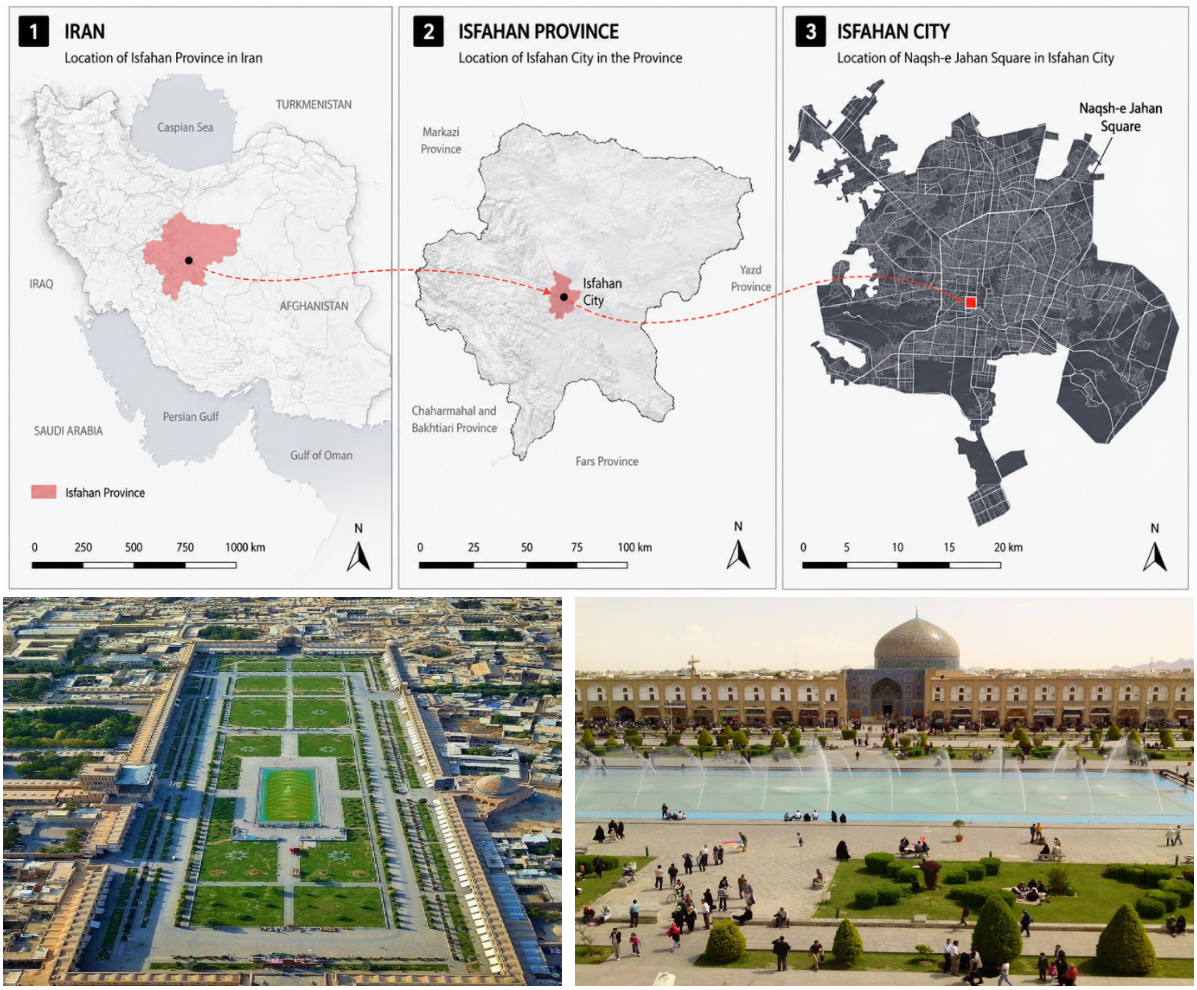

Figure 5: Geographical location of Naqsh-e Jahan Square in Isfahan City, Iran. (1) Location of Isfahan Province within Iran; (2) Location of Isfahan City within Isfahan Province; and (3) Location of Naqsh-e Jahan Square within Isfahan City.

FINDINGS AND DISCUSSION

The structure of the presence model

The principal finding is structural rather than numerical: the environmental determinants of presence in urban squares resolve into a coherent four criterion hierarchy in which each criterion is both conceptually distinct and empirically warranted (Tab. 1–2, Fig. 4). On the illustrative weights, the physical–spatial and sensory–environmental criteria carry the largest shares, together accounting for well over half of the model. This ordering is consistent with the emphasis in the design literature on form and ambient quality as the primary levers of public space experience (Gehl, 1987; Montgomery, 1998), and with

empirical findings that the design and sensory qualities of a space are strong predictors of its restorative and social use (Ríos Rodríguez et al., 2021). Figure 5 shows, again illustratively, how the model discriminates between a richly framed historic square and a sparse contemporary one across the four criteria. (Fig. 6)

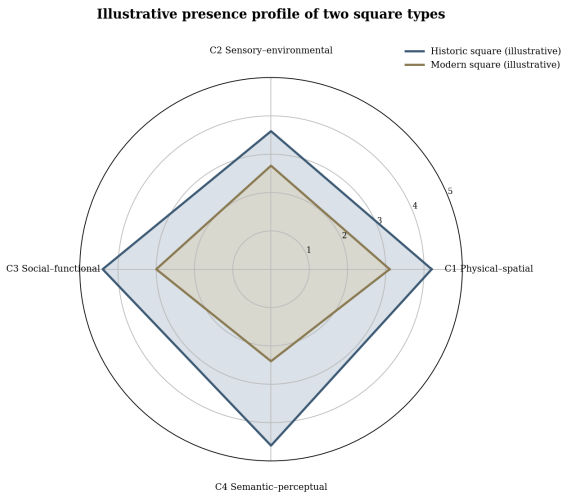

Figure 6: Illustrative presence profile of two contrasting square types across the four criteria (Source: Authors)

Why an environment centered, subjective model

The findings bear on a persistent tension in the literature. Presence and sense of place are frequently treated as holistic, almost ineffable qualities that resist decomposition (Relph, 1976); yet designers must act on specific, separable features. The model resolves this tension by treating presence as a weighted composite of environmental determinants that is nonetheless accessed through a single subjective judgement honoring both the holism of the experience and the analytic needs of practice. This is the same move Canter (1977) made in defining place as the intersection of setting, activity and meaning, extended here into a measurable and weighted instrument. The HSE approach is essential to this resolution: because presence exists only as experienced, an instrument that records perceived environmental quality is not a second-best proxy for some objective measure but the appropriate measure in principle. A second point concerns the role of meaning. The semantic–perceptual criterion carries the smallest illustrative weight, yet it would be a serious misreading to conclude that meaning is peripheral. In a heritage square such as Naghsh e Jahan, identity and symbolic value are so pervasive that they may be experienced as a constant backdrop rather than a variable feature, which can depress their measured weight even as they underwrite the entire experience. This is a known hazard of decomposing place into indicators, and it is flagged here as a matter for interpretation rather than suppressed (Relph, 1976). The point also warns against transferring the heritage square weights uncritically to contemporary squares, where meaning is less given and may behave as a stronger variable.

An integrated model

These considerations motivate the integrated model in Figure 6. Rather than positing a direct line from environment to presence, the model routes environmental features through subjective evaluation the HSE instrument, weighted by fuzzy Delphi consensus and conditions the whole on contextual moderators of climate, time and culture. A feedback path returns the measured presence outcome to the environmental features, expressing the design cycle in which diagnosis informs intervention and intervention is re diagnosed. The model's claim is falsifiable: it predicts that squares scoring highly across the two dominant criteria will register the strongest presence, and that a square strong on only one criterion will exhibit a characteristic shortfall detectable in its criterion profile. (Fig. 7)

Design implications

Four implications follow for the design and management of urban squares. First, because physical–spatial and sensory–environmental features dominate the model, interventions that strengthen enclosure, human scale, thermal comfort and sensory richness are likely to yield the largest

gains in presence per unit of resource. Second, because the model is decomposable, a square can be diagnosed criterion by criterion, so that scarce funds are directed to the weakest dimension rather than spread thinly. Third, because presence is measured subjectively and across conditions, management can track a square's performance over time and across seasons rather than relying on one off physical audits. Fourth, because meaning may be underweighted precisely where it is most pervasive, heritage squares warrant an explicit safeguarding of their semantic qualities that a purely weight driven reading might neglect.

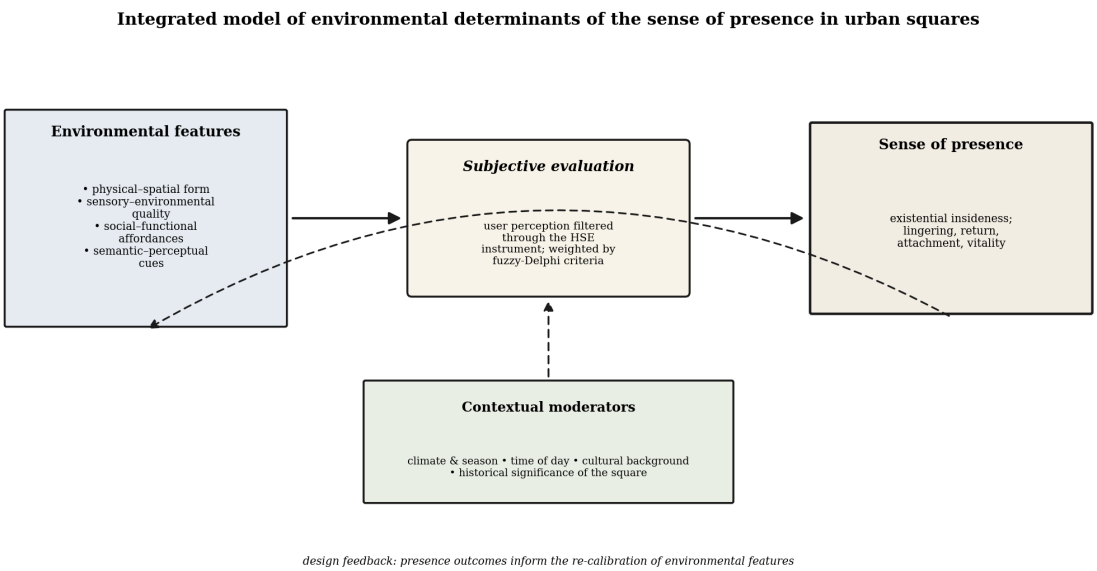

Figure 7: Integrated model of the environmental determinants of the sense of presence in urban squares (Source: Authors)

RESULTS AND CONCLUSION

This study set out to convert a rich but diffuse idea the sense of presence in urban squares into a transparent, environment centered and transferable model, operationalized through a Human Subjective Evaluation instrument and screened by a fuzzy Delphi procedure. Its contribution is twofold. Conceptually, it reframes presence as a weighted composite of four environmental criteria physical–spatial, sensory–environmental, social–functional and semantic–perceptual mediated by subjective evaluation and conditioned by context, thereby reconciling the holism of place experience with the analytic needs of design practice. Methodologically, it offers a replicable pipeline that moves from a literature derived indicator pool, through expert consensus under uncertainty, to a field ready perceptual instrument, so that the resulting weights are auditable rather than asserted. The study's principal limitation is also its principal invitation: the model is complete as an instrument but awaits field validation with square users, and the weights reported here are illustrative until the fuzzy Delphi panel and the HSE survey are conducted. Three lines of work follow directly. First, convening the expert panel and computing the actual criterion weights would convert the structure from illustrative to established. Second, administering the HSE instrument at Naghsh-e-Jahan Square across seasons and times of day would test the model in the demanding setting for which it was designed and would activate its contextual moderators. Third, replicating the instrument in ordinary and contemporary squares would test the trans-

ferability of the heritage derived weights and, in particular, whether the semantic criterion behaves as a stronger variable where meaning is less given. Pursued together, these steps would turn a validated design into validated evidence, and would give urban designers a diagnostic tool for the elusive but decisive quality that separates a square that is merely crossed from one that is genuinely inhabited.

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