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Salutogenic Hospital Design for Health Promotion: A Mixed-Methods Study of Environmental Factors and Their Relationship with Patients' Sense of Coherence

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Abstract

Background: Health promotion emphasizes reducing stress and strengthening individual coping mechanisms. Hospitals, as pivotal healthcare settings, can advance this objective through salutogenic design, which targets the enhancement of patients' Sense of Coherence (SOC)—comprising comprehensibility, manageability, and meaningfulness. However, empirical evidence linking architectural design to SOC remains limited.

Objectives: This study aimed to identify key architectural components supporting salutogenic hospital design and model their interrelationships with patients' SOC.

Methods: An exploratory mixed-methods design was utilized. A qualitative phase involving documentary analysis and a Delphi expert panel identified initial factors. Subsequently, a 45-item questionnaire was administered to 210 inpatients at Shahid Rajaei Heart Hospital (January–March 2024). Validity and reliability were confirmed via expert review, Cronbach's alpha, and exploratory factor analysis. Data were analyzed using SPSS-27 and structural equation modeling (SEM) in AMOS.

Results: Expert consensus refined seven initial factors into a six-factor user-validated model: legibility and functional performance, environmental comfort, naturalness, safety and hygiene, psycho-social comfort, and aesthetics. Reliability was acceptable ($\alpha = 0.726$), and sampling adequacy was confirmed (KMO = 0.907). Correlation analysis revealed distinct associations: legibility correlated strongly with comprehensibility; environmental comfort and safety with manageability; and naturalness, aesthetics, and psycho-social comfort with meaningfulness. SEM confirmed significant interrelationships among all six factors with good model fit.

Conclusion: The findings indicate the complexity of patient safety challenges during the COVID-19 pandemic and the need for comprehensive approaches to improve safety conditions in healthcare systems. Specific environmental design factors significantly contribute to patients' perceptual and psychological well-being. The six-factor model validates a salutogenic design approach, demonstrating that environmental quality can enhance comprehensibility, manageability, and meaningfulness in healthcare contexts.

Keywords: Salutogenic design, Health promotion, Hospital architecture, Sense of coherence, Healing environment.

1. Background

Health promotion constitutes an integral component of comprehensive, redesigned healthcare models. Within this paradigm, health is conceptualized not merely as the absence of disease, but as a dynamic process aimed at empowering individuals to enhance their quality of life (1). The World Health Organization (WHO) defines health promotion as a process enabling individuals to increase control over their health, emphasizing the creation of supportive environments that both protect against health threats and bolster individual capacity and self-reliance (2). In this context, the environment encompasses the social, natural, and built domains, along with their interactions. An environmental approach facilitates the adaptation and implementation of abstract health promotion strategies within specific settings such as homes, workplaces, communities,

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and hospitals (3,4). Accordingly, the WHO identifies hospitals as pivotal settings for health promotion (2).

Hospitals play a central role in representing healthcare systems, as most individuals encounter them at some point, and they function as major employers within communities (5,6). Moreover, hospitals are embedded within other health-promoting settings, including workplaces and social environments. Consequently, health-promoting hospitals should be regarded as integral to the broader endeavor of cultivating healthier communities (7,8). Within the health promotion literature, several theoretical perspectives—including health behavior, health equity, and Sense of Coherence—are particularly prominent. While the health behavior perspective emphasizes strategies that encourage healthy lifestyles and the health equity perspective centers on access to services and environmental conditions, the SOC perspective, rooted in salutogenic theory, concentrates on strengthening individuals' capacities to cope effectively with stressors and maintain well-being (9).

The salutogenic approach, introduced by Aaron Antonovsky, poses the fundamental question of what creates health rather than what causes disease (10). Antonovsky conceptualized health and illness as poles on a continuum, arguing that movement toward health depends upon an individual's level of Sense of Coherence (11,12). Sense of Coherence is defined as a stable life orientation comprising three interrelated components—comprehensibility, manageability, and meaningfulness—and functions as a mediating variable in health outcomes (12,13). Research indicates that physical environments can significantly influence psychological well-being and stress reduction by strengthening these components (13,14). During illness, individuals experience heightened stress and instability, rendering them particularly sensitive to environmental stimuli. Salutogenic architecture can support recovery and health promotion by enhancing environmental legibility, fostering a sense of control, and creating meaningful spatial experiences (15). In hospital settings, where patients often assume a passive role with decisions made by healthcare professionals, designing environments with clear, predictable spatial sequences can enhance perceived safety and control (16). Empirical evidence demonstrates that physical design factors—such as access to natural light, connection to nature, acoustic control, color, materials, privacy, air quality, thermal comfort, aesthetics, and opportunities for social interaction—play a crucial role in mitigating stress, improving mental health, and enhancing patients' quality of life (17,18).

Despite a growing body of research on healthcare environments, most studies have examined individual environmental factors in isolation. A notable gap persists regarding the structural and simultaneous modeling of salutogenic design components in hospitals, particularly based on user experience. This gap is especially pronounced in research conducted within the Iranian healthcare context, underscoring the need for model-based inquiry aimed at promoting health through hospital design.

This study aimed to identify and model the key physical and spatial design factors of hospitals that contribute to health promotion by strengthening patients' Sense of Coherence within a salutogenic framework. By analyzing the structural relationships among these factors, the study sought to provide practical design guidelines to enhance patients' coping capacity and promote overall health.

2. Objective

An exploratory mixed-methods design was employed, comprising qualitative and quantitative phases followed by structural equation modeling.

In the first phase, key factors related to health-promoting, salutogenic, and stress-reducing hospital design were extracted through documentary content analysis of peer-reviewed national and international articles, books, and theses. A two-round Delphi technique was subsequently applied to refine and validate these components. Delphi participants included experts in architecture and psychology. In the first round, data were collected via semi-structured interviews and open-ended questionnaires. Based on these results, a researcher-developed closed-ended questionnaire utilizing a nine-point Likert scale (1 = very low; 9 = very high) was designed. Items were revised and reduced in each Delphi round based on the level of expert consensus. Following two rounds, Q-factor analysis (19) was employed to classify participants, and the components associated with their perspectives were extracted and summarized. Subsequently, experts evaluated the relationships between the identified factors and the components of SOC.

In the second phase, a cross-sectional survey was conducted among hospitalized patients. A closed-ended questionnaire based on the previously extracted components was developed using a five-point Likert scale (1 = very low; 5 = very high). Convenience sampling was employed (20,21). In accordance with Klein's recommendation of at least five participants per variable and a minimum sample size of 200 for exploratory factor analysis, 210 patients hospitalized at Shahid Rajaei Heart Hospital were included. Data were analyzed using R-factor analysis in SPSS-27. Reliability was assessed using Cronbach's alpha coefficient (values > 0.70 considered acceptable). Sampling adequacy and data suitability for factor analysis were evaluated using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity; a KMO value > 0.60 indicated adequate sampling (22).

In the final phase, structural equation modeling (SEM) was performed using AMOS software to examine causal relationships and determine effect coefficients among components (23).

2.1. Procedural Details:

Documentary content analysis was conducted on 327 articles, books, and theses (domestic and international) over six months (March–September 2024). The Delphi phase (October–December 2024) involved experts in architecture, psychology, medicine, and healthcare. In the first round, 10 participants were selected via convenience sampling (6 architecture faculty members; 4 healthcare professionals comprising two physicians, one nurse, and one psychologist). The expert questionnaire was refined over two rounds based on an objective-content table. Data from 26 experts were analyzed in SPSS. Reliability was satisfactory (Cronbach's alpha = 0.726). The KMO value (0.629) and significant Bartlett's test ($p < 0.05$) confirmed data adequacy for factor analysis. Q-factor analysis—which classifies individuals rather than variables (24)—identified seven factor categories. Experts then assessed the relationships between these factors and SOC constructs.

In the subsequent phase (January–March 2025), a user questionnaire was developed, comprising 45 items measured on a four-point Likert scale (1 = strongly disagree; 4 = strongly agree). Based on Klein's criterion, 210 patients were recruited from inpatient wards at Shahid Rajaei Heart Hospital. Access was coordinated with ward nurses; eligible patients were approached individually after a brief explanation of study objectives. Inclusion criteria were: age 18–75 years; hospitalization exceeding 48 hours; admission to general cardiac wards; adequate cognitive ability to understand and respond (as judged by the researcher and ward staff); and absence of acute psychiatric disorders or severe mental conditions affecting environmental perception.

Following data collection, six factors were extracted. Factor naming was based on the highest number of common items from users' perspectives. Face validity was confirmed by five experts. Reliability was excellent (Cronbach's alpha = 0.971 for 45 items). The KMO value (0.907) and significant Bartlett's test ($p < 0.05$) confirmed sampling adequacy (25).

To examine relationships between environmental design factors and SOC components, Pearson correlation analysis was performed. The six extracted environmental factors (F1–F6) served as the primary study variables; factor scores were calculated by averaging associated items. Because SOC was not directly measured, its three components were operationalized based on the conceptual grouping of questionnaire items. Specifically, items pertaining to spatial clarity and organization represented comprehensibility; items related to environmental comfort and safety represented manageability; and items concerning aesthetics, natural elements, and psycho-social comfort represented meaningfulness. Pearson correlation coefficients (r) assessed the strength and direction of these relationships, with statistical significance set at $p < 0.05$. Assumptions of normality and linearity were examined and confirmed prior to analysis (24).Subsequently, SEM—including confirmatory factor analysis and path analysis—was employed as a robust statistical approach for examining complex relationships among variables (26). Analyses were conducted using AMOS software in March 2025. Model fit was evaluated using multiple indices: chi-square to degrees of freedom ratio (χ^2/df < 2), significance level ($p > 0.05$), Goodness-of-Fit Index (GFI), Normed Fit Index (NFI), Comparative Fit Index (CFI) with acceptable values > 0.90, and Root Mean Square Error of Approximation (RMSEA) with values < 0.05 (27).

3. Methods

A comprehensive review of recent domestic and international literature was initially conducted, focusing on hospital design, environmental variables, stress-reducing factors, salutogenic theory, and health promotion.

The Delphi method was employed to investigate variables affecting hospital design from expert perspectives. Open-ended interviews were conducted in the first round, followed by the development and administration of an initial expert questionnaire in the second round. After analyzing responses, a revised questionnaire was implemented.Q-factor analysis was then conducted to identify principal factors and their interrelationships. Commonalities were used to determine the variance of individual expert responses, while total explained variance assessed the variance accounted for by the factors. Mean scores of items within each component were used in calculating total variance to address unequal participant contributions.

Post-rotation analysis indicated that among 26 participants, eight factors with eigenvalues greater than one were initially identified. Approximately 70% of respondents shared common perspectives, while about 30% reflected individual viewpoints, likely influenced by personal knowledge and preferences. This suggests an underlying objective reality captured by the questionnaire, accounting for the majority of shared expert opinion.

Expert viewpoints were ultimately classified into seven distinct factors, with naming based on the highest number of shared responses:Factor 1 (Safety and Health): 6 experts (participants 17, 11, 16, 20, 1, 15), Factor 2 (Functional Performance): 4 experts (participants 14, 12, 10, 7), Factor 3 (Environmental Comfort): 2 experts (participants 6, 18), Factor 4 (Aesthetics): 3 experts (participants 21, 4, 26), Factor 5 (Legibility): 3 experts (participants 8, 3, 9), Factor 6 (Naturalness): 4 experts (participants 25, 2, 23, 19), Factor 7 (Psycho-social Comfort): 3 experts (participants 5, 13, 24)

The eighth factor, associated with a single participant (No. 22), did not constitute a distinct fact or structure and was excluded. Subsequently, ten experts evaluated associations between these seven factors and the three SOC components. According to the majority, comprehensibility is primarily associated with environmental legibility; manageability relates to environmental comfort, functional performance, and safety and hygiene; and meaningfulness demonstrates the strongest association with aesthetics, psycho-social comfort, and naturalness.

Based on the documentary analysis and Delphi findings, a 45-item user questionnaire was developed and administered. Of the 210 patients recruited at Shahid Rajaei Heart Hospital, 195 completed valid questionnaires were included in the analysis. Among respondents, 116 (approximately 59%) were female and 79 (approximately 41%) were male. Regarding age distribution: 5% were 18–29 years; 23% were 30–40 years; 32% were 41–50 years; and 41% were over 50 years old. Educational attainment varied: 19% held a high school diploma; 13% an associate degree; 48% a bachelor's degree; 14% a master's degree; and 5% a doctoral degree (Table 1).

Table 1: Demographic characteristics of participants in this survey in percentage

Gender N (%)	Male	79 (41)
	Female	116 (59)
Age (year) N (%)	18–29 years	9 (5)
	30–40 years	45 (23)
	41–50 years	63 (32)
	over 50 years	79 (41)
Education N (%)	Diploma	38 (19)
	Associate degree	26 (13)
	Bachelor’s degree	94 (48)
	Master’s degree	27 (14)
	PhD	10 (5)

Exploratory factor analysis (EFA) of the 45 items initially extracted 10 factors with eigenvalues greater than 1, accounting for a cumulative variance of 68.74% (Table 2). This suggests that approximately 69% of respondents' perceptions were shared, while about 31% reflected individual differences.

Table 2: Variance before and after rotation

Comp.	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	15.951	35.447	35.447	15.951	35.447	35.447	9.685	21.523	21.523
2	3.500	7.778	43.225	3.500	7.778	43.225	3.195	7.099	28.623
3	2.237	4.971	48.196	2.237	4.971	48.196	2.856	6.346	34.969
4	1.691	3.758	51.954	1.691	3.758	51.954	2.733	6.074	41.043
5	1.567	3.483	55.437	1.567	3.483	55.437	2.586	5.746	46.790
6	1.453	3.230	58.667	1.453	3.230	58.667	2.363	5.250	52.040
7	1.248	2.773	61.440	1.248	2.773	61.440	2.142	4.759	56.799
8	1.173	2.608	64.047	1.173	2.608	64.047	2.114	4.697	61.495
9	1.090	2.422	66.470	1.090	2.422	66.470	1.720	3.822	65.317
10	1.022	2.271	68.740	1.022	2.271	68.740	1.540	3.423	68.740

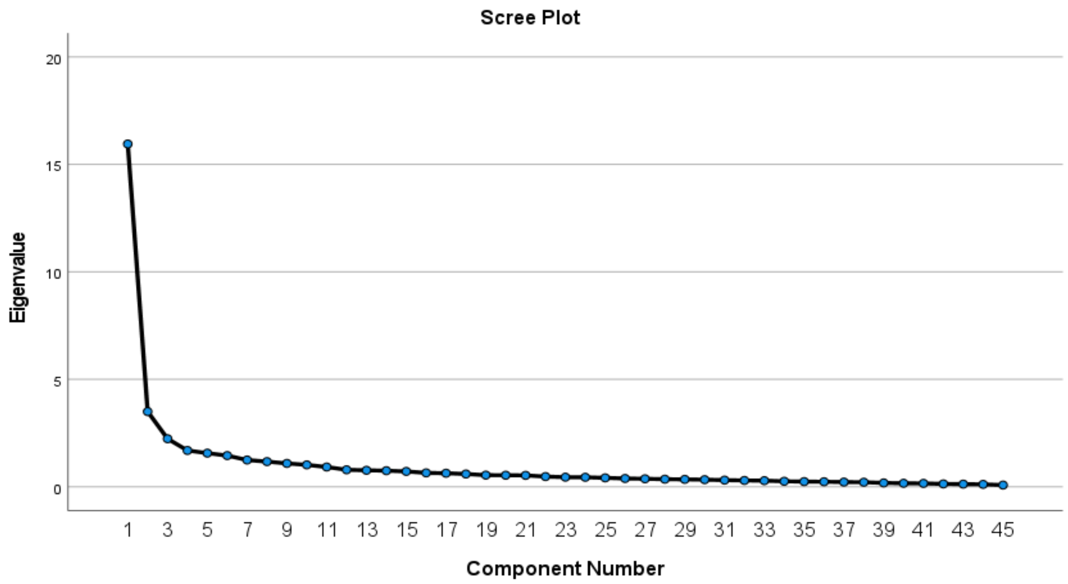

Figure 1: Scree plot

The scree plot for determining the R factors is shown in Figure 1, which identifies ten factors greater than one. Interpretation of the rotated factor matrix (Table 3) indicated that six main factors could be meaningfully identified in the user questionnaire. Variables with factor loadings greater than ±0.30 were considered significant and assigned accordingly. The first factor comprised 19 items; the second and third factors each included four items; the fourth comprised three items; and the fifth and sixth factors each consisted of three items. The seventh and eighth factors, each containing only two items, were not considered principal factors due to insufficient item loadings. Although the ninth factor included three items, and the tenth comprised two, the latter did not form an independent, interpretable structure. Overall, a six-factor solution was supported as the most stable and interpretable structure.

Table 3: Rotated component matrix

	Component									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
VAR00026	.817	.040	.213	.216	.019	.009	.129	-.007	-.022	-.062
VAR00025	.794	.259	.093	.136	.163	.001	-.052	.070	.102	-.103
VAR00007	.786	.103	.242	.113	.015	.024	.165	.007	.114	.044
VAR00024	.754	.254	-.079	.086	.301	.002	.005	-.008	.142	-.054
VAR00017	.747	.175	.147	.140	.108	-.038	.087	.186	.158	.131
VAR00016	.737	.084	.192	-.002	.138	-.022	.186	.118	.233	.139
VAR00022	.735	.389	.024	.071	.073	-.068	.071	.201	-.038	-.118
VAR00045	.692	.026	.154	.246	.114	.013	-.075	-.050	-.016	-.084
VAR00039	.660	-.095	.312	.249	.198	-.046	.022	.009	.034	.060
VAR00023	.626	.270	-.095	.172	.227	-.042	.067	.245	.095	-.038
VAR00011	.618	-.104	.258	.080	-.049	.246	.002	.093	.295	.105
VAR00006	.589	.070	.352	.092	.006	.140	.161	.302	-.268	.185
VAR00021	.582	.091	.202	.291	.002	.022	.095	.184	-.001	-.394
VAR00018	.560	.124	.105	.169	.174	.019	.119	.502	.240	.096
VAR00036	.528	.028	.228	-.025	.453	.195	.210	.041	.083	-.026
VAR00015	.512	-.084	.419	.092	-.029	-.180	.124	.227	.382	.064
VAR00038	.506	-.047	.165	.474	.360	.075	-.005	.113	-.055	.115
VAR00043	.478	.143	.137	.167	.308	.024	.398	.223	-.038	.326
VAR00030	.464	.092	.428	.324	.307	-.008	-.030	.197	.219	.120
VAR00004	.153	.710	-.016	.082	.244	.107	.158	-.153	.056	.025
VAR00003	.177	.695	.193	.213	.060	.166	.146	.173	.087	.060

VAR00029	.180	.648	.135	-.103	.347	.086	-.179	.171	.082	.087
VAR00005	.164	.534	.060	.374	-.002	.170	.086	.083	.169	.479
VAR00034	.338	.301	.648	.116	.166	-.115	.053	.086	.127	-.014
VAR00035	.315	-.081	.622	.011	.060	.212	.227	.171	-.222	-.020
VAR00033	.396	.212	.566	.043	.112	.011	.023	-.084	.144	-.124
VAR00037	.111	.145	.560	.265	.337	-.180	.037	.205	.168	.008
VAR00041	.235	.147	.204	.723	.062	-.078	.133	.236	-.006	-.051
VAR00042	.400	.088	-.052	.647	.076	.203	.129	-.101	.102	.077
VAR00040	.360	.026	.115	.618	.126	.105	.296	.227	.000	.055
VAR00028	.137	.204	.086	.119	.672	.093	.152	.161	.086	.097
VAR00031	.347	.215	.190	.188	.557	.005	.003	.100	.181	-.179
VAR00027	.180	.377	.174	.037	.502	.298	.169	.018	-.043	.015
VAR00010	-.066	.009	-.038	.085	.171	.845	-.020	.054	.129	.001
VAR00009	-.035	.294	-.093	.120	.080	.736	.075	.144	.051	.152
VAR00008	.059	.520	.118	-.123	-.120	.576	.017	.040	.045	-.160
VAR00001	.056	.042	.075	.084	.002	-.010	.830	.066	.055	.007
VAR00002	.139	.129	.055	.242	.235	.091	.724	.207	.172	.023
VAR00019	.079	.047	.077	.097	.074	.215	.069	.792	.043	-.064
VAR00020	.247	.062	.169	.158	.208	-.028	.334	.602	-.058	.032
VAR00013	.418	.150	-.007	.041	.132	.210	.155	-.005	.664	.067
VAR00014	.089	.272	.177	-.029	.257	.296	.295	.076	.472	-.007
VAR00012	.375	.168	.280	.069	.025	.139	.011	.027	.466	-.444
VAR00044	.240	.282	.104	.277	.169	.226	.076	.033	-.017	.554
VAR00032	.368	.024	.173	.307	.353	.161	.000	.135	-.094	-.487

The six extracted factors were labeled as follows: Legibility and Functional Performance (F1), Environmental Comfort (F2), Naturalness (F3), Safety and Hygiene (F4), Psycho-Social Comfort (F5), and Aesthetics (F6). Table 4 presents the questionnaire items and corresponding factor analysis results according to their categories.

Table 4: Users' Perspectives Analysis

Main variable	No.	questions	factor loading
Legibility and Functional Performance (F1)	26	It is easy for me to find my way in this environment	.817
	25	The environment feels familiar and easy to understand	.794
	7	The spaces are adaptable and flexible	.786
	24	The equipment and furniture are easy to use	.754
	17	The layout of the room allows me to use facilities easily	.747
	16	The location of different spaces seems logical	.737
	22	The proximity of different spaces makes sense to me	.735
	45	The location of different spaces seems logical	.692
	39	The environment appears structurally safe	.660
	23	The nurse station is accessible when needed	.626
	11	The size of spaces is adequate for movement	.618
	6	I can see important areas when needed	.589
	21	I can easily access important areas	.582
	18	The arrangement of spaces is clear and understandable	.560
	36	Supportive spaces are easily accessible	.528
	15	The environment feels safe to me	.512
	38	Hygiene facilities are available and accessible	.506
	43	The design avoids potentially harmful elements	.478
Environmental Comfort (F2)	4	Natural light and artificial lighting systems are controllable	.710
	3	The temperature is comfortable and adjustable	.695
	29	Furniture and equipment are comfortable	.648
	5	Acoustic control systems and noise reduction strategies are acceptable	.534
Naturalness (F3)	34	Use of indoor plants and natural elements enhance my experience	.648
	35	I have windows with natural views in my room	.622
	33	I have access to courtyards and green roofs	.566
	37	Nature imagery in rooms and corridors create a calming effect	.560
Safety and Hygiene (F4)	41	Hygiene facilities and antibacterial materials are well located	.723
	42	Corridors and pathways are free of physical barriers and obstacles	.647
	40	Floors are slip-resistant ceramic	.618
Psycho–Social Comfort	28	I feel I have enough privacy by using partitions	.672
	31	The environment feels familiar and easily understandable	.557

(F5)	27	There are appropriate meeting spaces within rooms and wards	.502
Aesthetic (F6)	10	The interior design of decoration and furnishings is visually appealing	.845
	9	The colors of materials and areas are pleasant	.736
	8	Decorative lighting design improves visual quality	.576
	13	Form and shape of spaces and Furniture design is attractive	.664
	14	The design is harmonious and coherence	.472
	12	Use of artworks and artistic objects improve the environment	.466

3.1. Correlation Analysis

In the next step the Pearson correlation analysis between environmental factors and the components of sense of coherence were conducted and the results are presented in Table 5.

Pearson correlation analysis between environmental factors and SOC components was conducted (Table 5). Findings indicate that Legibility and Functional Performance (F1) exhibited the strongest correlation with comprehensibility ($r = 0.72$, $p < 0.001$), underscoring the importance of spatial clarity and organization. Regarding manageability, both Environmental Comfort (F2) and Safety and Hygiene (F4) demonstrated strong correlations ($r = 0.68$ and $r = 0.75$, respectively; $p < 0.001$). For meaningfulness, Psycho-Social Comfort (F5), Aesthetics (F6), and Naturalness (F3) exhibited the strongest associations ($r = 0.80$, $r = 0.76$, and $r = 0.70$, respectively; $p < 0.001$).

All environmental factors demonstrated statistically significant correlations with the three SOC components, albeit with varying strengths.

Table5: Correlation between Environmental Factors and Sense of Coherence Component

Variables	Comprehensibility (C)	Manageability (M)	Meaningfulness (Me)
Legibility and Functional Performance (F1)	**0.72***	0.65***	0.40***
Environmental Comfort (F2)	0.30**	**0.68***	0.45***
Naturalness (F3)	0.25*	0.35**	**0.70***
Safety and Hygiene (F4)	0.40***	**0.75***	0.30**
Psycholo–Social Comfort (F5)	0.35**	0.45***	**0.80***
Aesthetic Quality (F6)	0.28**	0.38**	**0.76***
* p < 0.05, ** p < 0.01, *** p < 0.001			

3.2. Structural Equation Modeling

Path analysis and SEM were conducted to examine causal relationships among the extracted design factors (Figure 2). The coefficient of determination (R^2) ranged from 0 to 1, indicating the proportion of variance explained. As shown in Table 6, R^2 values indicated that approximately 40% of variance in Safety and Hygiene (F4), 43% in Naturalness (F3), 25% in Environmental Comfort (F2), 32% in Aesthetic Quality (F6), and 49% in Psycho-Social Comfort (F5) were explained within the hospital design model.

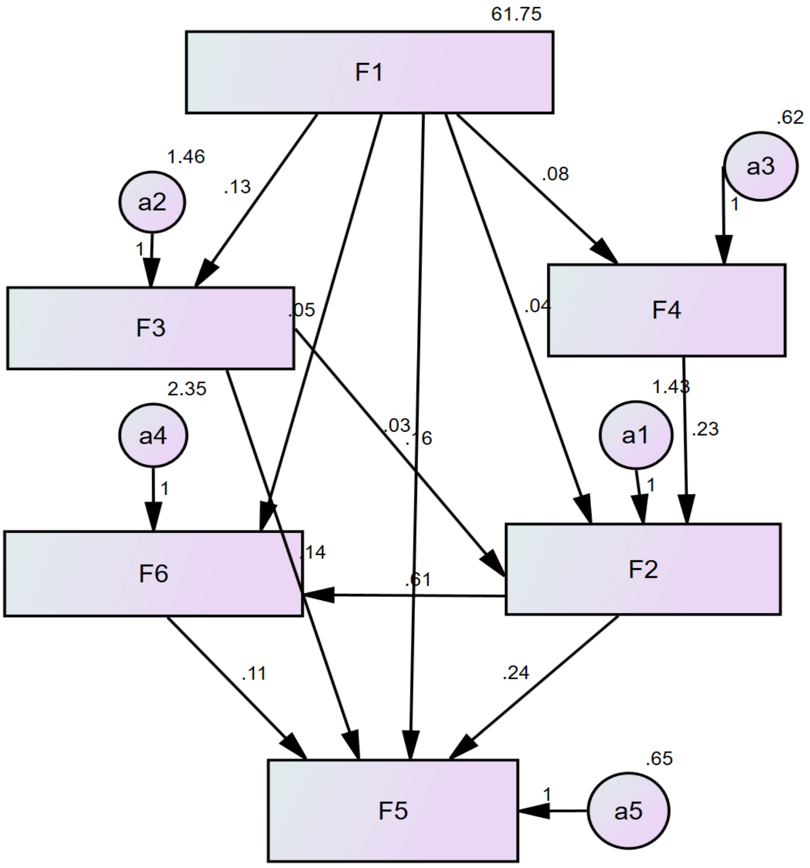

Figure 2: The model fitted in AMOS among the physical variables of the salutogenic hospital

Table 6 presents the standardized direct, indirect, and total effects, along with the standard errors (SE), critical ratios (CR), and significance levels (P-values) for the relationships among the extracted hospital design factors. Table 7 presents the standardized direct, indirect, and total effects, along with standard errors (SE), critical ratios (CR), and significance levels for relationships among the extracted factors. Results indicated that Naturalness (F3) had a significant positive effect on Legibility and Functional Performance (F1) ($\beta = 0.660$, $p < 0.001$). Similarly, Safety and

Hygiene (F4) exerted a significant direct influence on F1 (β = 0.634, p < 0.001). Environmental Comfort (F2) demonstrated significant direct effects on F4 (β = 0.173, p = 0.032), F3 (β = 0.185, p = 0.026), and a moderate direct effect on F1 (β = 0.225, p = 0.021). Aesthetic Quality (F6) played a central mediating role, significantly affecting F2 (β = 0.452, p < 0.001) and F1 (β = 0.198, p = 0.003). Psycho-Social Comfort (F5) showed significant direct effects on F6 (β = 0.177, p = 0.004) and F2 (β = 0.295, p < 0.001), and contributed indirectly to F3 and F1 through intermediary factors.

Table 6: Correlation and coefficient of determination of the model on the variables

Variables	Variable name	R^2	R
F4	safety and hygiene	.401	0.633
F3	naturalness	.436	0.660
F2	Environmental comfort	.246	0.495
F6	aesthetic quality	.325	0.570
F5	psycho–social comfort	.496	0.704

Table 7: Relationships among the extracted hospital design factors.

	Regression Weights	Standardized Regression Weights	S.E.	C.R.	P	Standardized Indirect Effects
F1 F3 <---	.135	.660	.011	12.237	***	0.000
F1 F4<---	.082	.634	.007	11.404	***	0.000
F4 F2<---	.234	.173	.109	2.151	.032	0.000
F1 F2<---	.039	.225	.017	2.305	.021	0.232
F3 F2<---	.158	.185	.071	2.225	.026	0.000
F1 F6<---	.047	.198	.016	2.989	.003	0.206
F2 F6<---	.612	.452	.090	6.817	***	0.000
F1 F5<---	.034	.235	.010	3.275	.001	0.336
F6 F5<---	.108	.177	.038	2.858	.004	0.000
F3 F5<---	.139	.196	.049	2.853	.004	0.065
F2 F5<---	.244	.295	.053	4.583	***	0.80

Model fit indices demonstrated excellent goodness of fit: $\chi^2 = 0.576$, df = 4, $\chi^2/df = 0.723$; p = 0.994; GFI = 0.995; NFI = 0.994; CFI = 1.000; and RMSEA = 0.000. These values confirm a highly acceptable and well-fitted model. Modification indices (Table 8) suggested potential expansion of certain paths, indicating indirect relationships and possible influence of additional external factors.

Table 8: Variances of variables in the final model and estimation of operational errors

A2	Naturalism	1.458	.148	9.849	0.000
A3	Safety and Health	.625	.063	9.849	0.000
A1	Environmental Comfort	1.432	.145	9.849	0.000
A4	Aesthetics	2.347	.238	9.849	0.000
A5	Psychosocial Comfort	.655	.066	9.849	0.001

4. Discussion

The present study sought to develop and validate a conceptual model for hospital design grounded in a salutogenic approach, integrating documentary analysis, Delphi technique, Q-factor analysis, user-based survey with R-factor analysis, correlation analysis, and SEM. This stepwise approach enabled the identification, refinement, and empirical validation of environmental design factors from both expert and user perspectives.

Documentary analysis provided a theoretical foundation by identifying key environmental variables related to hospital design, stress reduction, and health promotion. The Delphi technique combined with Q-factor analysis facilitated the extraction and categorization of expert viewpoints, yielding seven conceptual groupings that were later refined into core dimensions. This phase ensured the model was grounded in interdisciplinary knowledge from architecture, psychology, and healthcare.

The user-based survey and R-factor analysis validated the structure from patients' perspectives, resulting in six main factors: legibility and functional performance, environmental comfort, naturalness, safety and hygiene, psycho-social comfort, and aesthetics. Consistency between expert-based (Q-factor) and user-based (R-factor) findings strengthens the model's credibility and construct validity.

Correlation analysis provided further insight into how these factors relate to SOC components. Legibility and functional performance were more strongly associated with comprehensibility; environmental comfort and safety with manageability; and naturalness, aesthetics, and psycho-social comfort with meaningfulness. These results align with Antonovsky's salutogenic theory, which conceptualizes health as a dynamic process shaped by individuals' capacity to perceive their environment as comprehensible, manageable, and meaningful (29).

Specifically, legibility and functional clarity exerted the strongest influence on patients' comprehensibility. Clear spatial organization, intuitive wayfinding, and functional efficiency reduce confusion and cognitive overload, thereby alleviating anxiety and psychological stress (30,31). Regarding manageability, environmental comfort and safety-hygiene emerged as most influential. Adequate thermal, acoustic, and lighting conditions, together with perceptions of cleanliness and safety, enhance patients' sense of control—

essential for supporting adaptive coping in vulnerable states (32-37).

Meaningfulness was most strongly associated with aesthetics, naturalness, and psychosocial comfort. The presence of natural elements, visually pleasing environments, and opportunities for social interaction and emotional support contribute to more positive, meaningful patient experiences, fostering emotional engagement and hope—central to salutogenic health promotion (17,38-48).

Overall, results underscore that salutogenic design components operate in an interconnected manner, exerting both direct and indirect effects on patients' SOC. Health promotion in hospital environments thus requires an integrated, human-centered approach addressing functional, environmental, psychological, and aesthetic dimensions simultaneously (49-51).

Structural equation modeling confirmed that these six factors are not independent but rather interconnected components of a broader environmental system. Environmental comfort and safety demonstrated strong direct and indirect effects, while psycho-social comfort and aesthetics played central roles in shaping overall user experience.

4.1. Limitations and Strengths

Several limitations should be acknowledged. Convenience sampling, the cross-sectional design, and the single-site focus limit generalizability. Although the researcher-developed questionnaire demonstrated acceptable validity and reliability, the absence of standardized instruments may affect comparability. Potential response bias and lack of control for confounding variables (e.g., illness severity) may have influenced results. Furthermore, SOC components were not directly measured; relationships were inferred based on conceptual alignment and should be interpreted with caution.

Nonetheless, the study has notable strengths. The mixed-methods design, integration of expert and user perspectives, and sequential validation process enhanced the robustness of findings. Convergence across phases (Delphi, factor analysis, SEM) supports the reliability and internal consistency of the proposed model.

5. Conclusion

The findings demonstrate that the physical environment of hospitals can actively promote health. Hospital design grounded in six principal components—legibility and functionality, environmental comfort, naturalness, safety and hygiene, psycho-social comfort, and aesthetics—can enhance patients' health status by strengthening their Sense of Coherence.

Legibility and functionality contributed most strongly to comprehensibility by reducing spatial ambiguity and enhancing psychological security. Environmental comfort and safety-hygiene significantly influenced manageability by increasing perceived control and reducing environmental stressors. Naturalness, aesthetics, and psycho-social comfort contributed substantially to meaningfulness, transforming the treatment experience into a more humane, supportive, and health-oriented process. Consistent with the health promotion paradigm, this approach emphasizes empowerment, reinforcement of coping resources, and support for physical, psychological, and social dimensions of health. However, these relationships should be interpreted as associational rather than causal given methodological limitations.

The study underscores the necessity of moving toward salutogenic and health-promoting design frameworks. The conceptual model presented herein provides a strategic foundation for healthcare policymakers, hospital administrators, and architects to develop human-centered, supportive healthcare environments. Future research should apply this model in diverse settings, utilize standardized SOC measures, and employ longitudinal designs to further validate and extend these findings.

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52.