Thermal Hotel with AHP-QFD Methodology

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The methodology is based on applying the Quality Function Deployment (QFD) technique to listen to the voice of the customer, in addition to the Analytic Hierarchy Process (AHP), which allows selection of the best design alternative. The literature shows that QFD–AHP methods have been tried in different areas of the building industry, but there are few examples of combining building design processes. In the study process, collaboration environments between stakeholders were established and the operability of the method used was tested with real actors. The matrix solutions realised in the horizontal and vertical sections of the framework of the model can be reused in different projects with different user demands. This added a modular and developable feature to the model.

Keywords: architectural design ; building industry ; customer satisfaction ; Quality Function Deployment (QFD) ; thermal hotel buildings

1. Introduction

Rapid and continuous change is inevitable in the building industry. For this reason, quality-oriented [1][2][3] approaches should be adopted at every phase of the production process to ensure continuous superiority in international competition. The quality policy adopted in projects that are designed to be long lasting is vital in this respect.

The building design process starts with an idea and a requirement. This process proceeds through actions such as inputs, processes, and outputs. The designer-oriented feature of the initial phase of this process reflects the poor transfer of occupant expectations to the design process. In addition, it is very difficult for designers to evaluate their own designs objectively, and to formulate the effects of the designed space on their users [4][5]. The success of the building process is proportional to the accuracy and timeliness of the data from the planning and design phases. Feedback of experience is particularly valuable in buildings because they are primarily customised products from which the prototypes are built and occupied.

However, the construction industry has been slow to learn from buildings in use because the industry does not closely consider the buildings' occupants [6]. This results in the production of buildings that cannot meet the expectations of customers. Therefore, it is vital to develop methods that take into account the feedback and expectations of building users beginning from the first phase of building construction.

The literature review shows that there are several investigations that use the QFD method in the construction industry [7][8][9][10][11][12][13][14][15][16][17][18][19][20][21][22][23][24].

Eldin and Hikle [15] considered QFD to be a process that manages the development of a new production. In their study, QFD was sampled in a building design project. In this study, a model was created of university classes in the future, whereas Singhaputtangkul et al. [20] used the Knowledge-Based Decision Support System, Quality Function Deployment (KBDSS-QFD), to decide on the building envelopes. Wood et al. [23] utilised the same method to achieve occupant satisfaction in green hospital design. Singhaputtangkul and Zhao [25] suggested that building designers should focus on QFD in the construction industry so that they can make the most appropriate decisions while creating building shells with sustainable and developable design goals. The book discusses some features that can be integrated into the traditional QFD method to improve efficiency. Juan et al. [26] stated that user expectations are different in the production of housing in the building industry. They used the QFD method to reveal the expectations and cognitive differences of the designers and residential users, and to produce solutions.

In the building industry, customer expectations are difficult to determine, and eliminating these deficiencies in the application phase causes problems in the production process. However, determining customer expectations in the first phase of the building production process has a great importance in the successful implementation of the process.

In the literature, it is seen that there are some examples where QFD-AHP methods have been tried in different areas of the building industry, but there are few studies in which these methods have been combined with building design processes. For this reason, in the current study, it was emphasised that a multi-criteria method should be used to determine the correct strategies based on user satisfaction in the design process, which is the early stage of building production. This investigation tried to include the QFD method in the design process of thermal tourism hotel buildings.

To test the method, a field study was conducted in a thermal tourism region in Turkey. When building thermal tourism hotels, the philosophy of quality must be adopted throughout the life cycle of the hotels to increase the success and ensure the sustainability of the buildings. It is of great importance that the philosophy of quality is transferred to every phase of design and implementation in this process when construction has begun in the region.

This study aims to create awareness about the continuity of a sustainable construction process with a competitive power structure, taking into account occupant satisfaction. Considering the complex structures of thermal hotels and the characteristics associated with these structures, the QFD method is considered to be an appropriate method for transferring customer (user) requirements to designs in the most accurate manner. By including the QFD method in the thermal hotel design process, a common language is produced for the expectations of all stakeholders.

The present investigation utilised the Quality Function Deployment (QFD) method, which was developed to improve quality and to ensure customer satisfaction in the production and service sectors. It was predicted that the QFD method would transfer the expectations of the customers and the technical requirements to the designs in the most accurate manner and eliminate the deficiencies in this direction. The adaptability of the QFD method and its structure, which can analyse both the qualitative and quantitative measures, will enable the concept of quality to be incorporated into the design processes. The structure of the study is presented in **Figure 1**.

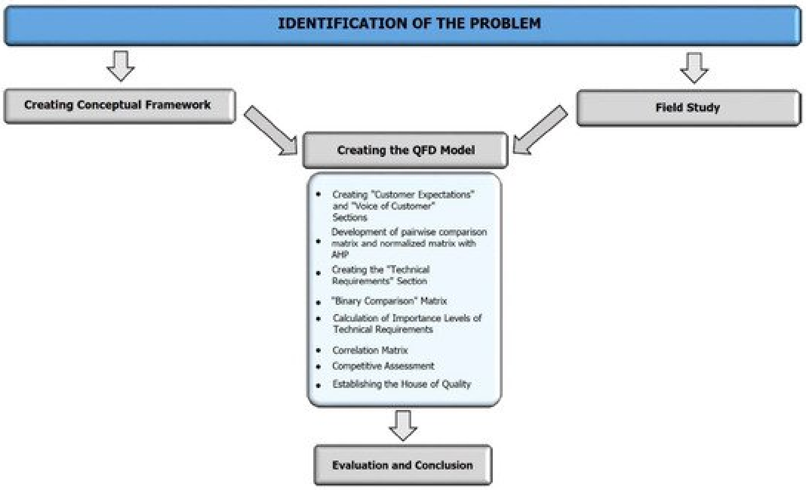
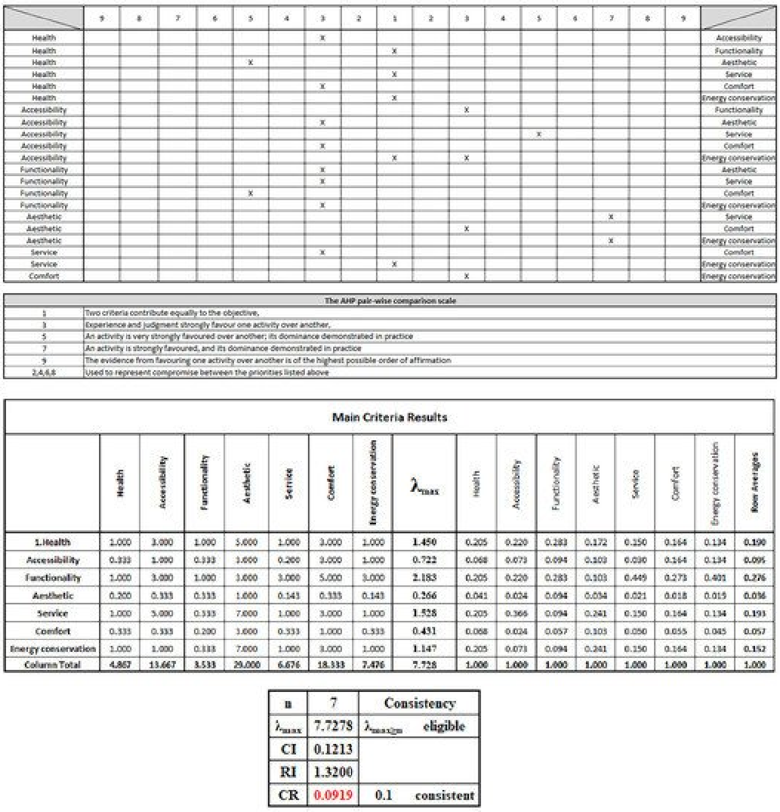


Figure 1. The structure of the study.

2. Analysis on Results

In August 2017, interviews were conducted with a randomly selected focus group of 60 people using facilities to obtain their demands for thermal hotels. The answers given to the questionnaires were ranked from the most positive answers to the least positive with the "average of the scores" method. Numerous disorganised data collected from questionnaires were first grouped with the affinity diagram and rearranged in main and subgroups with the help of the hierarchy diagram. In March 2018, the AHP pairwise comparison matrix was applied to a focus group of 20 people, and consistency analyses were undertaken. Conducting these determinations at the preliminary design phase enabled the transfer of the correct data to the stakeholders of the project. AHP pairwise comparison matrix analyses are presented in **Figure 1** as an example (**Figure 2**, **Table 1**).



	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Health							X											Accessibility
Health									X									Functionality
Health					X													Aesthetic
Health									X									Service
Health							X											Comfort
Health									X									Energy conservation
Accessibility											X							Functionality
Accessibility							X											Aesthetic
Accessibility													X					Service
Accessibility							X											Comfort
Accessibility									X		X							Energy conservation
Functionality							X											Aesthetic
Functionality							X											Service
Functionality					X													Comfort
Functionality							X											Energy conservation
Aesthetic															X			Service
Aesthetic											X							Comfort
Aesthetic															X			Energy conservation
Service							X											Comfort
Service									X									Energy conservation
Comfort											X							Energy conservation

The AHP pair-wise comparison scale	
1	Two criteria contribute equally to the objective.
3	Experience and judgment strongly favour one activity over another.
5	An activity is very strongly favoured over another; its dominance demonstrated in practice
7	An activity is strongly favoured, and its dominance demonstrated in practice
9	The evidence from favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Used to represent compromise between the priorities listed above

Main Criteria Results

	Health	Accessibility	Functionality	Aesthetic	Service	Comfort	Energy conservation	λ_{max}	Health	Accessibility	Functionality	Aesthetic	Service	Comfort	Energy conservation	Row Averages
1.Health	1.000	3.000	1.000	5.000	1.000	3.000	1.000	1.450	0.205	0.220	0.283	0.172	0.150	0.164	0.134	0.190
Accessibility	0.333	1.000	0.333	3.000	0.200	3.000	1.000	0.722	0.068	0.073	0.094	0.103	0.030	0.164	0.134	0.095
Functionality	1.000	3.000	1.000	3.000	3.000	5.000	3.000	2.183	0.205	0.220	0.283	0.103	0.449	0.273	0.401	0.276
Aesthetic	0.200	0.333	0.333	1.000	0.143	0.333	0.143	0.266	0.041	0.024	0.094	0.034	0.021	0.018	0.019	0.036
Service	1.000	5.000	0.333	7.000	1.000	3.000	1.000	1.528	0.205	0.366	0.094	0.241	0.150	0.164	0.134	0.193
Comfort	0.333	0.333	0.200	3.000	0.333	1.000	0.333	0.431	0.068	0.024	0.057	0.103	0.050	0.055	0.045	0.057
Energy conservation	1.000	1.000	0.333	7.000	1.000	3.000	1.000	1.147	0.205	0.073	0.094	0.241	0.150	0.164	0.134	0.152
Column Total	4.867	13.667	3.533	29.000	6.676	18.333	7.476	7.728	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

n	7	Consistency	
λ_{max}	7.7278	$\lambda_{max \geq n}$	eligible
CI	0.1213		
RI	1.3200		
CR	0.0919	0.1	consistent

Figure 2. AHP pairwise comparison matrices result (example—Questionnaire 1).

Table 1. AHP pairwise comparison matrices result table (Questionnaire 1).

Main Criteria	1	2	3	4	5	6	7	Weights
(1) Health	**1.000**	**3.000**	**1.000**	**5.000**	**1.000**	**3.000**	**1.000**	**0.1897**
(2) Accessibility	**0.333**	**1.000**	**0.333**	**3.000**	**0.200**	**3.000**	**1.000**	**0.0953**
(3) Functionality	**1.000**	**3.000**	**1.000**	**3.000**	**3.000**	**5.000**	**3.000**	**0.2764**
(4) Aesthetic	**0.200**	**0.333**	**0.333**	**1.000**	**0.143**	**0.333**	**0.143**	**0.0361**
(5) Service	**1.000**	**5.000**	**0.333**	**7.000**	**1.000**	**3.000**	**1.000**	**0.1935**
(6) Comfort	**0.333**	**0.333**	**0.200**	**3.000**	**0.333**	**1.000**	**0.333**	**0.0574**
(7) Energy conservation	**1.000**	**1.000**	**0.333**	**7.000**	**1.000**	**3.000**	**1.000**	**0.1516**
Consistency ratio: 0.0919								
Health								
(1) Health effects of hot spring	**1.000**	**3.000**	**0.333**					**0.2605**
(2) Clean air and climate impacts on health	**0.333**	**1.000**	**0.200**					**0.1062**
(3) Use of organic products	**3.000**	**5.000**	**1.000**					**0.6333**
Consistency ratio: 0.0477								
Accessibility								
(1) Location	**1.000**	**0.200**	**3.000**	**0.333**				**0.1192**
(2) Disability solution	**5.000**	**1.000**	**9.000**	**5.000**				**0.6275**
(3) Vehicle and pedestrian path	**0.333**	**0.111**	**1.000**	**0.333**				**0.0554**
(4) Inter-unit accessibility	**3.000**	**0.200**	**3.000**	**1.000**				**0.1978**
Consistency ratio: 0.0989								
Functionality								
(1) Flexibility and Expandability	**1.000**	**1.000**	**3.000**	**5.000**	**3.000**			**0.3373**

Main Criteria	1	2	3	4	5	6	7	Weights
(2) Suitability for use	1.000	1.000	3.000	5.000	3.000			0.3373
(3) Use of local materials	0.333	0.333	1.000	5.000	1.000			0.1475
(4) Appropriate size	0.200	0.200	0.200	1.000	0.333			0.0513
(5) Performance	0.333	0.333	1.000	3.000	1.000			0.1265
Consistency ratio: 0.0386								
Aesthetic								
(1) Facade of building	1.000	0.333	1.000					0.1867
(2) local architecture design	3.000	1.000	5.000					0.6555
(3) Originality	1.000	0.200	1.000					0.1578
Consistency ratio: 0.0372								
Service								
(1) Staff service	1.000	5.000	3.000					0.6555
(2) Social facilities	0.200	1.000	1.000					0.1578
(3) Economic	0.333	1.000	1.000					0.1867
Consistency ratio: 0.0372								
Comfort								
(1) Noise and light control	1.000	1.000	0.333					0.1867
(2) Temperature control	1.000	1.000	0.200					0.1578
(3) Spatial comfort	3.000	5.000	1.000					0.6555
Consistency ratio: 0.0372								
Energy conservation								
(1) Environmental awareness	1.000	0.333	0.333	3.000				0.1454
(2) Natural environment data	3.000	1.000	0.333	5.000				0.2816
(3) Use of natural resources	3.000	3.000	1.000	7.000				0.5152
(4) Action plans	0.333	0.200	0.143	1.000				0.0578
Consistency ratio: 0.0738								

Using the Analytical Hierarchy Process (AHP) method, the importance of the customer requirements was calculated. In March 2018, the AHP pairwise comparison matrices were applied to a focus group of 20 people, and consistency analyses were undertaken. Conducting these determinations at the preliminary design phase enabled the transfer of the correct data to the stakeholders of the project. The comparison matrices between the criteria are square matrices with dimensions of $n * n$. The matrix components on the diagonal of these matrices take the value 1 because each criterion is compared to itself.

The comparison matrices show the importance of the criteria in relation to each other according to a certain logic. However, to determine the percentage distributions of these criteria, the totals of the columns that make up the comparison matrices are used. The comparison matrices show the importance of the criteria in relation to each other in certain logic (**Table 2** and **Table 3**). Although the AHP has a consistent system in itself, the accuracy of the results naturally depends on the consistency of the comparison between the criteria made by the decision maker. Based on the customer expectations and importance rating, a horizontal section is created that expresses the "voice of the customer" in the house of quality. The column of importance ratings and the column of relative importance ratings adjacent to it provide a valuable source of information for detailed analysis of customer needs and expectations. This column is formed by calculating the relative importance of each customer's expectations in relation to each other in each line. The vertical column of the QFD method, based on customer expectations, includes the technical requirements section that contains information about the customer. The technical requirements were determined as a result of the literature reviews, interviews with thermal hotel occupants, managers, and expert technical staff, and field studies.

Table 2. AHP consistency ratio results (f = 20).

CRITERIA	F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10	F 11	F 12	F 13	F 14	F 15	F 16	F 17	F18	F 19	F 20
Main criteria	0.0919	0.0859	0.0878	0.0690	0.0748	0.0855	0.0908	0.0960	0.0990	0.0922	0.0879	0.0903	0.0992	0.0929	0.0928	0.0959	0.0887	0.1448	0.0709	0.0815
Health subcriteria	0.0477	0.0834	0.0093	0.0000	0.0477	0.0564	0.0961	0.0390	0.0961	0.0758	0.0897	0.0000	0.0000	0.0961	0.0477	0.0477	0.0961	0.0834	0.0477	0.0961
Accessibility subcriteria	0.0989	0.0604	0.0696	0.0276	0.0713	0.0931	0.0875	0.0914	0.0983	0.0000	0.0931	0.0713	0.0997	0.0654	0.0260	0.0000	0.0664	0.0213	0.0533	0.0493
Functionality subcriteria	0.0386	0.0882	0.0777	0.0920	0.0479	0.0904	0.0430	0.0439	0.0998	0.0690	0.0000	0.0802	0.0000	0.0745	0.0183	0.0718	0.0240	0.0519	0.0761	0.0982
Aesthetic subcriteria	0.0372	0.0477	0.0961	0.0961	0.0000	0.0961	0.0477	0.0000	0.0477	0.0093	0.0093	0.0477	0.0000	0.0477	0.0477	0.0477	0.0607	0.0961	0.0607	0.0000
Service subcriteria	0.0372	0.0093	0.0961	0.0000	0.0000	0.0834	0.0834	0.0000	0.3065	0.0607	0.0607	0.0758	0.0479	0.0000	0.0000	0.0758	0.0961	0.0000	0.0000	0.0000
Comfort subcriteria	0.0372	0.0961	0.0477	0.0477	0.0000	0.0961	0.0309	0.0000	0.0477	0.0000	0.0611	0.0000	0.0170	0.0961	0.0000	0.0000	0.0000	0.0309	0.0607	0.0000
Energy conservation subcriteria	0.0738	0.0738	0.0604	0.0713	0.0545	0.0689	0.0576	0.0079	0.0369	0.0664	0.0826	0.0738	0.0654	0.0000	0.0873	0.0545	0.0997	0.0874	0.0689	0.0808

Table 3. Importance of customer requirements (f = 20).

CRITERIA	F1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10	F 11	F 12	F 13	F 14	F 15	F16	F 17	F 18	F 19	F 20	Importance of Customer Requirements
1. Health	0.1897	0.2435	0.3947	0.2586	0.2857	0.0594	0.4750	0.4103	0.4054	0.1423	0.3783	0.3370	0.2240	0.1013	0.2523	0.3418	0.1261	0.2823	0.2536	0.2758	0.2719
1.1. Health contribution of thermal water	0.2605	0.6434	0.6687	0.7143	0.6333	0.5247	0.7235	0.6689	0.7235	0.7028	0.5105	0.7143	0.4286	0.7235	0.6333	0.6333	0.7235	0.6434	0.6333	0.7235	0.6315
1.2. Health contribution of climate	0.1062	0.0738	0.2431	0.1429	0.1062	0.1416	0.0833	0.2674	0.0833	0.1822	0.1001	0.1429	0.4286	0.1932	0.2605	0.2605	0.1932	0.2828	0.2605	0.1932	0.1873
1.3. Use of organic products	0.6333	0.2828	0.0882	0.1429	0.2605	0.3338	0.1932	0.0637	0.1932	0.1149	0.3893	0.1429	0.1429	0.0833	0.1062	0.1062	0.0833	0.0738	0.1062	0.0833	0.1812
2. Accessibility	0.0953	0.0446	0.0782	0.2951	0.0502	0.1038	0.0971	0.2238	0.0911	0.1019	0.0409	0.0597	0.0548	0.0499	0.0356	0.2501	0.0550	0.0667	0.0239	0.0319	0.0925
2.1. Location	0.1192	0.5134	0.0347	0.5324	0.0989	0.1591	0.6585	0.2707	0.0943	0.1000	0.1591	0.0989	0.0765	0.5579	0.5549	0.1250	0.0969	0.3889	0.2715	0.0780	0.2494
2.2. Disability solutions	0.6275	0.1009	0.3119	0.0606	0.1716	0.2630	0.0484	0.0513	0.0490	0.3000	0.5011	0.3648	0.5430	0.2633	0.0967	0.3750	0.2906	0.3889	0.5646	0.5117	0.2942
2.3. Vehicle and pedestrian path	0.0554	0.1188	0.2437	0.2191	0.6080	0.5011	0.1515	0.1044	0.2725	0.3000	0.0768	0.3648	0.2445	0.1219	0.0967	0.3750	0.2281	0.1535	0.0825	0.1725	0.2245
2.4. Inter-units accessibility	0.1978	0.2670	0.4097	0.1879	0.1216	0.0768	0.1416	0.5736	0.5842	0.3000	0.2630	0.1716	0.1360	0.0569	0.2516	0.1250	0.3844	0.0687	0.0814	0.2378	0.2318
3. Functionality	0.2764	0.0771	0.1060	0.0923	0.1961	0.1013	0.1218	0.0917	0.0692	0.2032	0.0409	0.0794	0.1298	0.0808	0.1495	0.0578	0.2163	0.0836	0.1437	0.0828	0.1200
3.1. Flexibility and Expandability	0.3373	0.4314	0.0452	0.1297	0.1066	0.1372	0.0593	0.0327	0.2767	0.0559	0.2381	0.0366	0.2308	0.2188	0.0857	0.2622	0.3331	0.1184	0.0545	0.4527	0.1821
3.2. Suitability for intended use	0.3373	0.2198	0.2279	0.4225	0.2316	0.4448	0.2609	0.2781	0.5495	0.2877	0.2381	0.2474	0.2308	0.3795	0.0763	0.2622	0.3736	0.2753	0.4433	0.2374	0.3012
3.3. Using appropriate materials	0.1475	0.1036	0.1428	0.0883	0.2610	0.2357	0.2609	0.1329	0.0729	0.1344	0.2381	0.1000	0.2308	0.1139	0.2905	0.2622	0.1516	0.2753	0.2239	0.1450	0.1806
3.4. Appropriate size	0.0513	0.0547	0.0850	0.1631	0.0516	0.0669	0.0782	0.2781	0.0623	0.1344	0.0476	0.1000	0.0769	0.0514	0.2571	0.0874	0.0777	0.0346	0.1029	0.0601	0.0961

CRITERIA	F1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10	F 11	F 12	F 13	F 14	F 15	F16	F 17	F 18	F 19	F 20	Importance of Customer Requirements
3.5. Performance	0.1265	0.1904	0.4991	0.1964	0.3492	0.1154	0.3408	0.2781	0.0386	0.3877	0.2381	0.5161	0.2308	0.2364	0.2905	0.1259	0.0641	0.2963	0.1755	0.1047	0.2400
4. Aesthetic	0.0361	0.2683	0.0217	0.0597	0.0559	0.0483	0.0344	0.0314	0.0222	0.0346	0.1526	0.0282	0.0869	0.3249	0.0602	0.0234	0.0825	0.0641	0.0772	0.0807	0.0797
4.1. Facade of building	0.1867	0.1062	0.7235	0.7235	0.7778	0.7235	0.6333	0.7143	0.1062	0.6687	0.0882	0.1062	0.6000	0.6333	0.1062	0.1062	0.5889	0.7235	0.1593	0.1429	0.4309
4.2. Use of the local architecture	0.6555	0.2605	0.1932	0.0833	0.1111	0.1932	0.1062	0.1429	0.2605	0.0882	0.6687	0.6333	0.2000	0.1062	0.6333	0.2605	0.2519	0.0833	0.5889	0.4286	0.2975
4.3. Originality	0.1578	0.6333	0.0833	0.1932	0.1111	0.0833	0.2605	0.1429	0.6333	0.2431	0.2431	0.2605	0.2000	0.2605	0.2605	0.6333	0.1593	0.1932	0.2519	0.4286	0.2716
5. Service	0.1935	0.1098	0.2010	0.1194	0.2255	0.1515	0.1172	0.1138	0.1746	0.3160	0.1811	0.3275	0.2821	0.1849	0.1121	0.1208	0.2123	0.2615	0.1719	0.2326	0.1905
5.1. Staff Service	0.5654	0.2431	0.7235	0.2000	0.4286	0.2828	0.6434	0.3333	0.5007	0.2519	0.5889	0.7028	0.3278	0.2000	0.4286	0.7028	0.7235	0.3333	0.4286	0.4286	0.4519
5.2. Social Facilities	0.2750	0.6687	0.0833	0.6000	0.4286	0.0738	0.2828	0.3333	0.3102	0.5889	0.2519	0.1822	0.2611	0.2000	0.4286	0.1822	0.0833	0.3333	0.4286	0.4286	0.3212
5.3. Economy	0.1596	0.0882	0.1932	0.2000	0.1429	0.6434	0.0738	0.3333	0.1890	0.1593	0.1593	0.1149	0.4111	0.6000	0.1429	0.1149	0.1932	0.3333	0.1429	0.1429	0.2269
6. Comfort	0.0574	0.1452	0.1469	0.1403	0.1333	0.1451	0.1330	0.1025	0.1997	0.1764	0.1811	0.1319	0.1976	0.1572	0.3117	0.1463	0.2314	0.2157	0.2096	0.2326	0.1697
6.1. Noise and light control	0.1867	0.0833	0.2605	0.1062	0.1429	0.1932	0.1150	0.0667	0.2605	0.1429	0.0904	0.1429	0.0755	0.0833	0.1429	0.2000	0.1429	0.1150	0.1593	0.4286	0.1569
6.2. Temperature control	0.1578	0.1932	0.1062	0.2605	0.4286	0.0833	0.4055	0.4667	0.1062	0.4286	0.3537	0.4286	0.3338	0.1932	0.4286	0.6000	0.4286	0.4055	0.2519	0.1429	0.3101
6.3. Spatial comfort	0.6555	0.7235	0.6333	0.6333	0.4286	0.7235	0.4796	0.4667	0.6333	0.4286	0.5559	0.4286	0.5907	0.7235	0.4286	0.2000	0.4286	0.4796	0.5889	0.4286	0.5329
7. Energy conservation	0.1516	0.1115	0.0516	0.0344	0.0534	0.3906	0.0215	0.0265	0.0379	0.0256	0.0251	0.0364	0.0248	0.1010	0.0786	0.0597	0.0764	0.0261	0.1201	0.0637	0.0758
7.1. Environmental awareness	0.1454	0.1454	0.5134	0.3648	0.5081	0.2104	0.3875	0.0791	0.3936	0.2281	0.5464	0.2816	0.5579	0.3000	0.4072	0.5081	0.1360	0.2959	0.4813	0.4732	0.3482
7.2. Natural environment data	0.2816	0.2816	0.1188	0.1716	0.2289	0.0979	0.1792	0.4270	0.1645	0.2906	0.1246	0.1454	0.0569	0.3000	0.0722	0.1932	0.2445	0.1348	0.2104	0.1220	0.1923
7.3. Use of natural resources	0.5152	0.5152	0.2670	0.3648	0.1932	0.4813	0.3042	0.4270	0.3936	0.3844	0.2679	0.5152	0.1219	0.1000	0.2753	0.2289	0.5430	0.4955	0.2104	0.1220	0.3363
7.4. Action plans	0.0578	0.0578	0.1009	0.0989	0.0699	0.2104	0.1292	0.0669	0.0483	0.0969	0.0611	0.0578	0.2633	0.3000	0.2453	0.0699	0.0765	0.0737	0.0979	0.2827	0.1233
Total	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000	7.0000

After determining the technical requirements to meet customer needs, matrix solutions were derived on the house of quality (**Figure 3**). To create the relations matrices section in the house of quality, we asked for the help of an experienced technical team working on thermal hotel projects. The team, consisting of two architects and one mechanical engineer, tried to identify the relationship between customer expectations and technical requirements. This method allows the project team to know the relationships between customer expectations and technical requirements at the design phase, and enables the assessment of potential threats and opportunities. After determining the relationships, the technical importance rating was calculated according to customer expectations.

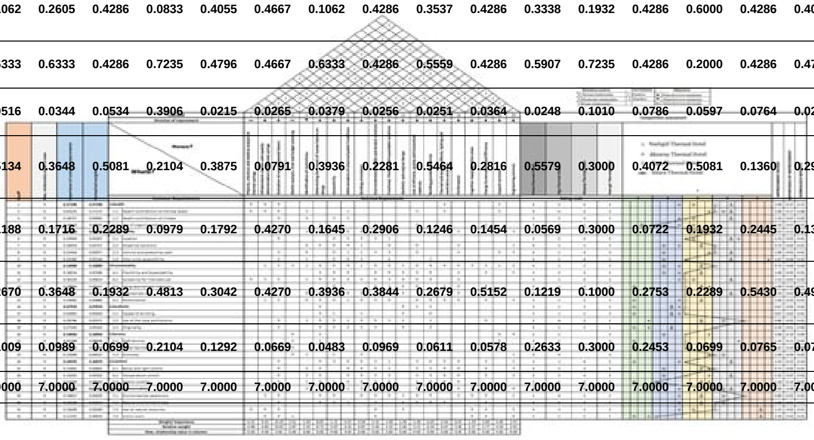


Figure 3. The house of quality for thermal hotel design.

The calculated technical importance rating is shown at the bottom of the house of quality. A lower row contains the relative importance (normalised) value of these ratings. The values obtained for each technical requirement were added, and the results were then added to the technical importance rating line in the lower part of the relations matrices. After establishing the relationship matrices section and calculating the importance of technical requirements, the technical team was asked to determine the correlation relationships. The correlation matrices showed that each technical requirement had a positive or negative relationship.

In the study, a competition analysis section was added to the skeleton of the house of quality (**Figure 3**). The purpose of the technical assessment of competition is to allow the companies wishing to use the model to assess their status in the sector and to compare their status with that of other companies. In this study, Aksaray Ihlara Thermal Holiday Village (Cappadocia) was accepted as the research company, and it was compared with its competitors in its vicinity. The demands in the customer voice section were assessed using a five point scale. When the results of the assessment of competition are combined with the other results of the matrices, it can be determined how much the company is behind its competitors in terms of meeting customer expectations. Thus, the company gains knowledge about the topics that need improvement.

3. Current Insights

The analysis studies revealed that the most important customer needs are “health”, “service”, “comfort” and “functionality”. These are followed by “accessibility”, “aesthetics”, and “energy conservation”, also in order of importance. These results imply that the primary purpose of thermal hotel visits is to receive treatment and be healed. In other words, customers who visit these facilities primarily for health reasons demand clean, spacious designs where they can obtain good service, rest, have fun, and feel comfortable.

According to the subcriteria, the health criterion includes the subcriteria of “Health effects of hot spring”, “Clean air and climate impacts on health”, and “organic product use”, in order of importance. Climate cure treatments, which are complementary to thermal water treatment at thermal hotels, should also be included in the design. Facilities should be located in a large recreational area, isolated from noise and traffic density, and intertwined with nature. The materials used must be organic and hygienic. The service criterion includes the subcriteria of “service by the staff”, “social facilities”, and “economic”, in order of importance. The comfort criterion includes the subcriteria of “ensuring spatial comfort”, “control of temperature”, and “control of sound and light”, in order of importance. In thermal hotel designs, spatial comfort should be considered. Special attention to ventilation and air conditioning issues, and arrangements for noise, temperature, and light and humidity control, will improve the design and use quality.

Although thermal hotel designs are similar to the designs of accommodation facilities, the most obvious difference is that the design of their basic units is based on hot springs and the climate. Therefore, when designing thermal hotels, these differences should be considered, and design criteria specific to spa and wellness units should be established.

Accurate use of planning and design principles in the production process of thermal hotels will lay the foundations for sustainable development. As a result of the study conducted in Aksaray and its vicinity, macroplanning decisions, which are the cornerstone of the design, determined the most important criteria for both customer expectations and technical requirements. The calculation of the importance ratings of technical requirements enabled the determination of technical requirements with high importance ratings, and allowed the technical team to focus on these requirements. By calculating the importance of technical requirements, more important technical requirements were identified and the design team was able to focus on these requirements. Thus, a healthier design and production process was achieved.

Considering the importance ratings of technical requirements calculated based on the customer expectations, it can be seen that “climate factor and assessment of environmental factors” has the highest importance rating (“10.20”). According to this item, which was calculated as a result of comparing customer expectations and technical requirements, the location of the thermal source and topographic conditions are crucial for thermal hotel design. This is an appropriate solution to avoid damaging the source and deliver the source to the facility in the shortest possible manned. The locations should have a relaxing natural and artificial environment. In addition, the thermal hotel should not be located in an area with unplanned urbanisation. Topographic characteristics change the effects and duration of climate elements, and thus lead to changes in the effect of the climate on buildings. In addition, when determining the location of the buildings, areas that are free of noise and other environmental problems should be preferred as much as possible.

“Determining the effect of human factors that are effective in macro- and microplanning decisions on design” has the second highest importance rating (“8.85”), indicating that it has a vital place in the design of thermal hotels. Human factors also determine behavioural performance. Performance is the determinant of the relationships between the physical environment and human behaviour, human satisfaction, and sociological and psychological satisfaction. These include factors such as the size of a building, the proximity of the indoor areas, the frequency of their use, and the spaces created for privacy and social interaction. These factors are of great importance for design quality. The macro- and microplanning decisions of thermal hotels are shaped according to the environmental structure, location, socio-cultural and socio-economic status, and customer profile.

Furthermore, the requirement of “spatial arrangements” has the third highest importance rating (“6.65”). Furthermore, the “geometry and dimensions of the building” has the fourth highest importance rating (“6.63”), whereas the “thermal and acoustic effects, lighting, and ventilation solutions” has the fifth highest importance rating (“6.56”). “The performance characteristics” has the sixth highest importance rating (“6.05”), “environmentally friendly and durable solutions” has the seventh highest importance rating (“5.52”), and the “use of efficient, quality and economical materials” has the eighth highest importance rating (“5.28”).

“Transportation and accessibility” has the ninth highest importance rating (“5.15”), whereas the “orientation of the building” has the tenth highest importance rating (“4.94”). When these requirements are transferred to designs, thermal facilities should be considered as a whole. Around the accommodation and curing centre, green spaces, jogging and hiking trails, and entertainment venues (recreational water facilities such as the Aqua Park) should be established. Between units, there should be open and closed passages. The dimensions determined in the spatial arrangements should have measures that can provide freedom of movement and function; production of nonfunctional spaces should be avoided. The geometry of the building should take into account local texture, regional climate data, and environmental factors. The production of sustainable buildings should consider the effect of parameters such as the climate of the region; active and passive systems in accordance with the climate, or the combined use of the two; topography; vegetation; and orientation of the building with respect to the sun and the wind.

The technical requirement of “infrastructure works for the protection of thermal resources, and capacity determination” has the eleventh highest importance rating (“4.92”). According to this technical requirement, protection areas must be determined. Planning of thermal facilities requires interdisciplinary studies. Water flow should be measured, and the catchment area should be formed. Geological structure and hydrogeological conditions, the topographic structure of the environment and climatic conditions, soil types, the drainage area boundary, residential areas, and industrial facilities should be determined. In addition, for thermal tourism in the region of a hot spring, the strategy plans should be prepared at the preliminary design phase.

The "convenient, flexible and improved solutions" has the twelfth highest importance rating ("4.58"). Spaces should be flexible and able to be improved. Interior comfort conditions will provide a more aware approach to energy efficiency by grouping different locations (zoning/creating buffer space). When designing buildings, building geometry cannot be considered to be independent of the local fabric and contemporary architectural factors cannot be ignored. Both cases should be well blended in designs. The building must reflect the character of its environment. Accurate volume organisations are crucial to improve the quality of designs. In the same manner, adding different functions to the same space when designing spaces provides a significant flexibility tool. Flexibility in design includes elements such as multifunctionality, increased spatial relationships, the creation of a multifunctional facade, the creation of divisible/connectable spaces, and the capacity of areas of usage. By comparison, structural flexibility can be assessed under the two subheadings of bearing systems and structural components. The concept of flexibility in bearing systems requires features such as large openings, flexibility in structural joints, and effective intervention in the system.

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