1 Roof System Selection

1.1 Weighting Factor of Criteria for Each Stakeholder

Stakeholder 1: Architect

A. Pairwise Comparison

	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image
Initial cost	1.000	0.333	0.333	0.333	0.200	0.200	0.200	0.111
Maintenance cost	3.000	1.000	2.000	0.333	0.200	0.200	0.250	0.200
Replacement cost	3.000	0.500	1.000	0.333	0.333	0.333	0.250	0.200
Support system	3.000	3.000	3.000	1.000	0.333	0.333	0.333	0.250
Usability period	5.000	5.000	3.000	3.000	1.000	0.500	4.000	0.500
Functional perform	5.000	5.000	3.000	3.000	2.000	1.000	5.000	0.500
Reliability	5.000	4.000	4.000	3.000	0.250	0.200	1.000	0.333
Image	9.000	5.000	5.000	4.000	2.000	2.000	3.000	1.000
Σ	34.000	23.833	21.333	15.000	6.317	4.767	14.033	3.094

B. Normalization and Analysis

	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image	Σ	weight
Initial cost	0.029	0.014	0.016	0.022	0.032	0.042	0.014	0.036	0.205	0.026
Maintenance cost	0.088	0.042	0.094	0.022	0.032	0.042	0.018	0.065	0.402	0.050
Replacement cost	0.088	0.021	0.047	0.022	0.053	0.070	0.018	0.065	0.383	0.048
Support system	0.088	0.126	0.141	0.067	0.053	0.070	0.024	0.081	0.649	0.081
Usability period	0.147	0.210	0.141	0.200	0.158	0.105	0.285	0.162	1.407	0.176
Functional perform	0.147	0.210	0.141	0.200	0.317	0.210	0.356	0.162	1.742	0.218
Reliability	0.147	0.168	0.188	0.200	0.040	0.042	0.071	0.108	0.963	0.120
Image	0.265	0.210	0.234	0.267	0.317	0.420	0.214	0.323	2.249	0.281

C. Consistency Ratio

Consistency	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image	Σ	
Initial cost	0.026	0.017	0.016	0.027	0.035	0.044	0.024	0.031	0.219	8.562
Maintenance cost	0.077	0.050	0.096	0.027	0.035	0.044	0.030	0.056	0.415	8.256
Replacement cost	0.077	0.025	0.048	0.027	0.059	0.073	0.030	0.056	0.395	8.230
Support system	0.077	0.151	0.144	0.081	0.059	0.073	0.040	0.070	0.694	8.562
Usability period	0.128	0.251	0.144	0.243	0.176	0.109	0.481	0.141	1.673	9.512
Functional performance	0.128	0.251	0.144	0.243	0.352	0.218	0.602	0.141	2.078	9.547
Reliability	0.128	0.201	0.192	0.243	0.044	0.044	0.120	0.094	1.066	8.855
Image	0.231	0.251	0.240	0.324	0.352	0.435	0.361	0.281	2.475	8.807
									Σ	70.3305
									λ max	8.79131
									CI	0.11304
									CR	0.08017

Stakeholder 2: Facility Manager

A. Pair wise Comparison

	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image
Initial cost	1	0.2	0.142857143	0.111111111	0.2	0.2	0.333333333	0.25
Maintenance cost	5	1	2	2	2	2	3	3
Replacement cost	7	0.5	1	3	2	3	5	5
Support system	9	0.5	0.333333333	1	3	3	5	5
Usability period	5	0.5	0.5	0.333333333	1	2	3	3
Functional performance	5	0.5	0.333333333	0.333333333	0.5	1	3	3
Reliability	3	0.333333333	0.2	0.2	0.333333333	0.333333333	1	2
Image	4	0.333333333	0.2	0.2	0.333333333	0.333333333	0.5	1
Σ	39	3.866666667	4.70952381	7.177777778	9.366666667	11.86666667	20.83333333	22.25

B. Normalization and Analysis

	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image	Σ	weight
Initial cost	0.026	0.052	0.030	0.015	0.021	0.017	0.016	0.011	0.189	0.024
Maintenance cost	0.128	0.259	0.425	0.279	0.214	0.169	0.144	0.135	1.751	0.219
Replacement cost	0.179	0.129	0.212	0.418	0.214	0.253	0.240	0.225	1.870	0.234
Support system	0.231	0.129	0.071	0.139	0.320	0.253	0.240	0.225	1.608	0.201
Usability period	0.128	0.129	0.106	0.046	0.107	0.169	0.144	0.135	0.964	0.121
Functional performance	0.128	0.129	0.071	0.046	0.053	0.084	0.144	0.135	0.791	0.099
Reliability	0.077	0.086	0.042	0.028	0.036	0.028	0.048	0.090	0.435	0.054
Image	0.103	0.086	0.042	0.028	0.036	0.028	0.024	0.045	0.392	0.049

C. Consistency Ratio

Criteria	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image	Σ	
Initial cost	0.024	0.044	0.033	0.022	0.024	0.020	0.018	0.012	0.197	8.370
Maintenance cost	0.118	0.219	0.468	0.402	0.241	0.198	0.163	0.147	1.955	8.933
Replacement cost	0.165	0.109	0.234	0.603	0.241	0.297	0.272	0.245	2.166	9.264
Support system	0.212	0.109	0.078	0.201	0.362	0.297	0.272	0.245	1.776	8.834
Usability period	0.118	0.109	0.117	0.067	0.121	0.198	0.163	0.147	1.040	8.625
Functional performance	0.118	0.109	0.078	0.067	0.060	0.099	0.163	0.147	0.841	8.508
Reliability	0.071	0.073	0.047	0.040	0.040	0.033	0.054	0.098	0.456	8.388
Image	0.094	0.073	0.047	0.040	0.040	0.033	0.027	0.049	0.404	8.241
									Σ	69.16201
									λ max	8.645252
									CI	0.092179
									CR	0.065375

Stakeholder 3: Project Manager

A. Pair wise Comparison

	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image
Initial cost	1	7	7	5	7	5	9	9
Maintenance cost	0.142857143	1	2	0.333333333	2	0.333333333	3	3
Replacement cost	0.142857143	0.5	1	0.333333333	2	0.333333333	3	3
Support system	0.2	3	3	1	0.5	0.5	5	5
Usability period	0.142857143	0.5	0.5	2	1	0.5	3	3
Functional performance	0.2	3	3	2	2	1	5	5
Reliability	0.111111111	0.333333333	0.333333333	0.2	0.333333333	0.2	1	2
Image	0.111111111	0.333333333	0.333333333	0.2	0.333333333	0.2	0.5	1
Σ	2.050793651	15.66666667	17.16666667	11.06666667	15.16666667	8.066666667	29.5	31

B. Normalization and Analysis

	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image	Σ	Weight
Initial cost	0.488	0.447	0.408	0.452	0.462	0.620	0.305	0.290	3.471	0.434
Maintenance cost	0.070	0.064	0.117	0.030	0.132	0.041	0.102	0.097	0.652	0.081
Replacement cost	0.070	0.032	0.058	0.030	0.132	0.041	0.102	0.097	0.562	0.070
Support system	0.098	0.191	0.175	0.090	0.033	0.062	0.169	0.161	0.980	0.122
Usability period	0.070	0.032	0.029	0.181	0.066	0.062	0.102	0.097	0.638	0.080
Functional performance	0.098	0.191	0.175	0.181	0.132	0.124	0.169	0.161	1.231	0.154
Reliability	0.054	0.021	0.019	0.018	0.022	0.025	0.034	0.065	0.258	0.032
Image	0.054	0.021	0.019	0.018	0.022	0.025	0.017	0.032	0.209	0.026

C. Consistency Ratio

consistence	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image	Σ	
Initial cost	0.434	0.570	0.491	0.612	0.558	0.769	0.290	0.235	3.961	9.130
Maintenance cost	0.062	0.081	0.140	0.041	0.159	0.051	0.097	0.078	0.711	8.722
Replacement cost	0.062	0.041	0.070	0.041	0.159	0.051	0.097	0.078	0.600	8.542
Support system	0.087	0.244	0.211	0.122	0.040	0.077	0.161	0.131	1.073	8.760
Usability period	0.062	0.041	0.035	0.245	0.080	0.077	0.097	0.078	0.715	8.963
Functional performance	0.087	0.244	0.211	0.245	0.159	0.154	0.161	0.131	1.392	9.046
Reliability	0.048	0.027	0.023	0.024	0.027	0.031	0.032	0.052	0.265	8.216
Image	0.048	0.027	0.023	0.024	0.027	0.031	0.016	0.026	0.223	8.534
									Σ	69.91216
									λ max	8.739019
									CI	0.105574
									CR	0.074875

1.2 Weighting Factor of Each Technical Solution for Each Criteria

Criteria: initial cost

A. Pairwise Comparison

Initial cost	a1	a2	a3	a4	a5
a1 (steel)	1	3	1	0.333333	5
a2 (precast)	0.333333	1	0.333333	0.166667	2
a3 (timber)	1	3	1	0.333333	5
a4 (RC)	3	6	3	1	7
a5 (Space frame)	0.2	0.5	0.2	0.142857	1
Σ	5.533333	13.5	5.533333	1.97619	20

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weight
0.1807	0.2222	0.1807	0.1687	0.2500	1.0023	0.2005
0.0602	0.0741	0.0602	0.0843	0.1000	0.3789	0.0758
0.1807	0.2222	0.1807	0.1687	0.2500	1.0023	0.2005
0.5422	0.4444	0.5422	0.5060	0.3500	2.3848	0.4770
0.0361	0.0370	0.0361	0.0723	0.0500	0.2316	0.0463

C. Concistency Ratio							
	a1	a2	a3	a4	a5	Σ	
a1 (steel)	0.200469	0.227336	0.200469	0.158987	0.231615	1.018876	5.082471
a2 (precast)	0.066823	0.075779	0.066823	0.079494	0.092646	0.381564	5.035243
a3 (timber)	0.200469	0.227336	0.200469	0.158987	0.231615	1.018876	5.082471
a4 (RC)	0.601406	0.454672	0.601406	0.476961	0.324261	2.458706	5.154939
a5 (Space frame)	0.040094	0.037889	0.040094	0.068137	0.046323	0.232537	5.019899
						Σ	25.37502
						λ max	5.075005
				CR	0.016742	CI	0.018751

Criteria: maintenance cost

A. Pairwise Comparison					
maintenance cost	a1	a2	a3	a4	a5
a1 (steel)	1	0.25	2	0.166667	0.5
a2 (precast)	4	1	5	0.5	3
a3 (timber)	0.5	0.2	1	0.142857	0.333333
a4 (RC)	6	2	7	1	5
a5 (Space frame)	2	0.333333	3	0.2	1
Σ	13.5	3.783333	18	2.009524	9.833333

B. Normalization and Analysis							
a1	a2	a3	a4	a5	Σ	weighting
0.0741	0.0661	0.1111	0.0829	0.0508	0.3851	0.0770
0.2963	0.2643	0.2778	0.2488	0.3051	1.3923	0.2785
0.0370	0.0529	0.0556	0.0711	0.0339	0.2504	0.0501
0.4444	0.5286	0.3889	0.4976	0.5085	2.3681	0.4736
0.1481	0.0881	0.1667	0.0995	0.1017	0.6041	0.1208

C. Concistency Ratio							
	a1	a2	a3	a4	a5	Σ	
a1 (steel)	0.07701	0.069615	0.100178	0.078936	0.060414	0.386152	5.014309
a2 (precast)	0.30804	0.278458	0.250444	0.236807	0.362485	1.436235	5.157811
a3 (timber)	0.038505	0.055692	0.050089	0.067659	0.040276	0.252221	5.035467
a4 (RC)	0.46206	0.556916	0.350622	0.473615	0.604142	2.447355	5.167399
a5 (Space frame)	0.15402	0.092819	0.150267	0.094723	0.120828	0.612657	5.070479
						Σ	25.44547
						λ max	5.089093
						CI	0.022273
						CR	0.019887

Criteria: replacement cost

A. Pairwise Comparison

replacement cost	a1	a2	a3	a4	a5
a1 (steel)	1	0.25	0.5	0.2	0.333333
a2 (precast)	4	1	3	0.5	3
a3 (timber)	2	0.333333	1	0.333333	0.5
a4 (RC)	5	2	3	1	3
a5 (Space frame)	3	0.333333	2	0.333333	1
Σ	15	3.916667	9.5	2.366667	7.833333

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weighting
0.0667	0.0638	0.0526	0.0845	0.0426	0.3102	0.0620
0.2667	0.2553	0.3158	0.2113	0.3830	1.4320	0.2864
0.1333	0.0851	0.1053	0.1408	0.0638	0.5284	0.1057
0.3333	0.5106	0.3158	0.4225	0.3830	1.9653	0.3931
0.2000	0.0851	0.2105	0.1408	0.1277	0.7641	0.1528

C. Concistency Ratio

	a1	a2	a3	a4	a5	Σ	
a1 (steel)	0.062038	0.071601	0.052838	0.078611	0.050942	0.31603	5.094164
a2 (precast)	0.248151	0.286404	0.317027	0.196528	0.458482	1.506591	5.260366
a3 (timber)	0.124075	0.095468	0.105676	0.131018	0.076414	0.532651	5.040438
a4 (RC)	0.310188	0.572809	0.317027	0.393055	0.458482	2.051561	5.219526
a5 (Space frame)	0.186113	0.095468	0.211351	0.131018	0.152827	0.776778	5.082712
						Σ	25.69721
						λ max	5.139441
						CI	0.03486
						CR	0.031125

Criteria: support system

A. Pairwise Comparison

salvage value	a1	a2	a3	a4	a5
a1 (steel)	1	5	3	7	0.333333
a2 (precast)	0.2	1	0.333333	2	0.142857
a3 (timber)	0.333333	3	1	5	0.2
a4 (RC)	0.142857	0.5	0.2	1	0.111111
a5 (Space frame)	3	7	5	9	1
Σ	4.67619	16.5	9.533333	24	1.787302

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weighting
0.2138	0.3030	0.3147	0.2917	0.1865	1.3097	0.2619
0.0428	0.0606	0.0350	0.0833	0.0799	0.3016	0.0603
0.0713	0.1818	0.1049	0.2083	0.1119	0.6782	0.1356
0.0306	0.0303	0.0210	0.0417	0.0622	0.1857	0.0371
0.6415	0.4242	0.5245	0.3750	0.5595	2.5248	0.5050

C. Concistency Ratio							
	a1	a2	a3	a4	a5	∑	
a1 (steel)	0.261946	0.301603	0.406938	0.259932	0.168318	1.398738	5.339784
a2 (precast)	0.052389	0.060321	0.045215	0.074266	0.072136	0.304328	5.045167
a3 (timber)	0.087315	0.180962	0.135646	0.185666	0.100991	0.69058	5.091043
a4 (RC)	0.037421	0.03016	0.027129	0.037133	0.056106	0.18795	5.061507
a5 (Space frame)	0.785839	0.422245	0.67823	0.334198	0.504954	2.725466	5.397457
						Σ	25.93496
						λ max	5.186992
				CR	0.041739	CI	0.046748

Criteria: usability period

A. Pairwise Comparison					
usability period	a1	a2	a3	a4	a5
a1 (steel)	1	0.5	3	0.5	3
a2 (precast)	2	1	3	0.5	2
a3 (timber)	0.333333	0.333333	1	0.2	0.5
a4 (RC)	2	2	5	1	3
a5 (Space frame)	0.333333	0.5	2	0.333333	1
Σ	5.666667	4.333333	14	2.533333	9.5

B. Normalization and Analysis							
a1	a2	a3	a4	a5	Σ	weight
0.1765	0.1154	0.2143	0.1974	0.3158	1.0193	0.2039
0.3529	0.2308	0.2143	0.1974	0.2105	1.2059	0.2412
0.0588	0.0769	0.0714	0.0789	0.0526	0.3388	0.0678
0.3529	0.4615	0.3571	0.3947	0.3158	1.8821	0.3764
0.0588	0.1154	0.1429	0.1316	0.1053	0.5539	0.1108

C. Concistency Ratio							
	a1	a2	a3	a4	a5	Σ	
a1 (steel)	0.20386	0.120589	0.203252	0.188215	0.332344	1.048261	5.142067
a2 (precast)	0.40772	0.241178	0.203252	0.188215	0.221563	1.261928	5.232348
a3 (timber)	0.067953	0.080393	0.067751	0.075286	0.055391	0.346773	5.118366
a4 (RC)	0.40772	0.482356	0.338754	0.37643	0.332344	1.937604	5.147319
a5 (Space frame)	0.067953	0.120589	0.135502	0.125477	0.110781	0.560302	5.057723
						Σ	25.69782
						λ max	5.139565
						CI	0.034891
						CR	0.031153

Criteria: functional

A. Pairwise Comparison

functional	a1	a2	a3	a4	a5
a1 (steel)	1	3	3	5	2
a2 (precast)	0.333333	1	0.5	2	0.5
a3 (timber)	0.333333	2	1	2	0.5
a4 (RC)	0.2	0.5	0.5	1	0.333333
a5 (Space frame)	0.5	2	2	3	1
Σ	2.366667	8.5	7	13	4.333333

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weight
0.4225	0.3529	0.4286	0.3846	0.4615	2.0502	0.4100
0.1408	0.1176	0.0714	0.1538	0.1154	0.5992	0.1198
0.1408	0.2353	0.1429	0.1538	0.1154	0.7882	0.1576
0.0845	0.0588	0.0714	0.0769	0.0769	0.3686	0.0737
0.2113	0.2353	0.2857	0.2308	0.2308	1.1938	0.2388

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C. Concistency Ratio

	a1	a2	a3	a4	a5	Σ	
a1 (steel)	0.41004	0.359491	0.472936	0.368605	0.477526	2.088599	5.093642
a2 (precast)	0.13668	0.11983	0.078823	0.147442	0.119381	0.602157	5.025079
a3 (timber)	0.13668	0.239661	0.157645	0.147442	0.119381	0.80081	5.079816
a4 (RC)	0.082008	0.059915	0.078823	0.073721	0.079588	0.374055	5.073918
a5 (Space frame)	0.20502	0.239661	0.315291	0.221163	0.238763	1.219898	5.109243
						Σ	25.3817
						λ max	5.07634
						CI	0.019085
						CR	0.01704

Criteria: reliability

A. Pairwise Comparison

reliability	a1	a2	a3	a4	a5
a1 (steel)	1	2	3	2	3
a2 (precast)	0.5	1	2	2	2
a3 (timber)	0.333333	0.5	1	2	1
a4 (RC)	0.5	0.5	0.5	1	2
a5 (Space frame)	0.333333	0.5	1	0.5	1
Σ	2.666667	4.5	7.5	7.5	9

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weight
0.3750	0.4444	0.4000	0.2667	0.3333	1.8194	0.3639
0.1875	0.2222	0.2667	0.2667	0.2222	1.1653	0.2331
0.1250	0.1111	0.1333	0.2667	0.1111	0.7472	0.1494
0.1875	0.1111	0.0667	0.1333	0.2222	0.7208	0.1442
0.1250	0.1111	0.1333	0.0667	0.1111	0.5472	0.1094

C. Concistency Ratio							
	a1	a2	a3	a4	a5	Σ	
a1 (steel)	0.363889	0.466111	0.448333	0.288333	0.328333	1.895	5.207634
a2 (precast)	0.181944	0.233056	0.298889	0.288333	0.218889	1.221111	5.239571
a3 (timber)	0.121296	0.116528	0.149444	0.288333	0.109444	0.785046	5.253098
a4 (RC)	0.181944	0.116528	0.074722	0.144167	0.218889	0.73625	5.106936
a5 (Space frame)	0.121296	0.116528	0.149444	0.072083	0.109444	0.568796	5.197124
						Σ	26.00436
						λ max	5.200872
				CR	0.044838	CI	0.050218

Criteria: image

A. Pairwise Comparison					
image	a1	a2	a3	a4	a5
a1 (steel)	1	0.5	3	0.5	0.333333
a2 (precast)	2	1	2	2	0.5
a3 (timber)	0.333333	0.5	1	0.5	0.2
a4 (RC)	2	0.5	2	1	0.5
a5 (Space frame)	3	2	5	2	1
Σ	8.333333	4.5	13	6	2.533333

B. Normalization and Analysis							
a1	a2	a3	a4	a5	Σ	weight
0.1200	0.1111	0.2308	0.0833	0.1316	0.6768	0.1354
0.2400	0.2222	0.1538	0.3333	0.1974	1.1468	0.2294
0.0400	0.1111	0.0769	0.0833	0.0789	0.3903	0.0781
0.2400	0.1111	0.1538	0.1667	0.1974	0.8690	0.1738
0.3600	0.4444	0.3846	0.3333	0.3947	1.9171	0.3834
						1

C. Concistency Ratio							
	a1	a2	a3	a4	a5	Σ	
a1 (steel)	0.135359	0.114677	0.234189	0.086899	0.127809	0.698932	5.163564
a2 (precast)	0.270717	0.229354	0.156126	0.347597	0.191713	1.195507	5.212496
a3 (timber)	0.04512	0.114677	0.078063	0.086899	0.076685	0.401444	5.142565
a4 (RC)	0.270717	0.114677	0.156126	0.173798	0.191713	0.907031	5.218869
a5 (Space frame)	0.406076	0.458708	0.390315	0.347597	0.383426	1.986121	5.179934
						Σ	25.91743
						λ max	5.183486
						CI	0.045871
						CR	0.040957

1.3 Synthesis (Weighting Factor of Each Technical Solution for Each Stakeholder)

SH1 Architect	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image	Weighting
	0.025628	0.050279	0.047932	0.081081	0.175912	0.21772	0.120363	0.281085	
a1 (steel)	0.005138	0.003872	0.002974	0.021239	0.035861	0.089274	0.043799	0.038047	0.2402
a2 (precast)	0.001942	0.014001	0.013728	0.004891	0.042426	0.026089	0.028051	0.064468	0.1956
a3 (timber)	0.005138	0.002518	0.005065	0.010998	0.011918	0.034323	0.017988	0.021942	0.1099
a4 (RC)	0.012224	0.023813	0.01884	0.003011	0.066219	0.016051	0.017352	0.048852	0.2064
a5 (Space frame)	0.001187	0.006075	0.007325	0.040942	0.019488	0.051983	0.013173	0.107775	0.2479
SH2 Facility Manager	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image	Weighting
	0.023578	0.218879	0.233768	0.200999	0.120532	0.098902	0.054378	0.048965	
a1 (steel)	0.004727	0.016856	0.014502	0.052651	0.024572	0.040554	0.019788	0.006628	0.1803
a2 (precast)	0.001787	0.060949	0.066952	0.012124	0.02907	0.011851	0.012673	0.01123	0.2066
a3 (timber)	0.004727	0.010963	0.024704	0.027265	0.008166	0.015591	0.008127	0.003822	0.1034
a4 (RC)	0.011246	0.103664	0.091884	0.007464	0.045372	0.007291	0.00784	0.00851	0.2833
a5 (Space frame)	0.001092	0.026447	0.035726	0.101495	0.013353	0.023614	0.005951	0.018775	0.2265
SH3 Project Manager	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image	Weighting
	0.433847	0.081472	0.070201	0.122483	0.079726	0.153889	0.032266	0.026116	
a1 (steel)	0.086973	0.006274	0.004355	0.032084	0.016253	0.063101	0.011741	0.003535	0.2243
a2 (precast)	0.032876	0.022686	0.020106	0.007388	0.019228	0.018441	0.00752	0.00599	0.1342
a3 (timber)	0.086973	0.004081	0.007419	0.016614	0.005402	0.02426	0.004822	0.002039	0.1516
a4 (RC)	0.206928	0.038586	0.027593	0.004548	0.030011	0.011345	0.004652	0.004539	0.3282
a5 (Space frame)	0.020097	0.009844	0.010729	0.061848	0.008832	0.036743	0.003531	0.010013	0.1616
Aggregation	Initial cost	Maintenance cost	Replacement cost	Support system	Usability period	Functional perform	Reliability	Image	Weighting
	0.1610	0.1169	0.1173	0.1349	0.1254	0.1568	0.0690	0.1187	
a1 (steel)	0.0323	0.0090	0.0073	0.0353	0.0256	0.0643	0.0251	0.0161	0.2149
a2 (precast)	0.0122	0.0325	0.0336	0.0081	0.0302	0.0188	0.0161	0.0272	0.1788
a3 (timber)	0.0323	0.0059	0.0124	0.0183	0.0085	0.0247	0.0103	0.0093	0.1216
a4 (RC)	0.0768	0.0554	0.0461	0.0050	0.0472	0.0116	0.0099	0.0206	0.2726
a5 (Space frame)	0.0075	0.0141	0.0179	0.0681	0.0139	0.0374	0.0076	0.0455	0.2120

2 Highrise Building Column Selection

2.1 Weighting factor of Criteria for Each Stakeholder

Designer	Function	Cost	normalization		Σ	weighting
Function	1	7	0.875	0.875	1.75	0.875
Cost	0.142857143	1	0.125	0.125	0.25	0.125
Σ	1.142857143	8				

Programmer	Function	Cost	normalization		Σ	weighting
Function	1	0.142857143	0.125	0.125	0.25	0.125
Cost	7	1	0.875	0.875	1.75	0.875
Σ	8	1.142857143				

Construction Manager	Function	Cost	normalization		Σ	weighting
Function	1	3	0.75	0.75	1.5	0.75
Cost	0.333333333	1	0.25	0.25	0.5	0.25
Σ	1.333333333	4				

Stakeholder 1 Designer

A. Pairwise Comparison

	satisfying décor	capacity and strength	constructability	maximize space	minimize creep	expedite design	reuse material	minimize error
Satisfying décor	1	2	5	3	7	7	9	7
Capacity and strength	0.5	1	5	3	5	5	7	7
Constructability	0.2	0.2	1	0.333333333	3	3	5	3
Maximize space	0.333333333	0.333333333	3	1	5	5	7	5
Minimize creep	0.142857143	0.2	0.333333333	0.2	1	0.5	3	2
Expedite design	0.142857143	0.2	0.333333333	0.2	2	1	3	5
Reuse material	0.111111111	0.142857143	0.2	0.142857143	0.333333333	0.333333333	1	2
Minimize error	0.142857143	0.142857143	0.333333333	0.2	0.5	0.2	0.5	1
Σ	2.573015873	4.219047619	15.2	8.076190476	23.83333333	22.03333333	35.5	32

B. Normalization and Analysis

	satisfying décor	capacity and strength	constructability	maximize space	minimize creep	expedite design	reuse material	minimize error	Σ	weight
Satisfying décor	0.389	0.474	0.329	0.371	0.294	0.318	0.254	0.219	2.647	0.331
Capacity and strength	0.194	0.237	0.329	0.371	0.210	0.227	0.197	0.219	1.984	0.248
Constructability	0.078	0.047	0.066	0.041	0.126	0.136	0.141	0.094	0.729	0.091
Maximize space	0.130	0.079	0.197	0.124	0.210	0.227	0.197	0.156	1.320	0.165
Minimize creep	0.056	0.047	0.022	0.025	0.042	0.023	0.085	0.063	0.361	0.045
Expedite design	0.056	0.047	0.022	0.025	0.084	0.045	0.085	0.156	0.520	0.065
Reuse material	0.043	0.034	0.013	0.018	0.014	0.015	0.028	0.063	0.228	0.028
Minimize error	0.056	0.034	0.022	0.025	0.021	0.009	0.014	0.031	0.211	0.026

C. Consistency Ratio

	satisfying décor	capacity and strength	constructability	maximize space	minimize creep	expedite design	reuse material	minimize error	Σ	
Satisfying décor	0.331	0.496	0.456	0.495	0.316	0.455	0.256	0.185	2.989	9.036
Capacity and strength	0.165	0.248	0.456	0.495	0.226	0.325	0.199	0.185	2.299	9.267
Constructability	0.066	0.050	0.091	0.055	0.135	0.195	0.142	0.079	0.814	8.933
Maximize space	0.110	0.083	0.273	0.165	0.226	0.325	0.199	0.132	1.513	9.172
Minimize creep	0.047	0.050	0.030	0.033	0.045	0.032	0.085	0.053	0.376	8.329
Expedite design	0.047	0.050	0.030	0.033	0.090	0.065	0.085	0.132	0.533	8.206
Reuse material	0.037	0.035	0.018	0.024	0.015	0.022	0.028	0.053	0.232	8.153
Minimize error	0.047	0.035	0.030	0.033	0.023	0.013	0.014	0.026	0.222	8.410
									Σ	69.50537
									λ max	8.688172
									CI	0.09831
									CR	0.069724

Stakeholder 2 Programmer

A. Pair wise Comparison

	satisfying décor	capacity and strength	constructability	maximize space	minimize creep	expedite design	reuse material	minimize error
Satisfying décor	1	3	0.3333	0.5	0.5	0.5	0.33333	2
Capacity and strength	0.3333	1	0.3333	0.5	0.5	0.5	0.25	0.3333
Constructability	3	3	1	2	2	2	5	5
Maximize space	2	2	0.5	1	2	2	3	3
Minimize creep	2	2	0.5	0.5	1	2	3	3
Expedite design	2	2	0.5	0.5	0.5	1	3	3
Reuse material	3	4	0.2	0.3333	0.33333	0.3333	1	2
Minimize error	0.5	3	0.2	0.33333	0.3333	0.3333	0.5	1
Σ	13.83333333	20	3.566666667	5.666666667	7.166666667	8.666666667	16.08333333	19.33333333

B. Normalization and Analysis

	satisfying décor	capacity and strength	constructability	maximize space	minimize creep	expedite design	reuse material	minimize error	Σ	weight
Satisfying décor	0.072	0.150	0.093	0.088	0.070	0.058	0.021	0.103	0.656	0.082
Capacity and strength	0.024	0.050	0.093	0.088	0.070	0.058	0.016	0.017	0.416	0.052
Constructability	0.217	0.150	0.280	0.353	0.279	0.231	0.311	0.259	2.080	0.260
Maximize space	0.145	0.100	0.140	0.176	0.279	0.231	0.187	0.155	1.413	0.177
Minimize creep	0.145	0.100	0.140	0.088	0.140	0.231	0.187	0.155	1.185	0.148
Expedite design	0.145	0.100	0.140	0.088	0.070	0.115	0.187	0.155	1.000	0.125
Reuse material	0.217	0.200	0.056	0.059	0.047	0.038	0.062	0.103	0.782	0.098
Minimize error	0.036	0.150	0.056	0.059	0.047	0.038	0.031	0.052	0.469	0.059

C. Consistency Ratio

	satisfying décor	capacity and strength	constructability	maximize space	minimize creep	expedite design	reuse material	minimize error	Σ	
Satisfying décor	0.082	0.156	0.087	0.088	0.074	0.062	0.033	0.117	0.699	8.533
Capacity and strength	0.027	0.052	0.087	0.088	0.074	0.062	0.024	0.020	0.435	8.361
Constructability	0.246	0.156	0.260	0.353	0.296	0.250	0.489	0.293	2.343	9.014
Maximize space	0.164	0.104	0.130	0.177	0.296	0.250	0.293	0.176	1.590	9.003
Minimize creep	0.164	0.104	0.130	0.088	0.148	0.250	0.293	0.176	1.353	9.137
Expedite design	0.164	0.104	0.130	0.088	0.074	0.125	0.293	0.176	1.154	9.237
Reuse material	0.246	0.208	0.052	0.059	0.049	0.042	0.098	0.117	0.871	8.904
Minimize error	0.041	0.156	0.052	0.059	0.049	0.042	0.049	0.059	0.506	8.641
									Σ	70.8297
									λ max	8.853712
									CI	0.121959
									CR	0.086496

Stakeholder 3 Construction Manager

A. Pair wise Comparison

	satisfying décor	capacity and strength	constructability	maximize space	minimize creep	expedite design	reuse material	minimize error
Satisfying décor	1	5	0.333333333	3	3	3	0.333333333	0.2
Capacity and strength	0.2	1	0.2	0.333333333	2	0.5	0.2	0.2
Constructability	3	5	1	5	5	5	0.5	0.5
Maximize space	0.333333333	3	0.2	1	0.5	0.333333333	0.2	0.142857143
Minimize creep	0.333333333	0.5	0.2	2	1	0.333333333	0.2	0.2
Expedite design	0.333333333	2	0.2	3	3	1	0.333333333	0.142857143
Reuse material	3	5	2	5	5	3	1	0.5
Minimize error	5	5	2	7	7	7	2	1
Σ	13.2	26.5	6.133333333	26.33333333	26.5	20.16666667	4.766666667	2.885714286

B. Normalization and Analysis

	satisfying décor	capacity and strength	constructability	maximize space	minimize creep	expedite design	reuse material	minimize error	Σ	weight
Satisfying décor	0.076	0.189	0.054	0.114	0.113	0.149	0.070	0.069	0.834	0.104
Capacity and strength	0.015	0.038	0.033	0.013	0.075	0.025	0.042	0.069	0.310	0.039
Constructability	0.227	0.189	0.163	0.190	0.189	0.248	0.105	0.173	1.484	0.185
Maximize space	0.025	0.113	0.033	0.038	0.019	0.017	0.042	0.050	0.336	0.042
Minimize creep	0.025	0.019	0.033	0.076	0.038	0.017	0.042	0.069	0.318	0.040
Expedite design	0.025	0.075	0.033	0.114	0.113	0.050	0.070	0.050	0.529	0.066
Reuse material	0.227	0.189	0.326	0.190	0.189	0.149	0.210	0.173	1.652	0.207
Minimize error	0.379	0.189	0.326	0.266	0.264	0.347	0.420	0.347	2.537	0.317

C. Consistency Ratio

	satisfying décor	capacity and strength	constructability	maximize space	minimize creep	expedite design	reuse material	minimize error	Σ	
Satisfying décor	0.104	0.194	0.062	0.126	0.119	0.199	0.069	0.063	0.936	8.977
Capacity and strength	0.021	0.039	0.037	0.014	0.080	0.033	0.041	0.063	0.328	8.474
Constructability	0.313	0.194	0.185	0.210	0.199	0.331	0.103	0.159	1.693	9.130
Maximize space	0.035	0.116	0.037	0.042	0.020	0.022	0.041	0.045	0.359	8.539
Minimize creep	0.035	0.019	0.037	0.084	0.040	0.022	0.041	0.063	0.342	8.591
Expedite design	0.035	0.077	0.037	0.126	0.119	0.066	0.069	0.045	0.575	8.686
Reuse material	0.313	0.194	0.371	0.210	0.199	0.199	0.207	0.159	1.850	8.955
Minimize error	0.521	0.194	0.371	0.294	0.278	0.463	0.413	0.317	2.852	8.993
									Σ	70.34443
									λ max	8.793054
									CI	0.113293
									CR	0.08035

2.2 Weighting Factor of Each Technical Solution for Each Criteria

Criteria: satisfying decor

A. Pair wise Comparison

satisfying décor	a1	a2	a3	a4
a1 (36x36; 6.0; 1.92)	1	2	2	5
a2 (40x40; 6.0; 0.92)	0.5	1	0.5	2
a3 (32x32; 9.0; 1.07)	0.5	2	1	3
a4 (36dia; 9.0; 0.99)	0.2	0.5	0.333333	1
Σ	2.2	5.5	3.833333	11

B. Normalization and Analysis

a1	a2	a3	a4	Σ	weight
0.454545	0.363636	0.521739	0.454545	1.794466	0.448617
0.227273	0.181818	0.130435	0.181818	0.721344	0.180336
0.227273	0.363636	0.26087	0.272727	1.124506	0.281126
0.090909	0.090909	0.086957	0.090909	0.359684	0.089921
					1

C. Consistency Ratio

	a1	a2	a3	a4	Σ	
a1 (36x36; 6.0; 1.92)	0.448617	0.360672	0.562253	0.449605	1.821146	4.059471
a2 (40x40; 6.0; 0.92)	0.224308	0.180336	0.140563	0.179842	0.725049	4.020548
a3 (32x32; 9.0; 1.07)	0.224308	0.360672	0.281126	0.269763	1.13587	4.040422
a4 (36dia; 9.0; 0.99)	0.089723	0.090168	0.093709	0.089921	0.363521	4.042674
					Σ	16.16312
					λ max	4.040779
					CI	0.013593
					CR	0.015273

Criteria: capacity and strength

A. Pair wise Comparison

capacity and strength	a1	a2	a3	a4
a1 (36x36; 6.0; 1.92)	1	0.5	2	2
a2 (40x40; 6.0; 0.92)	2	1	2	2
a3 (32x32; 9.0; 1.07)	0.5	0.5	1	2
a4 (36dia; 9.0; 0.99)	0.5	0.5	0.5	1
Σ	4	2.5	5.5	7

B. Normalization and Analysis

a1	a2	a3	a4	Σ	weighting
0.25	0.2	0.363636	0.285714	1.099351	0.274838
0.5	0.4	0.363636	0.285714	1.549351	0.387338
0.125	0.2	0.181818	0.285714	0.792532	0.198133
0.125	0.2	0.090909	0.142857	0.558766	0.139692

C. Consistency Ratio						
capacity and strength	a1	a2	a3	a4	Σ	
a1 (36x36; 6.0; 1.92)	0.274838	0.193669	0.396266	0.279383	1.144156	4.163024
a2 (40x40; 6.0; 0.92)	0.549675	0.387338	0.396266	0.279383	1.612662	4.163453
a3 (32x32; 9.0; 1.07)	0.137419	0.193669	0.198133	0.279383	0.808604	4.081114
a4 (36dia; 9.0; 0.99)	0.137419	0.193669	0.099067	0.139692	0.569846	4.079314
					Σ	16.48691
					λ max	4.121727
					CI	0.040576
					CR	0.04559

Criteria: constructability

A. Pair wise Comparison				
constructability	a1	a2	a3	a4
a1 (36x36; 6.0; 1.92)	1	0.5	2	0.333333
a2 (40x40; 6.0; 0.92)	2	1	2	0.333333
a3 (32x32; 9.0; 1.07)	0.5	0.5	1	0.333333
a4 (36dia; 9.0; 0.99)	3	3	3	1
Σ	6.5	5	8	2

B. Normalization and Analysis					
a1	a2	a3	a4	Σ	weighting
0.153846	0.1	0.25	0.166667	0.670513	0.167628
0.307692	0.2	0.25	0.166667	0.924359	0.23109
0.076923	0.1	0.125	0.166667	0.46859	0.117147
0.461538	0.6	0.375	0.5	1.936538	0.484135

C. Consistency Ratio						
constructability	a1	a2	a3	a4	Σ	
a1 (36x36; 6.0; 1.92)	0.167628	0.115545	0.234295	0.161378	0.678846	4.049713
a2 (40x40; 6.0; 0.92)	0.335256	0.23109	0.234295	0.161378	0.962019	4.162968
a3 (32x32; 9.0; 1.07)	0.083814	0.115545	0.117147	0.161378	0.477885	4.079343
a4 (36dia; 9.0; 0.99)	0.502885	0.693269	0.351442	0.484135	2.031731	4.196624
					Σ	16.48865
					λ max	4.122162
					CI	0.040721
					CR	0.045754

Criteria: maximize space

A. Pair wise Comparison				
maximize space	a1	a2	a3	a4
a1 (36x36; 6.0; 1.92)	1	2	0.5	0.333333
a2 (40x40; 6.0; 0.92)	0.5	1	0.5	0.333333
a3 (32x32; 9.0; 1.07)	2	2	1	0.333333
a4 (36dia; 9.0; 0.99)	3	3	3	1
Σ	6.5	8	5	2

B. Normalization and Analysis					
a1	a2	a3	a4	Σ	weight
0.153846	0.25	0.1	0.166667	0.670513	0.167628
0.076923	0.125	0.1	0.166667	0.46859	0.117147
0.307692	0.25	0.2	0.166667	0.924359	0.23109
0.461538	0.375	0.6	0.5	1.936538	0.484135

C. Consistency Ratio						
maximize space	a1	a2	a3	a4	Σ	
a1 (36x36; 6.0; 1.92)	0.167628	0.234295	0.115545	0.161378	0.678846	4.049713
a2 (40x40; 6.0; 0.92)	0.083814	0.117147	0.115545	0.161378	0.477885	4.079343
a3 (32x32; 9.0; 1.07)	0.335256	0.234295	0.23109	0.161378	0.962019	4.162968
a4 (36dia; 9.0; 0.99)	0.502885	0.351442	0.693269	0.484135	2.031731	4.196624
					Σ	16.48865
					λ max	4.122162
					CI	0.024432
					CR	0.027452

Criteria: minimize creep

A. Pair wise Comparison				
minimize creep	a1	a2	a3	a4
a1 (36x36; 6.0; 1.92)	1	0.333333	2	2
a2 (40x40; 6.0; 0.92)	3	1	3	3
a3 (32x32; 9.0; 1.07)	0.5	0.333333	1	0.5
a4 (36dia; 9.0; 0.99)	0.5	0.333333	2	1
Σ	5	2	8	6.5

B. Normalization and Analysis					
a1	a2	a3	a4	Σ	weight
0.2	0.166667	0.25	0.307692	0.924359	0.23109
0.6	0.5	0.375	0.461538	1.936538	0.484135
0.1	0.166667	0.125	0.076923	0.46859	0.117147
0.1	0.166667	0.25	0.153846	0.670513	0.167628

C. Consistency Ratio						
minimize creep	a1	a2	a3	a4	Σ	
a1 (36x36; 6.0; 1.92)	0.23109	0.161378	0.234295	0.335256	0.962019	4.162968
a2 (40x40; 6.0; 0.92)	0.693269	0.484135	0.351442	0.502885	2.031731	4.196624
a3 (32x32; 9.0; 1.07)	0.115545	0.161378	0.117147	0.083814	0.477885	4.079343
a4 (36dia; 9.0; 0.99)	0.115545	0.161378	0.234295	0.167628	0.678846	4.049713
					Σ	16.48865
					λ max	4.122162
					CI	0.040721
					CR	0.045754

Criteria: expedite design

A. Pair wise Comparison				
expedite design	a1	a2	a3	a4
a1 (36x36; 6.0; 1.92)	1	0.5	2	2
a2 (40x40; 6.0; 0.92)	2	1	3	3
a3 (32x32; 9.0; 1.07)	0.5	0.333333	1	0.5
a4 (36dia; 9.0; 0.99)	0.5	0.333333	2	1
Σ	4	2.166667	8	6.5

B. Normalization and Analysis						
a1	a2	a3	a4	Σ	weight
0.25	0.230769	0.25	0.307692	1.038462	0.259615
0.5	0.461538	0.375	0.461538	1.798077	0.449519
0.125	0.153846	0.125	0.076923	0.480769	0.120192
0.125	0.153846	0.25	0.153846	0.682692	0.170673

C. Consistency Ratio						
expedite design	a1	a2	a3	a4	Σ	
a1 (36x36; 6.0; 1.92)	0.259615	0.22476	0.240385	0.341346	1.066106	4.106481
a2 (40x40; 6.0; 0.92)	0.519231	0.449519	0.360577	0.512019	1.841346	4.096257
a3 (32x32; 9.0; 1.07)	0.129808	0.14984	0.120192	0.085337	0.485176	4.036667
a4 (36dia; 9.0; 0.99)	0.129808	0.14984	0.240385	0.170673	0.690705	4.046948
					Σ	16.28635
					λ max	4.071588
					CI	0.023863
					CR	0.026812

Criteria: reuse material

A. Pair wise Comparison

reuse material	a1	a2	a3	a4
a1 (36x36; 6.0; 1.92)	1	0.5	2	0.5
a2 (40x40; 6.0; 0.92)	2	1	2	0.5
a3 (32x32; 9.0; 1.07)	0.5	0.5	1	0.5
a4 (36dia; 9.0; 0.99)	2	2	2	1
Σ	5.5	4	7	2.5

B. Normalization and Analysis

a1	a2	a3	a4	Σ	weight
0.181818	0.125	0.285714	0.2	0.792532	0.198133
0.363636	0.25	0.285714	0.2	1.099351	0.274838
0.090909	0.125	0.142857	0.2	0.558766	0.139692
0.363636	0.5	0.285714	0.4	1.549351	0.387338

C. Consistency Ratio

reuse material	a1	a2	a3	a4	Σ	
a1 (36x36; 6.0; 1.92)	0.198133	0.137419	0.279383	0.193669	0.808604	4.081114
a2 (40x40; 6.0; 0.92)	0.396266	0.274838	0.279383	0.193669	1.144156	4.163024
a3 (32x32; 9.0; 1.07)	0.099067	0.137419	0.139692	0.193669	0.569846	4.079314
a4 (36dia; 9.0; 0.99)	0.396266	0.549675	0.279383	0.387338	1.612662	4.163453
					Σ	16.48691
					λ max	4.121727
					CI	0.040576
					CR	0.04559

Criteria: minimize error

A. Pair wise Comparison

minimize error	a1	a2	a3	a4
a1 (36x36; 6.0; 1.92)	1	0.333333	2	3
a2 (40x40; 6.0; 0.92)	3	1	3	5
a3 (32x32; 9.0; 1.07)	0.5	0.333333	1	2
a4 (36dia; 9.0; 0.99)	0.333333	0.2	0.5	1
Σ	4.833333	1.866667	6.5	11

B. Normalization and Analysis

a1	a2	a3	a4	Σ	weight
0.206897	0.178571	0.307692	0.272727	0.965888	0.241472
0.62069	0.535714	0.461538	0.454545	2.072488	0.518122
0.103448	0.178571	0.153846	0.181818	0.617684	0.154421
0.068966	0.107143	0.076923	0.090909	0.343941	0.085985

C. Consistency Ratio

minimize error	a1	a2	a3	a4	Σ	
a1 (36x36; 6.0; 1.92)	0.241472	0.172707	0.308842	0.257955	0.980977	4.062488
a2 (40x40; 6.0; 0.92)	0.724416	0.518122	0.463263	0.429926	2.135726	4.122053
a3 (32x32; 9.0; 1.07)	0.120736	0.172707	0.154421	0.17197	0.619835	4.013926
a4 (36dia; 9.0; 0.99)	0.080491	0.103624	0.077211	0.085985	0.347311	4.039194
					Σ	16.23766
					λ max	4.059415
					CI	0.019805
					CR	0.022253

Criteria: material cost

A. Pair wise Comparison

material	a1	a2	a3	a4
a1 (36x36; 6.0; 1.92)	1	0.5	0.2	0.333333
a2 (40x40; 6.0; 0.92)	2	1	0.333333	0.333333
a3 (32x32; 9.0; 1.07)	5	3	1	2
a4 (36dia; 9.0; 0.99)	3	3	0.5	1
Σ	11	7.5	2.033333	3.666667

B. Normalization and Analysis

a1	a2	a3	a4	Σ	weight
0.090909	0.066667	0.098361	0.090909	0.346846	0.086711
0.181818	0.133333	0.163934	0.090909	0.569995	0.142499
0.454545	0.4	0.491803	0.545455	1.891803	0.472951
0.272727	0.4	0.245902	0.272727	1.191356	0.297839

C. Consistency Ratio

material	a1	a2	a3	a4	Σ	
a1 (36x36; 6.0; 1.92)	0.086711	0.071249	0.09459	0.09928	0.351831	4.057491
a2 (40x40; 6.0; 0.92)	0.173423	0.142499	0.15765	0.09928	0.572851	4.020045
a3 (32x32; 9.0; 1.07)	0.433557	0.427496	0.472951	0.595678	1.929682	4.08009
a4 (36dia; 9.0; 0.99)	0.260134	0.427496	0.236475	0.297839	1.221945	4.102702
					Σ	16.26033
					λ max	4.065082
					CI	0.021694
					CR	0.024375

Criteria: construction method cost

A. Pair wise Comparison

method	a1	a2	a3	a4
a1 (36x36; 6.0; 1.92)	1	2	0.333333	0.142857
a2 (40x40; 6.0; 0.92)	0.5	1	0.2	0.111111
a3 (32x32; 9.0; 1.07)	3	5	1	0.2
a4 (36dia; 9.0; 0.99)	7	9	5	1
Σ	11.5	17	6.533333	1.453968

B. Normalization and Analysis

a1	a2	a3	a4	Σ	weight
0.086957	0.117647	0.05102	0.098253	0.353877	0.088469
0.043478	0.058824	0.030612	0.076419	0.209333	0.052333
0.26087	0.294118	0.153061	0.137555	0.845603	0.211401
0.608696	0.529412	0.765306	0.687773	2.591186	0.647797

C. Consistency Ratio

method	a1	a2	a3	a4	Σ	
a1 (36x36; 6.0; 1.92)	0.088469	0.104667	0.070467	0.092542	0.356145	4.025636
a2 (40x40; 6.0; 0.92)	0.044235	0.052333	0.04228	0.071977	0.210826	4.028515
a3 (32x32; 9.0; 1.07)	0.265408	0.261667	0.211401	0.129559	0.868035	4.106109
a4 (36dia; 9.0; 0.99)	0.619285	0.471	1.057004	0.647797	2.795085	4.314758
					Σ	16.47502
					λ max	4.118754
					CI	0.039585
					CR	0.044477

2.3 Synthesis (Weighting Factor of Each Technical Solution for Each Stakeholder)

SH1 Designer	satisfying décor	capacity and strength	Constructability	maximize space	minimize creep	expedite design	reuse material	minimize error	material	method	Weight
	0.289	0.217	0.080	0.144	0.040	0.057	0.025	0.023	0.104	0.021	
a1 (36x36; 6.0; 1.92)	0.1299	0.0597	0.0134	0.0242	0.0091	0.0148	0.0049	0.0056	0.0090	0.0018	0.2724
a2 (40x40; 6.0; 0.92)	0.0522	0.0841	0.0184	0.0169	0.0191	0.0256	0.0068	0.0120	0.0148	0.0011	0.2511
a3 (32x32; 9.0; 1.07)	0.0814	0.0430	0.0093	0.0334	0.0046	0.0068	0.0035	0.0036	0.0493	0.0044	0.2393
a4 (36dia; 9.0; 0.99)	0.0260	0.0303	0.0386	0.0699	0.0066	0.0097	0.0096	0.0020	0.0310	0.0135	0.2373

SH2 Programmer	satisfying décor	capacity and strength	constructability	maximize space	minimize creep	expedite design	reuse material	minimize error	material	method	Weight
	0.010	0.007	0.032	0.022	0.019	0.016	0.012	0.007	0.583	0.292	
a1 (36x36; 6.0; 1.92)	0.0046	0.0018	0.0054	0.0037	0.0043	0.0041	0.0024	0.0018	0.0506	0.0258	0.1044
a2 (40x40; 6.0; 0.92)	0.0018	0.0025	0.0075	0.0026	0.0090	0.0070	0.0034	0.0038	0.0831	0.0153	0.1360
a3 (32x32; 9.0; 1.07)	0.0029	0.0013	0.0038	0.0051	0.0022	0.0019	0.0017	0.0011	0.2759	0.0617	0.3575
a4 (36dia; 9.0; 0.99)	0.0009	0.0009	0.0157	0.0107	0.0031	0.0027	0.0047	0.0006	0.1737	0.1889	0.4021

SH3 Construction manager	satisfying décor	capacity and strength	Constructability	maximize space	minimize creep	expedite design	reuse material	minimize error	material	method	Weight
	0.078	0.029	0.139	0.031	0.030	0.050	0.155	0.238	0.031	0.219	
a1 (36x36; 6.0; 1.92)	0.0351	0.0080	0.0233	0.0053	0.0069	0.0129	0.0307	0.0574	0.0027	0.0194	0.2016
a2 (40x40; 6.0; 0.92)	0.0141	0.0112	0.0321	0.0037	0.0144	0.0223	0.0426	0.1232	0.0045	0.0114	0.2796
a3 (32x32; 9.0; 1.07)	0.0220	0.0058	0.0163	0.0073	0.0035	0.0060	0.0216	0.0367	0.0148	0.0462	0.1802
a4 (36dia; 9.0; 0.99)	0.0070	0.0041	0.0673	0.0152	0.0050	0.0085	0.0600	0.0204	0.0093	0.1417	0.3386

Aggregation	satisfying décor	capacity and strength	Constructability	maximize space	minimize creep	expedite design	reuse material	minimize error	material	method	Weight
	0.126	0.084	0.084	0.066	0.029	0.041	0.064	0.089	0.240	0.177	
a1 (36x36; 6.0; 1.92)	0.0565	0.0231	0.0140	0.0111	0.0068	0.0106	0.0127	0.0216	0.0208	0.0157	0.1928
a2 (40x40; 6.0; 0.92)	0.0227	0.0326	0.0194	0.0077	0.0142	0.0183	0.0176	0.0463	0.0341	0.0093	0.2222
a3 (32x32; 9.0; 1.07)	0.0354	0.0167	0.0098	0.0152	0.0034	0.0049	0.0089	0.0138	0.1133	0.0374	0.2590
a4 (36dia; 9.0; 0.99)	0.0113	0.0118	0.0406	0.0319	0.0049	0.0069	0.0248	0.0077	0.0714	0.1147	0.3260

3 Wall System Selection

3.1 Weighting Factor of Each Criteria for Each Stakeholder

Property management	Initial	LCC	normalization		Σ	weighting
Initial	1	0.111111111	0.1	0.1	0.2	0.1
LCC	9	1	0.9	0.9	1.8	0.9
Σ	10	1.111111111				1
Project management	Initial	LCC	normalization		Σ	weighting
Initial	1	9	0.9	0.9	1.8	0.9
LCC	0.111111111	1	0.1	0.1	0.2	0.1
Σ	1.111111111	10				1
Architect	Initial	LCC	normalization		Σ	weighting
Initial	1	2	0.666666667	0.666666667	1.333333333	0.666666667
LCC	0.5	1	0.333333333	0.333333333	0.666666667	0.333333333
Σ	1.5	3				1
QS	Initial	LCC	normalization		Σ	weighting
Initial	1	3	0.75	0.75	1.5	0.75
LCC	0.333333333	1	0.25	0.25	0.5	0.25
Σ	1.333333333	4				1
Engineer	Initial	LCC	normalization		Σ	weighting
Initial	1	0.25	0.2	0.2	0.4	0.2
LCC	4	1	0.8	0.8	1.6	0.8
Σ	5	1.25				1

Stakeholder 1: Property management

A. Pairwise Comparison

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image
Structural stability	1	0.2	0.333333333	0.333333333	0.2	0.142857143	0.2	0.111111111
Rain and water	5	1	2	3	0.333333333	0.333333333	2	3
Thermal	3	0.5	1	2	0.333333333	0.2	0.5	0.2
Accoustic	3	0.333333333	0.5	1	0.2	0.2	0.333333333	0.5
Protect asset	5	3	3	5	1	0.5	3	3
Fire safety	7	3	5	5	2	1	3	5
Satisfy	5	0.5	2	3	0.333333333	0.333333333	1	2
Image	9	0.333333333	5	2	0.333333333	0.2	0.5	1
Σ	38	8.866666667	18.83333333	21.33333333	4.733333333	2.90952381	10.53333333	14.81111111

B. Normalization and Analysis

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Σ	Weight
Structural stability	0.0263	0.0226	0.0177	0.0156	0.0423	0.0491	0.0190	0.0075	0.2000	0.0250
Rain and water	0.1316	0.1128	0.1062	0.1406	0.0704	0.1146	0.1899	0.2026	1.0686	0.1336
Thermal	0.0789	0.0564	0.0531	0.0938	0.0704	0.0687	0.0475	0.0135	0.4823	0.0603
Accoustic	0.0789	0.0376	0.0265	0.0469	0.0423	0.0687	0.0316	0.0338	0.3664	0.0458
Protect asset	0.1316	0.3383	0.1593	0.2344	0.2113	0.1718	0.2848	0.2026	1.7341	0.2168
Fire safety	0.1842	0.3383	0.2655	0.2344	0.4225	0.3437	0.2848	0.3376	2.4110	0.3014
Satisfy	0.1316	0.0564	0.1062	0.1406	0.0704	0.1146	0.0949	0.1350	0.8497	0.1062
Image	0.2368	0.0376	0.2655	0.0938	0.0704	0.0687	0.0475	0.0675	0.8878	0.1110

C. Concistency Ratio

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Σ	
Structural stability	0.0250	0.0267	0.0201	0.0153	0.0434	0.0431	0.0212	0.0123	0.2071	8.2809
Rain and water	0.1250	0.1336	0.1206	0.1374	0.0723	0.1005	0.2124	0.3329	1.2346	9.2432
Thermal	0.0750	0.0668	0.0603	0.0916	0.0723	0.0603	0.0531	0.0222	0.5015	8.3184
Accoustic	0.0750	0.0445	0.0301	0.0458	0.0434	0.0603	0.0354	0.0555	0.3900	8.5162
Protect asset	0.1250	0.4007	0.1809	0.2290	0.2168	0.1507	0.3187	0.3329	1.9546	9.0175
Fire safety	0.1750	0.4007	0.3014	0.2290	0.4335	0.3014	0.3187	0.5549	2.7146	9.0073
Satisfy	0.1250	0.0668	0.1206	0.1374	0.0723	0.1005	0.1062	0.2220	0.9507	8.9501
Image	0.2250	0.0445	0.3014	0.0916	0.0723	0.0603	0.0531	0.1110	0.9592	8.6434
									Σ	69.97697
									λ	8.747121
									CI	0.106732
									CR	0.075696

Stakeholder 2: Project management

A. Pairwise Comparison

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image
Structural stability	1	3	3	5	5	0.333333333	0.333333333	2
Rain and water	0.333333333	1	3	4	3	0.333333333	0.25	0.333333333
Thermal	0.333333333	0.333333333	1	3	2	0.2	0.2	0.333333333
Accoustic	0.2	0.25	0.333333333	1	0.5	0.2	0.142857143	0.2
Protect asset	0.2	0.333333333	0.5	2	1	0.2	0.2	0.2
Fire safety	3	3	5	5	5	1	0.5	2
Satisfy	3	4	5	7	5	2	1	3
Image	0.5	3	3	5	5	0.5	0.333333333	1
Σ	8.566666667	14.91666667	20.83333333	32	26.5	4.766666667	2.95952381	9.066666667

B. Normalization and Analysis

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Σ	weight
Structural stability	0.1167	0.2011	0.1440	0.1563	0.1887	0.0699	0.1126	0.2206	1.2099	0.1512
Rain and water	0.0389	0.0670	0.1440	0.1250	0.1132	0.0699	0.0845	0.0368	0.6793	0.0849
Thermal	0.0389	0.0223	0.0480	0.0938	0.0755	0.0420	0.0676	0.0368	0.4248	0.0531
Accoustic	0.0233	0.0168	0.0160	0.0313	0.0189	0.0420	0.0483	0.0221	0.2185	0.0273
Protect asset	0.0233	0.0223	0.0240	0.0625	0.0377	0.0420	0.0676	0.0221	0.3015	0.0377
Fire safety	0.3502	0.2011	0.2400	0.1563	0.1887	0.2098	0.1689	0.2206	1.7356	0.2169
Satisfy	0.3502	0.2682	0.2400	0.2188	0.1887	0.4196	0.3379	0.3309	2.3541	0.2943
Image	0.0584	0.2011	0.1440	0.1563	0.1887	0.1049	0.1126	0.1103	1.0762	0.1345

C. Concistency Ratio

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Σ	
Structural stability	0.1512	0.2547	0.1593	0.1366	0.1885	0.0723	0.0981	0.2691	1.3298	8.7924
Rain and water	0.0504	0.0849	0.1593	0.1093	0.1131	0.0723	0.0736	0.0448	0.7077	8.3338
Thermal	0.0504	0.0283	0.0531	0.0819	0.0754	0.0434	0.0589	0.0448	0.4362	8.2155
Accoustic	0.0302	0.0212	0.0177	0.0273	0.0188	0.0434	0.0420	0.0269	0.2277	8.3353
Protect asset	0.0302	0.0283	0.0265	0.0546	0.0377	0.0434	0.0589	0.0269	0.3066	8.1339
Fire safety	0.4537	0.2547	0.2655	0.1366	0.1885	0.2169	0.1471	0.2691	1.9321	8.9060
Satisfy	0.4537	0.3397	0.2655	0.1912	0.1885	0.4339	0.2943	0.4036	2.5703	8.7345
Image	0.0756	0.2547	0.1593	0.1366	0.1885	0.1085	0.0981	0.1345	1.1558	8.5912
									Σ	68.04257
									λ	8.505322
									CI	0.072189
									CR	0.051198

Stakeholder 3: Architect

A. Pairwise Comparison

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image
Structural stability	1	5	3	3	3	3	0.333333333	0.25
Rain and water	0.2	1	2	0.333333333	2	0.5	0.2	0.142857143
Thermal	0.333333333	0.5	1	0.333333333	2	0.333333333	0.333333333	0.2
Accoustic	0.333333333	3	3	1	0.5	0.333333333	0.2	0.2
Protect asset	0.333333333	0.5	0.5	2	1	0.333333333	0.2	0.2
Fire safety	0.333333333	2	3	3	3	1	0.333333333	0.2
Satisfy	3	5	3	5	5	3	1	0.333333333
Image	4	7	5	5	7	5	3	1
Σ	9.533333333	24	20.5	19.66666667	23.5	13.5	5.6	2.526190476

B. Normalization and Analysis

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Σ	weight
Structural stability	0.1049	0.2083	0.1463	0.1525	0.1277	0.2222	0.0595	0.0990	1.1205	0.1401
Rain and water	0.0210	0.0417	0.0976	0.0169	0.0851	0.0370	0.0357	0.0566	0.3916	0.0489
Thermal	0.0350	0.0208	0.0488	0.0169	0.0851	0.0247	0.0595	0.0792	0.3700	0.0463
Accoustic	0.0350	0.1250	0.1463	0.0508	0.0213	0.0247	0.0357	0.0792	0.5180	0.0648
Protect asset	0.0350	0.0208	0.0244	0.1017	0.0426	0.0247	0.0357	0.0792	0.3640	0.0455
Fire safety	0.0350	0.0833	0.1463	0.1525	0.1277	0.0741	0.0595	0.0792	0.7576	0.0947
Satisfy	0.3147	0.2083	0.1463	0.2542	0.2128	0.2222	0.1786	0.1320	1.6691	0.2086
Image	0.4196	0.2917	0.2439	0.2542	0.2979	0.3704	0.5357	0.3959	2.8092	0.3511

C. Concistency Ratio

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Σ	
Structural stability	0.1401	0.2447	0.1388	0.1943	0.1365	0.2841	0.0695	0.0878	1.2957	9.2513
Rain and water	0.0280	0.0489	0.0925	0.0216	0.0910	0.0474	0.0417	0.0502	0.4213	8.6074
Thermal	0.0467	0.0245	0.0463	0.0216	0.0910	0.0316	0.0695	0.0702	0.4013	8.6772
Accoustic	0.0467	0.1468	0.1388	0.0648	0.0228	0.0316	0.0417	0.0702	0.5633	8.6996
Protect asset	0.0467	0.0245	0.0231	0.1295	0.0455	0.0316	0.0417	0.0702	0.4128	9.0725
Fire safety	0.0467	0.0979	0.1388	0.1943	0.1365	0.0947	0.0695	0.0702	0.8486	8.9605
Satisfy	0.4202	0.2447	0.1388	0.3238	0.2275	0.2841	0.2086	0.1170	1.9647	9.4169
Image	0.5602	0.3426	0.2313	0.3238	0.3185	0.4735	0.6259	0.3511	3.2270	9.1897
									Σ	71.87504
									λ	8.98438
									CI	0.140626
									CR	0.099735

Stakeholder 4: QS

A. Pairwise Comparison

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image
Structural stability	1	5	5	5	2	0.5	2	5
Rain and water	0.2	1	0.5	0.5	0.2	0.2	0.25	0.5
Thermal	0.2	2	1	3	0.2	0.2	0.2	0.5
Accoustic	0.2	2	0.333333333	1	0.2	0.2	0.2	0.333333333
Protect asset	0.5	5	5	5	1	0.5	3	5
Fire safety	2	5	5	5	2	1	2	6
Satisfy	0.5	4	5	5	0.333333333	0.5	1	5
Image	0.2	2	2	3	0.2	0.166666667	0.2	1
Σ	4.8	26	23.83333333	27.5	6.133333333	3.266666667	8.85	23.33333333

B. Normalization and Analysis

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Σ	weight
Structural stability	0.2083	0.1923	0.2098	0.1818	0.3261	0.1531	0.2260	0.2143	1.7117	0.2140
Rain and water	0.0417	0.0385	0.0210	0.0182	0.0326	0.0612	0.0282	0.0214	0.2628	0.0328
Thermal	0.0417	0.0769	0.0420	0.1091	0.0326	0.0612	0.0226	0.0214	0.4075	0.0509
Accoustic	0.0417	0.0769	0.0140	0.0364	0.0326	0.0612	0.0226	0.0143	0.2997	0.0375
Protect asset	0.1042	0.1923	0.2098	0.1818	0.1630	0.1531	0.3390	0.2143	1.5575	0.1947
Fire safety	0.4167	0.1923	0.2098	0.1818	0.3261	0.3061	0.2260	0.2571	2.1159	0.2645
Satisfy	0.1042	0.1538	0.2098	0.1818	0.0543	0.1531	0.1130	0.2143	1.1843	0.1480
Image	0.0417	0.0769	0.0839	0.1091	0.0326	0.0510	0.0226	0.0429	0.4607	0.0576

C. Concistency Ratio

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Σ	
Structural stability	0.2140	0.1642	0.2547	0.1873	0.3894	0.1322	0.2961	0.2879	1.9258	9.0008
Rain and water	0.0428	0.0328	0.0255	0.0187	0.0389	0.0529	0.0370	0.0288	0.2775	8.4468
Thermal	0.0428	0.0657	0.0509	0.1124	0.0389	0.0529	0.0296	0.0288	0.4220	8.2854
Accoustic	0.0428	0.0657	0.0170	0.0375	0.0389	0.0529	0.0296	0.0192	0.3036	8.1043
Protect asset	0.1070	0.1642	0.2547	0.1873	0.1947	0.1322	0.4441	0.2879	1.7722	9.1029
Fire safety	0.4279	0.1642	0.2547	0.1873	0.3894	0.2645	0.2961	0.3455	2.3296	8.8078
Satisfy	0.1070	0.1314	0.2547	0.1873	0.0649	0.1322	0.1480	0.2879	1.3135	8.8724
Image	0.0428	0.0657	0.1019	0.1124	0.0389	0.0441	0.0296	0.0576	0.4929	8.5603
									Σ	69.18068
									λ	8.647585
									CI	0.092512
									CR	0.065611

Stakeholder 5: Engineer

A. Pairwise Comparison

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image
Structural stability	1	0.33	0.5	2	1	0.5	3	3
Rain and water	3	1	2	4	3	2	5	5
Thermal	2	0.5	1	3	3	1	3	5
Accoustic	0.5	0.25	0.333333333	1	0.5	0.333333333	2	2
Protect asset	1	0.333333333	0.333333333	2	1	0.333333333	3	3
Fire safety	2	0.5	1	3	3	1	4	5
Satisfy	0.333333333	0.2	0.333333333	0.5	0.333333333	0.25	1	0.5
Image	0.333333333	0.2	0.2	0.5	0.333333333	0.2	2	1
Σ	10.16666667	3.316666667	5.7	16	12.16666667	5.616666667	23	24.5

B. Normalization and Analysis

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Σ	weight
Structural stability	0.0984	0.1005	0.0877	0.1250	0.0822	0.0890	0.1304	0.1224	0.8357	0.1045
Rain and water	0.2951	0.3015	0.3509	0.2500	0.2466	0.3561	0.2174	0.2041	2.2216	0.2777
Thermal	0.1967	0.1508	0.1754	0.1875	0.2466	0.1780	0.1304	0.2041	1.4695	0.1837
Accoustic	0.0492	0.0754	0.0585	0.0625	0.0411	0.0593	0.0870	0.0816	0.5146	0.0643
Protect asset	0.0984	0.1005	0.0585	0.1250	0.0822	0.0593	0.1304	0.1224	0.7768	0.0971
Fire safety	0.1967	0.1508	0.1754	0.1875	0.2466	0.1780	0.1739	0.2041	1.5130	0.1891
Satisfy	0.0328	0.0603	0.0585	0.0313	0.0274	0.0445	0.0435	0.0204	0.3186	0.0398
Image	0.0328	0.0603	0.0351	0.0313	0.0274	0.0356	0.0870	0.0408	0.3502	0.0438

C. Concistency Ratio

	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Σ	
Structural stability	0.1045	0.0926	0.0918	0.1286	0.0971	0.0946	0.1195	0.1313	0.8600	8.2326
Rain and water	0.3134	0.2777	0.3674	0.2573	0.2913	0.3783	0.1991	0.2189	2.3033	8.2942
Thermal	0.2089	0.1388	0.1837	0.1930	0.2913	0.1891	0.1195	0.2189	1.5432	8.4010
Accoustic	0.0522	0.0694	0.0612	0.0643	0.0485	0.0630	0.0797	0.0876	0.5260	8.1777
Protect asset	0.1045	0.0926	0.0612	0.1286	0.0971	0.0630	0.1195	0.1313	0.7978	8.2171
Fire safety	0.2089	0.1388	0.1837	0.1930	0.2913	0.1891	0.1593	0.2189	1.5830	8.3701
Satisfy	0.0348	0.0555	0.0612	0.0322	0.0324	0.0473	0.0398	0.0219	0.3251	8.1632
Image	0.0348	0.0555	0.0367	0.0322	0.0324	0.0378	0.0797	0.0438	0.3529	8.0611
									Σ	65.91711
									λ	8.239638
									CI	0.034234
									CR	0.024279

3.2 Weighting Factor of Each Technical Solution for Each Criteria

Criteria: structural stability

A. Pairwise Comparison

Structural stability	a1	a2	a3	a4	a5
a1 (RC brick)	1	0.5	0.333333	0.25	0.2
a2 (precast)	2	1	0.333333	0.2	0.142857
a3 (metal frame)	3	3	1	0.333333	0.2
a4 (timber)	4	5	3	1	0.333333
a5 (glass wall)	5	7	5	3	1
Σ	15	16.5	9.666667	4.783333	1.87619

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weight
0.0667	0.0303	0.0345	0.0523	0.1066	0.2903	0.0581
0.1333	0.0606	0.0345	0.0418	0.0761	0.3464	0.0693
0.2000	0.1818	0.1034	0.0697	0.1066	0.6616	0.1323
0.2667	0.3030	0.3103	0.2091	0.1777	1.2668	0.2534
0.3333	0.4242	0.5172	0.6272	0.5330	2.4350	0.4870

C. Concistency Ratio

	a1	a2	a3	a4	a5	Σ	
a1 (RC brick)	0.058063	0.034638	0.044103	0.063338	0.0974	0.297542	5.12445
a2 (precast)	0.116126	0.069275	0.044103	0.050671	0.069571	0.349747	5.048658
a3 (metal frame)	0.17419	0.207826	0.13231	0.084451	0.0974	0.696176	5.261692
a4 (timber)	0.232253	0.346376	0.396931	0.253353	0.162333	1.391246	5.49133
a5 (glass wall)	0.290316	0.484927	0.661552	0.76006	0.486998	2.683852	5.511013
						Σ	26.43714
						λ max	5.287429
				CR	0.064158	CI	0.071857

Criteria: rain and water protection

A. Pairwise Comparison

Rain and water	a1	a2	a3	a4	a5
a1 (RC brick)	1	0.5	0.333333	5	0.2
a2 (precast)	2	1	0.333333	5	0.2
a3 (metal frame)	3	3	1	7	0.333333
a4 (timber)	0.2	0.2	0.142857	1	0.142857
a5 (glass wall)	5	5	3	7	1
Σ	11.2	9.7	4.809524	25	1.87619

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weight
0.0893	0.0515	0.0693	0.2000	0.1066	0.5167	0.1033
0.1786	0.1031	0.0693	0.2000	0.1066	0.6576	0.1315
0.2679	0.3093	0.2079	0.2800	0.1777	1.2427	0.2485
0.0179	0.0206	0.0297	0.0400	0.0761	0.1843	0.0369
0.4464	0.5155	0.6238	0.2800	0.5330	2.3987	0.4797

C. Concistency Ratio

	a1	a2	a3	a4	a5	Σ	
a1 (RC brick)	0.103348	0.065757	0.082848	0.184321	0.095946	0.532219	5.1498
a2 (precast)	0.206695	0.131514	0.082848	0.184321	0.095946	0.701324	5.332694
a3 (metal frame)	0.310043	0.394542	0.248544	0.258049	0.15991	1.371088	5.516475
a4 (timber)	0.02067	0.026303	0.035506	0.036864	0.068533	0.187876	5.096431
a5 (glass wall)	0.516738	0.65757	0.745633	0.258049	0.47973	2.65772	5.540033
						Σ	26.63543
						λ max	5.327087
						CI	0.081772
						CR	0.07301

Criteria: thermal

A. Pairwise Comparison

thermal	a1	a2	a3	a4	a5
a1 (RC brick)	1	2	5	3	7
a2 (precast)	0.5	1	5	3	7
a3 (metal frame)	0.2	0.2	1	2	5
a4 (timber)	0.333333	0.333333	0.5	1	3
a5 (glass wall)	0.142857	0.142857	0.2	0.333333	1
Σ	2.17619	3.67619	11.7	9.333333	23

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weighting
0.4595	0.5440	0.4274	0.3214	0.3043	2.0567	0.4113
0.2298	0.2720	0.4274	0.3214	0.3043	1.5549	0.3110
0.0919	0.0544	0.0855	0.2143	0.2174	0.6635	0.1327
0.1532	0.0907	0.0427	0.1071	0.1304	0.5242	0.1048
0.0656	0.0389	0.0171	0.0357	0.0435	0.2008	0.0402

C. Concistency Ratio

	a1	a2	a3	a4	a5	Σ	
a1 (RC brick)	0.411337	0.621963	0.663455	0.314495	0.281109	2.29236	5.572943
a2 (precast)	0.205669	0.310981	0.663455	0.314495	0.281109	1.77571	5.710019
a3 (metal frame)	0.082267	0.062196	0.132691	0.209664	0.200792	0.687611	5.182044
a4 (timber)	0.137112	0.10366	0.066345	0.104832	0.120475	0.532426	5.078854
a5 (glass wall)	0.058762	0.044426	0.026538	0.034944	0.040158	0.204829	5.100522
						Σ	26.64438
						λ max	5.328876
				CR	0.07341	CI	0.082219

Criteria: accoustic

A. Pairwise Comparison

acoustic	a1	a2	a3	a4	a5
a1 (RC brick)	1	3	3	5	5
a2 (precast)	0.333333	1	3	5	5
a3 (metal frame)	0.333333	0.333333	1	3	2
a4 (timber)	0.2	0.2	0.333333	1	0.5
a5 (glass wall)	0.2	0.2	0.5	2	1
Σ	2.066667	4.733333	7.833333	16	13.5

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weighting
0.4839	0.6338	0.3830	0.3125	0.3704	2.1835	0.4367
0.1613	0.2113	0.3830	0.3125	0.3704	1.4384	0.2877
0.1613	0.0704	0.1277	0.1875	0.1481	0.6950	0.1390
0.0968	0.0423	0.0426	0.0625	0.0370	0.2811	0.0562
0.0968	0.0423	0.0638	0.1250	0.0741	0.4019	0.0804

C. Concistency Ratio

	a1	a2	a3	a4	a5	Σ	
a1 (RC brick)	0.436705	0.863044	0.417012	0.281118	0.401932	2.399811	5.495273
a2 (precast)	0.145568	0.287681	0.417012	0.281118	0.401932	1.533311	5.329894
a3 (metal frame)	0.145568	0.095894	0.139004	0.168671	0.160773	0.70991	5.107111
a4 (timber)	0.087341	0.057536	0.046335	0.056224	0.040193	0.287629	5.1158
a5 (glass wall)	0.087341	0.057536	0.069502	0.112447	0.080386	0.407213	5.065697
						Σ	26.11378
						λ max	5.222755
				CR	0.049722	CI	0.055689

Criteria: protect asset

A. Pairwise Comparison

protect asset	a1	a2	a3	a4	a5
a1 (RC brick)	1	0.333333	2	3	5
a2 (precast)	3	1	3	5	7
a3 (metal frame)	0.5	0.333333	1	3	3
a4 (timber)	0.333333	0.2	0.333333	1	3
a5 (glass wall)	0.2	0.142857	0.333333	0.333333	1
Σ	5.033333	2.009524	6.666667	12.33333	19

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weight
0.1987	0.1659	0.3000	0.2432	0.2632	1.1710	0.2342
0.5960	0.4976	0.4500	0.4054	0.3684	2.3175	0.4635
0.0993	0.1659	0.1500	0.2432	0.1579	0.8164	0.1633
0.0662	0.0995	0.0500	0.0811	0.1579	0.4547	0.0909
0.0397	0.0711	0.0500	0.0270	0.0526	0.2405	0.0481

C. Concistency Ratio

	a1	a2	a3	a4	a5	Σ	
a1 (RC brick)	0.234191	0.154499	0.326541	0.272836	0.240484	1.228551	5.245941
a2 (precast)	0.702572	0.463497	0.489812	0.454727	0.336677	2.447285	5.280048
a3 (metal frame)	0.117095	0.154499	0.163271	0.272836	0.14429	0.851991	5.21828
a4 (timber)	0.078064	0.092699	0.054424	0.090945	0.14429	0.460422	5.06262
a5 (glass wall)	0.046838	0.066214	0.054424	0.030315	0.048097	0.245887	5.112348
						Σ	25.91924
						λ max	5.183847
						CI	0.045962
						CR	0.041037

Criteria: fire safety

A. Pairwise Comparison

fire safety	a1	a2	a3	a4	a5
a1 (RC brick)	1	2	3	9	5
a2 (precast)	0.5	1	3	9	5
a3 (metal frame)	0.333333	0.333333	1	7	3
a4 (timber)	0.111111	0.111111	0.142857	1	0.2
a5 (glass wall)	0.2	0.2	0.333333	5	1
Σ	2.144444	3.644444	7.47619	31	14.2

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weight
0.4663	0.5488	0.4013	0.2903	0.3521	2.0588	0.4118
0.2332	0.2744	0.4013	0.2903	0.3521	1.5513	0.3103
0.1554	0.0915	0.1338	0.2258	0.2113	0.8177	0.1635
0.0518	0.0305	0.0191	0.0323	0.0141	0.1478	0.0296
0.0933	0.0549	0.0446	0.1613	0.0704	0.4244	0.0849

C. Concistency Ratio

	a1	a2	a3	a4	a5	Σ	
a1 (RC brick)	0.411762	0.620504	0.490642	0.265954	0.424441	2.213303	5.375197
a2 (precast)	0.205881	0.310252	0.490642	0.265954	0.424441	1.69717	5.470294
a3 (metal frame)	0.137254	0.103417	0.163547	0.206853	0.254665	0.865736	5.293496
a4 (timber)	0.045751	0.034472	0.023364	0.02955	0.016978	0.150116	5.079986
a5 (glass wall)	0.082352	0.06205	0.054516	0.147752	0.084888	0.431559	5.083849
						Σ	26.30282
						λ max	5.260564
				CR	0.058162	CI	0.065141

Criteria: satisfy

A. Pairwise Comparison

satisfy	a1	a2	a3	a4	a5
a1 (RC brick)	1	3	3	0.5	3
a2 (precast)	0.333333	1	0.5	0.2	0.2
a3 (metal frame)	0.333333	2	1	0.2	0.2
a4 (timber)	2	5	5	1	3
a5 (glass wall)	0.333333	5	5	0.333333	1
Σ	4	16	14.5	2.233333	7.4

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weight
0.2500	0.1875	0.2069	0.2239	0.4054	1.2737	0.2547
0.0833	0.0625	0.0345	0.0896	0.0270	0.2969	0.0594
0.0833	0.1250	0.0690	0.0896	0.0270	0.3939	0.0788
0.5000	0.3125	0.3448	0.4478	0.4054	2.0105	0.4021
0.0833	0.3125	0.3448	0.1493	0.1351	1.0251	0.2050

C. Concistency Ratio

	a1	a2	a3	a4	a5	Σ	
a1 (RC brick)	0.254737	0.178137	0.236327	0.201049	0.61503	1.48528	5.830652
a2 (precast)	0.084912	0.059379	0.039388	0.08042	0.041002	0.305101	5.138188
a3 (metal frame)	0.084912	0.118758	0.078776	0.08042	0.041002	0.403868	5.126811
a4 (timber)	0.509473	0.296895	0.393878	0.402099	0.61503	2.217375	5.514503
a5 (glass wall)	0.084912	0.296895	0.393878	0.134033	0.20501	1.114729	5.437436
						Σ	27.04759
						λ max	5.409518
				CR	0.09141	CI	0.102379

Criteria: image

A. Pairwise Comparison

image	a1	a2	a3	a4	a5
a1 (RC brick)	1	3	3	5	0.2
a2 (precast)	0.333333	1	3	5	0.2
a3 (metal frame)	0.333333	0.333333	1	3	0.142857
a4 (timber)	0.2	0.2	0.333333	1	0.111111
a5 (glass wall)	5	5	7	9	1
Σ	6.866667	9.533333	14.33333	23	1.653968

B. Normalization and Analysis

	a1	a2	a3	a4	a5	Σ	weight
a1 (RC brick)	0.1456	0.3147	0.2093	0.2174	0.1209	1.0079	0.2016
a2 (precast)	0.0485	0.1049	0.2093	0.2174	0.1209	0.7011	0.1402
a3 (metal frame)	0.0485	0.0350	0.0698	0.1304	0.0864	0.3701	0.0740
a4 (timber)	0.0291	0.0210	0.0233	0.0435	0.0672	0.1840	0.0368
a5 (glass wall)	0.7282	0.5245	0.4884	0.3913	0.6046	2.7369	0.5474

C. Concistency Ratio

	a1	a2	a3	a4	a5	Σ	
a1 (RC brick)	0.201586	0.420632	0.22205	0.184018	0.109477	1.137763	5.64405
a2 (precast)	0.067195	0.140211	0.22205	0.184018	0.109477	0.722951	5.156171
a3 (metal frame)	0.067195	0.046737	0.074017	0.110411	0.078198	0.376557	5.087466
a4 (timber)	0.040317	0.028042	0.024672	0.036804	0.06082	0.190655	5.180354
a5 (glass wall)	1.007931	0.701054	0.518117	0.331232	0.547383	3.105717	5.673756
						Σ	26.7418
						λ max	5.348359
						CI	0.08709
						CR	0.077759

Criteria: initial cost

A. Pairwise Comparison

initial	a1	a2	a3	a4	a5
a1 (RC brick)	1	9	5	9	7
a2 (precast)	0.111111	1	0.142857	2	0.333333
a3 (metal frame)	0.2	7	1	7	5
a4 (timber)	0.111111	0.5	0.142857	1	0.333333
a5 (glass wall)	0.142857	3	0.2	3	1
Σ	1.565079	20.5	6.485714	22	13.66667

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weight
0.6389	0.4390	0.7709	0.4091	0.5122	2.7702	0.5540
0.0710	0.0488	0.0220	0.0909	0.0244	0.2571	0.0514
0.1278	0.3415	0.1542	0.3182	0.3659	1.3075	0.2615
0.0710	0.0244	0.0220	0.0455	0.0244	0.1873	0.0375
0.0913	0.1463	0.0308	0.1364	0.0732	0.4780	0.0956

C. Concistency Ratio

	a1	a2	a3	a4	a5	Σ	
a1 (RC brick)	0.554036	0.46278	1.307473	0.33706	0.669187	3.330536	6.011406
a2 (precast)	0.06156	0.05142	0.037356	0.074902	0.031866	0.257104	5.000078
a3 (metal frame)	0.110807	0.35994	0.261495	0.262158	0.477991	1.47239	5.630672
a4 (timber)	0.06156	0.02571	0.037356	0.037451	0.031866	0.193943	5.178572
a5 (glass wall)	0.079148	0.15426	0.052299	0.112353	0.095598	0.493658	5.163891
						Σ	26.98462
						λ max	5.396924
				CR	0.088599	CI	0.099231

Criteria: LCC

A. Pairwise Comparison

LCC	a1	a2	a3	a4	a5
a1 (RC brick)	1	0.2	0.333333	7	3
a2 (precast)	5	1	3	9	5
a3 (metal frame)	3	0.333333	1	5	3
a4 (timber)	0.142857	0.111111	0.2	1	0.2
a5 (glass wall)	0.333333	0.2	0.333333	5	1
Σ	9.47619	1.844444	4.866667	27	12.2

B. Normalization and Analysis

a1	a2	a3	a4	a5	Σ	weight
0.1055	0.1084	0.0685	0.2593	0.2459	0.7876	0.1575
0.5276	0.5422	0.6164	0.3333	0.4098	2.4294	0.4859
0.3166	0.1807	0.2055	0.1852	0.2459	1.1339	0.2268
0.0151	0.0602	0.0411	0.0370	0.0164	0.1698	0.0340
0.0352	0.1084	0.0685	0.1852	0.0820	0.4793	0.0959

C. Concistency Ratio							
	a1	a2	a3	a4	a5	Σ	
a1 (RC brick)	0.157523	0.097177	0.075591	0.23778	0.287553	0.855624	5.431737
a2 (precast)	0.787615	0.485883	0.680323	0.305717	0.479255	2.738794	5.636736
a3 (metal frame)	0.472569	0.161961	0.226774	0.169843	0.287553	1.3187	5.815032
a4 (timber)	0.022503	0.053987	0.045355	0.033969	0.01917	0.174984	5.151352
a5 (glass wall)	0.052508	0.097177	0.075591	0.169843	0.095851	0.490969	5.122214
						Σ	27.15707
						λ max	5.431414
						CI	0.107854
						CR	0.096298

3.3 Synthesis (Weighting Factor of Each Technical Solution for Each Stakeholder)

Property Management	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Initial	LCC	Weight
	0.0219	0.1169	0.0528	0.0401	0.1897	0.2637	0.0929	0.0971	0.0125	0.1125	
a1 (RC brick)	0.0013	0.0121	0.0217	0.0175	0.0444	0.1086	0.0237	0.0196	0.0069	0.0177	0.2734
a2 (precast)	0.0015	0.0154	0.0164	0.0115	0.0879	0.0818	0.0055	0.0136	0.0006	0.0547	0.2890
a3 (metal frame)	0.0029	0.0290	0.0070	0.0056	0.0310	0.0431	0.0073	0.0072	0.0033	0.0255	0.1619
a4 (timber)	0.0055	0.0043	0.0055	0.0023	0.0172	0.0078	0.0374	0.0036	0.0005	0.0038	0.0879
a5 (glass wall)	0.0107	0.0561	0.0021	0.0032	0.0091	0.0224	0.0191	0.0532	0.0012	0.0108	0.1878
Project Management	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Initial	LCC	Weight
	0.038	0.021	0.013	0.007	0.009	0.054	0.074	0.034	0.675	0.075	
a1 (RC brick)	0.0022	0.0022	0.0055	0.0030	0.0022	0.0223	0.0187	0.0068	0.3740	0.0118	0.4487
a2 (precast)	0.0026	0.0028	0.0041	0.0020	0.0044	0.0168	0.0044	0.0047	0.0347	0.0364	0.1129
a3 (metal frame)	0.0050	0.0053	0.0018	0.0009	0.0015	0.0089	0.0058	0.0025	0.1765	0.0170	0.2252
a4 (timber)	0.0096	0.0008	0.0014	0.0004	0.0009	0.0016	0.0296	0.0012	0.0253	0.0025	0.0732
a5 (glass wall)	0.0184	0.0102	0.0005	0.0005	0.0005	0.0046	0.0151	0.0184	0.0645	0.0072	0.1399

Architect	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Initial	LCC	Weight
	0.123	0.043	0.040	0.057	0.040	0.083	0.183	0.307	0.083	0.042	
a1 (RC brick)	0.0071	0.0044	0.0166	0.0247	0.0093	0.0341	0.0465	0.0619	0.0462	0.0066	0.2576
a2 (precast)	0.0085	0.0056	0.0126	0.0163	0.0185	0.0257	0.0108	0.0431	0.0043	0.0202	0.1656
a3 (metal frame)	0.0162	0.0106	0.0054	0.0079	0.0065	0.0136	0.0144	0.0227	0.0218	0.0094	0.1285
a4 (timber)	0.0310	0.0016	0.0042	0.0032	0.0036	0.0024	0.0734	0.0113	0.0031	0.0014	0.1354
a5 (glass wall)	0.0597	0.0205	0.0016	0.0046	0.0019	0.0070	0.0374	0.1682	0.0080	0.0040	0.3129
QS	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Initial	LCC	Weight
	0.143	0.022	0.034	0.025	0.130	0.176	0.099	0.038	0.250	0.083	
a1 (RC brick)	0.0083	0.0023	0.0140	0.0109	0.0304	0.0726	0.0251	0.0077	0.1385	0.0131	0.3229
a2 (precast)	0.0099	0.0029	0.0106	0.0072	0.0602	0.0547	0.0059	0.0054	0.0129	0.0405	0.2100
a3 (metal frame)	0.0189	0.0054	0.0045	0.0035	0.0212	0.0288	0.0078	0.0028	0.0654	0.0189	0.1772
a4 (timber)	0.0361	0.0008	0.0036	0.0014	0.0118	0.0052	0.0397	0.0014	0.0094	0.0028	0.1122
a5 (glass wall)	0.0695	0.0105	0.0014	0.0020	0.0062	0.0150	0.0202	0.0210	0.0239	0.0080	0.1777
Engineer	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Initial	LCC	Weigh
	0.070	0.185	0.122	0.043	0.065	0.126	0.027	0.029	0.067	0.267	
a1 (RC brick)	0.0040	0.0191	0.0504	0.0187	0.0152	0.0519	0.0068	0.0059	0.0369	0.0420	0.2509
a2 (precast)	0.0048	0.0243	0.0381	0.0123	0.0300	0.0391	0.0016	0.0041	0.0034	0.1296	0.2874
a3 (metal frame)	0.0092	0.0460	0.0162	0.0060	0.0106	0.0206	0.0021	0.0022	0.0174	0.0605	0.1908
a4 (timber)	0.0176	0.0068	0.0128	0.0024	0.0059	0.0037	0.0107	0.0011	0.0025	0.0091	0.0726
a5 (glass wall)	0.0339	0.0888	0.0049	0.0034	0.0031	0.0107	0.0054	0.0160	0.0064	0.0256	0.1983
Aggregation	structural stability	rain and water	thermal	accoustic	prtect asset	fire safety	satisfy	image	Initial	LCC	Weight
	0.079	0.078	0.053	0.034	0.087	0.141	0.095	0.101	0.218	0.116	
a1 (RC brick)	0.0046	0.0080	0.0216	0.0150	0.0203	0.0579	0.0242	0.0204	0.1205	0.0182	0.3107
a2 (precast)	0.0055	0.0102	0.0164	0.0099	0.0402	0.0436	0.0056	0.0142	0.0112	0.0563	0.2130
a3 (metal frame)	0.0104	0.0193	0.0070	0.0048	0.0142	0.0230	0.0075	0.0075	0.0569	0.0263	0.1767
a4 (timber)	0.0200	0.0029	0.0055	0.0019	0.0079	0.0042	0.0381	0.0037	0.0081	0.0039	0.0963
a5 (glass wall)	0.0384	0.0372	0.0021	0.0028	0.0042	0.0119	0.0194	0.0553	0.0208	0.0111	0.2033

4 Highway Guardrail Selection

4.1 Weighting Factor of Each Criteria for Each Stakeholder

Stakeholder 1: Estate Manager

A. Pair wise Comparison

	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC
Protect traffic	1	2	2	1	0.2	5	3	0.2
Prevent crossover	0.5	1	2	2	0.2	5	3	0.2
Deflect vehicle	0.5	0.5	1	2	0.2	3	3	0.2
Protect property	1	0.5	0.5	1	0.2	3	3	0.333333333
Reduce maintenance	5	5	5	5	1	9	7	2
Enhance appearance	0.2	0.2	0.333333333	0.333333333	0.111111111	1		0.142857143
Initial cost	0.333333333	0.333333333	0.333333333	0.333333333	0.142857143		1	0.2
LCC	5	5	5	3	0.5	7	5	1
Σ	13.53333333	14.53333333	16.16666667	14.66666667	2.553968254	33	25	4.276190476

B. Normalization and Analysis

	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Σ	weight
Protect traffic	0.0739	0.1376	0.1237	0.0682	0.0783	0.1515	0.1200	0.0468	0.8000	0.0739
Prevent crossover	0.0369	0.0688	0.1237	0.1364	0.0783	0.1515	0.1200	0.0468	0.7624	0.0369
Deflect vehicle	0.0369	0.0344	0.0619	0.1364	0.0783	0.0909	0.1200	0.0468	0.6056	0.0369
Protect property	0.0739	0.0344	0.0309	0.0682	0.0783	0.0909	0.1200	0.0780	0.5746	0.0739
Reduce maintenance	0.3695	0.3440	0.3093	0.3409	0.3915	0.2727	0.2800	0.4677	2.7757	0.3695
Enhance appearance	0.0148	0.0138	0.0206	0.0227	0.0435	0.0303	0.0000	0.0334	0.1791	0.0148
Initial cost	0.0246	0.0229	0.0206	0.0227	0.0559	0.0000	0.0400	0.0468	0.2336	0.0246
LCC	0.3695	0.3440	0.3093	0.2045	0.1958	0.2121	0.2000	0.2339	2.0691	0.3695

C. Consistency Ratio

Criteria	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Σ	
Protect traffic	0.1000	0.1906	0.1514	0.0718	0.0694	0.1119	0.0876	0.0517	0.8345	8.3449
Prevent crossover	0.0500	0.0953	0.1514	0.1436	0.0694	0.1119	0.0876	0.0517	0.7610	7.9851
Deflect vehicle	0.0500	0.0477	0.0757	0.1436	0.0694	0.0672	0.0876	0.0517	0.5929	7.8325
Protect property	0.1000	0.0477	0.0378	0.0718	0.0694	0.0672	0.0876	0.0862	0.5677	7.9042
Reduce maintenance	0.5000	0.4765	0.3785	0.3591	0.3470	0.2015	0.2044	0.5173	2.9842	8.6011
Enhance appearance	0.0200	0.0191	0.0252	0.0239	0.0386	0.0224	0.0000	0.0369	0.1861	8.3134
Initial cost	0.0333	0.0318	0.0252	0.0239	0.0496	0.0000	0.0292	0.0517	0.2448	8.3818
LCC	0.5000	0.4765	0.3785	0.2155	0.1735	0.1567	0.1460	0.2586	2.3053	8.9133
									Σ	66.27626
									λ max	8.284533
									CI	0.040648
									CR	0.028828

Stakeholder 2: Project Manager

A. Pair wise Comparison

	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC
Protect traffic	1	3	3	5	5	0.333333333	0.1111111	2
Prevent crossover	0.333333333	1	3	4	3	0.333333333	0.2	0.333333333
Deflect vehicle	0.333333333	0.333333333	1	3	2	0.2	0.2	0.333333333
Protect property	0.2	0.25	0.333333333	1	0.5	0.2	0.1428571	0.2
Reduce maintenance	0.2	0.333333333	0.5	2	1	0.2	0.2	0.2
Enhance appearance	3	3	5	5	5	1	0.3333333	2
Initial cost	9	5	5	7	5	3	1	3
LCC	0.5	3	3	5	5	0.5	0.3333333	1
Σ	14.56666667	15.91666667	20.83333333	32	26.5	5.766666667	2.5206349	9.066666667

B. Normalization and Analysis

	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Σ	weight
Protect traffic	0.0686	0.1885	0.1440	0.1563	0.1887	0.0578	0.0441	0.2206	1.0685	0.1336
Prevent crossover	0.0229	0.0628	0.1440	0.1250	0.1132	0.0578	0.0793	0.0368	0.6418	0.0802
Deflect vehicle	0.0229	0.0209	0.0480	0.0938	0.0755	0.0347	0.0793	0.0368	0.4118	0.0515
Protect property	0.0137	0.0157	0.0160	0.0313	0.0189	0.0347	0.0567	0.0221	0.2090	0.0261
Reduce maintenance	0.0137	0.0209	0.0240	0.0625	0.0377	0.0347	0.0793	0.0221	0.2950	0.0369
Enhance appearance	0.2059	0.1885	0.2400	0.1563	0.1887	0.1734	0.1322	0.2206	1.5056	0.1882
Initial cost	0.6178	0.3141	0.2400	0.2188	0.1887	0.5202	0.3967	0.3309	2.8273	0.3534
LCC	0.0343	0.1885	0.1440	0.1563	0.1887	0.0867	0.1322	0.1103	1.0410	0.1301

C. Consistency Ratio

Criteria	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Σ	
Protect traffic	0.1336	0.2407	0.1544	0.1306	0.1844	0.0627	0.0393	0.2602	1.2059	9.0286
Prevent crossover	0.0445	0.0802	0.1544	0.1045	0.1106	0.0627	0.0707	0.0434	0.6711	8.3647
Deflect vehicle	0.0445	0.0267	0.0515	0.0784	0.0737	0.0376	0.0707	0.0434	0.4266	8.2858
Protect property	0.0267	0.0201	0.0172	0.0261	0.0184	0.0376	0.0505	0.0260	0.2226	8.5233
Reduce maintenance	0.0267	0.0267	0.0257	0.0522	0.0369	0.0376	0.0707	0.0260	0.3027	8.2079
Enhance appearance	0.4007	0.2407	0.2574	0.1306	0.1844	0.1882	0.1178	0.2602	1.7800	9.4581
Initial cost	1.2021	0.4011	0.2574	0.1828	0.1844	0.5646	0.3534	0.3904	3.5362	10.0061
LCC	0.0668	0.2407	0.1544	0.1306	0.1844	0.0941	0.1178	0.1301	1.1189	8.5989

Σ	70.47338
λ max	8.809172
CI	0.115596
CR	0.081983

Stakeholder 3: QS

A. Pair wise Comparison

	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC
Protect traffic	1	3	3	3	3	3	0.3333333	0.25
Prevent crossover	0.333333333	1	2	0.333333333	2	0.5	0.2	0.142857143
Deflect vehicle	0.333333333	0.5	1	0.333333333	2	0.333333333	0.3333333	0.2
Protect property	0.333333333	3	3	1	0.5	0.333333333	0.3333333	0.2
Reduce maintenance	0.333333333	0.5	0.5	2	1	0.333333333	0.2	0.2
Enhance appearance	0.333333333	2	3	3	3	1	0.3333333	0.2
Initial cost	3	5	3	3	5	3	1	0.333333333
LCC	4	7	5	5	7	5	3	1
Σ	9.666666667	22	20.5	17.66666667	23.5	13.5	5.7333333	2.526190476

B. Normalization and Analysis

	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Σ	weight
Protect traffic	0.1034	0.1364	0.1463	0.1698	0.1277	0.2222	0.0581	0.0990	1.0629	0.1329
Prevent crossover	0.0345	0.0455	0.0976	0.0189	0.0851	0.0370	0.0349	0.0566	0.4099	0.0512
Deflect vehicle	0.0345	0.0227	0.0488	0.0189	0.0851	0.0247	0.0581	0.0792	0.3720	0.0465
Protect property	0.0345	0.1364	0.1463	0.0566	0.0213	0.0247	0.0581	0.0792	0.5571	0.0696
Reduce maintenance	0.0345	0.0227	0.0244	0.1132	0.0426	0.0247	0.0349	0.0792	0.3761	0.0470
Enhance appearance	0.0345	0.0909	0.1463	0.1698	0.1277	0.0741	0.0581	0.0792	0.7806	0.0976
Initial cost	0.3103	0.2273	0.1463	0.1698	0.2128	0.2222	0.1744	0.1320	1.5951	0.1994
LCC	0.4138	0.3182	0.2439	0.2830	0.2979	0.3704	0.5233	0.3959	2.8462	0.3558

C. Consistency Ratio

Criteria	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Σ	
Protect traffic	0.1329	0.1537	0.1395	0.2089	0.1410	0.2927	0.0665	0.0889	1.2242	9.2133
Prevent crossover	0.0443	0.0512	0.0930	0.0232	0.0940	0.0488	0.0399	0.0508	0.4453	8.6891
Deflect vehicle	0.0443	0.0256	0.0465	0.0232	0.0940	0.0325	0.0665	0.0712	0.4038	8.6844
Protect property	0.0443	0.1537	0.1395	0.0696	0.0235	0.0325	0.0665	0.0712	0.6008	8.6279
Reduce maintenance	0.0443	0.0256	0.0232	0.1393	0.0470	0.0325	0.0399	0.0712	0.4230	8.9974
Enhance appearance	0.0443	0.1025	0.1395	0.2089	0.1410	0.0976	0.0665	0.0712	0.8714	8.9307
Initial cost	0.3986	0.2562	0.1395	0.2089	0.2351	0.2927	0.1994	0.1186	1.8490	9.2731
LCC	0.5315	0.3587	0.2325	0.3482	0.3291	0.4879	0.5982	0.3558	3.2417	9.1116
									Σ	71.52747
									λ max	8.940933
									CI	0.134419
									CR	0.095333

Stakeholder 4: Design in house

A. Pair wise Comparison

	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC
Protect traffic	1	5	5	5	2	0.2	2	5
Prevent crossover	0.2	1	0.5	0.5	0.2	0.142857143	0.25	0.5
Deflect vehicle	0.2	2	1	3	0.2	0.2	0.2	0.5
Protect property	0.2	2	0.333333333	1	0.2	0.2	0.2	0.333333333
Reduce maintenance	0.5	5	5	5	1	0.5	3	5
Enhance appearance	5	7	5	5	2	1	5	6
Initial cost	0.5	4	5	5	0.333333333	0.2	1	5
LCC	0.2	2	2	3	0.2	0.166666667	0.2	1
Σ	7.8	28	23.83333333	27.5	6.133333333	2.60952381	11.85	23.33333333

B. Normalization and Analysis

	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Σ	weight
Protect traffic	0.1282	0.1786	0.2098	0.1818	0.3261	0.0766	0.1688	0.2143	1.4842	0.1855
Prevent crossover	0.0256	0.0357	0.0210	0.0182	0.0326	0.0547	0.0211	0.0214	0.2304	0.0288
Deflect vehicle	0.0256	0.0714	0.0420	0.1091	0.0326	0.0766	0.0169	0.0214	0.3957	0.0495
Protect property	0.0256	0.0714	0.0140	0.0364	0.0326	0.0766	0.0169	0.0143	0.2878	0.0360
Reduce maintenance	0.0641	0.1786	0.2098	0.1818	0.1630	0.1916	0.2532	0.2143	1.4564	0.1820
Enhance appearance	0.6410	0.2500	0.2098	0.1818	0.3261	0.3832	0.4219	0.2571	2.6710	0.3339
Initial cost	0.0641	0.1429	0.2098	0.1818	0.0543	0.0766	0.0844	0.2143	1.0282	0.1285
LCC	0.0256	0.0714	0.0839	0.1091	0.0326	0.0639	0.0169	0.0429	0.4463	0.0558

C. Consistency Ratio

Criteria	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Σ	
Protect traffic	0.1855	0.1440	0.2473	0.1799	0.3641	0.0668	0.2571	0.2789	1.7236	9.2904
Prevent crossover	0.0371	0.0288	0.0247	0.0180	0.0364	0.0477	0.0321	0.0279	0.2528	8.7764
Deflect vehicle	0.0371	0.0576	0.0495	0.1079	0.0364	0.0668	0.0257	0.0279	0.4089	8.2671
Protect property	0.0371	0.0576	0.0165	0.0360	0.0364	0.0668	0.0257	0.0186	0.2947	8.1896
Reduce maintenance	0.0928	0.1440	0.2473	0.1799	0.1820	0.1669	0.3856	0.2789	1.6775	9.2144
Enhance appearance	0.9276	0.2016	0.2473	0.1799	0.3641	0.3339	0.6426	0.3347	3.2317	9.6794
Initial cost	0.0928	0.1152	0.2473	0.1799	0.0607	0.0668	0.1285	0.2789	1.1701	9.1035
LCC	0.0371	0.0576	0.0989	0.1079	0.0364	0.0556	0.0257	0.0558	0.4751	8.5166
									Σ	71.03734
									λ max	8.879668
									CI	0.125667
									CR	0.089125

Stakeholder 5: Engineer

A. Pair wise Comparison

	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC
Protect traffic	1	0.33	0.5	2	1	0.5	3	3
Prevent crossover	3	1	2	3	3	2	5	5
Deflect vehicle	2	0.5	1	3	3	1	3	3
Protect property	0.5	0.333333333	0.333333333	1	0.5	0.333333333	2	2
Reduce maintenance	1	0.333333333	0.333333333	2	1	0.333333333	3	3
Enhance appearance	2	0.5	1	3	3	1	3	5
Initial cost	0.333333333	0.2	0.333333333	0.5	0.333333333	0.333333333	1	0.5
LCC	0.333333333	0.2	0.333333333	0.5	0.333333333	0.2	2	1
Σ	10.16666667	3.4	5.833333333	15	12.16666667	5.7	22	22.5

B. Normalization and Analysis

	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Σ	weight
Protect traffic	0.0984	0.0980	0.0857	0.1333	0.0822	0.0877	0.1364	0.1333	0.8551	0.1069
Prevent crossover	0.2951	0.2941	0.3429	0.2000	0.2466	0.3509	0.2273	0.2222	2.1790	0.2724
Deflect vehicle	0.1967	0.1471	0.1714	0.2000	0.2466	0.1754	0.1364	0.1333	1.4069	0.1759
Protect property	0.0492	0.0980	0.0571	0.0667	0.0411	0.0585	0.0909	0.0889	0.5504	0.0688
Reduce maintenance	0.0984	0.0980	0.0571	0.1333	0.0822	0.0585	0.1364	0.1333	0.7972	0.0997
Enhance appearance	0.1967	0.1471	0.1714	0.2000	0.2466	0.1754	0.1364	0.2222	1.4958	0.1870
Initial cost	0.0328	0.0588	0.0571	0.0333	0.0274	0.0585	0.0455	0.0222	0.3356	0.0420
LCC	0.0328	0.0588	0.0571	0.0333	0.0274	0.0351	0.0909	0.0444	0.3799	0.0475

C. Consistency Ratio

Criteria	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Σ	
Protect traffic	0.1069	0.0908	0.0879	0.1376	0.0997	0.0935	0.1259	0.1425	0.8847	8.2772
Prevent crossover	0.3206	0.2724	0.3517	0.2064	0.2990	0.3740	0.2098	0.2375	2.2713	8.3389
Deflect vehicle	0.2138	0.1362	0.1759	0.2064	0.2990	0.1870	0.1259	0.1425	1.4865	8.4525
Protect property	0.0534	0.0908	0.0586	0.0688	0.0498	0.0623	0.0839	0.0950	0.5627	8.1787
Reduce maintenance	0.1069	0.0908	0.0586	0.1376	0.0997	0.0623	0.1259	0.1425	0.8242	8.2706
Enhance appearance	0.2138	0.1362	0.1759	0.2064	0.2990	0.1870	0.1259	0.2375	1.5815	8.4582
Initial cost	0.0356	0.0545	0.0586	0.0344	0.0332	0.0623	0.0420	0.0237	0.3444	8.2080
LCC	0.0356	0.0545	0.0586	0.0344	0.0332	0.0374	0.0839	0.0475	0.3851	8.1098
									Σ	66.29395
									λ max	8.286744
							CR	0.029052	CI	0.040963

4.2 Weighting Factor of Each Technical Solution for Each Criteria

Criteria: Protect traffic

A. Pairwise Comparison

resist shift super structure	a1	a2	a3
a1 (Metal plate)	1	0.5	2
a2 (Concrete wall)	2	1	5
a3 (Wooden-faced)	0.5	0.2	1
Σ	3.5	1.7	8

B. Normalization and Analysis

a1	a2	a3	Σ	weight
0.285714	0.294118	0.25	0.829832	0.276611
0.571429	0.588235	0.625	1.784664	0.594888
0.142857	0.117647	0.125	0.385504	0.128501

C. Concistency Ratio

resist shift super structure	a1	a2	a3	Σ	
a1 (Metal plate)	0.276611	0.297444	0.257003	0.831057	3.00443
a2 (Concrete wall)	0.553221	0.594888	0.642507	1.790616	3.010006
a3 (Wooden-faced)	0.138305	0.118978	0.128501	0.385784	3.00218
				Σ	9.016616
				λ max	3.005539
		CR	0.002473	CI	0.002769

Criteria: Prevent crossover

A. Pairwise Comparison

resist shift super structure	a1	a2	a3
a1 (Metal plate)	1	3	5
a2 (Concrete wall)	0.333333	1	3
a3 (Wooden-faced)	0.2	0.333333	1
Σ	1.533333	4.333333	9

B. Normalization and Analysis

a1	a2	a3	Σ	weight
0.652174	0.692308	0.555556	1.900037	0.633346
0.217391	0.230769	0.333333	0.781494	0.260498
0.130435	0.076923	0.111111	0.318469	0.106156

C. Concistency Ratio

resist shift super structure	a1	a2	a3	Σ	
a1 (Metal plate)	0.633346	0.781494	0.530782	1.945621	3.071973
a2 (Concrete wall)	0.211115	0.260498	0.318469	0.790082	3.032969
a3 (Wooden-faced)	0.126669	0.086833	0.106156	0.319658	3.011202
				Σ	9.116144
				λ max	3.038715
				CI	0.019357
				CR	0.017283

Criteria: Deflect vehicle

A. Pairwise Comparison

resist shift super structure	a1	a2	a3
a1 (Metal plate)	1	2	0.5
a2 (Concrete wall)	0.5	1	0.333333
a3 (Wooden-faced)	2	3	1
Σ	3.5	6	1.833333

B. Normalization and Analysis

a1	a2	a3	Σ	weight
0.285714	0.333333	0.272727	0.891775	0.297258
0.142857	0.166667	0.181818	0.491342	0.163781
0.571429	0.5	0.545455	1.616883	0.538961

C. Concistency Ratio

resist shift super structure	a1	a2	a3	Σ	
a1 (Metal plate)	0.297258	0.327561	0.269481	0.8943	3.008495
a2 (Concrete wall)	0.148629	0.163781	0.179654	0.492063	3.004405
a3 (Wooden-faced)	0.594517	0.491342	0.538961	1.62482	3.014726
				Σ	9.027626
				λ max	3.009209
				CI	0.004604
				CR	0.004111

Criteria: Protect property

A. Pairwise Comparison

resist shift super structure	a1	a2	a3
a1 (Metal plate)	1	0.5	0.2
a2 (Concrete wall)	2	1	0.333333
a3 (Wooden-faced)	5	3	1
Σ	8	4.5	1.533333

B. Normalization and Analysis

a1	a2	a3	Σ	weight
0.125	0.111111	0.130435	0.366546	0.122182
0.25	0.222222	0.217391	0.689614	0.229871
0.625	0.666667	0.652174	1.943841	0.647947

C. Concistency Ratio

resist shift super structure	a1	a2	a3	Σ	
a1 (Metal plate)	0.122182	0.114936	0.129589	0.366707	3.001318
a2 (Concrete wall)	0.244364	0.229871	0.215982	0.690217	3.002627
a3 (Wooden-faced)	0.61091	0.689614	0.647947	1.94847	3.007145
				Σ	9.01109
				λ max	3.003697
				CI	0.001848
				CR	0.00165

Criteria: Reduce maintenance

A. Pairwise Comparison

resist shift super structure	a1	a2	a3
a1 (Metal plate)	1	3	5
a2 (Concrete wall)	0.333333	1	3
a3 (Wooden-faced)	0.2	0.333333	1
Σ	1.533333	4.333333	9

B. Normalization and Analysis

a1	a2	a3	Σ	weight
0.652174	0.692308	0.555556	1.900037	0.633346
0.217391	0.230769	0.333333	0.781494	0.260498
0.130435	0.076923	0.111111	0.318469	0.106156

C. Concistency Ratio

resist shift super structure	a1	a2	a3	Σ	
a1 (Metal plate)	0.633346	0.781494	0.530782	1.945621	3.071973
a2 (Concrete wall)	0.211115	0.260498	0.318469	0.790082	3.032969
a3 (Wooden-faced)	0.126669	0.086833	0.106156	0.319658	3.011202
				Σ	9.116144
				λ max	3.038715
				CI	0.019357
				CR	0.017283

Criteria: Enhance appearance

A. Pairwise Comparison

resist shift super structure	a1	a2	a3
a1 (Metal plate)	1	0.5	0.2
a2 (Concrete wall)	2	1	0.333333
a3 (Wooden-faced)	5	3	1
Σ	8	4.5	1.533333

B. Normalization and Analysis

a1	a2	a3	Σ	weight
0.125	0.111111	0.130435	0.366546	0.122182
0.25	0.222222	0.217391	0.689614	0.229871
0.625	0.666667	0.652174	1.943841	0.647947

C. Concistency Ratio					
resist shift super structure	a1	a2	a3	Σ	
a1 (Metal plate)	0.122182	0.114936	0.129589	0.366707	3.001318
a2 (Concrete wall)	0.244364	0.229871	0.215982	0.690217	3.002627
a3 (Wooden-faced)	0.61091	0.689614	0.647947	1.94847	3.007145
				Σ	9.01109
				λ max	3.003697
				CI	0.001848
				CR	0.00165

Criteria: Initial cost

A. Pairwise Comparison			
resist shift super structure	a1	a2	a3
a1 (Metal plate)	1	0.333333	2
a2 (Concrete wall)	3	1	5
a3 (Wooden-faced)	0.5	0.2	1
Σ	4.5	1.533333	8

B. Normalization and Analysis				
a1	a2	a3	Σ	weight
0.222222	0.217391	0.25	0.689614	0.229871
0.666667	0.652174	0.625	1.943841	0.647947
0.111111	0.130435	0.125	0.366546	0.122182

C. Concistency Ratio					
resist shift super structure	a1	a2	a3	Σ	
a1 (Metal plate)	0.229871	0.215982	0.244364	0.690217	3.002627
a2 (Concrete wall)	0.689614	0.647947	0.61091	1.94847	3.007145
a3 (Wooden-faced)	0.114936	0.129589	0.122182	0.366707	3.001318
				Σ	9.01109
				λ max	3.003697
				CI	0.001848
				CR	0.00165

Criteria: LCC

A. Pairwise Comparison

resist shift super structure	a1	a2	a3
a1 (Metal plate)	1	2	5
a2 (Concrete wall)	0.5	1	3
a3 (Wooden-faced)	0.2	0.333333	1
Σ	1.7	3.333333	9

B. Normalization and Analysis

a1	a2	a3	Σ	weight
0.588235	0.6	0.555556	1.743791	0.581264
0.294118	0.3	0.333333	0.927451	0.30915
0.117647	0.1	0.111111	0.328758	0.109586

C. Concistency Ratio

resist shift super structure	a1	a2	a3	Σ	
a1 (Metal plate)	0.581264	0.618301	0.54793	1.747495	3.006372
a2 (Concrete wall)	0.290632	0.30915	0.328758	0.92854	3.003524
a3 (Wooden-faced)	0.116253	0.10305	0.109586	0.328889	3.001193
				Σ	9.011088
				λ max	3.003696
				CI	0.001848
				CR	0.00165

4.3 Synthesis (Weighting Factor of Each Technical Solution for Each Stakeholder)

	Estate Management									
	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Weight	Ranking
	0.100	0.095	0.076	0.072	0.347	0.022	0.029	0.259		
a1 (Metal plate)	0.028	0.060	0.023	0.009	0.220	0.003	0.007	0.150	0.4988	1st
a2 (Concrete wall)	0.059	0.025	0.012	0.017	0.090	0.005	0.019	0.080	0.3076	2nd
a3 (Wooden-faced)	0.013	0.010	0.041	0.047	0.037	0.015	0.004	0.028	0.1935	3rd

Project Management										
	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Weight	Ranking
	0.134	0.080	0.051	0.026	0.037	0.188	0.353	0.130		
a1 (Metal plate)	0.037	0.051	0.015	0.003	0.023	0.023	0.081	0.076	0.3095	2nd
a2 (Concrete wall)	0.079	0.021	0.008	0.006	0.010	0.043	0.229	0.040	0.4369	1st
a3 (Wooden-faced)	0.017	0.009	0.028	0.017	0.004	0.122	0.043	0.014	0.2536	3rd
QS										
	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Weight	Ranking
	0.133	0.051	0.046	0.070	0.047	0.098	0.199	0.356		
a1 (Metal plate)	0.037	0.032	0.014	0.009	0.030	0.012	0.046	0.207	0.3859	2nd
a2 (Concrete wall)	0.079	0.013	0.008	0.016	0.012	0.022	0.129	0.110	0.3899	1st
a3 (Wooden-faced)	0.017	0.005	0.025	0.045	0.005	0.063	0.024	0.039	0.2243	3rd
Design in house										
	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Weight	Ranking
	0.186	0.029	0.049	0.036	0.182	0.334	0.129	0.056		
a1 (Metal plate)	0.051	0.018	0.015	0.004	0.115	0.041	0.030	0.032	0.3067	3rd
a2 (Concrete wall)	0.110	0.008	0.008	0.008	0.047	0.077	0.083	0.017	0.3589	1st
a3 (Wooden-faced)	0.024	0.003	0.027	0.023	0.019	0.216	0.016	0.006	0.3343	2nd
Engineer										
	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Weight	Ranking
	0.107	0.272	0.176	0.069	0.100	0.187	0.042	0.047		
a1 (Metal plate)	0.030	0.173	0.052	0.008	0.063	0.023	0.010	0.028	0.3860	1st
a2 (Concrete wall)	0.064	0.071	0.029	0.016	0.026	0.043	0.027	0.015	0.2900	2nd
a3 (Wooden-faced)	0.014	0.029	0.095	0.045	0.011	0.121	0.005	0.005	0.3241	3rd
Aggregation										
	Protect traffic	Prevent crossover	Deflect vehicle	Protect property	Reduce maintenance	Enhance appearance	Initial cost	LCC	Weight	Ranking
	0.107	0.272	0.176	0.069	0.100	0.187	0.042	0.047		
a1 (Metal plate)	0.036	0.067	0.024	0.007	0.090	0.020	0.035	0.099	0.3774	1st
a2 (Concrete wall)	0.078	0.028	0.013	0.013	0.037	0.038	0.098	0.052	0.3567	2nd
a3 (Wooden-faced)	0.017	0.011	0.043	0.035	0.015	0.107	0.018	0.019	0.2660	3rd

5 Support Bridge Selection

5.1 Weighting Factor of Each Criteria for Each Stakeholder

Stakeholder 1: Estate Manager

A. Pair wise Comparison

	Received load	Resist shift	Receive force earth	Allow mini distortion	Resist strike water	Resist erosion water	Fix element furnish	Beautify appearance
Received load	1	3	3	0.5	0.5	0.25	0.333333	0.5
Resist shift	0.333333	1	0.333333	0.5	0.333333	0.5	0.5	0.5
Receive force earth	0.333333	3	1	0.333333	0.25	0.5	0.5	0.5
Allow mini distortion	2	2	3	1	0.5	3	3	2
Resist strike water	2	3	4	2	1	3	3	3
Resist erosion water	4	2	2	0.333333	0.333333	1	0.5	0.5
Fix element furnish	3	2	2	0.333333	0.333333	2	1	0.5
Beautify appearance	2	2	2	0.5	0.333333	2	2	1
Σ	14.66667	18	17.33333	5.5	3.583333	12.25	10.83333	8.5

B. Normalization and Analysis

	Received load	Resist shift	Receive force earth	Allow mini distortion	Resist strike water	Resist erosion water	Fix element furnish	Beautify appearance	Σ	weight
Received load	0.0682	0.1667	0.1731	0.0909	0.1395	0.0204	0.0308	0.0588	0.7484	0.0935
Resist shift	0.0227	0.0556	0.0192	0.0909	0.0930	0.0408	0.0462	0.0588	0.4272	0.0534
Receive force earth	0.0227	0.1667	0.0577	0.0606	0.0698	0.0408	0.0462	0.0588	0.5233	0.0654
Allow mini distortion	0.1364	0.1111	0.1731	0.1818	0.1395	0.2449	0.2769	0.2353	1.4990	0.1874
Resist strike water	0.1364	0.1667	0.2308	0.3636	0.2791	0.2449	0.2769	0.3529	2.0513	0.2564
Resist erosion water	0.2727	0.1111	0.1154	0.0606	0.0930	0.0816	0.0462	0.0588	0.8395	0.1049
Fix element furnish	0.2045	0.1111	0.1154	0.0606	0.0930	0.1633	0.0923	0.0588	0.8991	0.1124
Beautify appearance	0.1364	0.1111	0.1154	0.0909	0.0930	0.1633	0.1846	0.1176	1.0123	0.1265

C. Consistency Ratio

Consistency	Received load	Resist shift	Receive force earth	Allow mini distortion	Resist strike water	Resist erosion water	Fix element furnish	Beautify appearance	Σ	
Received load	0.0935	0.1602	0.1962	0.0937	0.1282	0.0262	0.0375	0.0633	0.7988	8.5395
Resist shift	0.0312	0.0534	0.0218	0.0937	0.0855	0.0525	0.0562	0.0633	0.4575	8.5662
Receive force earth	0.0312	0.1602	0.0654	0.0625	0.0641	0.0525	0.0562	0.0633	0.5553	8.4899
Allow mini distortion	0.1871	0.1068	0.1962	0.1874	0.1282	0.3148	0.3372	0.2531	1.7107	9.1299
Resist strike water	0.1871	0.1602	0.2616	0.3748	0.2564	0.3148	0.3372	0.3796	2.2717	8.8596
Resist erosion water	0.3742	0.1068	0.1308	0.0625	0.0855	0.1049	0.0562	0.0633	0.9841	9.3787
Fix element furnish	0.2806	0.1068	0.1308	0.0625	0.0855	0.2099	0.1124	0.0633	1.0517	9.3582
Beautify appearance	0.1871	0.1068	0.1308	0.0937	0.0855	0.2099	0.2248	0.1265	1.1650	9.2069
									Σ	71.52881
									λ max	8.941101
									CI	0.134443
									CR	0.09535

Stakeholder 2: Project Manager

A. Pair wise Comparison

	Received load	Resist shift	Receive force earth	Allow mini distortion	Resist strike water	Resist erosion water	Fix element furnish	Beautify appearance
Received load	1	2	2	0.5	2	0.333333	0.333333	0.5
Resist shift	0.5	1	0.333333	0.5	3	0.5	0.5	0.5
Receive force earth	0.5	3	1	0.333333	0.5	0.5	0.333333	0.5
Allow mini distortion	2	2	3	1	2	0.333333	0.25	0.5
Resist strike water	0.5	0.333333	2	0.5	1	0.333333	0.333333	0.5
Resist erosion water	3	2	2	3	3	1	0.5	0.5
Fix element furnish	3	2	3	4	3	2	1	2
Beautify appearance	2	2	2	2	2	2	0.5	1
Σ	12.5	14.33333	15.33333	11.83333	16.5	7	3.75	6

B. Normalization and Analysis

	Received load	Resist shift	Receive force earth	Allow mini distortion	Resist strike water	Resist erosion water	Fix element furnish	Beautify appearance	Σ	weight
Received load	0.0800	0.1395	0.1304	0.0423	0.1212	0.0476	0.0889	0.0833	0.7333	0.0917
Resist shift	0.0400	0.0698	0.0217	0.0423	0.1818	0.0714	0.1333	0.0833	0.6437	0.0805
Receive force earth	0.0400	0.2093	0.0652	0.0282	0.0303	0.0714	0.0889	0.0833	0.6166	0.0771
Allow mini distortion	0.1600	0.1395	0.1957	0.0845	0.1212	0.0476	0.0667	0.0833	0.8985	0.1123
Resist strike water	0.0400	0.0233	0.1304	0.0423	0.0606	0.0476	0.0889	0.0833	0.5164	0.0645
Resist erosion water	0.2400	0.1395	0.1304	0.2535	0.1818	0.1429	0.1333	0.0833	1.3048	0.1631
Fix element furnish	0.2400	0.1395	0.1957	0.3380	0.1818	0.2857	0.2667	0.3333	1.9807	0.2476
Beautify appearance	0.1600	0.1395	0.1304	0.1690	0.1212	0.2857	0.1333	0.1667	1.3059	0.1632

C. Consistency Ratio

Consistency	Received load	Resist shift	Receive force earth	Allow mini distortion	Resist strike water	Resist erosion water	Fix element furnish	Beautify appearance		
Received load	0.0917	0.1609	0.1542	0.0562	0.1291	0.0544	0.0825	0.0816	0.8105	8.8426
Resist shift	0.0458	0.0805	0.0257	0.0562	0.1936	0.0816	0.1238	0.0816	0.6888	8.5603
Receive force earth	0.0458	0.2414	0.0771	0.0374	0.0323	0.0816	0.0825	0.0816	0.6797	8.8181
Allow mini distortion	0.1833	0.1609	0.2312	0.1123	0.1291	0.0544	0.0619	0.0816	1.0148	9.0351
Resist strike water	0.0458	0.0268	0.1542	0.0562	0.0645	0.0544	0.0825	0.0816	0.5660	8.7691
Resist erosion water	0.2750	0.1609	0.1542	0.3369	0.1936	0.1631	0.1238	0.0816	1.4892	9.1302
Fix element furnish	0.2750	0.1609	0.2312	0.4493	0.1936	0.3262	0.2476	0.3265	2.2103	8.9272
Beautify appearance	0.1833	0.1609	0.1542	0.2246	0.1291	0.3262	0.1238	0.1632	1.4654	8.9769
									Σ	71.0595
									λ max	8.882437
									CI	0.126062
									CR	0.089406

Stakeholder 3: Engineer

A. Pair wise Comparison

	Received load	Resist shift	Receive force earth	Allow mini distortion	Resist strike water	Resist erosion water	Fix element furnish	Beautify appearance
Received load	1	2	2	0.33333	2	0.333333	0.333333	0.25
Resist shift	0.5	1	0.333333	0.5	3	0.5	0.5	0.25
Receive force earth	0.5	3	1	0.333333	0.5	0.5	0.5	0.25
Allow mini distortion	3	2	3	1	2	0.333333	0.333333	0.25
Resist strike water	0.5	0.333333	2	0.5	1	0.333333	0.333333	0.2
Resist erosion water	3	2	2	3	3	1	0.5	0.25
Fix element furnish	3	2	2	3	3	2	1	0.25
Beautify appearance	4	4	4	4	5	4	4	1
Σ	15.5	16.33333	16.33333	12.66666	19.5	9	7.5	2.7

B. Normalization and Analysis

	Received load	Resist shift	Receive force earth	Allow mini distortion	Resist strike water	Resist erosion water	Fix element furnish	Beautify appearance	Σ	weight
Received load	0.0645	0.1224	0.1224	0.0263	0.1026	0.0370	0.0444	0.0926	0.6124	0.0765
Resist shift	0.0323	0.0612	0.0204	0.0395	0.1538	0.0556	0.0667	0.0926	0.5220	0.0653
Receive force earth	0.0323	0.1837	0.0612	0.0263	0.0256	0.0556	0.0667	0.0926	0.5439	0.0680
Allow mini distortion	0.1935	0.1224	0.1837	0.0789	0.1026	0.0370	0.0444	0.0926	0.8553	0.1069
Resist strike water	0.0323	0.0204	0.1224	0.0395	0.0513	0.0370	0.0444	0.0741	0.4214	0.0527
Resist erosion water	0.1935	0.1224	0.1224	0.2368	0.1538	0.1111	0.0667	0.0926	1.0995	0.1374
Fix element furnish	0.1935	0.1224	0.1224	0.2368	0.1538	0.2222	0.1333	0.0926	1.2773	0.1597
Beautify appearance	0.2581	0.2449	0.2449	0.3158	0.2564	0.4444	0.5333	0.3704	2.6682	0.3335

C. Consistency Ratio

Consistency	Received load	Resist shift	Receive force earth	Allow mini distortion	Resist strike water	Resist erosion water	Fix element furnish	Beautify appearance		
Received load	0.0765	0.1305	0.1360	0.0356	0.1054	0.0458	0.0532	0.0834	0.6664	8.7064
Resist shift	0.0383	0.0653	0.0227	0.0535	0.1580	0.0687	0.0798	0.0834	0.5696	8.7292
Receive force earth	0.0383	0.1958	0.0680	0.0356	0.0263	0.0687	0.0798	0.0834	0.5959	8.7648
Allow mini distortion	0.2296	0.1305	0.2040	0.1069	0.1054	0.0458	0.0532	0.0834	0.9588	8.9685
Resist strike water	0.0383	0.0218	0.1360	0.0535	0.0527	0.0458	0.0532	0.0667	0.4679	8.8818
Resist erosion water	0.2296	0.1305	0.1360	0.3207	0.1580	0.1374	0.0798	0.0834	1.2755	9.2808
Fix element furnish	0.2296	0.1305	0.1360	0.3207	0.1580	0.2749	0.1597	0.0834	1.4928	9.3499
Beautify appearance	0.3062	0.2610	0.2720	0.4276	0.2634	0.5498	0.6386	0.3335	3.0521	9.1510
									Σ	71.83233
									λ max	8.979042
									CI	0.139863
									CR	0.099194

5.2 Weighting Factor of Each Technical Solution for Each Criteria

Criteria: received load super structure

A. Pair wise Comparison

Received load	a1	a2	a3
Steel structure	1	2	6
Reinforced Concrete structure	0.5	1	4
Wooden structure	0.16666667	0.25	1
Σ	1.66666667	3.25	11

B. Normalization and Analysis

a1	a2	a3	Σ	weight
0.6	0.615385	0.545455	1.760839	0.586946
0.3	0.307692	0.363636	0.971329	0.323776
0.1	0.076923	0.090909	0.267832	0.089277
				1

C. Consistency Ratio					
Received load	a1	a2	a3	Σ	
Steel structure	0.58694639	0.647552	0.535664	1.770163	3.015886
Reinforced Concrete structure	0.29347319	0.323776	0.35711	0.974359	3.009359
Wooden structure	0.0978244	0.080944	0.089277	0.268046	3.002393
				Σ	9.027638
				λ max	3.009213
				CI	0.004606
				CR	0.007942

Criteria: resist shift super structure

A. Pair wise Comparison			
resist shift super structure	a1	a2	a3
Steel structure	1	4	3
Reinforced Concrete structure	0.25	1	0.5
Wooden structure	0.333333	2	1
Σ	1.583333	7	4.5

B. Normalization and Analysis				
a1	a2	a3	Σ	weight
0.631579	0.571429	0.666667	1.869674	0.623225
0.157895	0.142857	0.111111	0.411863	0.137288
0.210526	0.285714	0.222222	0.718463	0.239488
				1

C. Consistency Ratio					
resist shift super structure	a1	a2	a3	Σ	
Steel structure	0.623225	0.549151	0.718463	1.890838	3.033959
Reinforced Concrete structure	0.155806	0.137288	0.119744	0.412838	3.007099
Wooden structure	0.207742	0.274575	0.239488	0.721805	3.013953
				Σ	9.055012
				λ max	3.018337
				CI	0.009169
				CR	0.015808

Criteria: receive force earthquake

A. Pair wise Comparison			
Received force earthquake	a1	a2	a3
Steel structure	1	3	3
Reinforced Concrete structure	0.333333	1	0.5
Wooden structure	0.333333	2	1
Σ	1.666667	6	4.5

B. Normalization and Analysis				
a1	a2	a3	Σ	weight
0.6	0.5	0.666667	1.766667	0.588889
0.2	0.166667	0.111111	0.477778	0.159259
0.2	0.333333	0.222222	0.755556	0.251852
				1

C. Consistency Ratio					
Received force earthquake	a1	a2	a3	Σ	
Steel structure	0.588889	0.477778	0.755556	1.822222	3.09434
Reinforced Concrete structure	0.196296	0.159259	0.125926	0.481481	3.023256
Wooden structure	0.196296	0.318519	0.251852	0.766667	3.044118
				Σ	9.161713
				λ max	3.053904
				CI	0.026952
				CR	0.046469

Criteria: allow mini distortion

A. Pair wise Comparison			
Allow mini distortion	a1	a2	a3
Steel structure	1	2	2
Reinforced Concrete structure	0.5	1	2
Wooden structure	0.5	0.5	1
Σ	2	3.5	5

B. Normalization and Analysis				
a1	a2	a3	Σ	weight
0.5	0.571429	0.4	1.471429	0.490476
0.25	0.285714	0.4	0.935714	0.311905
0.25	0.142857	0.2	0.592857	0.197619
				1

C. Consistency Ratio					
Allow mini distortion	a1	a2	a3	Σ	
Steel structure	0.49047619	0.62381	0.395238	1.509524	3.07767
Reinforced Concrete structure	0.2452381	0.311905	0.395238	0.952381	3.053435
Wooden structure	0.2452381	0.155952	0.197619	0.59881	3.03012
				Σ	9.161225
				λ max	3.053742
				CI	0.026871
				CR	0.046329

Criteria: resist strike water

A. Pair wise Comparison			
Resist strike water	a1	a2	a3
Steel structure	1	6	2
Reinforced Concrete structure	0.166667	1	0.5
Wooden structure	0.5	2	1
	1.666667	9	3.5

B. Normalization and Analysis				
a1	a2	a3	Σ	weight
0.6	0.666667	0.571429	1.838095	0.612698
0.1	0.111111	0.142857	0.353968	0.117989
0.3	0.222222	0.285714	0.807937	0.269312

C. Consistency Ratio					
Resist strike water	a1	a2	a3	Σ	
Steel structure	0.612698	0.707937	0.538624	1.859259	3.034542
Reinforced Concrete structure	0.102116	0.117989	0.134656	0.354762	3.006726
Wooden structure	0.306349	0.235979	0.269312	0.81164	3.013752
				Σ	9.055021
				λ max	3.01834
				CI	0.00917
				CR	0.015811

Criteria: resist erosion water

A. Pair wise Comparison			
Resist erosion water	a1	a2	a3
Steel structure	1	4	2
Reinforced Concrete structure	0.25	1	0.333333
Wooden structure	0.5	3	1
Σ	1.75	8	3.333333

B. Normalization and Analysis				
a1	a2	a3	Σ	weight
0.571429	0.5	0.6	1.671429	0.557143
0.142857	0.125	0.1	0.367857	0.122619
0.285714	0.375	0.3	0.960714	0.320238
				1

C. Consistency Ratio					
Resist erosion water	a1	a2	a3	Σ	
Steel structure	0.557143	0.490476	0.640476	1.688095	3.029915
Reinforced Concrete structure	0.139286	0.122619	0.106746	0.368651	3.006472
Wooden structure	0.278571	0.367857	0.320238	0.966667	3.018587
				Σ	9.054974
				λ max	3.018325
				CI	0.009162
				CR	0.015797

Criteria: fix element furnish structure

A. Pair wise Comparison			
Fix element furnish furniture	a1	a2	a3
Steel structure	1	0.2	0.25
Reinforced Concrete structure	5	1	2
Wooden structure	4	0.5	1
Σ	10	1.7	3.25

B. Normalization and Analysis				
a1	a2	a3	Σ	weight
0.1	0.117647	0.076923	0.29457	0.09819
0.5	0.588235	0.615385	1.70362	0.567873
0.4	0.294118	0.307692	1.00181	0.333937

C. Consistency Ratio					
Fix element furnish furniture	a1	a2	a3	Σ	
Steel structure	0.09819005	0.113575	0.083484	0.295249	3.006912
Reinforced Concrete structure	0.49095023	0.567873	0.667873	1.726697	3.040637
Wooden structure	0.39276018	0.283937	0.333937	1.010633	3.026423
				Σ	9.073973
				λ max	3.024658
				CI	0.012329
				CR	0.021257

Criteria: beautify appearance

A. Pair wise Comparison			
Beauty appearance	a1	a2	a3
Steel structure	1	2	0.5
Reinforced Concrete structure	0.5	1	0.5
Wooden structure	2	2	1
Σ	3.5	5	2

B. Normalization and Analysis				
a1	a2	a3	Σ	weight
0.285714	0.4	0.25	0.935714	0.311905
0.142857	0.2	0.25	0.592857	0.197619
0.571429	0.4	0.5	1.471429	0.490476

C. Consistency Ratio					
Beauty appearance	a1	a2	a3	Σ	
Steel structure	0.311905	0.395238	0.245238	0.952381	3.053435
Reinforced Concrete structure	0.155952	0.197619	0.245238	0.59881	3.03012
Wooden structure	0.62381	0.395238	0.490476	1.509524	3.07767
				Σ	9.161225
				λ max	3.053742
				CI	0.026871
				CR	0.046329

5.3 Synthesis (Weighting Factor of Each Technical Solution for Each Stakeholder)

	Synthesis of 3 Stakeholders and aggregation										
	Received load	Resist shift	Receive force earthquake	Allow mini distortion	Resist strike water	Resist erosion water	Fix element furnish	Beautify appearance	Initial cost	LCC	Weight
Stakeholder 1 (Estate Manager)											
a1 (steel bridge)	0.045	0.024	0.027	0.086	0.114	0.046	0.006	0.023	0.004	0.038	0.413
a2 (reinforced concrete)	0.023	0.009	0.007	0.037	0.025	0.016	0.049	0.013	0.009	0.146	0.334
a3 (wooden)	0.008	0.005	0.014	0.023	0.053	0.01	0.028	0.059	0.029	0.024	0.253
Stakeholder 2 (Project Manager)											
a1 (steel bridge)	0.02	0.016	0.013	0.021	0.003	0.011	0.008	0.026	0.093	0.021	0.232
a2 (reinforced concrete)	0.012	0.006	0.005	0.012	0.015	0.035	0.04	0.021	0.41	0.08	0.636
a3 (wooden)	0.004	0.004	0.006	0.006	0.002	0.005	0.021	0.023	0.053	0.011	0.135
Stakeholder 3 (Engineer)											
a1 (steel bridge)	0.046	0.031	0.034	0.051	0.03	0.065	0.012	0.045	0.002	0.02	0.336
a2 (reinforced concrete)	0.027	0.014	0.008	0.025	0.005	0.03	0.079	0.023	0.01	0.096	0.317
a3 (wooden)	0.008	0.009	0.013	0.013	0.01	0.02	0.044	0.217	0.004	0.012	0.35
Aggregation											
a1 (steel bridge)	0.037	0.024	0.025	0.053	0.049	0.041	0.009	0.031	0.033	0.026	0.327
a2 (reinforced concrete)	0.021	0.010	0.007	0.025	0.015	0.027	0.056	0.019	0.143	0.107	0.429
a3 (wooden)	0.007	0.006	0.011	0.014	0.022	0.012	0.031	0.100	0.029	0.016	0.246

6 Building Energy System Selection

6.1 Weighting Factor of Each Criteria for Each Stakeholder

Stakeholder 1: Facility management

A. Pair wise Comparison

	initial cost	replaces	energy cost	omcost	tech sus	eco sus	soci sus
Initial cost	1	0.333333	0.2	0.111111	0.333333	0.142857	0.2
Replacement cost	3	1	0.333333	0.142857	0.5	0.2	0.333333
Energy cost	5	3	1	0.2	0.5	0.333333	0.5
O/M cost	9	7	5	1	7	2	3
Technical sustainability	3	2	2	0.142857	1	0.333333	0.5
Economical sustainability	7	5	3	0.5	3	1	0.5
Social sustainability	5	3	2	0.333333	2	2	1
Σ	33	21.33333	13.53333	2.430159	14.33333	6.009524	6.033333

B. Normalization and Analysis

	initial cost	replacost	energy cost	omcost	tech sus	eco sus	soci sus	Σ	weight
Initial cost	0.030303	0.015625	0.014778	0.045722	0.023256	0.023772	0.033149	0.186605	0.026658
Replacement cost	0.090909	0.046875	0.024631	0.058785	0.034884	0.033281	0.055249	0.344613	0.04923
Energy cost	0.151515	0.140625	0.073892	0.082299	0.034884	0.055468	0.082873	0.621555	0.088794
O/M cost	0.272727	0.328125	0.369458	0.411496	0.488372	0.332805	0.497238	2.700221	0.385746
Technical sustainability	0.090909	0.09375	0.147783	0.058785	0.069767	0.055468	0.082873	0.599335	0.085619
Economical sustainability	0.212121	0.234375	0.221675	0.205748	0.209302	0.166403	0.082873	1.332497	0.190357
Social sustainability	0.151515	0.140625	0.147783	0.137165	0.139535	0.332805	0.165746	1.215174	0.173596

C. Consistency Ratio

	initial cost	replacost	energycost	omcost	tech sus	eco sus	soci sus	Σ	
Initial cost	0.026658	0.01641	0.017759	0.042861	0.02854	0.027194	0.034719	0.19414	7.282668
Replacement cost	0.079974	0.04923	0.029598	0.055107	0.04281	0.038071	0.057865	0.352655	7.163358
Energycost	0.133289	0.147691	0.088794	0.077149	0.04281	0.063452	0.086798	0.639983	7.207538
O/M cost	0.239921	0.344613	0.443968	0.385746	0.599335	0.380713	0.520789	2.915085	7.557009
Technical sustainability	0.079974	0.098461	0.177587	0.055107	0.085619	0.063452	0.086798	0.646998	7.556678
Economical sustainability	0.186605	0.246152	0.266381	0.192873	0.256858	0.190357	0.086798	1.426023	7.491322
Social sustainability	0.133289	0.147691	0.177587	0.128582	0.171239	0.380713	0.173596	1.312698	7.561782
								Σ	51.82035
								λ max	7.402908
						CR	0.050872	CI	0.067151

Stakeholder 2 Design management

A. Pairwise Comparison

	initialcost	replacost	energycost	omcost	tech sus	eco sus	soci sus
Initial cost	1	0.5	0.2	0.333333	0.25	0.25	0.333333
Replacement cost	2	1	0.2	0.333333	0.25	0.25	0.333333
Energycost	5	5	1	3	2	2	4
O/M cost	3	3	0.333333	1	0.333333	0.333333	0.333333
Technical sustainability	4	4	0.5	3	1	0.5	3
Economical sustainability	4	4	0.5	3	2	1	3
Social sustainability	3	3	0.25	3	0.333333	0.333333	1
Σ	22	20.5	2.983333	13.66667	6.166667	4.666667	12

B. Normalization and Analysis

	initialcost	replacost	energycost	omcost	tech sus	eco sus	soci sus	Σ	weight
Initial cost	0.045455	0.02439	0.067039	0.02439	0.040541	0.053571	0.027778	0.283164	0.040452
Replacement cost	0.090909	0.04878	0.067039	0.02439	0.040541	0.053571	0.027778	0.353009	0.05043
Energycost	0.227273	0.243902	0.335196	0.219512	0.324324	0.428571	0.333333	2.112112	0.30173
O/M cost	0.136364	0.146341	0.111732	0.073171	0.054054	0.071429	0.027778	0.620868	0.088695
Technical sustainability	0.181818	0.195122	0.167598	0.219512	0.162162	0.107143	0.25	1.283355	0.183336
Economical sustainability	0.181818	0.195122	0.167598	0.219512	0.324324	0.214286	0.25	1.55266	0.221809
Social sustainability	0.136364	0.146341	0.083799	0.219512	0.054054	0.071429	0.083333	0.794832	0.113547

C. Concistency Ratio

	initialcost	replacost	energycost	omcost	tech sus	eco sus	soci sus	Σ	
Initial cost	0.040452	0.025215	0.060346	0.029565	0.045834	0.055452	0.037849	0.294714	7.285514
Replacement cost	0.080904	0.05043	0.060346	0.029565	0.045834	0.055452	0.037849	0.36038	7.146178
Energycost	0.20226	0.252149	0.30173	0.266086	0.366673	0.443617	0.45419	2.286705	7.578641
O/M cost	0.121356	0.151289	0.100577	0.088695	0.061112	0.073936	0.037849	0.634815	7.157246
Technical sustainability	0.161808	0.201719	0.150865	0.266086	0.183336	0.110904	0.340642	1.415362	7.720024
Economical sustainability	0.161808	0.201719	0.150865	0.266086	0.366673	0.221809	0.340642	1.709602	7.707557
Social sustainability	0.121356	0.151289	0.075433	0.266086	0.061112	0.073936	0.113547	0.86276	7.598234
								Σ	52.19339
								λ max	7.456199
						CR	0.057601	CI	0.076033

Stakeholder 3: Project management

A. Pairwise Comparison

	initialcost	replacost	energycost	omcost	tech sus	eco sus	soci sus
Initial cost	1	9	5	7	2	3	5
Replacement cost	0.111111	1	0.2	0.333333	0.142857	0.142857	0.2
Energycost	0.2	5	1	3	0.2	0.333333	0.5
O/M cost	0.142857	3	0.333333	1	0.142857	0.2	0.333333
Technical sustainability	0.5	7	5	7	1	3	5
Economical sustainability	0.333333	7	3	5	0.333333	1	3
Social sustainability	0.2	5	2	3	0.2	0.333333	1
Σ	2.487302	37	16.53333	26.33333	4.019048	8.009524	15.03333

B. Normalization and Analysis

	initialcost	replacost	energycost	omcost	tech sus	eco sus	soci sus	Σ	weight
Initial cost	0.402042	0.243243	0.302419	0.265823	0.49763	0.374554	0.332594	2.418306	0.345472
Replacement cost	0.044671	0.027027	0.012097	0.012658	0.035545	0.017836	0.013304	0.163138	0.023305
Energycost	0.080408	0.135135	0.060484	0.113924	0.049763	0.041617	0.033259	0.514591	0.073513
O/M cost	0.057435	0.081081	0.020161	0.037975	0.035545	0.02497	0.022173	0.27934	0.039906
Technical sustainability	0.201021	0.189189	0.302419	0.265823	0.248815	0.374554	0.332594	1.914416	0.273488
Economical sustainability	0.134014	0.189189	0.181452	0.189873	0.082938	0.124851	0.199557	1.101875	0.157411
Social sustainability	0.080408	0.135135	0.120968	0.113924	0.049763	0.041617	0.066519	0.608334	0.086905

C. Concistency Ratio									
	initialcost	replacost	energycost	omcost	tech sus	eco sus	soci sus	Σ	
Initial cost	0.345472	0.209749	0.367565	0.27934	0.546976	0.472232	0.434525	2.655859	7.687617
Replacement cost	0.038386	0.023305	0.014703	0.013302	0.03907	0.022487	0.017381	0.168634	7.235808
Energycost	0.069094	0.116527	0.073513	0.119717	0.054698	0.05247	0.043452	0.529472	7.202426
O/M cost	0.049353	0.069916	0.024504	0.039906	0.03907	0.031482	0.028968	0.2832	7.096723
Technical sustainability	0.172736	0.163138	0.367565	0.27934	0.273488	0.472232	0.434525	2.163024	7.909026
Economical sustainability	0.115157	0.163138	0.220539	0.199528	0.091163	0.157411	0.260715	1.207651	7.671978
Social sustainability	0.069094	0.116527	0.147026	0.119717	0.054698	0.05247	0.086905	0.646437	7.438446
								Σ	52.24202
								λ max	7.463146
								CI	0.077191
								CR	0.058478

6.2 Weighting Factor of Each Technical Solution for Each Criteria

Criteria: initial cost

A. Pairwise Comparison			
initial cost	passive	electric	user
passive	1	0.2	0.142857
electric	5	1	0.333333
user	7	3	1
Σ	13	4.2	1.47619

B. Normalization and Analysis				
passive	electric	user	Σ	
0.076923	0.047619	0.096774	0.221316	0.073772
0.384615	0.238095	0.225806	0.848517	0.282839
0.538462	0.714286	0.677419	1.930167	0.643389

C. Concistency Ratio					
initial cost	passive	electric	user	Σ	
passive	0.073772	0.056568	0.091913	0.222253	3.012692
electric	0.368861	0.282839	0.214463	0.866163	3.062387
user	0.516405	0.848517	0.643389	2.008311	3.121457
				Σ	9.196535
				λmax	3.065512
				CI	0.032756
				CR	0.056476

Criteria: replacement cost

A. Pairwise Comparison			
replacost	passive	electric	user
passive	1	5	2
electric	0.2	1	0.333333
user	0.5	3	1
	1.7	9	3.333333

B. Normalization and Analysis				
passive	electric	user	Σ	
0.588235	0.555556	0.6	1.743791	0.581264
0.117647	0.111111	0.1	0.328758	0.109586
0.294118	0.333333	0.3	0.927451	0.30915
				1

C. Concistency Ratio					
replacost	passive	electric	user	Σ	
passive	0.581264	0.54793	0.618301	1.747495	3.006372
electric	0.116253	0.109586	0.10305	0.328889	3.001193
user	0.290632	0.328758	0.30915	0.92854	3.003524
				Σ	9.011088
				λ max	3.003696
				CI	0.001848
				CR	0.003186

Criteria: energy cost

A. Pairwise Comparison			
energycost	passive	electric	user
passive	1	9	5
electric	0.111111	1	0.2
user	0.2	5	1
Σ	1.311111	15	6.2

B. Normalization and Analysis				
passive	electric	user	Σ	
0.762712	0.6	0.806452	2.169163	0.723054
0.084746	0.066667	0.032258	0.18367	0.061223
0.152542	0.333333	0.16129	0.647166	0.215722

C. Concistency Ratio					
energycost	passive	electric	user	Σ	
passive	0.723054	0.551011	1.07861	2.352676	3.253802
electric	0.080339	0.061223	0.043144	0.184707	3.016935
user	0.144611	0.306117	0.215722	0.66645	3.089395
				Σ	9.360131
				λ max	3.120044
				CI	0.060022
				CR	0.103486

Criteria: operation and maintenance cost

A. Pairwise Comparison			
om cost	passive	electric	user
passive	1	5	3
electric	0.2	1	0.5
user	0.333333	2	1
Σ	1.533333	8	4.5

B. Normalization and Analysis				
passive	electric	user	Σ	
0.652174	0.625	0.666667	1.943841	0.647947
0.130435	0.125	0.111111	0.366546	0.122182
0.217391	0.25	0.222222	0.689614	0.229871

C. Concistency Ratio					
om cost	passive	electric	user	Σ	
passive	0.647947	0.61091	0.689614	1.94847	3.007145
electric	0.129589	0.122182	0.114936	0.366707	3.001318
user	0.215982	0.244364	0.229871	0.690217	3.002627
				Σ	9.01109
				λ max	3.003697
				CI	0.001848
				CR	0.003187

Criteria: technical sustainability

A. Pairwise Comparison			
tech sus	passive	electric	user
passive	1	0.333333	0.5
electric	3	1	3
user	2	0.333333	1
Σ	6	1.666667	4.5

B. Normalization and Analysis				
passive	electric	user	Σ	
0.166667	0.2	0.111111	0.477778	0.159259
0.5	0.6	0.666667	1.766667	0.588889
0.333333	0.2	0.222222	0.755556	0.251852

C. Concistency Ratio					
tech sus	passive	electric	user	Σ	
passive	0.166667	0.196296	0.125926	0.488889	3.069767
electric	0.5	0.588889	0.755556	1.844444	3.132075
user	0.333333	0.196296	0.251852	0.781481	3.102941
				Σ	9.304784
				λ max	3.101595
				CI	0.050797
				CR	0.087582

Criteria: economic sustainability

A. Pairwise Comparison			
eco sus	passive	electric	user
passive	1	3	0.333333
electric	0.333333	1	0.2
user	3	5	1
Σ	4.333333	9	1.533333

B. Normalization and Analysis				
passive	electric	user	Σ	
0.230769	0.333333	0.217391	0.781494	0.260498
0.076923	0.111111	0.130435	0.318469	0.106156
0.692308	0.555556	0.652174	1.900037	0.633346
				1

C. Concistency Ratio					
eco sus	passive	electric	user	Σ	
passive	0.260498	0.318469	0.211115	0.790082	3.032969
electric	0.086833	0.106156	0.126669	0.319658	3.011202
user	0.781494	0.530782	0.633346	1.945621	3.071973
				Σ	9.116144
				λ max	3.038715
				CI	0.019357
				CR	0.033375

Criteria: socio sustainability

A. Pairwise Comparison			
sociosus	passive	electric	user
passive	1	3	0.2
electric	0.333333	1	0.142857
user	5	7	1
	6.333333	11	1.342857

B. Normalization and Analysis				
passive	electric	user	Σ	
0.157895	0.272727	0.148936	0.579558	0.193186
0.052632	0.090909	0.106383	0.249924	0.083308
0.789474	0.636364	0.744681	2.170518	0.723506

C. Concistency Ratio					
sociosus	passive	electric	user	Σ	
passive	0.193186	0.249924	0.144701	0.587811	3.042719
electric	0.064395	0.083308	0.103358	0.251061	3.013655
user	0.96593	0.583155	0.723506	2.272592	3.141082
				Σ	9.197456
				λ max	3.065819
				CI	0.032909
				CR	0.05674

6.3 Synthesis (Weighting Factor of Each Technical Solution for Each Stakeholder)

Facility Manager								
	initialcost	replacost	energycost	omcost	tech sus	eco sus	soci sus	Weight
passive	0.001967	0.028616	0.064203	0.249943	0.013636	0.049588	0.033536	0.441488
electric	0.00754	0.005395	0.005436	0.047131	0.05042	0.020208	0.014462	0.150592
user	0.017151	0.015219	0.019155	0.088672	0.021563	0.120562	0.125598	0.40792
Design manager								
	initialcost	replacost	energycost	omcost	tech sus	eco sus	soci sus	Weight
passive	0.002984	0.029313	0.218167	0.05747	0.029198	0.057781	0.021936	0.416849
electric	0.011441	0.005526	0.018473	0.010837	0.107965	0.023546	0.009459	0.187248
user	0.026026	0.01559	0.06509	0.020388	0.046174	0.140482	0.082153	0.395903
Project manager								
	initialcost	replacost	energycost	omcost	tech sus	eco sus	soci sus	Weight
passive	0.025486	0.013546	0.053154	0.025857	0.043555	0.041005	0.016789	0.219393
electric	0.097713	0.002554	0.004501	0.004876	0.161054	0.01671	0.00724	0.294647
user	0.222273	0.007205	0.015858	0.009173	0.068878	0.099696	0.062876	0.48596
Aggregation								
	initialcost	replacost	energycost	omcost	tech sus	eco sus	soci sus	Weight
passive	0.010146	0.023825	0.111841	0.11109	0.028796	0.049458	0.024087	0.359243
electric	0.038898	0.004492	0.00947	0.020948	0.10648	0.020155	0.010387	0.210829
user	0.088483	0.012671	0.033368	0.039411	0.045538	0.120247	0.090209	0.429927