Evaluating Inclusive Campus Environment Design Criteria Using CFPR and FANP Methodologies

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Abstract: - University campuses bring together individuals from different socio-cultural backgrounds. At the same time, university campuses contribute to the personal and intellectual development of individuals and serve as a socialization area. Campuses create vitality with their social, cultural, economic, and spatial effects. In this paper, we study for evaluating inclusive campus environment design criteria using the Fuzzy Analytical Network Process (FANP) and Consistent Fuzzy Preference Relations (CFPR) techniques, which are two Multi-Criteria Decision Making (MCDM) methods. Seven Inclusive Campus Environment Design Criteria are “Land Use Organization”, “Compactness”, “Connectivity”, “Configuration”, “Living campus”, “Greens” and “Context”. The major contribution of our study is to prioritize inclusive campus environment design criteria by using numerical methods from the decision maker's perspective. According to the authors’ knowledge, this will be the first interdisciplinary study to use MCDM methods for evaluating inclusive campus environment design criteria. Additionally, the results of both methodologies are compared.

Key-Words: - Campus climate; Inclusive design; Decision making; Fuzzy Logic; CFPR; Fuzzy ANP.

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1 Introduction

Every individual who lives in the city and can participate in daily life in public spaces has the right to benefit equally from the opportunities and opportunities provided by the town where he lives. The concept of Inclusive Design has emerged to enable people to reach the current options as equally as possible [1], and it is defined as the process of designing products and environments that many people can use in many possible situations [2].

Since the city's public spaces have an important place in urban development, they should be shaped according to need. Campuses emerge as critical public spaces, as they function as small cities thanks to their facilities and social environment. Campus areas affect our attitudes towards education and should be shaped according to need and designed to include all campus users [3].

Universities are institutions that play a locomotive role in the development and direction of the cities and regions they are located in. Therefore all users have equal rights and laws and set an example for the accessibility of everyone in spatial and physical terms. The accessibility and accessibility of all people who have to use the campus from students, employees, or campuses must be provided by these institutions. Universities are also among the institutions that need to be most sensitive about the accessibility of all places in terms of education, work, and right to life for individuals with disabilities, which cannot be ignored anymore [4].

The campus environment results in a diversity of individuals from different backgrounds. To lay the foundation for a learning community, the academy's primary mission should be to create an environment fostering diversity and understanding the difference.

According to [5], a comprehensive campus plan requires the following criteria;

• Prioritizing the general plan over individual buildings,

• Compactness to create vitality and interaction possibilities for using the campus,

• Environmental aspects are adopted,

• Being repairable,

• Visually sufficient by using the campus architecture,

• Availability of integration technology,

• Establishing a beneficial physical relationship with the campus environment.

Selecting or prioritizing alternatives from a range of available alternatives based on multi-criteria is referred to as MCDM. There are many methodologies within MCDM. Each method has different characteristics [6].

MCDM is a methodological and modeling tool used to deal with complex engineering problems. Experts face many issues with unclear and incomplete information in MCDM issues. Because the characteristics of these problems frequently require such knowledge [7].

We can list the steps of MCDM as follows [8]:

1. Establish evaluation criteria that link capabilities to goals.

2. Build an alternative system to succeed objectives.

3. Evaluate alternatives according to criteria.

4. Apply a standard multi-criteria evaluation methodology.

5. Choose one alternative as ‘‘optimal’’.

6. If it's not considered the final solution, collect information, and move to the next iteration of multi-criteria optimization.

In this paper, we applied CFPR and FANP methodologies to select the best inclusive campus environment design criteria. There are so many papers that use the CFPR methodology for MCDM problems in the literature. Patel et al. [9] used the CFPR method to compute the hazard index representing the hazard level of projects. Alias and Abdullah [10] assessed criteria that determine the quality of life (QoL) among the population in Setiu Wetlands by using the CFPR method. Chao [11] used the AHP model to construct the hierarchy of criteria and used the CFPR to evaluate the multi-criteria for the selection of a smartphone. Cheng et al. [12] developed the CFPR-ANP methodology to obtain preference-weights of criteria for Research and Development (R&D) Project Selection. Ozdemir et al. [13] determined personnel selection criteria and prioritized these criteria by CFPR. Alias et al. [14] proposed a modified approach of consistent fuzzy preference relation with geometric Bonferroni mean operator for assessing the quality of life. Park et al. [15] utilized the CFPR method, which handles both quantitative and qualitative factors to choose optimal routes for small and medium ports (SMPs). Huynh and Phi [16] applied CFPR to select a strategy that attracts Foreign Direct Investment in developing industries for Vietnam.

Many studies use the FANP method for MCDM problems in the literature. Hemmati et al. [17] constructed the FANP model and applied it to a sulfuric acid production facility for selecting the maintenance policy. Danai et al. [18] proposed an FANP method for selecting the best supplier in the supply chain. Alilou et al. [19] developed a novel framework to assess watershed health using the FANP method considering topo-hydrological and geo-environmental criteria. Galankashi et al. [20] developed specific criteria and an FANP method to prioritize and select portfolios on the Tehran Stock Exchange (TSE). Many studies use MCDM methods in the literature [21-28].

The rest of this study is organized as follows: a short explanation for an inclusive campus climate is given in the 2nd section. CFPR and FANP methodologies are examined in the 3rd and 4th sections, respectively. An application of CFPR and FANP methodologies in evaluating inclusive campus environment design criteria and computational results are given in the 5th section. Finally, future research directions and a comparison of the results are discussed in the 6th section.

2 Inclusive Campus Environment Design

Architecture is experienced from the moment it approaches the site and building from the street. The form can be seen by the eye, which gives information about the physical environment. Therefore, inclusive buildings must be architecturally fully accessible for use by people regardless of age and abilities. In campus design, the administration's inclusion target and perception should be this approach. It should use inclusive architecture as communication when people walk around and experience the building [3].

The criteria to be considered in designing an inclusive campus environment are explained in the following headings [29].

Land Use Organization: It is necessary to offer sports, research, housing and different academic opportunities in conjunction with each other. Kenney et al. [5] that combining possibilities has social, educational and financial benefits; increased vocational education and society; learning; security; competitive acceptance; He said it provides flexibility for growth.

Compactness: It is necessary to ensure the campus density and the proximity of the buildings. Kenney et al. [5] stated that "physical intensity, walking from place to place more easily in students and staff, encourages interaction and strengthens the sense of corporate identity".

Connectivity: Street network connection degree within the campus, the campus and its surroundings should be connected.

Configuration: Scale and design to emphasize new buildings, creating a focal point at the pedestrian axis end, achieving prominent visual corridors, emphasizing outdoor foci it is necessary to make changes, to switch between different areas on the campus, to maintain and increase the appearance of character-defining features.

Living campus: It is necessary to increase the campus life degree, that is, the time spent on the campus. It is necessary to improve housing on campus, expand and diversify housing options on campus. The increase in campus housing can impact on campus sustainability by reducing learning, livability, sense of community, and student commute.

Greenness: The naturalness or the greenness level should be sufficient. To create vivid open spaces, it is necessary to design landscapes, protect park-like campuses, provide a view between buildings, provide a view of city streets, fulfill ecological functions to develop local vegetation by integrating it into the campus landscape. Coulson et al. [30], "Nature, recognized for both its beauty and uplift, became one of the most notable aspects in the location… the natural environment was organized to benefit the well-being and moral character of students for the well-being of the people".

Context: The degree of surrounding urbanism affects the campus environment. To create a mixed-use campus town with the city, it is necessary to develop a street corridor, to construct conference centers, student cafeterias, student clubs [31].

3 Consistent Fuzzy Preference Relations Method (CFPR)

Herrera-Viedma et al. [32] introduced CFPR by reducting the pairwise comparison. The methodology only requires $n-1$ judgments for a preference matrix with n elements. Furthermore, CFPR reduces decision-making times, so it provides better consistency. It determines the relative importance of main criteria and subcriteria using the calculation procedure [33, 34].

Steps of the CFPR method are used in this study [35, 36]. Linguistic terms and corresponding numbers are used to obtain pairwise comparisons and can be seen in Table 1.

Table 1. Linguistic scale.

Definition	Relative Importance
Intermediate values	2, 4, 6, 8
Equally important	1
Moderately more important	3
Strongly more important	5
Very strongly more important	7
Absolutely more important	9

4 Fuzzy Analytic Network Process Method (FANP)

Saaty [37] introduced the Analytical Network Process (ANP) and suggested using ANP to find the solution to the problem between alternatives or criteria [38]. ANP method is used to evaluate the priorities of the alternatives of the goal and the elements in the network. Buckley's Fuzzy AHP algorithm [39, 40, 41] based FANP is used for weighting the inclusive campus environment design criteria in this paper.

The steps of FANP are used in this study [42, 43]. To solve the problem with the FANP method, fuzzy numbers are used as shown in Table 2.

Table 2. Degrees of linguistic importance and relation between fuzzy numbers.

High/Low Levels		Fuzzy Numbers
Label	Linguistic Terms	
Extra High	EH	(9, 9, 9)
Very High	VH	(7, 9, 9)
High	H	(5, 7, 9)
Slightly High	SH	(3, 5, 7)
Middle	M	(1, 3, 5)
Slightly Low	SL	(1, 1, 3)
Just equal	E	(1, 1, 1)

5 APPLICATION

In this paper, we apply CFPR and FANP methodologies to prioritize the inclusive campus environment criteria. 7 main criteria and 31 subcriteria were determined and weighted accordingly [3]. 3 experts with the same importance value from academia were asked about weighting the criteria. The main criteria and the subcriteria are as seen in Fig. 1.

"Land Use Organization" (MC1) criteria includes subcriteria as "Integrating Academic and Research Activities in Common Facilities" (SC11), "Bringing Together Communities of Different Disciplines" (SC12), "Concentrating the Campus and Workplace, Including Housing and Activities" (SC13), and "Converting Low-Intensity Land Uses into Athletic Areas and Greenhouses" (SC14).

"Compactness" (MC2) criteria contains subcriteria as "Having as many University Functions as Possible in the Center or Close to it" (SC21), "Limiting the Use of Fillers and Restricting Movement where Possible" (SC22), and "Making Programs to Encourage Interdisciplinary Cooperation" (SC23).

"Connectivity" (MC3) criteria consist of from "Development of New Pedestrian Paths, Walking Areas and Passages" (SC31), "Green Corridors to Connect Different Parts of the Campus" (SC32), "Development of Strong Physical Connections between the Campus and the Neighborhood" (SC33), "Additional Campus Entrances" (SC34).

"Configuration" (MC4) criteria includes "Scaling and Designing to Emphasize New Buildings" (SC41), "Creating Semi-Enclosed Spaces with Many Entrances" (SC42), "Creating a Focal Point at the Pedestrian Axis End" (SC43), "Placing Towers or Other Prominent Building Elements at Focal Points" (SC44), "Emphasizing Outdoor Foci It Is Necessary to Make Changes, to Switch between Different Areas on the Campus" (SC45), "Carrying Out a Series of Open Space Projects to Help Illuminate the Pedestrian Paths" (SC46), "Providing Hierarchy" (SC47), "Maintaining and Increasing the Appearance of Character-Defining Features" (SC48) subcriteria.

"Living campus" (MC5) criteria contain subcriteria as "Increasing Housing on Campus" (SC51), "Expanding and Diversifying Housing Options on Campus" (SC52), "Establishing Multidisciplinary Academic Facilities and Position them in the Core Campus" (SC53).

"Greenness" (MC6) criteria includes the following subcriteria: "Designing Landscapes to Create Vivid Open Spaces" (SC61), "Protect Park-Like Campuses" (SC62), "Providing a View between Buildings, Provide a View of City Streets" (SC63), "Fulfilling Ecological Functions to Create a more Manageable Parking Space" (SC64), and "Developing Local Vegetation by Integrating it into the Campus Landscape" (SC65).

"Context" (MC7) criteria contains these subcriteria: "Creating a Mixed-Use Campus Town with the City, to Create a Street Corridor" (SC71), "Constructing Conference Centers, Student Cafeterias, Student Clubs, Theaters and Alumni Centers" (SC72), "Encouraging Private Development and Investment" (SC73), and "Considering the Campus as a Destination for the Public" (SC74).

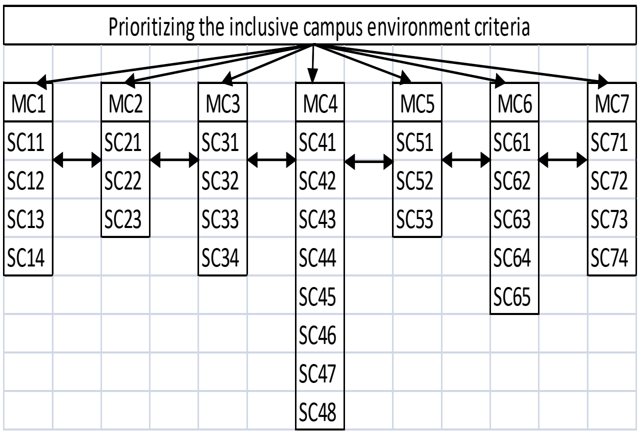

Figure 1. Network of the problem.

5.1 Computational Results of the CFPR methodology

For the computations of CFPR methodology, all experts were asked to determine the importance of different main criteria and sub-criteria based on Table 1. The pairwise comparison matrices for the main criteria and sub-criteria (SC11) were provided by decision maker 1 are shown in Table 3 and Table 4, respectively.

Table 3. Fuzzy preference pairwise comparison matrix of decision maker 1 for the main criteria.

	MC1	MC2	MC3	MC4	MC5	MC6	MC7
MC1	1	0.333					
MC2		1	0.2				
MC3			1	7			
MC4				1	0.333		
MC5					1	0.2	
MC6						1	5
MC7							1

Table 4. Fuzzy preference pairwise comparison matrix of decision maker 1 for the sub-criteria (MC1).

	SC11	SC12	SC13	SC14
SC11	1	0.143		
SC12		1	5	
SC13			1	5
SC14				1

Then, the remaining p_{ij}^{k} for main and sub-criteria are calculated by using CFPR method (Table 5, 6).

Table 5. Transformed fuzzy preference values of decision maker 1 for the main criteria.

	MC1	MC2	MC3	MC4	MC5	MC6	MC7
MC1	0.5	0.25	-0.116	0.327	0.077	-0.290	0.077
MC2	0.75	0.5	0.134	0.577	0.327	-0.040	0.327
MC3	1.116	0.866	0.5	0.943	0.693	0.327	0.693
MC4	0.673	0.423	0.057	0.5	0.25	-0.116	0.25
MC5	0.923	0.673	0.307	0.75	0.5	0.134	0.5
MC6	1.290	1.040	0.673	1.116	0.866	0.5	0.866
MC7	0.923	0.673	0.307	0.75	0.5	0.134	0.5

Table 6. Transformed fuzzy preference values of decision maker 1 for the sub-criteria.

	SC11	SC12	SC13	SC14
SC11	0.5	0.057	0.423	0.790
SC12	0.943	0.5	0.866	1.232
SC13	0.577	0.134	0.5	0.866
SC14	0.210	-0.232	0.134	0.5

Preference values transformed by transformation function for main and sub-criteria are obtained by the CFPR method (Table 7, 8).

Table 7. Preference values transformed by transformation function for the main criteria.

	MC1	MC2	MC3	MC4	MC5	MC6	MC7
MC1	0.5	0.342	0.110	0.390	0.232	0	0.232
MC2	0.658	0.5	0.268	0.548	0.390	0.158	0.390
MC3	0.890	0.732	0.5	0.780	0.622	0.390	0.622
MC4	0.610	0.452	0.220	0.5	0.342	0.110	0.342
MC5	0.768	0.610	0.378	0.658	0.5	0.268	0.5
MC6	1	0.842	0.610	0.890	0.732	0.5	0.732
MC7	0.768	0.610	0.378	0.658	0.5	0.268	0.5

Table 8. Preference values transformed by transformation function for the sub-criteria.

	SC11	SC12	SC13	SC14
SC11	0.5	0.198	0.448	0.698
SC12	0.802	0.5	0.75	1
SC13	0.552	0.25	0.5	0.75
SC14	0.302	0	0.25	0.5

Likewise, the fuzzy preference relation matrices of the other 2 decision-makers for all main and sub-criteria are calculated by using the above computational procedure.
To integrate the judgments of 3 decision-makers, the CFPR method is used and the aggregated pairwise comparison matrices for main and sub-criteria are shown in Table 9 and Table 10, respectively.

Table 9. Aggregated pairwise comparison matrix of 3 decision makers for the main criteria.

	MC1	MC2	MC3	MC4	MC5	MC6	MC7
MC1	1.5	1.591	1.191	1.640	1.232	0.75	1.521
MC2	1.408	1.5	1.099	1.548	1.140	0.658	1.429
MC3	1.809	1.901	1.5	1.949	1.541	1.059	1.830
MC4	1.360	1.452	1.051	1.5	1.092	0.610	1.381
MC5	1.768	1.860	1.459	1.908	1.5	1.018	1.789
MC6	2.25	2.342	1.941	2.390	1.982	1.5	2.271
MC7	1.479	1.571	1.170	1.619	1.211	0.729	1.5

Table 10. Aggregated pairwise comparison matrix of 3 decision makers for the sub-criteria.

	SC11	SC12	SC13	SC14
SC11	1.5	1.036	1.683	1.709
SC12	1.964	1.5	2.147	2.173
SC13	1.317	0.853	1.5	1.526
SC14	1.291	0.827	1.474	1.5

The normalized fuzzy preference relation matrices for main and sub-criteria are calculated by using the CFPR method (Table 11, 12).

Table 11. Normalized fuzzy preference relation matrix for the main criteria.

	MC1	MC2	MC3	MC4	MC5	MC6	MC7
MC1	0.130	0.130	0.127	0.131	0.127	0.119	0.130
MC2	0.122	0.123	0.117	0.123	0.118	0.104	0.122
MC3	0.156	0.156	0.159	0.155	0.159	0.167	0.156
MC4	0.117	0.119	0.112	0.119	0.113	0.096	0.118
MC5	0.153	0.152	0.155	0.152	0.155	0.161	0.153
MC6	0.194	0.192	0.206	0.190	0.204	0.237	0.194
MC7	0.128	0.129	0.124	0.129	0.125	0.115	0.128

Table 12. Normalized fuzzy preference relation matrix for the sub-criteria.

	SC11	SC12	SC13	SC14
SC11	0.247	0.246	0.247	0.247
SC12	0.323	0.356	0.316	0.315
SC13	0.217	0.202	0.220	0.221
SC14	0.213	0.196	0.217	0.217

Finally, the importance weight of the main criteria and sub-criteria determined by three decision-makers using CFPR can be seen from Table 13 and Table 14, respectively.

Table 13. Importance weight of the main criteria.

	Importance Weight
MC1	0.127
MC2	0.118
MC3	0.158
MC4	0.113
MC5	0.154
MC6	0.203
MC7	0.125

Table 14. Importance weight of the sub-criteria.

	Importance Weight
SC11	0.247
SC12	0.327
SC13	0.215
SC14	0.211

The importance weight and the ranking for each set of sub-criteria are shown in Table 15.

Table 15. Importance weight of the criteria calculated using CFPR.

Main Criteria	Weight	Ranking of MC	Subcriteria	Local Weight	Ranking of SC	Global Weight	Ranking
MC1	0.127	4	SC11	0.247	11	0.031	17
			SC12	0.327	5	0.042	8
			SC13	0.215	14	0.027	20
			SC14	0.211	15	0.027	21
MC2	0.118	6	SC21	0.308	6	0.036	12
			SC22	0.252	10	0.030	19
			SC23	0.440	1	0.052	2
MC3	0.158	2	SC31	0.299	7	0.047	4
			SC32	0.299	7	0.047	4
			SC33	0.199	19	0.031	16
			SC34	0.204	18	0.032	15
MC4	0.113	7	SC41	0.093	29	0.011	29
			SC42	0.125	26	0.014	26
			SC43	0.150	22	0.017	22
			SC44	0.129	25	0.015	25
			SC45	0.150	22	0.017	22
			SC46	0.146	23	0.017	23
			SC47	0.107	27	0.012	27
			SC48	0.099	28	0.011	28
MC5	0.154	3	SC51	0.270	9	0.042	9
			SC52	0.402	2	0.062	1
			SC53	0.329	4	0.051	3
MC6	0.203	1	SC61	0.205	17	0.042	10
			SC62	0.209	16	0.042	7
			SC63	0.170	21	0.034	14
			SC64	0.220	13	0.044	5
			SC65	0.197	20	0.040	11
MC7	0.125	5	SC71	0.240	12	0.030	18
			SC72	0.344	3	0.043	6
			SC73	0.130	24	0.016	24
			SC74	0.286	8	0.036	13

According to Table 15, it can be said that the most important main criteria for an inclusive campus environment are Greenness (MC6) > Connectivity (MC3) > Living campus (MC5) and the most important subcriteria are Making Programs to Encourage Interdisciplinary Cooperation (SC23)> Expanding and Diversifying Housing Options on

Campus (SC52) > Constructing Conference Centers, Student Cafeterias, Student Clubs, Theaters and Alumni Centers (SC72). Overall ranking according to the global weight calculated using CFPR are Expanding and Diversifying Housing Options on Campus (SC52) > Making Programs to Encourage Interdisciplinary Cooperation (SC23)> Establishing Multidisciplinary Academic Facilities and Position them in the Core Campus (SC53).

5.2 Computational Results of the CFPR methodology

To weight the criteria using FANP methodology, the comparisons are made with experts using fuzzy scales, as shown in Table 2. Evaluations of the criteria by 3 experts were the same as the values of the CFPR methodology. The geometric mean of the decision-makers' evaluations is taken and the fuzzy comparison matrix of the main criteria and the fuzzy comparison matrix of the subcriteria SC11 can be seen in Table 16 and Table 17, respectively.

Table 16. The fuzzy comparison matrix of the main criteria.

	MC1			MC2			MC3			MC4			MC5			MC6			MC7		
MC1	1	1	1	1	1	1	0.1	0.2	0.3	1	1	3	0.3	1	1	0.1	0.1	0.2	1	1	3
MC2	1	1	1	1	1	1	0.1	0.2	0.3	1	1	3	0.3	1	1	0.1	0.1	0.2	1	1	3
MC3	3	5	7	3	5	7	1	1	1	5	7	9	1	3	5	0.3	1	1	5	7	9
MC4	0.3	1	1	0.3	1	1	0.1	0.1	0.2	1	1	1	0.2	0.3	1	0.1	0.1	0.1	1	1	1
MC5	1	1	3	1	1	3	0.2	0.3	1	1	3	5	1	1	1	0.1	0.2	0.3	1	3	5
MC6	5	7	9	5	7	9	1	1	3	7	9	9	3	5	7	1	1	1	7	9	9
MC7	0.3	1	1	0.3	1	1	0.1	0.1	0.2	1	1	1	0.2	0.3	1	0.1	0.1	0.1	1	1	1

Table 17. The fuzzy comparison matrix of the subcriteria SC1.

	SC11			SC12			SC13			SC14		
SC11	1	1	1	0.11	0.14	0.20	1	1	3	1	3	5
SC12	5	7	9	1.00	1	1	7	9	9	9	9	9
SC13	0.33	1	1	0.11	0.11	0.14	1	1	1	1	1	3
SC14	0.2	0.33	1	0.11	0.11	0.11	0.33	1	1	1	1	1

The fuzzy weight matrix of the criteria according to the goal and the fuzzy weight matrix of the subcriteria are given in Tables 18, and 19, respectively. The evaluation and the methodology described above produced the results shown in Table 20.

Table 18. Fuzzy weight matrix of the criteria according to the goal.

	L	M	U
MC1	0.033	0.058	0.128
MC2	0.033	0.058	0.128
MC3	0.128	0.310	0.567
MC4	0.021	0.045	0.083
MC5	0.042	0.089	0.256
MC6	0.224	0.394	0.748
MC7	0.021	0.045	0.083

Table 19. Fuzzy weight matrix of the subcriteria.

	L	M	U
SC11	0.005	0.010	0.022
SC12	0.0302	0.057	0.114
SC13	0.004	0.007	0.014
SC14	0.003	0.005	0.011
SC21	0.004	0.008	0.0160
SC22	0.002	0.004	0.007
SC23	0.0178	0.037	0.072
SC31	0.0302	0.057	0.110
SC32	0.0302	0.057	0.114
SC33	0.005	0.010	0.022
SC34	0.005	0.010	0.022
SC41	0.004	0.007	0.014
SC42	0.007	0.015	0.039
SC43	0.020	0.042	0.081
SC44	0.011	0.028	0.059
SC45	0.0201	0.041	0.081
SC46	0.0201	0.041	0.081
SC47	0.005	0.010	0.022
SC48	0.005	0.010	0.022
SC51	0.002	0.004	0.007
SC52	0.007	0.015	0.0393
SC53	0.004	0.007	0.014
SC61	0.041	0.080	0.151
SC62	0.041	0.080	0.151
SC63	0.021	0.042	0.078
SC64	0.041	0.080	0.140
SC65	0.0302	0.057	0.114
SC71	0.020	0.042	0.081
SC72	0.058	0.106	0.194
SC73	0.002	0.004	0.007
SC74	0.011	0.027	0.059

Table 20. Importance weight of the criteria calculated using FANP.

Main Criteria	Weight	Ranking of MC	Subcriteria	Local Weight	Ranking of SC	Global Weight	Ranking
MC1	0.073	4	SC11	0.012	12	0.001	17
			SC12	0.067	4	0.005	8
			SC13	0.008	14	0.001	20
			SC14	0.006	15	0.0004	22
MC2	0.073	4	SC21	0.010	13	0.001	18
			SC22	0.004	17	0.0003	24
			SC23	0.042	8	0.003	10
MC3	0.335	2	SC31	0.066	5	0.022	5
			SC32	0.067	4	0.022	4
			SC33	0.012	12	0.004	9
			SC34	0.012	12	0.004	9
MC4	0.0499	5	SC41	0.008	14	0.0004	23
			SC42	0.021	11	0.001	16
			SC43	0.048	6	0.002	12
			SC44	0.033	9	0.002	13
			SC45	0.048	6	0.002	12
			SC46	0.048	6	0.002	12
			SC47	0.012	12	0.0006	19
			SC48	0.0123	12	0.0006	19
MC5	0.129	3	SC51	0.004	17	0.0006	21
			SC52	0.021	11	0.003	11
			SC53	0.008	14	0.001	15
MC6	0.455	1	SC61	0.091	2	0.041	1
			SC62	0.091	2	0.041	1
			SC63	0.047	7	0.021	6
			SC64	0.087	3	0.040	2
			SC65	0.067	4	0.031	3
MC7	0.050	5	SC71	0.048	6	0.002	12
			SC72	0.119	1	0.006	7
			SC73	0.005	16	0.0002	25
			SC74	0.033	10	0.002	14

According to Table 19, it can be said that the most important main criteria for inclusive campus environment are Greenness (MC6) > Connectivity (MC3) > Living campus (MC5) and the most important subcriteria are Constructing Conference Centers, Student Cafeterias, Student Clubs, Theaters and Alumni Centers (SC72) > Designing Landscapes to Create Vivid Open Spaces (SC61) = Protect Park-Like Campuses (SC62) > Fulfilling Ecological Functions to Create a more Manageable Parking Space (SC64). Overall ranking according to the global weight calculated using FANP are Designing Landscapes to Create Vivid Open Spaces (SC61) = Protect Park-Like Campuses (SC62) > Fulfilling Ecological Functions to Create a more Manageable Parking Space (SC64) > Developing Local Vegetation by Integrating it into the Campus Landscape (SC65).

6 Conclusion

The concept of Inclusive Design has emerged to ensure that individuals can benefit from all opportunities equally. The inclusive environment ensures equal opportunities and participation of all. Inclusive design is not only an architectural problem but also a political, economic, social, and technological issue. Since university campuses are evaluated in the context of small cities or public spaces, they should be equally accessible to everyone. In order to give equal rights in campus design, the inclusive campus design criteria must be met.

Although the physical environment is the source of some opportunities, the physical environment of the campus has a great psychological impact. Having socialization areas on campus directs individuals to spend more time on campus. Social opportunities offered by the campus; Structures such as show areas and sports halls turn the campus into a living space and have positive psychological effects. All these facilities can be used by everyone and designed with the principles of inclusiveness creates a positive effect [3].

In this paper, CFPR and FANP methodologies are used to evaluate of inclusive campus environment design criteria. As a result of the evaluation process, both of these two MCDM methods, CFPR and FANP, have determined the most important main criteria for an inclusive campus environment as Greenness (MC6), Connectivity (MC3), and Living campus (MC5).

The most important subcriteria determined using CFPR are Making Programs to Encourage Interdisciplinary Cooperation (SC23), Expanding and Diversifying Housing Options on Campus (SC52), and Constructing Conference Centers, Student Cafeterias, Student Clubs, Theaters and Alumni Centers (SC72). On the other hand, the most important subcriteria determined using FANP are Constructing Conference Centers, Student Cafeterias, Student Clubs, Theaters and Alumni Centers (SC72), Designing Landscapes to Create

Vivid Open Spaces (SC61), Protect Park-Like Campuses (SC62), and Fulfilling Ecological Functions to Create a more Manageable Parking Space (SC64). Also, this causes variation in the overall ranking.

The reason for this difference can be thought of as, at the FANP calculation step, all of the pairwise comparisons are taken into account. FANP methodology considers interactivity among all subcriteria. The main contribution of this paper is to prioritize the inclusive campus environment criteria using numerical methods with experts' views.

For future research, this problem can be studied with the help of other MCDM methods. In addition, trapezoidal fuzzy sets could be used instead of triangular fuzzy sets for the decision-making phase and intelligent software can be developed to automatically obtain solutions.

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Contribution of individual authors to the creation of a scientific article (ghostwriting policy)

All authors conceived of the presented idea. Sahika Ozdemir developed the theory. Kemal Gokhan Nalbant designed the model and the computational framework. Kemal Gokhan Nalbant and Yavuz Ozdemir performed the computations. Sahika Ozdemir supervised the findings of this work. Kemal Gokhan Nalbant wrote the manuscript with support from Sahika Ozdemir and Yavuz Ozdemir.

All authors discussed the results and contributed to the final manuscript.

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