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An interdisciplinary urban furniture design model

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Abstract
Urban furniture is a multifaceted object shaped by several factors such as user needs, social structure, urban pattern, geographical characteristics, economy, technology, and material. As an interface connecting user to the city, urban furniture contributes to the construction of an urban identity, have placemaking power and support public activities. Although the urban furniture is subject to design in different disciplines, multidisciplinary studies to urban furniture design are very limited and the definition and range of urban furniture is not clear. Buildings such as kiosks are evaluated as urban furniture by decision makers such as municipalities who mostly expect design alternatives without defining clear design expectations or evaluation criteria. This research proposes a multidisciplinary model to urban furniture design as an analytical design method. The proposed model has three stages before furniture design: "defining and evaluating design criteria", "Classification of urban furniture based on the criteria scores" and "Creating urban furniture design matrix combining criteria evaluation, furniture clusters, local characteristics, and summarize design concept, keywords, form and material characteristics for furniture design". Based on this model, a design matrix for Ordu city is prepared and one of urban furniture design example is presented here. 10 main and 84 sub-criteria graded based on 30 furniture types via interdisciplinary workshop with 16 professional participants. This research reveals that differences in the urban furniture design approaches and evaluation criteria of different disciplines exist. The proposed model integrates multi-disciplinary approach, local characteristics, furniture clusters which is a new classification based on criteria scores.

Keywords
Urban furniture design, Interdisciplinary design model, Furniture design criteria, Cluster analysis.

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1. Introduction

Urban open spaces are backbone of all urban systems serving all activities in the city. To support activities which are classified as "necessary activities", "optional activities", and "resultant (social) activities", outdoor areas have high quality (Gehl, 2001) and well equipped with urban furniture. The role of urban furniture is very crucial to invite people and increase the use of public space (Bolkaner et al., 2019). Therefore, urban furniture is one of the key elements that helps adapting urban structure and life to the transformation of cities (Barbaux, 2010). With their great potential to support urban activities and their critical role in constructing the urban identity, the demand by the municipalities for urban furniture design increases day by day. However, this demand usually ends up with the selection of an alternative design product which is manufactured and applied to the area.

This research is based on an empirical and evidence-based urban design method developed for Ordu Municipality by research-based design group. The project was developed as a response to the municipality's expectations to create diverse and functional urban environment and to enhance urban identity via urban furniture designs. Within this context, the main task was defined by the municipality as developing five design alternatives for each thirty furniture which were listed in the technical brief to achieve 150 different design alternatives as total.

On the other hand, there were no specific information in the brief about evaluation method or selection criteria for alternative urban furniture designs which is considered as the challenging part of the project. Another challenging issue was the wide range of the urban furniture which was expected to be designed from small objects like sitting units and building façade flower bed to technical infrastructure elements life traffic light or transformer unit. And some buildings like mukhtar's office was one of the elements listed by the municipality that need to be designed with five alternatives.

This project revealed several facts & problems:

1.Urban furniture design is in the realm of multiple disciplines. Thus, interdisciplinary approach is required for urban furniture design

2.Discussion on the definition, extent, design criteria and alternative uses of the term "urban furniture" is critical.

3.There is vast amount of furniture types which need to be grouped. Classification of urban furniture based on the design criteria rather than function will simplify the design process

4.A systematic urban furniture design method and evaluation criteria is needed to facilitate design process for municipalities and designers.

These problems refer to our two hypotheses: First of all, there is a variation among different disciplines about the extent, criteria and scores of urban furniture. This variation indicates that furniture design needs the contribution of several disciplines as an interdisciplinary design approach. The second hypothesis of this research is urban furniture can be classified according to design criteria scores rather than their function. Furniture clusters represents the existence of changing level of common characteristics of urban furniture.

We aimed to develop an interdisciplinary and comprehensive design model and apply this model to Ordu city as a solution to these problems. In the most research main focus is classification of furniture, evaluation of furniture, or specific features of urban furniture such as material, form, etc. The main distinctions of this research are; Executing an interdisciplinary study for urban furniture design process, definition of highly detailed and two-level hierarchical criteria set, evaluation of criteria based on the furniture types instead of design examples and developing quantitative methodology for scoring and clustering furniture based on criteria scores. Briefly, the proposed model defines a design process rather than an evaluation method for existing or designed urban furniture. Therefore, starting from the definition of design criteria, criterion scores, classification of urban furniture, site characteristics, main keywords of the design concept, it covers the early stages of the urban furniture design process, and the proposed design matrix helps to define key

features of urban furniture design.

Urban furniture is explained as synonym of "street furniture" in the Macmillan dictionary, which is defined as "things that have been placed at the side of a street, for example lights, road signs, and containers for rubbish". Because of the dilemma between private sphere of furniture and street as public space, Chris van Uffelen interprets a "street furniture" term as "absurd combination of words (Van Uffelen, 2010)". Added to this, street furniture are unmovable and usually bolted to floor confronting the word "mobile" which is the Latin origin of furniture (Van Uffelen, 2010). Another definition is "… elements introduced to outdoor spaces to provide comfort and convenience for the people who use them (Main & Hannah, 2010)" excluding some elements such as fire hydrants and water features (Main & Hannah, 2010). As the location of furniture is not limited with streets, we prefer to use "urban furniture". Added to this, design of furniture breaks the barriers and new names or definitions required to suppress differences such as "indoor furniture", "outdoor furniture", and "urban furniture". Definition of furniture as "design of movable, functional objects that support human activities such as tables, chairs, sofas, beds and storages (Sayuti et al., 2015)", also covers the urban furniture. Inclusion of living elements to the indoor furniture, namely, "biophilic design" increases the integration of nature and furniture design and attraction of users (Sayuti et al., 2015). Furniture with a living organism also can be evaluated as ecological and multi-functional characteristics of an urban furniture which connects with nature.

While urban furniture before industrial revolution are limited with the lantern, hitching post, and bench (Malt, 1970), the contemporary urban furniture have limitless function and characteristics. Even if some small objects given as example in the definition, extent of urban furniture might be expanded to include small buildings such as kiosks or public WC. Several examples in the book named "Furnitrecture: Furniture that transforms space" shows the space generating potential of furniture (Yudina, 2015) as an architectural unit. Even a "house was conceived as one large piece of wooden furniture" and "concrete storage items appear as architectural elements (Yudina, 2015)." Design of urban furniture differs from other product designs by its wide range of scale and interaction with urban space and public use. Therefore, Chi Ho In defined this variety as "very wide and diverse ranging from designing products and furniture, architecture, landscape and up to urban design" (In, 2011). This means that urban furniture needs to be designed as a multi-disciplinary and complex process requiring detailed analysis of the site in addition to the requirements of product design.

Several architects design furniture outside of the buildings such as Athlone bench of Keith Williams Architects, grandstand outdoor table of Push Architects, Modular outdoor seating of SLHO & Associates, prospect outdoor table of Push Architects or Seating stones of UNStudio (Fatih, 2013). Urban furniture is designed in a public space connecting use, architecture and nature; thus, it should be a product of a collaboration of different professions such as, industrial product designer, architect, urban designer, landscape architect, etc. according to the main characteristics of urban space and urban furniture. As Malt mentioned, "close relationship between client and designer during programming and design development helps ensure acceptability of the end product" (Malt, 1970). Although if the user is uncertain, visual appeal and user satisfaction are two very important criteria that should be reached. Sometimes aesthetic of the furniture or engendering/expressing cultural-architectural heritage defines the character of space and found successful by community (Main & Hannah, 2010). Visual coherence, eye-catching memorable image like red telephone booths of London, harmonious urban furniture design is important in terms for likeability of furniture and urban space. Form, color, texture, materials, and functionality helps to evaluate furniture design (Ghorab & Caymaz, 2014; Radwan & Morsy, 2016). On the other hand, comfort and ergonomics may lead the decision as pragmatic needs of user rather than aesthetic appearance

and according to the research, seating preferences of different ethnicities are similar in many ways (Lesan & Gjerde, 2021). Outdoor space with a furniture is a space that people stop and physical interaction with space starts and the existence of a furniture is an evidence that it was designed with people in mind (Main & Hannah, 2010). Orientation of furniture to each other can support social interaction or not. Location of urban furniture close to businesses and activities play important role in stimulating use (Lesan & Gjerde, 2021).

Design or evaluation criteria of urban furniture need to involve social and spatial environment characteristics, and furniture-based criteria together. A research that classifies urban furniture based on functions as: decorative elements, service furniture, leisure furniture, trade furniture, signaling furniture, and advertisement furniture and uses two different approaches to analyze all furniture: In the first approach, they consider environmental features as "social and cultural aspects", "commercial aspects", "landscape and environment", "ergonomic aspects", and "specifications and visual identity". The second approach compares formal and ergonomic aspects in relation with interface and integration via classification criteria of "preservation and maintenance", "ergonomics informative aspect", "visual pollution", "ergonomics interface and integration", and "publicity" (Mourthé & de Menezes, 2000). Even a single furniture has great potential to change close environment. Therefore, design dimensions of a single urban furniture also correspond physical, activity-use and meaning which classified as "shelter-protection", "tree-shade", "bordering", "lighting-bicycle park", "availability for different activities and uses", and "contribution to the urban identity, image and sense of space" for a sitting unit and expectation from the design is being "useful", "functional", and "creative" (Alpak et al., 2020).

2. Urban furniture design criteria

Street furnishing quickly changes the character of the city (Malt, 1970). Urban furniture can be a distinctive feature of a neighborhood but their role as a design element to solve every day problems (Broto & Krauel, 2010) or to add alternative uses to an urban space proves their validity. Coloring of furniture is a strategy to achieve inclusive design project and facilitates users' orientation (Gamito & da Silva, 2014). Recently, smart technologies also used in urban furniture that offers contextualized information and interactive services such as touch screen, audio, wayfinding, environmental sensors, charging station, mobile integration, wi-fi, and management software (Gómez-Carmona et al., 2019). While urban furniture spread out everywhere, they can be used for data collection that provide real-time data (Nassar et al., 2019).

Aesthetics is important for urban furniture as an art object, expression of cultural-architectural heritage, enhancing different experiences such as hearing sound of wind, etc., ability to maintain, function, symbolic meaning, identity, providing opportunities to disadvantageous people such as elderly or disabled, user profile, material, physical connection to nature, environmental value, color, style, configuration, expressing the notion of community, supporting multiple activities, ergonomics, hygiene, security and safety, are some other criteria to evaluate urban furniture (Main & Hannah, 2010). The "adaptation to changing spaces, durability or resistance to harsh atmospheric conditions or vandalism, versatility or multiple use and aesthetic value…" are evaluated as an inspiring criteria to designers (Broto & Krauel, 2010). Use of local material increases adaptation to the environmental condition, harmony with existing architecture (Şatir & Korkmaz, 2005), and supports local production and reduces carbon footprint as well as it is shown in the research on the use of Urfa stone in urban furniture design (Tel et al., 2021). Adaptation to diverse and changing urban spaces is achieved via enhancing the flexibility of urban furniture (Siu & Wong, 2015). Based on the industrial design awards in Turkey, criteria for good design are defined as "Novelty and innovation", "Functionality", "Aesthetics", "Sensitivity to Users", "Production Quality and Producibility", Con-

tribution to Brand and Potential for Competition", "Sensitivity to Society", and "Respect to Environment" and according to this research, award winning designs fulfill "innovation", "Functional superiority" and "Aesthetic superiority" (Hasdoğan, 2012). As urban furniture are located in easily accessible public open spaces importance of the "accessibility" of the furniture even do not noticed but the significance of an urban furniture is strongly connected to accessibility (Sanches & Frankel, 2010). Although most researches analyses main characteristics of urban furniture to discuss the urban furniture design and the involvement of users, or propose "social control" for safety (Ojani, 2019), praises gentrification of public areas to promote image of the city to investors (Gouvea & Mont'Alvão, 2013), another research argues the power of exclusion of the poor and homeless and evaluated as a hostile approach (Orhan & Atay, 2021).

3. Methodology

In this research an interdisciplinary and quantitative design model is proposed to facilitate urban furniture design process. This research consists of three stages; 1. Furniture Design Criteria and Scores: defining and scaling design criteria via workshop, 2. Urban furniture clusters: Grouping urban furniture with hierarchical cluster analysis based on criteria scores, 3. Design matrix: Integrating furniture designs based on criteria scores, furniture clusters and site analysis to define key features that can be used to create alternative design sets of urban furniture. First two stages define general principles of urban furniture design criteria while the design matrix designed to be a specific guide to design urban furniture for a particular area via combining local characteristics and furniture clusters.

The interdisciplinary workshop which is a first stage, had two sessions: In the first session urban furniture design discussed under four modules: The first module aims to discuss "urban furniture" term to reveal similarities and differences about terminology and design approach between related disciplines. In the second module, the characteristics on urban furniture were discussed. Design parameters which are, design criteria, prominent concepts, role of urban furniture in urban identity, and past and future of urban furniture design was the title of third module to be discussed. In the fourth module multi-disciplinary and participatory design process were questioned.

In this model we focused on design criteria and classification urban furniture based on the grading of all criteria, which are:

1. "*Production (P)*" is the first main criterion of urban furniture. This criterion has 5 sub-criteria related to the "Cost (P1)", "Ease of production (P2)", "Easy maintenance (P3)", "Ease of transport (P4)", and "User participation (P5)" to the production process.

2."*Location (L)*" is another criterion which is extended by eight sub-criteria: Historic area (L1), Housing area (L2), City center (L3), Rural area (L4), Seashore (L5), Park (L6), Square (L7), and Street/Road (L8).

3. "*Material (M)*" is one of the most important parameters to design an urban furniture. This parameter evaluated via fourteen sub-criteria: Durability (M1), Natural material (M2), Texture (M3), Color (M4), Transparency (M5), Technology (M6), Hygiene (M7), Light (M8), Simplicity (M9), Recycle (M10), User age group (M11), Local material (M12), Ground surface (M13), and Thermal comfort (M14).

4. "*Form (F)*" includes Dimensions (F1), Simplicity (F2), Repetition (F3), Singularity (F4), Being Areal (F5), Being Nodal (F6), Being Linear (F7), Being volumetric (F8), Figure-ground (F9), Figurativeness (F10), Contradiction (F11), Aesthetic (F12), and Perceptibility (F13) as sub criteria.

5. "*Unity (UN)*" represents harmony with urban area, other furniture and internal parts of each furniture. Therefore, Consistence to urban pattern (UN1), Color harmony (UN2), Morphological harmony (UN3), Harmony of material (UN4), Harmony to ground (UN5), Differentiation (UN6), and Dominance (UN7) are defined as sub-criteria of Unity.

6. "*Ecology (E)*" criteria include six sub-criteria related to the energy, material and water related factors:

Energy consumption (E1), Minimum material (E2), Local material (E3), Eco-friendly material (E4), Water consumption (E5), and Water permeability (E6).

7. "*Function (FN)*" is appeared as a basic criterion of all urban furniture which detailed by eleven sub-criteria as; Sitting-resting (FN1), Lighting (FN2), Informing (FN3), Transport-access (FN4), Flexibility (FN5), Multi functionality (FN6), Service providing (FN7), Guidance (FN8), Boundary setting (FN9), Shading (FN10), and Thermal comfort (FN11).

8."*Infrastructure (I)*" was already used a criterion for some special urban furniture such as billboards but use of technology in other urban furniture and multifunctionality increased the range of this criteria. Electric (I1), Internet (I2), Water (I3), Drainage (I4), and Smart systems (I5) defined as sub-criteria of Infrastructure.

9. "*Use (U)*" includes six sub-criteria: Ergonomics/comfort (U1), Accessibility (U2), Density(U3), Safety(U4), Protection(U5), and Functionality(U6)

10. "*Site Selection (S)*" is the last criteria used to evaluate urban furniture. This criterion differs from the "location" criteria because this criterion covers Intersection (S1), Road side (S2), Isolated area (S3), Main route (S4), Building front (S5), Visibility (S6), Close to activity (S7), Centrality (S8), and Safety (S9)

3.1. Scaling the furniture design criteria

In this research we applied scaling in three levels: Scaling 10 main criteria as leading factors of urban furniture design is the first level. The second level is scoring 84 sub-criteria and all design criteria for 30 urban furniture types are scored in the third level. Sixteen professional participants gave scores to main and sub-criteria. Five-point Likert scale from 1 to 5 is applied for grading. "1" means the least important criteria while "5" means the most important criteria. Then, criteria scores were given for each urban furniture. Mean score for each furniture calculated by scores of all participants. Two-level criteria evaluation matrix helps us to explore the existence and variations of most important features of each criterion in relation to the changing furniture.

Some furniture evaluated as "not major furniture" by some participants (P) and were not scored. These are: "Building façade flowerbed" (1P), "Cabstand" (3P), "Cashomat" (2P), "Flagpole" (1P), "Mukhtar's office" (4P), "Parking meter" (1P), "Peddler cart" (2P), "Public WC" (2P), "Ticket automat" (1P), "Traffic sign board" (1P), and "Transformer building" (4P). This method reveals that theoretical evaluation of criteria and sub criteria might differ from the evaluation of criteria based on specific urban furniture and this difference can be used to define common features or requirements of urban furniture clusters. The reliability of criteria scores given by 16 participants in the interdisciplinary workshop were analyzed via Cronbach's alpha (Cronbach, 1951) value. "When the measurements represent multiple questionnaire/test items, which is the most common application, Cronbach's alpha is referred to as a measure of "internal consistency" reliability" (Bonett & Wright, 2015). In our data set, the Cronbach's alpha value is calculated as 0,905 for all criteria which is very close to 1 that means the data is very reliable. We also calculated Cronbach's alpha value for main criteria and sub-criteria scores separately and get the 0,722 for the main criteria which is high enough and 0,900 for sub criteria which means the reliability increases when the detail level of criteria increases.

Three different scores analyzed comparatively: The main criteria scores, sub criteria scores for 30 urban furniture type and average values of sub-criteria scores based on each main criterion. A main criterion consists of several sub-criteria which can have changing level of importance. Therefore, sub-criteria give opportunity to think different aspects of main criteria. On the other hand, matching criteria and sub-criteria with various types of urban furniture changes the importance of criteria according to the main requirements of changing furniture types.

3.2. Cluster analysis for urban furniture

Urban furniture is generally grouped by their primary function. Joseph M. Serra classified furniture as "Urban layout and delimitation", "Rest", "Lighting", "Garden and water", "Communication", "Public service", "Commercial", "Cleaning" (Serra, 1996). Asatekin classified urban furniture under four groups based on use of space as follows;

1. Transient use: Paving and kerb elements classified under "transient use" for transportation. On the other hand, most of the furniture share location and some of them are multifunctional, therefore there is an interaction between different furniture and it is difficult to group multifunctional furniture by only criteria of "function".

2. Stationary use: Seating and canopy elements, kiosks are evaluated under this group. This use facilitates the use for a certain length of time.

3. Functional use: This group refers to meeting the needs of citizens such as street or bus stop names for location information, advertisements, posters for social information, traffic signs, etc. for convention information, public-address systems for general communication needs, drinking fountains for physiological needs.

4. Ancillary use: The needs that arise while using first three group is defined as separate group such as furniture related to service, maintenance, safety or spiritual needs. Lighting elements, bollards, railings, litter bins, etc. are some examples of these furniture (Asatekin, 2001).

Functionality is primary role of furniture which defines main role and essential requirements leading the design process. On the other hand, same furniture with different design is not expected to be located together but different furniture has to be located in same place to meet various needs of user such as resting, light, barrier between vehicles and pedestrians, shading elements, etc. Therefore, definition of common features or criteria for different furniture is needed to create a furniture set that answers various requirements of the place. Grouping furniture by their common features and using similar characteristics by their "family tree" instead of designing each furniture independent from each other generates harmony and using similar materials might reduce unit cost of material as well.

Grouping urban furniture based on the evaluations of criteria is another goal of this research. The cluster analysis is a quantitative method applied to the problem of grouping cases similar to procedures of factor analysis that grouping dependent variables (Revelle, 1979). Therefore, in this research average scores of ten criteria and eighty-four sub-criteria used to group furniture via hierarchical cluster analysis.

Hierarchical cluster analysis follows four steps: creating data matrix, standardize data matrix if required, measuring similarities among all pairs of objects and processing the similarity values which results in a diagram called a "dendrogram" that shows the hierarchy of similarities among all pairs of objects. (Romesburg, 2004).

Some participants prefer to group furniture by their main functions and gave scores as a group like the "park meter", "ticket automat", "advertising sign", and "billboard".

3.3. Design matrix

The design matrix integrates "all criteria", according to the criteria scores defined by an interdisciplinary workshop, "urban furniture", urban furniture clusters based on criteria scores and "local features" which can be used to define design concept. As the design matrix is a phase before urban furniture design, design criteria and local characteristics are used to define design concept and main characteristics of urban furniture such as identity, unity with environment via form, material, color, etc.

The design matrix is a summary of all criteria and all analyses on urban furniture. Each cluster and each furniture can be analyzed individually. The other advantage of this matrix is enabling comparative evaluation of criteria scores for clusters and all furniture. Some criteria are fundamental and have high scores for all furniture (Figure 1,c1), therefore important for all clusters. Some criteria are very important for only few furniture in one or few clusters (Figure 1,c2)

which are not the most fundamental criteria for all furniture but important for only few furniture. This reflects the closeness or similarity of furniture in the family tree of all furniture. If the criteria have high scores in all furniture in one cluster, this means that that cluster have more homogeneity related to that criterion which is critical for that cluster (Figure 1,c3). If two or more cluster have more common criteria scores, we can expect to have furniture that have more common features in these clusters than other clusters. Thus, columns and rows of this matrix gives information about furniture resemblances and criteria importance and interaction among clusters and criteria. These resemblances might help to designers to find similarities and common design features of urban furniture design. Design principles, form and material choices can be defined based on the common features and criteria within or between clusters in this design matrix.

4. Interdisciplinary urban furniture design model for the Ordu city

Ordu City is one of the growing cities which have rich natural environment and historic background. The city has 30 archeological, 2 urban, 1 urban and archeological, and 6 natural sites, 39 site areas in total and 475 protected buildings exist (Atabeyoğlu et al., 2019). Urban growth and co-existence of the modern urban development and traditional urban pattern brings together some problems related to urban design. Ordu has been facing the same challenging conditions just like any other city in the world which has cultural and historical layers. One obvious problem is the loss or change of identity in urban design and furniture design solutions.

This research arises from a professional project on "urban design guidelines and urban furniture design" for Ordu Municipality in Turkey. This brings together several advantages to improve our research: First of all, the expectation of tangible outputs rather than a theoretical research or guideline is a challenge and great opportunity to bring together the theory and practice via new interdisciplinary and quantitative urban furniture design method ending with furniture design alternatives. Secondly, evaluations of furniture design of municipalities are generally subjective and developing a quantitative and interdisciplinary model for Ordu municipality is critical as an objective method. In this research we restated urban furniture design process for Ordu city for the "urban design guidelines and urban furniture design" project.

Although our proposed model is a general model for urban furniture design, the rich characteristics of the Ordu city and financial support of the municipality makes it a good candidate as a study area to discuss wide variety of design criteria. Canik and Black Sea mountains, highland villages, new urban developments, traditional settlement with urban site area, and rich natural areas increase the social and spatial variety of the city.

Starting from the discussion on the criteria in relation with the list of 30 urban furniture types given by Ordu municipality, we calculated urban furniture clusters based on the criteria scores

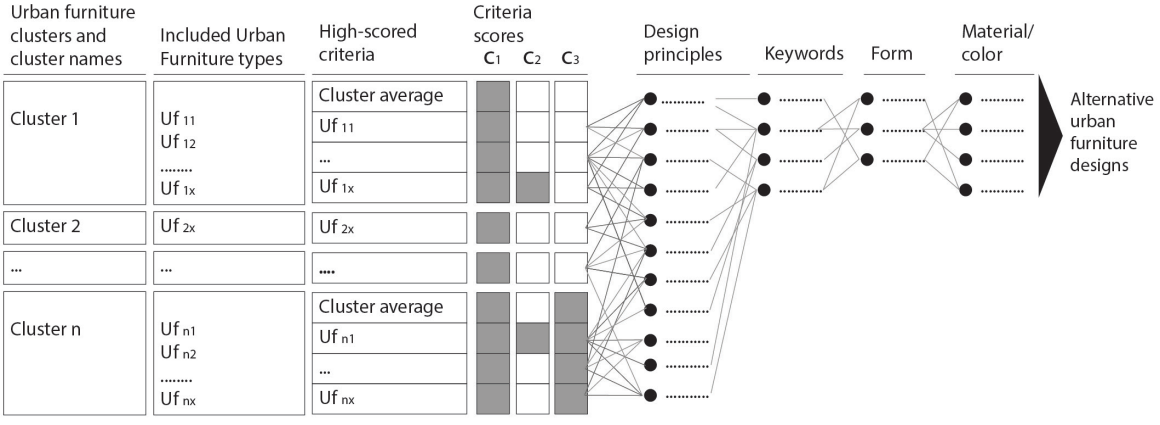

Figure 1. *Design matrix.*

and later on design matrix for Ordu city is created via using local characteristics. A fountain which is one of the 150 furniture designs and added here as an example.

The main stages of a model can be summarized as follows:

1. Definition of 10 main and 84 sub criteria for urban furniture design via interdisciplinary workshop
2. Criteria scoring as "Main criteria scores", "the average of sub-criteria scores for each main criterion", and "the average of sub-criteria scores for the given list of 30 urban furniture types".
3. Clustering furniture types based on the criteria scores via hierarchical cluster analysis.
4. Creating a specific design matrix for Ordu city which includes urban furniture clusters, keywords from local characteristics of Ordu, material, form alternatives and main design principles.
5. Based on the design matrix, five alternatives for each urban furniture are designed and one furniture is represented as an example to show the design approach and final product.

4.1. Criteria and scores

Urban furniture design criteria are finalized and main and sub criteria for 30 urban furniture types scored via workshop to be used as a guide in the design stage. Based on this grading the "Function (4.6 points)", "Material (4.6 points)", and "Production (4.7 points)" have highest values which are over 4.5 (Table 1). In the next stage, sub-criteria scores given and main criteria scores calculated based on the sub-criteria scores.

Criteria scores generally differ from the main criteria scores. This detailed scoring method helps to compare each sub-criteria score. Some sub-criteria have score that are lower than the score of the main criteria and reduces the mean value. On the other hand, order of the factors based on scores are also changed. The highest score is given to "Use (4.5 points)", "Ecology (4.4 points)" becomes second, and "Function (4.3 points)" and "Unity (4.3 points)" shared third degree (Table 1).

After the scoring of the sub-criteria, thirty urban furniture types evaluated by all criteria using Five-point Likert scale. The mean values of all urban furniture for each criterion are calculated. When criteria are matched with urban furniture, given scores tend to change. As the score of any criteria for the defined urban furniture increases, those criteria can be evaluated as main leading criteria and have great potential to be used to define common features and to create harmony between these urban furniture.

In the new scoring table, the score of the "Material" criteria is same as previous score. Main criteria "function" stays in the first degree by increasing score from 4.6 to 4.7. Score of "production" criteria decreased to 4.5 while "unity" criteria increased to 4.5 from 4.4 (Table 1).

Sub-criteria scores are different than main criteria scores. The most important sub-criteria found as "Durability" under "Material" criteria. All participants gave 5 points to "Durability". This criterion is essential for especially Ordu City which has harsh geographical conditions. "Functionality", "Aesthetic", and "Accessibility" have 4.9 as a mean criterion score of all participants. Difference of scores is seen in sub-criteria table as well. The most dramatic change is in "Accessibility" sub-criteria which decreased from 4.9 to 4.2. (Table 2).

Mean ranks value represents degree

Table 1. *Urban furniture design criteria scores.*

MAIN CRITERIA	MEAN OF MAIN CRITERIA SCORE	MEAN SUB-CRITERIA SCORES FOR EACH MAIN CRITERIA	MEAN SCORE FOR 30 URBAN FURNITURE	MEAN OF SUB CRITERIA SCORES FOR 30 UF. by MAIN CRITERIA
FN_FUNCTION	**4.6**	4.3	**4.7**	3.6
M_MATERIAL	**4.6**	4.1	**4.6**	3.8
P_PRODUCTION	**4.7**	4.0	**4.5**	4.0
UN_UNITY	4.4	4.3	**4.5**	4.0
E_ECOLOGY	4.5	4.4	4.3	3.8
U_USE	4.5	**4.5**	4.2	4.0
S_SITE SELECTION	4.3	3,8	4.2	3,8
I_INFRASTRUCTURE	3.7	3.8	3.9	3.6
F_FORM	3.9	3.9	3.9	3.6
L_LOCATION	3.9	3.8	3.7	3.7

of average scores of each participant. Sixteen sub-criteria have scores over 4 among all eighty-four sub-criteria. These sub-criteria with higher scores reveal that "material" (M1, P3, E4, UN4, U4), "visual characteristics" (F12, M4, F1, F13), and "unity to the environment" (UN5, UN1, U2, L7, M13, U6, S9) are distinguishing characteristics of urban furniture needed to be used to design new furniture.

Four main criteria and related 7 sub-criteria have highest scores. The four main criteria are: "Function", "Material", "Production" and "Use" with the scores sequentially 4,6; 4,6; 4,7; and 4,5. The highest scored sub-criteria is "Durability" under the main criteria "Material" with the score 5,0. Two sub-criteria are part of Function, which are "Aesthetic" with 4,9 score and "Perceptibility" with 4,8 score. The other two sub-criteria are "Functionality", and "Accessibility" with the scores 4,9. Although the average score of the main criteria "Ecology" is not one of the highest scored criteria, another high-scored sub-criterion is "Eco-friendly material" with 4,7 score. High consumption ratio of cities produces huge amount of waste and negative effect on the nature brings together new policies to convert waste into new materials. Research that propose recycling aggregates to produce concrete bench shows the technical feasibility of producing such benches (Sanchez-Roldan et al., 2020). The last high scored sub-criterion is "Easy maintenance" which is related to the "Production" main criteria. Therefore, these are preferred to be used in the design matrix to integrate different urban furniture.

Evaluations of urban furniture design criteria have some similarities and differences. The effect of disciplines on the criteria scores are analyzed in this research. 16 participants from industrial design (IndD: 3 participants), architecture (Arch: 2 participants), landscape architecture (LA: 5 participants), interior architecture (IntA: 1 participant), urban planning (UP:2 participants), industrial engineering (IEng: 1 participant), communication design (ComD: 1 participant), and software development (SD: 1 participant) disciplines joined the interdisciplinary workshop on urban furniture design. The scores of all participants are compared based on the discipline via Kruskal-Wallis test (Kruskal & Wallis, 1952) which is a nonparametric test that "does not require the fulfilment of assumptions of normal distribution, interval data and homogeneity of group variance" (Ostertagova et al., 2014). We used this test here to compare more than two independent samples to define whether discipline-based scores come from same statistical distribution. The significance value measured by Kruskal-Wallis test found for all criteria are "0.00" which means the difference exists in the variance of discipline scores (Table 3). Some disciplines have more similarity than others. Changing rank values represents the variations in the scores of disciplines. According to the mean rank values for each discipline for all criteria, Communication designer has highest rank (367) which means high criteria scores in general and Software developer has the lowest rank (151) corresponding the lowest criteria scores among nine disciplines. Additionally, the main criteria (Mc) rank (132) for Software engineer is lower than sub-criteria (Sc) rank (169). This might arise from the need of high sensitivity to the smallest details programming languages or the importance of the bug-free coding.

The ranks of the software developers are different for all main criteria (Mc) except "Ecology", "Infrastructure", and "Site selection". Communication designer did not score main crite-

Table 2. *Urban furniture design criteria scores.*

SUB-CRITERIA	SUB-CRITERIA SCORE	MEAN SCORE FOR 30 URBAN FURNITURE
M1_Durability	**5.0**	**4.7**
U6_Functionality	**4.9**	**4.5**
F12_Aesthetic	**4.9**	4.4
U2_Accessibility	**4.9**	4.2
F13_Perceptibility	**4.8**	4.3
E4_Eco-friendly material	**4.7**	4.2
P3_Easy maintenance	**4.6**	**4.5**
M4_Color	4.3	4.4
S9_Safety	4.6	4.4
UN5_Harmony to ground	4.5	4.3
M13_Ground surface	4.2	4.3
F1_Dimensions	4.2	4.2
L7_Square	4.5	4.2
U4_Safety	4.6	4.2
UN4_Harmony of material	4.5	4.2
UN1_Consistence to urban pattern	4.6	4.2

Table 3. *Kruskal-Wallis test results for the 10 Main criteria (Mc) and 84 sub criteria (Sc).*

				PRODUCTION			LOCATION			MATERIAL			FORM			UNITY			ECOLOGY			FUNCTION			INFRASTRUCTURE			USE			SITE SELECTION		
Kruskal-Wallis H					213.0	150.5		102.2	116.8		169.3	124.1		113.0	122.7		198.8	112.0		197.3	118.3		148.5	201.7		179.5	114.4		132.8	107.6		84.5	105.2
df					8	8		7	8		8	8		7	8		7	8		8	7		8	8		8	7		7	8		7	8
Asymp. Sig.					0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00
Ranks by discipline					Mean Rank			Mean Rank			Mean Rank			Mean Rank			Mean Rank			Mean Rank			Mean Rank			Mean Rank			Mean Rank			Mean Rank	
Mean ranks		Mc	Sc	N	Mc	Sc	N	Mc	Sc	N	Mc	Sc	N	Mc	Sc	N	Mc	Sc	N	Mc	Sc	N	Mc	Sc	N	Mc	Sc	N	Mc	Sc	N	Mc	Sc
Arch	253	235	272	**61**	**92**	248	61	305	339	61	155	225	61	227	251	61	296	308	61	250	271	61	245	264	61	312	308	61	218	200	61	250	301
ComD	**367**	339	384	31	351	437			347	31	310	413			383			241	31	362		31	311	434	31	365				393			424
IEng	230	247	213	31	351	292	31	176	191	31	310	**99**	31	245	231	31	325	156	31	183	218	31	301	299	31	157	212	**31**	**93**	240	31	328	191
IndD	260	266	254	62	302	176	62	232	217	62	267	286	62	342	324	62	280	325	62	311	287	62	268	286	62	190	188	62	289	219	62	183	227
IntA	266	284	248	31	318	**79**	31	314	153	31	281	277	31	223	**87**	31	295	348	31	328	276	31	282	352	31	200	311	31	305	357	31	298	243
LA	219	201	237	156	222	302	131	226	247	127	223	242	155	240	268	156	196	231	130	141	179	129	181	207	129	193	206	129	191	223	155	201	264
PrD	203	209	197	31	296	165	31	150	225	31	262	206	31	208	274	**31**	**111**	243	31	156	**89**	31	263	**76**	**31**	**79**	164	31	284	298	31	278	236
SD	**151**	132	169	**31**	**123**	131	**31**	**94**	**76**	**31**	**48**	**112**	**31**	**45**	**118**	**31**	**45**	**61**	31	183	339	**31**	**67**	206	62	298	330	**31**	**93**	224	31	328	**94**
UP	230	272	189	62	318	243	62	188	202	62	281	220	62	215	196	62	295	255	62	328	169	62	282	121	31	365	127	62	262	**145**	61	188	207
Total				496			440			467			464			465			470			469			469			438			463		

ria of "location", "form", "unity", "use", and "site selection" and sub criteria of "ecology", and "infrastructure" Main criteria scores of Architects (Arch), Product designers (PrD), and Industrial designers (IndD) are differing from other disciplines in only one criterion, which are, "P", "Un", and "U" sequentially. On the other hand, the ranks of the average values of sub-criteria (Sc) scores gave different results: The ranks of software development discipline are different than others in five criteria scores among 10 main criteria. Average sub criteria scores of interior architects for "production" and form" separates from the other disciplines. Surprisingly Industrial engineer's scores have lowest rank for the variance of average scores of "Material" sub-criteria. Unlike the sub-criteria scores, main criteria rank for "material" is calculated as highest for Industrial engineer and communication designer. The reason of this difference might cause by advanced knowledge of industrial engineers on materials that lead more critical evaluations decreasing sub-criteria scores related to urban furniture design. Ranks of each discipline scores for main and average sub-criteria grouped by main criteria shows that all disciplines have some differences but there is a larger distinction between communication designer and software developer and all other disciplines.

4.2. Urban furniture clusters

The second trivet of design matrix is grouping urban furniture. In this research we used the furniture scoring to execute cluster analysis. Following dendrogram graph of hierarchical cluster analysis shows the groups of thirty urban furniture. According to the dendrogram graph, all furniture can be grouped as seven clusters (Figure 2). In this graph, x axis shows the rescaled distances between furniture to define clusters and y axis shows the name and ID number of all furniture.

The clusters have different characteristics, therefore average cluster scores also change based on the features and importance of included furniture. Cluster 6 which includes light elements and sitting unit has highest cluster score (Table 4) as two primary urban furniture. On the other hand, Cluster 5 which includes only transformer building has lowest score reflecting the lowest interaction with users.

Production, function and material are prominent criteria among all clusters. Theoretical scores of all criteria and scores based on the specific furniture also differs from each other. Although production, material and function criteria have highest scores for all clusters, there are some differences in criteria and sub-criteria scores between each cluster. We used sub-criteria having 4,5 or more scores among all 84 sub-crite-

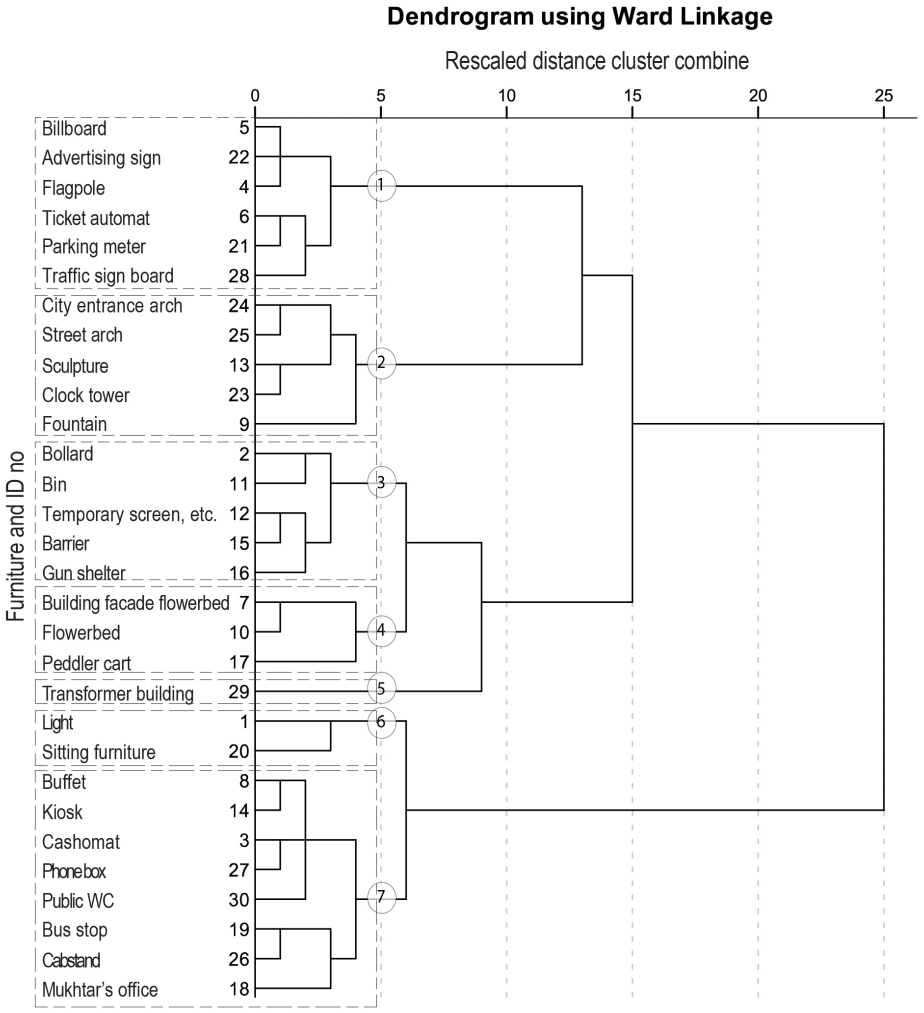

Figure 2. *Dendrogram graph for the classification of urban furniture based on design criteria scores.*

Table 4. *Average cluster and criteria scores.*

Cluster name	Furnitures		Cluster Score	P_PRODUCTION	L_LOCATION	M_MATERIAL	F_FORM	UN_UNITY	E_ECOLOGY	FN_FUNCTION	I_INFRASTRUCTURI	U_USE	S_SITE SELECTION
CL1: Info/management furniture	Billboard, Advertising sign, Flagpole, Ticket automat, Parking meter, Traffic sign board		3,8	4,6	3,5	4,5	3,9	4,5	4,3	**4,7**	3,9	4,1	4,1
CL2: Sculptural furniture	City entrance arch, Street arch, Sculpture, Clock tower, Fountain		3,8	4,5	3,7	**4,7**	4,0	4,5	4,3	**4,7**	3,9	4,2	4,1
CL3: Infrastructural furniture	Bollard, Bin, Temporary screen, Barrier, Gun shelter		3,7	4,6	3,6	4,6	4,0	4,5	4,4	**4,8**	3,6	4,2	4,1
CL4: Living furniture	Building facade flowerbed, Flowerbed, Peddler cart		3,7	4,6	3,8	4,6	3,9	4,4	4,4	**4,7**	4,0	4,4	4,4
CL5: Transformer	Transformer building	Min	3,4	4,4	3,6	**4,4**	3,3	4,0	4,2	**4,4**	4,2	3,4	4,0
CL6: Basic furniture	Light, Sitting furniture	Max	**4,0**	4,6	3,6	**4,7**	3,9	4,5	4,4	**4,7**	3,9	4,3	4,0
CL7: Architectural furniture	Buffet, Kiosque, Cashomat, Phone box, Public WC, Bus stop, Cabstand, Mukhtar's office		3,9	4,5	3,7	4,5	3,9	4,5	4,3	**4,6**	4,1	4,3	4,2

ria. Although the average value of some sub-criteria of cluster is 4,4 some furniture in the clusters gets 4,5 or higher scores. Therefore, those sub-criteria were included to the tables. The first cluster mainly contains furniture related to the information and technology use and named as "Info/management furniture". The criteria related to the functionality and durability have high scores in this cluster. Scores of "P3, M1, M4, M6, and U6" for the furniture in

the cluster 1 is 4,5 or higher (Table 5).

The main characteristics of cluster 2 is having sculpture effect and visual dominance such as clock tower. This cluster named as "sculptural furniture" and as it is expected, added to "M1", "F12" and "F13" scores for all furniture in this cluster is higher than other criteria (Table 5). Only 7 sub-criteria among 84 have 4,4 or more scores.

Cluster 3 includes barriers, bollard, gun shelter, and temporary screen which meet the functional and compulsory needs; therefore, this cluster is named as "Infrastructural furniture".

Easy maintenance and Durability are two highest-scored criteria for the cluster 4. Flowerbeds needs to meet some specific requirements of plants and peddler chart needs to adapt changing spatial and environmental conditions; thus, maintenance and durability are defined as most important criteria for cluster 4; "Living furniture" (Table 6).

The transformer building is separated from all other furniture as only furniture in the Cluster 5: "Transformer", because of its special features such as function, safety requirements, architecture and form. Four participants denoted that the transformer building should not be evaluated as one of main urban furniture. These buildings generally located in green areas and sometimes within the parks, but there is no interaction with users, conversely, the

Table 5. *High-scored criteria and criteria scores of the furniture in the Clusters 1-2 and 3.*

		Urban Furniture Clusters																				
		CL1							CL2						CL3							
Criteria and Sub-criteria	CRITERIA score	Advertising sign	Billboard	Flagpole	Parking meter	Ticket automat	Traffic sign board	**CL1 Average**	City entrance arch	Clock tower	Fountain	Sculpture	Street arch	**CL2 Average**	Barrier	Bin	Bollard	Gun shelter	Temporary screen	**CL3 Average**
P_PRODUCTION	4,7	4,6	4,6	4,6	4,7	4,6	4,5	4,6	4,4	4,4	4,6	4,4	4,5	4,5	4,6	4,5	4,6	4,6	4,6	4,6
M_MATERIAL	4,6	4,6	4,6	4,6	4,5	4,6	4,2	4,6	4,7	4,7	4,7	4,7	4,7	4,7	4,4	4,7	4,6	4,5	4,5	4,6
UN_UNITY	4,4	4,5	4,5	4,5	4,5	4,5	4,6	4,5	4,5	4,5	4,5	4,5	4,4	4,5	4,6	4,5	4,5	4,4	4,5	4,5
E_ECOLOGY	4,5	4,4	4,4	4,3	4,4	4,3	4,3	4,4	4,4	4,2	4,2	4,4	4,5	4,3	4,4	4,3	4,4	4,4	4,4	4,4
FN_FUNCTION	4,6	4,7	4,7	4,7	4,8	4,7	4,5	4,7	4,7	4,6	4,6	4,7	4,7	4,7	4,9	4,6	4,7	4,9	4,8	4,8
P1_Cost	4,4	4,3	4,3	4,2	4,3	4,1	4,3	4,3	3,4	3,3	3,4	3,3	3,5	3,4	4,7	4,3	4,3	4,7	4,5	4,5
P2_Ease of production	4,1	4,3	4,3	4,3	4,1	3,9	4,4	4,2	3,7	3,4	3,5	3,5	3,9	3,6	4,3	4,3	4,5	4,5	4,3	4,4
P3_Easy maintenance	4,6	4,8	4,8	4,8	4,9	4,6	4,7	4,7	4,1	4,1	4,2	4,2	4,4	4,2	4,7	4,7	4,8	4,7	4,5	4,7
P4_Ease of transport	3,8	4,3	4,3	4,4	4,5	4,3	4,3	4,3	3,8	3,3	3,3	4,0	4,2	3,7	4,3	4,4	4,6	4,5	4,6	4,5
L1_Historic area	4,3	3,2	3,2	3,8	3,8	3,8	3,6	3,7	4,2	4,6	4,4	4,3	4,5	4,4	4,3	4,0	3,9	4,2	3,6	4,0
L6_Park	4,0	3,4	3,5	3,5	3,5	3,5	3,2	3,5	3,3	3,8	4,5	4,2	3,4	3,8	3,8	4,4	4,1	3,6	3,2	3,8
L7_Square	4,5	4,4	4,4	4,2	3,9	4,1	3,9	4,2	3,6	4,5	4,5	4,5	3,9	4,2	3,9	4,5	4,3	3,9	3,4	4,0
M1_Durability	5,0	4,7	4,7	4,7	4,9	4,6	4,6	4,8	4,9	4,8	4,6	4,8	4,9	4,8	4,7	4,7	4,9	4,7	4,5	4,7
M4_Color	4,3	4,5	4,5	4,5	4,6	4,6	4,1	4,4	4,3	4,5	4,5	4,3	4,3	4,4	4,5	4,4	4,3	4,1	4,3	4,3
M6_Technology	4,2	4,6	4,6	4,3	4,8	4,6	4,3	4,5	3,5	3,9	4,0	3,3	3,5	3,6	2,9	3,6	3,6	3,4	3,5	3,4
M7_Hygiene	4,4	3,3	3,3	3,5	3,8	3,8	3,4	3,6	2,7	3,3	4,4	2,8	3,0	3,2	4,3	4,6	3,3	4,3	4,0	4,1
M13_Ground surface	4,2	4,3	4,3	4,6	4,3	4,4	4,1	4,3	4,1	4,7	4,7	4,5	4,1	4,4	4,5	4,5	4,4	4,5	4,2	4,4
F1_Dimensions	4,2	4,1	4,1	4,1	4,3	4,1	4,6	4,2	4,1	4,3	4,2	4,1	4,1	4,1	4,3	4,1	4,3	4,3	4,4	4,3
F3_Repetition	3,5	4,4	4,3	4,4	4,4	4,3	4,5	4,2	2,9	2,4	2,9	2,6	3,3	2,8	4,4	4,1	4,3	4,5	4,3	4,3
F9_Figure-ground	4,6	3,9	3,9	4,3	4,1	4,1	3,6	4,1	3,9	4,5	4,6	4,4	4,0	4,3	4,4	4,3	4,3	4,5	4,3	4,4
F12_Aesthetic	4,9	4,1	4,1	4,3	4,0	4,1	4,1	4,2	4,6	4,7	4,8	4,7	4,5	4,6	4,4	4,4	4,4	4,3	4,3	4,4
F13_Perceptibility	4,8	4,5	4,5	4,3	4,2	4,3	4,6	4,4	4,5	4,6	4,6	4,5	4,4	4,5	4,1	4,3	4,3	4,1	4,1	4,2
UN5_Harmony to ground	4,5	4,1	4,1	4,4	4,2	4,3	3,9	4,2	4,2	4,4	4,6	4,4	4,4	4,4	4,5	4,6	4,4	4,5	4,3	4,5
FN3_Informing	4,7	4,7	4,7	4,1	4,4	4,5	4,0	4,4	4,1	4,1	3,1	3,9	4,1	3,8	3,3	3,1	3,0	3,1	3,7	3,2
FN4_Transport-access	4,9	4,1	4,1	4,0	4,7	4,8	4,6	4,5	3,5	3,6	3,8	3,4	3,4	3,5	3,7	3,7	3,8	3,3	3,8	3,7
FN6_Multi functionality	4,5	3,1	3,1	3,3	3,8	4,0	2,9	3,5	3,5	3,7	3,7	3,5	3,7	3,6	3,6	3,8	3,6	3,4	3,9	3,7
FN7_Service providing	4,1	3,6	3,6	3,4	4,3	4,4	4,4	4,0	3,3	3,5	3,6	3,0	3,4	3,4	3,3	3,5	3,1	3,3	3,5	3,4
I1_Electric	4,0	4,7	4,7	3,8	4,7	4,4	4,2	4,3	3,9	4,0	2,9	3,6	3,9	3,7	2,9	2,6	3,3	3,0	3,1	3,0
I5_Smart systems	4,2	4,5	4,6	4,0	4,5	4,5	4,4	4,4	3,7	3,9	3,6	3,6	3,7	3,7	3,1	3,4	3,4	3,7	3,4	3,4
U1_Ergonomy/comfort	4,7	3,2	3,2	3,4	4,1	4,0	3,4	3,7	3,1	3,9	4,5	3,1	3,3	3,6	3,8	3,9	3,3	3,4	3,6	3,6
U2_Accessibility	4,9	3,9	3,9	3,7	4,8	4,5	4,5	4,3	3,8	4,2	4,4	4,1	3,9	4,1	3,9	4,1	3,8	3,9	4,1	3,9
U4_Safety	4,6	3,6	3,6	3,6	4,1	3,7	4,6	4,0	3,7	4,0	4,2	3,9	3,9	3,9	4,8	3,7	4,5	4,1	4,7	4,4
U6_Functionality	4,9	4,3	4,3	4,5	4,8	4,6	4,5	4,5	4,1	4,2	4,3	4,1	4,2	4,2	4,4	4,5	4,6	4,5	4,4	4,5
S7_Close to activity	4,5	4,2	4,2	4,1	4,3	4,2	4,3	4,3	3,2	3,5	3,9	3,4	3,4	3,5	3,8	4,2	3,5	3,5	3,5	3,7
S9_Safety	4,6	4,2	4,2	4,2	4,5	4,3	4,6	4,4	3,9	4,2	4,1	3,9	4,2	4,1	4,6	4,3	4,4	4,4	4,7	4,5

isolation and secure design of these elements are more important. Because its special character, the highest scores for this building is 4,4 (Table 6).

The cluster 6; "Basic furniture" contains sitting furniture and light have 17 criteria that has scores 4,4 or up and 11 of them are higher than 4,4. This reflects importance and prevalence of these two-basic urban furniture.

Cluster 7, "Architectural furniture", contains mainly building-like large elements that user can go inside or defines a volume larger than a human. These are have most arguable elements which are subject to the questions related to the membership of urban furniture set (Table 6). Even though these are large elements and some of them are buildings, their location in the public open spaces and interaction with people make us evaluate these elements a kind of public furniture. Moreover, design of these elements effects the character of open spaces and all other urban furniture and an interdisciplinary design

Table 6. *High-scored criteria and criteria scores of the furniture in the Clusters 4-5-6 and 7.*

	Urban Furniture Clusters																	
		CL4				CL5	CL6			CL7								
Criteria and Sub-criteria	CRITERIA score	Building facade flowerbed	Flowerbed	Peddler cart	CL4 Average	CL5: Transformer building	Light	Sitting furniture	CL6 Average	Buffet	Bus stop	Cabstand	Cashomat	Kiosque	Mukhtar' s office	Phone box	Public WC	CL7 Average
P PRODUCTION	4,7	4,5	4,6	4,5	4,6	4,4	4,6	4,6	4,6	4,5	4,6	4,5	4,3	4,5	4,4	4,6	4,5	4,5
M MATERIAL	4,6	4,7	4,6	4,6	4,6	4,4	4,6	4,7	4,7	4,6	4,6	4,6	4,5	4,6	4,4	4,5	4,5	4,5
UN UNITY	4,4	4,4	4,5	4,3	4,4	4,0	4,5	4,5	4,5	4,5	4,6	4,6	4,5	4,5	4,4	4,5	4,3	4,5
E ECOLOGY	4,5	4,4	4,4	4,4	4,4	4,2	4,4	4,5	4,4	4,4	4,4	4,4	4,3	4,4	4,0	4,3	4,3	4,3
FN FUNCTION	4,6	4,7	4,7	4,8	4,7	4,4	4,7	4,7	4,7	4,6	4,7	4,5	4,7	4,7	4,4	4,7	4,6	4,6
P1 Cost	4,4	4,1	4,1	4,2	4,1	4,0	4,5	4,4	4,4	4,4	4,5	4,2	4,1	4,3	4,3	4,1	4,2	4,3
P2 Ease of production	4,1	4,4	4,3	4,5	4,4	4,4	4,1	4,3	4,2	3,8	4,1	4,1	3,8	3,9	4,3	4,2	4,1	4,0
P3 Easy maintenance	4,6	4,8	4,8	4,7	4,8	4,2	4,7	4,9	4,8	4,0	4,3	4,2	4,3	4,3	4,3	4,5	4,4	4,3
P4 Ease of transport	3,8	4,4	4,3	4,4	4,4	3,2	4,5	4,5	4,5	3,0	3,3	2,9	3,8	3,1	3,1	3,9	3,2	3,3
L1 Historic area	4,3	4,1	4,3	3,8	4,0	3,7	4,1	4,4	4,2	3,9	4,3	4,2	3,8	3,9	4,1	4,4	3,9	4,1
L6 Park	4,0	3,3	4,3	3,9	3,8	3,7	4,4	4,4	4,4	3,5	3,5	3,5	3,5	3,9	3,4	3,5	4,2	3,6
L7 Square	4,5	4,0	4,3	4,4	4,3	3,4	4,6	4,6	4,6	4,4	4,4	4,5	4,4	4,5	4,4	4,5	4,4	4,4
M1 Durability	5,0	4,8	4,8	4,8	4,8	4,4	4,8	4,9	4,8	4,8	4,6	4,5	4,7	4,6	4,4	4,4	4,7	4,6
M4 Color	4,3	4,3	4,5	4,2	4,3	4,0	4,6	4,5	4,5	4,5	4,5	4,3	4,3	4,3	4,1	4,4	4,4	4,4
M6 Technology	4,2	3,1	3,1	3,9	3,4	4,3	4,8	3,8	4,3	4,1	4,4	4,4	4,6	4,2	3,8	4,4	4,5	4,3
M7 Hygiene	4,4	3,4	3,6	4,3	3,8	3,1	3,7	4,4	4,1	4,7	4,6	4,4	4,4	4,6	4,4	4,2	4,8	4,5
M13 Ground surface	4,2	3,6	4,2	3,5	3,7	4,0	4,5	4,4	4,5	4,3	4,4	3,9	4,1	4,5	4,0	4,2	4,1	4,2
F1 Dimensions	4,2	4,5	4,2	4,6	4,4	4,0	4,3	4,3	4,3	4,1	4,2	4,1	3,9	4,1	4,4	4,4	3,9	4,2
F3 Repetition	3,5	3,8	3,8	3,7	3,7	3,8	4,6	4,3	4,4	3,9	4,0	3,5	3,7	3,6	2,9	4,2	3,5	3,7
F9 Figure-ground	4,6	3,7	4,2	3,2	3,7	3,8	4,5	4,3	4,4	4,1	4,3	3,9	3,9	3,8	3,7	4,0	3,8	3,9
F12 Aesthetic	4,9	4,5	4,4	4,1	4,3	4,3	4,5	4,4	4,4	4,4	4,8	4,8	4,6	4,6	4,4	4,4	4,6	4,6
F13 Perceptibility	4,8	3,9	3,9	3,8	3,8	3,1	4,5	4,0	4,2	4,5	4,6	4,8	4,6	4,6	4,1	4,6	4,5	4,5
UN5 Harmony to ground	4,5	4,0	4,4	3,9	4,1	4,0	4,4	4,5	4,5	4,3	4,4	3,8	4,3	4,4	3,9	4,4	4,2	4,2
FN3 Informing	4,7	3,0	3,1	3,2	3,1	3,4	3,5	3,1	3,3	3,7	4,8	4,3	3,9	3,9	4,4	4,2	3,3	4,1
FN4 Transport-access	4,9	3,1	3,5	3,8	3,5	2,9	4,3	3,8	4,1	4,3	4,8	4,9	4,1	4,3	4,6	4,3	4,4	4,5
FN6 Multi functionality	4,5	4,2	4,3	3,6	4,1	2,6	4,2	4,5	4,4	4,3	4,4	4,3	3,4	4,1	4,2	3,8	3,7	4,0
FN7 Service providing	4,1	3,1	3,2	4,5	3,6	3,9	4,1	3,9	4,0	4,8	4,6	4,8	4,3	4,8	4,2	4,6	4,4	4,6
I1 Electric	4,0	3,2	3,2	4,0	3,5	4,4	4,9	3,6	4,3	4,5	4,7	5,0	4,3	4,3	4,5	4,6	4,2	4,5
I5 Smart systems	4,2	3,6	3,6	3,7	3,6	4,1	4,7	4,1	4,4	4,3	4,7	4,8	4,3	4,3	4,5	4,6	4,3	4,5
U1 Ergonomy/comfort	4,7	3,2	3,7	4,3	3,8	2,7	4,1	4,7	4,4	4,2	4,7	4,3	4,1	4,2	4,4	4,1	4,6	4,3
U2 Accessibility	4,9	3,9	4,1	4,2	4,0	2,8	4,3	4,7	4,5	4,9	4,8	4,9	4,4	4,7	4,3	4,6	4,6	4,7
U4 Safety	4,6	4,0	4,3	4,5	4,2	3,7	4,3	4,6	4,5	4,6	4,9	4,5	4,4	4,3	4,3	4,5	4,4	4,5
U6 Functionality	4,9	4,3	4,6	4,8	4,5	4,0	4,7	4,8	4,8	4,9	4,9	4,9	4,6	4,6	4,1	4,6	4,7	4,7
S7 Close to activity	4,5	3,2	3,5	4,3	3,7	2,5	4,4	4,4	4,4	4,4	4,3	4,3	3,9	4,3	3,8	4,3	4,2	4,2
S9 Safety	4,6	4,1	4,2	4,5	4,3	4,3	4,7	4,7	4,7	4,7	4,5	4,4	4,4	4,4	4,3	4,5	4,4	4,4

process have a potential to create harmony between these elements, other furniture and close environment.

4.3. Design matrix for Ordu city

The Ordu city has 96,56 km seashore including several bays and gulfs, and 60 km sandy beaches in the Black Sea Region in Turkey (Atabeyoğlu, 2014) but most of the land in the city is highland and the city is built on the hilly topography. Therefore, "ease of transport" and "ground surface" for urban furniture are two distinguishing criteria. Topographical variations also change the vegetation, urban pattern, micro-climate. Four different sub-climate types of Warm temperate and boreal climate can be seen in Ordu city (Ozturk et al., 2017) and 143 days of the year are rainy on average, which highlights the "material", "durability", "safety" and "easy maintenance" criteria for urban furniture design. Natural, architectural, social structure and climate needs to be analyzed carefully in the design, evaluation, or selection process of urban furniture (Ghorab & Caymaz, 2014). The research on playground areas in Akyazı neighborhood in Ordu city reveals that many urban furniture in the playground are broken and worn, covers are not suitable for rainy climate, ground materials are not durable, transformer buildings are not well isolated from the playground areas and light elements are not working well and causes safety issues (Yeşil & Beyli, 2018). Imitation of western culture in designing urban furniture without giving much attention to the vernacular, climatic and cultural conditions is stated as a problem in Iran (Allahdadi, 2017). Marzieh Allahdadi proposed a conceptual research process starting from social-cultural design to design criteria on "urban landscape", "urban spaces", and "urban furniture" reaching creation of interaction and human satisfaction in urban furniture design (Allahdadi, 2017).

Based on the site analysis and meeting with Ordu municipality and several public foundations, it can be said that the city is exceptionally rich in nature, many of the keywords are related to its natural features becomes prominent in our research such as "seashore", "hazelnut", "fishery", "anchovy (fish)", "Boztepe (hill)", "indigo blue", "mountain-sea-city", "nature", "fog", "waterfalls", "highland". Urban furniture design matrix summarizes prominent criteria for all clusters and keywords from local features, design principles, forms and materials to be used in furniture design (Table 7).

Some criteria for few furniture have high scores in only one cluster such as "L1", "P1", "L6", "M4", "M6", "M7", "F1", "F9", "FN3", "FN6", "FN7", "I5", "U1", "S7". Even though these criteria are critical for some urban furniture, the main goal of design matrix is finding the common criteria to use as backbone for the design of all urban furniture set. Therefore, these criteria were excluded from the simplified table which is a part of the design matrix (Table 7). Average criteria scores of each cluster for high scored criteria is given in the Table 7 and colored according to the score value.

Number of high-scored criteria and variability of criteria scores shows importance and homogeneity of furniture characteristics. Average cluster score of all criteria, amount of furniture in each criterion, standard deviation, and variance are given in the "Integrity/importance" parameter in the design matrix is calculated via dividing number of high-scored (4,5 or more) criteria to the amount of furniture. This analysis confirms that the Cluster 6 is more prominent cluster with high average cluster score, lowest variance and highest "integrity/importance" values.

Selection of form and material was the next step to design urban furniture. This matrix used as a base for all furniture to be designed as a part of design set. Urban furniture designed according to the prominent design principles, concepts, forms and materials in Ordu case. Combination of seven design criteria; "microclimatic design", "multifunctionality", "interactive", "modular", "self-supporting", "flexible", and "adaptable", six different keywords for local concepts; "water (sea-river-waterfall)", "textile", "waves", "topography", "vegetation", "urban form" , three basic form; "linear", "curvilinear" and "triangular", and six different materials; "concrete,

Table 7. *Urban furniture design matrix for Ordu city.*

		High scored criteria															Variability measures									
Cluster name	Furnitures	P2_Ease of production	*P3_Easy maintenance*	P4_Ease of transport	L7_Square	**M1_Durability**	*M4_Color*	*M13_Ground surface*	*F12_Aesthetic*	F13_Perceptibility	UN5_Harmony to ground	FN4_Transport-access	I1_Electric	U2_Accessibility	U4_Safety	**U6_Functionality**	S9_Safety	**Cluster Score**	Number of furniture	Std. Deviation (All criteria)	Variance (All criteria)	Std. Deviation (min. criteria score 4,5)	Variance (min. criteria score 4,5)	Number of Sub-criteria (4,5 or more)	Integrity/importance	Keywords	Design principles	Form	Material
CL1: Info/ management furniture	Billboard, Advertising sign, Flagpole, Ticket automat, Parking meter, Traffic sign board		4,8			**4,7**	4,5	4,4		4,4		4,4	4,4			4,5		3,8	6	0,19	0,05	0,13	0,02	5	0,8	Sea, river, Textile, Urban form, Vegetation, Waves, Topography	Microclimatic, Multifunctional, Interactive, Self-supporting, Flexible, Adaptive	Linear, Curvilinear, Triangular	Concrete, Wood, Metal, Corten, Plexy, Glass
CL2: Sculptural furniture	City entrance arch, Street arch, Sculpture, Clock tower, Fountain					4,8	4,4	4,4	4,6	4,5	4,4							3,8	5	0,24	0,08	0,08	0,01	3	0,6				
CL3: Infrastructural furniture	Bollard, Bin, Temporary screen, Barrier, Gun shelter	4,4	4,7	4,5		4,7		4,4	4,4		4,5				4,4	4,5	4,5	3,7	5	0,23	0,07	0,12	0,02	7	1,4				
CL4: Living furniture	Building facade flowerbed, Flowerbed, Peddler cart	4,4	4,8	4,4		4,8										4,5		3,7	3	0,25	0,09	0,08	0,01	3	1,0				
CL5: Transformer	Transformer building	4,4				4,4							4,4					3,4	1	-	-	-	-	-	-				
CL6: Basic furniture	Light, Sitting furniture		4,8	4,5	4,6	4,8	4,5	4,5	4,4		4,5			4,5	4,5	4,8	4,7	**4,0**	2	0,24	0,11	0,06	0,01	11	5,5				
CL7: Architectural furniture	Buffet, Kiosk, Cashomat, Phone box, Public WC, Bus stop, Cabstand, Mukhtar's Office				4,4	4,6	4,4		4,6	4,5		4,5		4,7	4,5	4,7	4,4	3,9	8	0,24	0,07	0,17	0,03	9	1,1				

"wood", "metal", "corten", "plexy", and "glass", helped to create more than two hundred furniture design for thirty furniture which are harmonious and adapted to the urban identity.

Thus, we created the design matrix for Ordu city and 150 alternative urban furniture designed by us as an interdisciplinary group of designers via using this matrix. As Jim Postell suppressed, "In a sense, designers do not design furnishings, designers design systems—creating larger systems out of smaller subsystems—and we design systems to integrate within larger systems (Postell, 2012)" Similarly, we proposed a design model and, only a fountain designed is represented here to show the integration of design matrix for the Ordu city and furniture design rather than adding more examples of design.

The selected Fountain is in the second (sculptural furniture) cluster. "Durability (M1)", "Color (M4)", "Ground surface (M13)", "Aesthetic (F12)", "Perceptibility (F13)", and "Harmony to ground (UN5)" are high scored criteria for the fountain (Figure 3,a). As a durable and harmonious material, "c\25 class colored precast concrete" is selected for the fountain design. Multi-functional design with waterfall for kids and water reservoir for animals creates lively place and increases the attraction. Two colors, dynamic geometry of design and water surface enable to adapt various grounds. High- and low-level Bibcock and animal friendly water reservoir creates more comfort for all potential users (Figure 3,b).

5. Conclusion

Urban furniture is a special component that effects urban environment which requires a collaborative work of many disciplines to design better urban environments. Each stage of the interdisciplinary urban furniture design model development process reveals critical evaluations. First of all, interdisciplinary workshop reveals that, urban furniture design approaches variates. Therefore, learning from the other disciplines experience via an interdisciplinary study enriches the design process. Secondly, quantitative evaluation of design criteria simplifies to find common features and most critical criteria set. In this model, criteria scores collected via three

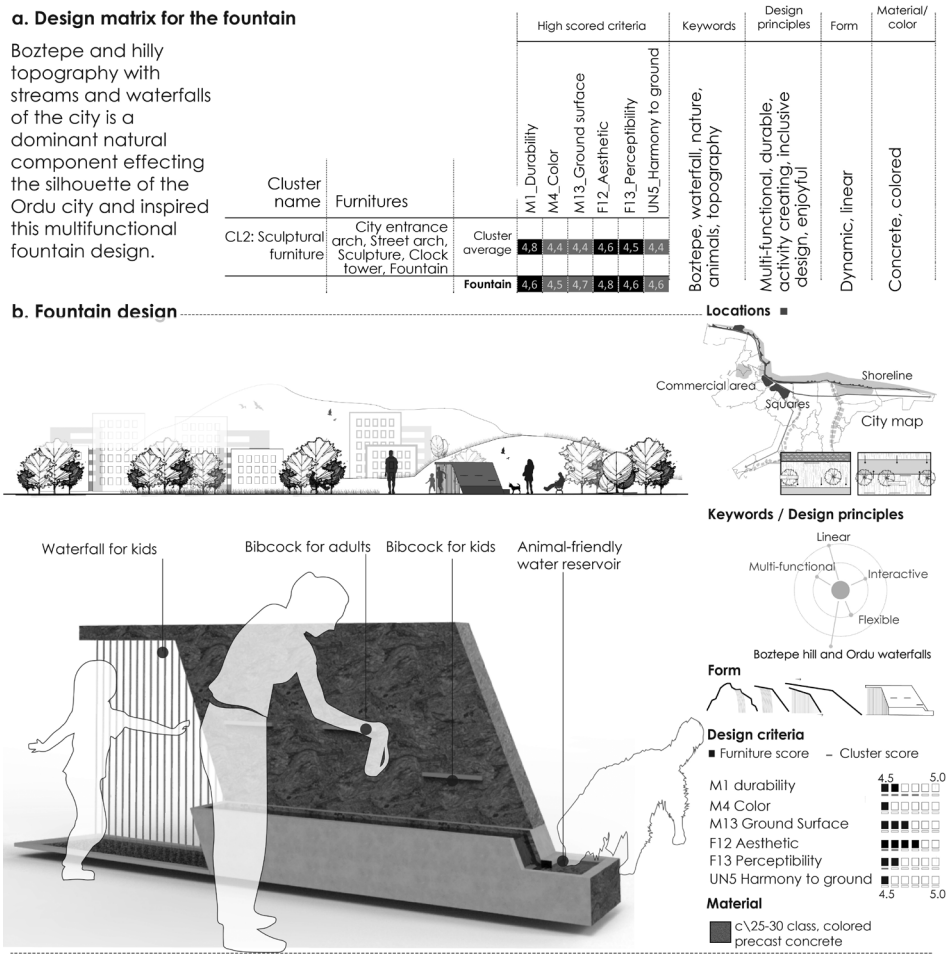

Figure 3. *Fountain design based on the design matrix for Ordu city.*

different ways: "Main criteria scores", "the average of sub-criteria scores for each main criterion", and "the average of sub-criteria scores for the given list of 30 urban furniture". Responses for each method are compared and we can say that there are some differences between main criteria score, average of sub criteria scores and the scores for 30 urban furniture types. Hierarchical organization of 10 main criteria and 84 sub criteria and scoring for all 30 urban furniture type in this model increases the precision of evaluations. "Function (FN)", "Material (M)", and "Production (P)" have highest scores of main criteria evaluations. According to the mean value of sub criteria for each main criterion, "Use (U)", "Ecology (E)", "Function (F)", and "Material (M)" have highest scores. Although the function and material still have highest scores, "use" and "ecology" added to the list instead of "production". This shows the critical role of two-level hierarchy of design model to have detailed scoring of criteria. Comparing scores of two levels might help to designers to improve design performance of urban furniture via reducing the differences in the scores and more precise evaluation of urban furniture. Urban furniture design is a multi-disciplinary task needs to involve all stakeholders (Sanches & Frankel, 2010). Collaboration of different disciplines and quantitative design model clarifies the main criteria set of urban furniture design and creates synergy in the design process.

With the quantitative evaluation of all criteria and 30 urban furniture types, clustering of furniture via statistical method became possible. The cluster analysis shows that the 30 urban furniture types can be grouped under seven clusters; "CL1: Info/management furniture", "CL2: Sculptural furniture", "CL3: Infrastructural furniture", "CL4: Living furniture", "CL5: Transformer", "CL6: Basic furniture", "CL7: Architectural furniture". The new classification

method of this research indicates that criteria-based classification is more comprehensive method which includes function, dimensional differences, and use together differing from the classification method of several researches (Bolkaner et al., 2019; Radwan & Morsy, 2016; Van Uffelen, 2010) based on only the function. Clustering of furniture reduces the time and effort in the design process while increasing the harmony and common design elements in all furniture and especially in each cluster. Furniture in the same cluster have similar requirements and interrelated functions. Cluster names represents the common characteristics of all furniture in that cluster. Which is a requirement for all furniture in the design process.

In this research we proposed an interdisciplinary model to define criteria, classify urban furniture via scores of professionals and received information from the local actors as municipality staff and local citizens but as M. Gabriela Sanchez and Lois Frankel denoted involving all stakeholders into the design process is also brings together critical improvements such as enrichment of the community life and reduction or prevention of vandalism (Sanches & Frankel, 2010). Therefore, the model can be improved via inclusion of all stakeholders to the design process itself.

Our design model involves generalized and two leveled hierarchical set of criteria and sub-criteria and site-specific design matrix for an urban furniture design. The proposed design matrix can be used as a guide to create distinctive designs of urban furniture according to the changing characteristics of the area.

The design matrix for Ordu City merges furniture clusters with local characteristics via keywords such as "sea", "textile", "waves", and "topography", design principles as "microclimatic", "multifunctional", and "adaptive", form characteristics like "curvilinear", and material set as "concrete", "corten", and "wood". There might be small differences in the criteria scores and urban furniture clusters but we expect to have different keywords, design principles, form and material selections for each specific area. This process also shows the adaptation capacity and flexibility of municipalities to accept new methodologies and quantitative methods ending with tangible products.

This research represents evaluations of several disciplines in urban furniture design by ten categories and 84 parameters. The proposed urban furniture design model summarizes urban furniture scores, clusters, local characteristics, design concept and keywords as a design matrix which can be used in urban furniture design projects by governments, designers, and decision makers.

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