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Research Article

Investigation of proper material selection for rainwater harvesting in squares having higher urban heat island effect potential: KBU Social Life Center example

Sibel Temizkan [a] ***and Merve Tuna Kayılı*** [b,*]

[a]*Karabuk University, Institue of Graduate Sciences, Karabük, 78050, Turkey*
[b]*Karabuk University, Department of Architecture, Safranbolu,78600, Turkey*

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ABSTRACT

With the revolution in industrialization, the gas amount emitted into the atmosphere grew, causing global warming and climate change. This developing shift has a detrimental impact on natural resources and hastens their decline. Water is one of the natural resources that has been impacted. Water scarcity is becoming a problem due to causes known to be urbanization, population increase and climate change. With regards to sustainable architecture, rainwater collection from buildings for its efficient use, application of simple water treatment processes and its reuse are considered to be among the precautions that may be taken in order to save water. In addition to playing a role in reducing water resources, urbanization has another detrimental characteristic, such as creating heat islands with highly impermeable surfaces. Top cover designs that promote green spaces and minimize heat island impacts are the most effective way for minimizing the detrimental effects that heat islands have on outdoor thermal comfort in urban settings. Therefore, a top cover was proposed in this study for mitigating the effect of heat island observed in KBU Social Life Center square that may be characterized as a vast heat island within the campus, as well as to bring it in feature of collecting rainwater in its immense area. Materials to be used in the proposed top cover as well as the factors affecting the selection of material were determined in terms of efficiency in rainwater collection and the mitigation of urban heat island effect. A considerably optimum material that can be used in the cover was determined by one of the multi-criteria decision-making methods known to be PROMETHEE method. As a consequence of its pricing, roof efficiency, and albedo coefficient qualities, the polycarbonate panel material has been chosen as the most acceptable material to be used for the suggested top cover.

1. Introduction

With the rapid increase in world population and industrialization, the limited natural resources are either being destroyed or wasted day by day. Since the first day of industrialization, intense competition in the industry has caused the wheels to spin and the machines to be operated faster, which increased the need for fossil fuels each passing day. Based on this consumption and production spiral, these economic activities have caused global warming by accelerating the emission of CO_2 gas. Therefore, the natural life cycle has changed as a result of increasing, changing, and developing human activities. On the other hand, by affecting the natural resources negatively, this change causes them to reduce and eventually deplete. One of the natural resources used up the most is water resources [1-3].

In addition to meeting the basic needs of people, water also plays an important role as a source of development in areas such as energy generation, industry, tourism, transport, and agriculture. However, each passing year, new countries are added to the list of water-scarce countries. Although Turkey does not take place on that list, it does not have sufficient water resources either. In Turkey, 73% of the water resources are used in irrigation, 16% in urban consumption, and 11% in industries [4, 5]. With its usable water amount of 1500m3 per person, it is among the countries approaching physical water scarcity.

* Corresponding author. Tel.: +90-370-418-8582; Fax: +90-370-418-8330.
E-mail addresses: sibelakmunarli@gmail.com *(S. Temizkan)*, mervetunakayili@karabuk.edu.tr *(M. Tuna Kayılı)*
ORCID: 0000-0003-1755-1290 *(S. Temizkan)*, 0000-0002-3803-8229 *(M. Tuna Kayılı)*
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In case of an increase in the country's population to 100 million, it is predicted that the amount of usable water per person will decrease to 1100m^3 [4, 5].

According to the World Population Prospects Report published by the UN Department of Economic and Social Affairs in 2017, the world population has reached 7.6 billion. The world population is expected to reach 8.6 billion by 2030, 9.8 billion by 2050, and 11.2 billion by the end of the century. This increase means that the world population will increase by 2.2 billion from 2017 to 2050 [4]. The rise in world population affects water resources in two ways. The first one is the decrease in the rate of water per person and the faster consumption of water resources, and the second one is the inability to ensure the continuity of water resources due to the widespread urbanization emerging to meet the housing needs of the increasing population [3- 5].

In addition to the water scarcity caused by the increase in urbanization, water-impermeable areas form urban heat islands, which in turn causes increasing temperatures in urban areas. The urban heat island (UHI) effect is defined as increased night temperature in urban areas caused by heat absorption on pavement and concrete surfaces due to anthropogenic climate change and reduced cooling by evaporation [6, 7]. Urban life quality is highly affected by harsh climatic conditions and high temperatures, and UHI's have adverse consequences that cause unsuitable temperature conditions, health problems, and diseases. Rising temperatures directly affect the energy consumed for cooling buildings and pose a greater risk of disease and eventually death [8-12] by transforming the city center and squares into thermally uncomfortable areas especially in summer [13]. Therefore, to mitigate the effects of UHI, it is essential to take into account environmental protection policies while planning and designing the cities [14-16].

Accordingly, the city centers face higher temperatures in urban areas. Factors, such as thermo-optical properties and albedo values of building materials resulting from the physical structure of the city, increasing in surface roughness, visual limitations due to street width and building height, anthropogenic warming, air pollutants, and decrease in water and humidity, cause cities to exhibit different climatic characteristics compared to their surroundings. Roofs are the surfaces most exposed to sunlight in urban areas. Therefore, roof and cover designs and material selection to be made for these designs play an important role in mitigating the urban heat island effect [17-19].

Considering solutions for the water crisis and urban heat islands can ensure the determination of a standard solution for both problems. In this context, the idea of rainwater collection in urban cover designs offering an effective solution in urban heat island areas is essential in terms of mitigating the UHI effect in the urban area and in saving rainwater by collecting it. The cover design and the covering material required to have the property of both eliminating the heat island effect and allowing efficient water collection has revealed the problem of covering material selection for a square with a high urban heat island effect. It is thought that a cover system to be designed with an optimum and appropriate material for these properties will mitigate the heat island in the square; thus, an efficient water collection will be able to be achieved. In this study, the square of Karabük University Social Life Center (SLC) serving a large number of users was chosen as the sample study area. The aim was to collect rainwater in the square having a heat island effect with higher efficiency. The materials to be used in the proposed urban cover design for the square were determined by taking into account their properties that were based on rainwater collection efficiency. The mitigation of the heat island effect was targeted, and it was aimed to select the optimum material by using the multi-criteria decision-making (MCDM) method. Furthermore, the annual volume of rainwater that could be obtained using the cover system was determined for the SLC Square.

Since any study using both the MCDM method and material selection at a time in a cover system design for rainwater harvesting as well as reducing the heat island effect was not encountered in the literature review, this can be shown as the original aspect of this study. In addition, this study is the first of its kind in terms of that it was applied to the Social Life center designed as a common use area within a public university campus and also it proposes a top cover system reducing the heat island effect by harvesting rainwater. These features of this study are expected to guide the architects, landscape architects, and decision-makers in the selection of materials for top cover design.

In the studies planned to be conducted in the future, the form of the top cover, different roofing materials to be proposed, and the determination of suggestions for effective rainwater harvesting and mitigating the urban heat island effect will contribute to the literature on this subject.

2. Material and Method

2.1 Case Study and Climate Data

Karabük University Social Life Center (SLC) located in the Demir Çelik Campus was established on an area of 8957m^2, and its total construction area is 1320 m^2. The roof area of the center planned for the rain harvesting is 1500m^2 and it has been designed as a flat walkable terrace roof with reinforced concrete floor. The square area belonging to the center is 5136m^2 and it is covered with marble. The square part also constitutes the roof of the SLC dining hall located on the ground floor (Figure 1) [20].

The climate type effective in Karabük is mainly seen in the Black Sea coastal belt of the Marmara Region and the north-facing parts and the mountains of the region. There is not much temperature difference between the summer and winter seasons. While the summer months are relatively calm, the winter months are warm in the coastal area but cold and snowy in the higher regions. Since there is precipitation in almost all seasons, there is usually no water shortage. The natural vegetation in higher areas comprises coniferous forests that grow in humid and cold conditions, while it is composed of moist broad-leaf forests in the coastal areas [21]. The average temperatures of January, the coldest month, and July, the warmest month are 4.2℃ and 22.1℃, respectively, and the annual average temperature is 13℃ [22]. Karabük is located inside the seaside, where the climate characteristics of the Western Black Sea region are only partially observed, and it is not able to benefit sufficiently from the humid air of the Black Sea. Although it has the characteristic features of the terrestrial climate, dry summers and cold winter temperatures are not observed as much as in the Central Anatolia region. Coniferous forests are seen in the inner parts, while broad-leaved forests are seen in the coastal areas [21].

The average annual precipitation in Karabük is 542 mm. Most rainfall is seen in the spring and winter months. Although Karabük receives rain every season due to the Black Sea climate, there are short-term droughts in July and August. Therefore, precipitation is relatively less during these months than in others. The share of summer precipitation in the annual total is 19.4% [22]. The precipitation data of the years between 1980 and 2018 obtained from the station information database of the Karabük Province Meteorological Department were analyzed in the SPSS 22 statistical package program, and standard deviations for years, seasons, and months were calculated accordingly. Based on the results, the deviation rate was found to be ± 7.62 liters considering the annual data. In line with these results, it was concluded that the average precipitation data of the last five years would be sufficient for calculations.

Monthly average precipitation data for the previous five years is given in Table 1. In accordance with the data obtained from the Karabük Meteorology Department, the average amount of precipitation for five years is observed to be 542 mm/year. The highest precipitation occurs in June with an average of 76.5 mm/year [20].

2.2 Material Selection

Various criteria come to the forefront while determining the most appropriate coating material alternatives for the top cover to be carried by the steel space frame system. These criteria can be shown as the price of materials, roof efficiency coefficient, albedo value, thermal conductivity, intrinsic heat, and emissivity [24, 25]. Based on the studies conducted so far, the materials that can be recommended as top cover materials can be listed as follows [26]: Glass, Membrane, Aluminum, PVC coating, PTFE coating, Polycarbonate panel, Shingle coating, Galvanized sheet. The materials that can be used in the top cover recommended for Karabük University SLC square and their properties are given in Table 2.

Figure 1. Karabük University Social Life Center [23]

2.3 Multi-Criteria Decision Method and PROMETHEE

To make accurate strategic decisions and selections, MCDM (Multi-Criteria Decision Making) methods enable decision-makers to solve various methods. Thus, by evaluating the determined alternatives in the best possible way, the most appropriate decision can be made. When it is required to make a selection among determined choices, multi-criteria decision-making methods are used to make the right decision. These methods are as follows [27, 28]:

- Basic Methods: Weighted Sum and Weighted Product Methods
- Valuable Combined Criteria Methods: AHP, TOPSIS, Gray Relation Method, Fuzzy TOPSIS
- Outranking Methods: Classified as ELECTRE and PROMETHEE (Preference Ranking Organization Method for Enrichment of Evaluations).

AHP: The AHP method is one of the most widely used MCDM methods in the literature. In the AHP method, the hierarchical structure of complex units, pairwise comparison, many criteria, eigenvector and consistency coefficient are used in the creation of weight coefficients. Among the usage areas of AHP, there are topics such as planning, choosing the best alternative, resource allocations, troubleshooting, and optimization [28, 29].

TOPSIS: With this method, among multi-criteria decisions, which one is the closest to the positive ideal solution and the farthest from the negative ideal solution can be evaluated. It has application opportunities in many areas such as risk and performance evaluation of enterprises in multi-purpose inventory planning [30].

Gray Relation Method: The GIA method is one of the widely used MCDM methods and has been developed for the analysis of relationships in cases of uncertainty caused by incomplete data or incomplete information [33].

Table 1. Monthly average precipitation data of Karabük province [22]

Year/Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
2014	48.2	7.0	27.9	80.7	81.7	110.7	24.3	16.7	105.7	108.1	18.5	80.9	710.4
2015	45.2	26.1	42.5	32.8	18.1	111.6	0.4	6.7	40.0	52.3	60.8	62.3	498.8
2016	77.2	64.4	21.2	50.9	116.8	12.6	4.1	3.2	41.9	5.6	29.4	60.4	487.7
2017	30.6	29.0	26.7	37.6	45.1	79.5	23.4	26.4	2.0	75.3	70.1	44.4	490.1
2018	27.9	23.6	120.5	8.6	43.5	68.1	66.8	4.1	20.5	56.8	39.9	44.0	524.3
Average (mm/year)	**45.8**	**30.0**	**47.7**	**42.1**	**61**	**76.5**	**23.8**	**11.4**	**42**	**59.6**	**43.7**	**58.4**	**542**

Table 2. Materials that can be used in cover and their properties [31, 32]

Materials	Unit Price	Roof Efficiency Coefficient	Albedo	Thermal Conductivity (W/(m*K))	Specific Heat (J/kg˚C)	Emissivity
Glass (10mm)	1500	0.9	0.7	1.0000	0.7530	0.84
Membrane	311	0.9	0.76	0.1380	2.0920	0.95
Aluminum	445	0.85	0.75	230.0000	0.8970	0.20
PVC	400	0.9	0.83	0.1670	1.6740	0.95
PTFE	622	0.9	0.69	5.5600	1.0040	0.95
Polycarbonate panel	29.8	0.9	0.86	0.1920	1.6740	0.95
Shingle	24	0.9	0.21	0.1200	1.2600	0.85
Galvanized sheet	19.3	0.85	0.4	53.0000	0.4800	0.4

Fuzzy TOPSIS: In the TOPSIS method, an index called positive – similarity to the ideal solution and negative – distance to the ideal solution is defined. As a result of this definition, the technique selects an option that is the most similar to the ideal answer. [34].

ELECTRE: The ELECTRE method is one of the MCDM methods, which is a technique that can interpret problems that dominate numerical calculations by converting them to verbal situations [35]. The ELECTRE method is a systematic analysis that compares all possible pairs of different alternatives regarding the criteria and reveals the values of alternatives based on these criteria [36]. Various criteria affect the selection at the decision stage, and the importance of these criteria relative to each other will lead the decision-maker to the most appropriate alternative. However, choosing the best among the alternatives is complicated. Each alternative may have different advantages over the other. Because it is pretty difficult to find exact solutions to such problems, some criteria are minimized while others are maximized. In such cases, PROMETHEE is a highly functional decision-making and ranking method that will make the closest optimum selection suitable for the purpose [37]. The PROMETHEE method, one of the most effective and frequently used methods in problem-solving today, has been developed based on the drawbacks of current preference methods in the literature [38]. Accordingly, the method evaluates the alternatives required for the decision-making problem based on determined preference functions and determines partial and complete preferences with the paired comparison technique. In the literature, there are many studies conducted in different fields by using the PROMETHEE method [39-50]. In this context, in this study, the PROMETHEE method was chosen to rank the coating material to be used in the cover proposed based on the properties given in Chapter 2 and eventually to select the optimum material. The Best Worst Method (BWM) was used to calculate the weights of the criteria used in the PROMETHEE method. In the context of this method, a survey was conducted on experts and academicians working in the material sector in Turkey to determine the importance weights of the main parameters in material selection. The reason for choosing experts and academicians in this study was to reach more realistic data by taking both theoretical and practical opinions. However, since it was impossible to get the population due to time and cost constraints, data were collected using snowball sampling, which is among non-random sampling methods. 104 online questionnaire forms were collected from experts and academicians. 12 out of the 104 forms were excluded as they were incomplete and inaccurate. Therefore, the total number of questionnaires included in the analysis was 92. Analyses were done using the SPSS software. The results of the frequency analysis regarding the answers given by the participants, including experts and academicians, in determining the importance weights of the criteria are shown in Table 3.

After obtaining the survey data, the multi-criteria decision problem was defined and the criteria were weighted using the excel file created by Rezaei [51, 52].

Table 3. The degree of importance given to criteria by participants [31, 32]

Job		Price	Roof efficiency	Albedo	Emissivity	Specific heat	Thermal conductivity
Expert	Average	7	8.02	7.67	8.02	7.55	8.17
	N	40	40	40	40	40	40
	Std. deviation	1.98	1.60	1.80	1.56	1.48	0.98
Academician	Average	7.11	7.78	8.01	7.84	7.28	8.03
	N	52	52	52	52	52	52
	Std. deviation	1.95	1.60	1.14	1.05	1.57	1.58
Total	Average	7.06	7.89	7.86	7.92	7.40	8.09
	N	92	92	92	92	92	92
	Std. deviation	1.96	1.59	1.46	1.29	1.53	1.35

Table 4. Averages and criterion weights calculated using the BWM method

Criteria	Average	Weighting by means (%)	Weighting with the Best Worst Method (BWM)
Price	7.06	15.28	0.142
Roof efficiency coefficient	7.89	17.07	0.142
Albedo value	7.86	17	0.142
Thermal conductivity coefficient	8.09	17.50	0.285
Specific heat	7.40	16.01	0.142
Emissivity	7.92	17.14	0.142
Total	46.22	100	1

Table 5. Roof coefficients according to roofing material

Roof Material	Roof Coefficient
Concrete	0.70
Metal-Tile-Marble (glazed tiles)-Glass-Membrane-PVC-PTFE-Polycarbonate panel-Shingle	0.90
Aluminum-Galvanized sheet	0.80

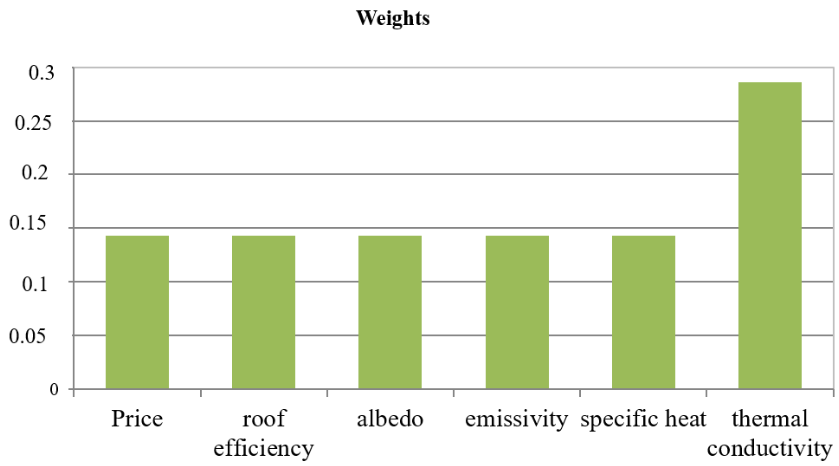

Figure 2. Graphical representation of the criteria weights

There are two most commonly used versions of BWM known as linear [52] and nonlinear [52]. In this study, the excel file based on linear BWM was used for weighting criteria. In this file, five steps that must be taken to construct and solve the problem are explained and formulated. Different pages (C=3, C=4,…) are given for problems with other criteria [53]. In the first step, the number of decision criteria is determined depending on the issue. In this study, the solution was attained using C=6. In the second step, the best (e.g., the most desirable, the most important) and the worst (e.g., the least desirable, the least important) criteria are determined according to the decision made by the decision-maker. In this context, the best criterion was found to be "thermal conductivity", whereas the worst criterion was determined to be "price". In the third and fourth steps, the preference of the decision-maker for "the best criterion over all other criteria" and "all other criteria against the worst criterion" is specified by selecting a number between 1 and

9 from the drop-down box [54,55]. In the last step, the weighting results are calculated using the solver in the data tab in Table 4, and then the weights are graphically depicted in Figure 2.

While weighting the material parameters during material selection, the weight of thermal conductivity criteria was determined as 0.28, whereas the weights of other parameters were determined as 0.14. Linear function type was preferred for the price parameter, while V-type was preferred for different criteria. In this study, it was found that the values for all criteria except the price criterion were very close to each other, thus even minor differences were important. Therefore, although the preference was done considering the decision points with values above the average, values below this average were not desired to be neglected as well. While minimum values were preferred for unit price, thermal conductivity and intrinsic heat criteria, maximum values were preferred for roof efficiency coefficient, albedo, and emissivity criteria.

2.4 Calculation of Rainwater Harvesting

In determining the amount of water to be obtained in rainwater harvesting, information such as roof coefficient, filter efficiency coefficient, precipitation amount of the location and the collection area for the harvesting process are needed.

Roof coefficient: It is a coefficient determined based on the rainwater collection capacity of the collection area. This coefficient varies depending on the covering material used on the roof, as shown in Table 5.

Filter efficiency coefficient: It is the efficiency coefficient of the first filter to be used for separating the rainwater obtained from the roof from visible solid materials. This coefficient is determined based on the loss of a certain amount of rainwater while being filtered and is specified as 0.9 according to the DIN1989 standard.

Rainwater collection area: It is the roof area of the building where rainwater is intended to be harvested.

Precipitation amount: It is the average annual precipitation amount determined by the Directorate General of Meteorology.

Using the above-mentioned definitions, the amount of rainwater harvesting in the building was calculated according to the Equation 1 below.

$$\sum W = A \times M \times \alpha \times \beta \quad (1)$$

in where;
$\sum W$: Total rainwater harvesting (m^3)
A: Rainwater collection area (m^2)
M: Precipitation amount (mm/m^2)
α: Roof coefficient (0.8)
β: Filter efficiency coefficient (0.9)

3. Results

In this study, decision matrices, including alternative materials and criteria, were created first. The criteria to be used in selecting the optimum material for rainwater harvesting were determined as unit price, roof efficiency coefficient, albedo value, thermal conductivity, intrinsic heat, and emissivity values. V-shape preference type functions were used for other linear criteria for the unit price. After creating decision matrices, the change functions were determined for all criteria. Then, the weight of each criterion was determined according to the experts' and academicians' opinions obtained through the questionnaire. Figure 3 shows the PROMETHEE I (partial ranking) results of the materials recommended for use in the top cover. Positive and negative values between +1 and -1 are calculated for each alternative measured during partial ranking. Whereas the positive value indicates the superiority of the discussed alternative over other options, the negative value indicates how weak the discussed alternative is when compared to other alternatives. The partial ranking analysis result of roofing materials shows that polycarbonate panels and PTFE materials have positive superiority values over other options. Similarly, it shows that aluminum has negative values compared to other alternatives and that this material is comparatively weak.

In Figure 4, the positive and negative superiority values of the materials have been shown graphically, which depicts which material is positive or negative in terms of which factor.

When the Network diagram seen in Figure 5 is examined, it is observed that the polycarbonate panel alternative is superior to other alternatives in terms of positive and negative superiority values. However, since both positive and negative superiority values of aluminum are lower than other alternatives, it is positioned as the worst alternative.

In PROMETHEE II, the ranking is made depending on the net superiority values found by subtracting the negative superiority values from the positive superiority values. The values between 0 and +1 are the first values to be preferred.

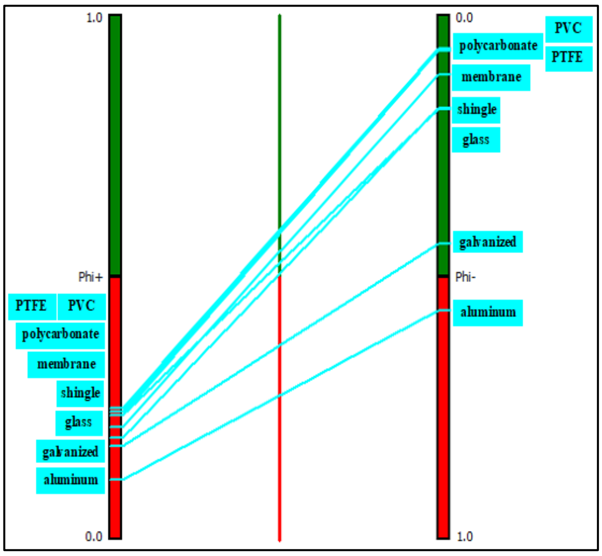

Figure 3. PROMETHEE I partial ranking for top cover material alternatives

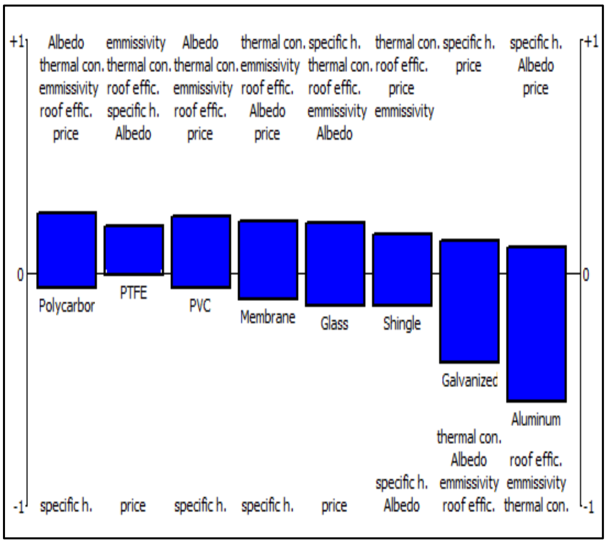

Figure 4. Superiority values for top cover coating material alternatives

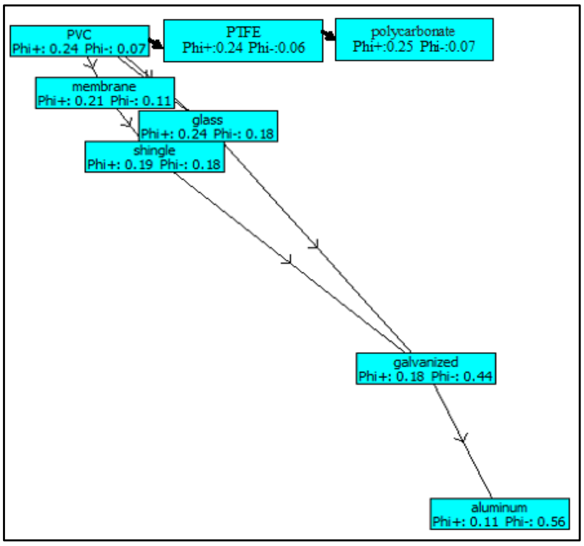

Figure 5. Network diagram for top cover coating material alternatives

With this ranking method, the most appropriate material is determined among the alternatives analyzed based on the selected criteria. According to the PROMETHEE II complete ranking result, with their positive net superiority values, polycarbonate panel (0.1836) and PTFE (0.1814) materials rank at the top among the preferences. In contrast, galvanized sheets (-0.2588) and aluminum (-0.4490) rank at the bottom with their negative net superiority values.

Table 6 contains the PROMETHEE Flow Table created based on the PROMETHEE II Complete Ranking result of the alternative materials included in the study. As a result of the study, while polycarbonate panel was the first roof material to be preferred with its net superiority value of 0.1836, aluminum coating material was the last to be preferred with its net superiority value of -0.4490. In addition, since the net superiority values of polycarbonate panels, PTFE coating, PVC coating, membrane and glass are found to be positive, respectively, according to the results of this analysis, these materials will be the first to be preferred.

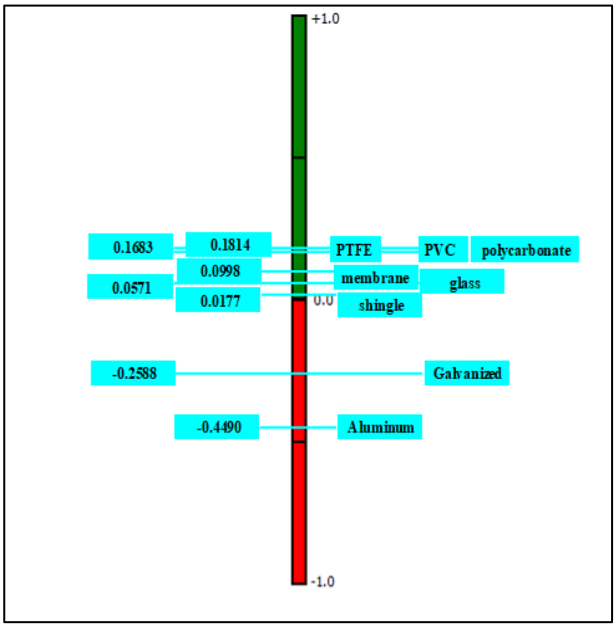

Figure 6. PROMETHEE II full ranking for top cover material alternatives

3. Conclusions

As a result of the study conducted for the selection of the most appropriate coat material to be used in the top cover recommended for SLC Square that had a high urban heat island effect, both to mitigate the urban heat island effect and to establish an effective rainwater collection system, the most appropriate material was determined as polycarbonate panel considering the material properties and operating limits specified for this purpose.

According to the results of this analysis, glass is a material with a high albedo and roof effectiveness coefficient despite its high price. Membrane is one of the materials that can be preferred because it has a high coefficient of roof effectiveness, high albedo, and low thermal conductivity. Despite its high price, PVC is a material that can be preferred in terms of roof conductivity, albedo, and thermal conductivity values. Although PTFE is a preferable material in terms of roof effectiveness, value, and albedo, its price is quite high compared to others. Polycarbonate panel is a preferable material in terms of roof effectiveness coefficient, thermal conductivity, and albedo values, as well as price. Although shingle is an ideal material in terms of price and roof efficiency coefficient, its albedo value is quite low. Although aluminum is a material that can be preferred due to its high albedo and roof efficiency coefficient, it has a very high price and thermal conductivity. Although galvanized sheet is an ideal material in terms of price, roof efficiency, and thermal conductivity, its albedo value is the lowest among the selected materials. Accordingly, the most appropriate material was determined as a polycarbonate panel. Based on the result of the analysis and these properties, the material that should not be preferred was determined as an aluminum coating.

Table 6. Roof coefficients according to roofing material

PROMETHEE Flow Chart				
Rank	**Material**	**Phi**	**Phi+**	**Phi-**
1	Polycarbonate panel	0.1836	0.2500	0.0664
2	PTFE covering	0.1814	0.2443	0.0629
3	PVC covering	0.1683	0.2360	0.0677
4	Membrane	0.0998	0.2133	0.1136
5	Glass	0.0571	0.2375	0.1804
6	Shingle covering	0.0177	0.1939	0.1762
7	Galvanized sheet	-0.2588	0.1767	0.4354
8	Aluminium	-0.4490	0.1144	0.5634

In the current situation, the amount of rainwater to be harvested may decrease due to the temperature changes in the square, evaporation caused by the heat island effect, water losses caused by heavy pedestrian traffic, and water puddles and defects on the ground of the square area. The most effective way to prevent this loss is to collect the rainwater on the roof surface in a shorter time and send it to the storage tanks. In this sense, the amount of rainwater collected may increase or decrease depending on the properties of the materials selected on the roof. Therefore, the selection of roofing materials to be used in these covers is important. This study and the obtained results suggest the mitigation of urban heat islands and efficient rainwater harvesting for public spaces and squares in city centers.

In addition, the principle of resource conservation in the building, which stands out as the principle of sustainable architecture, can only gain effectiveness with the decisions made during the design phase. Therefore, it should be underlined that the rainwater collection systems need to be considered during the design phase of the building rather than being considered as structures that are integrated later on.

Declaration

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. The author(s) also declared that this article is original, was prepared in accordance with international publication and research ethics, and ethical committee permission or any special permission is not required.

Author Contributions

S. Temizkan performed the analysis. M. Tuna Kayılı supervised and improved the study.

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