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Selection of Plant Location for Hemp Fibre Production in TR72 Region[#]

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ABSTRACT

This study has emerged within the scope of the sectoral studies requested by the Ministry of Industry and Technology of Turkish Republic from the Development Agencies, and aims to select the optimal plant location among the organized industrial zones in the TR72 Region consisting of Kayseri, Sivas and Yozgat provinces in order to produce processed fibre from the raw fibre obtained as a by-product of hemp cultivation. The criteria such as parcel unit price, electricity unit price, service water unit price, waste water unit price, natural gas unit price, insurance premium employer's share support period, investment contribution rate for insurance premium employer's share support, tax reduction rate, investment contribution rate for tax reduction, interest or profit share support, access to raw material sources, access to market and access to qualified labour supply that form the basis for the selection of plant location were determined and weighted according to the Stepwise Weight Assessment Ratio Analysis (SWARA) method The most available plant location among the emerging alternatives was determined by using Multi-Criteria Decision Making Methods consisting of Combined Comprimise Solution (COCOSO), Complex Proportional Assessment (COPRAS) and Multi-Attributive Ideal-Real Comparative Analysis (MAIRCA). Consequently, it was concluded that Kaleseramik Private Organized Industrial Zone (OIZ) located in Yozgat province is the most available plant location among the other seven alternatives.

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Introduction

Native to Central Asia, hemp fibre is known to have been cultivated for more than 12,000 years. Besides wild cannabis and cannabinoid varieties, which are typically dioecious, monoecious specimens are also encountered, which are single plants with both male and female inflorescences. Cultivation and production of cannabis plants offer many advantages for farmers. It is a plant species that needs little or no additives such as herbicides, pesticides, fungicides and fertilizers. Due to the rapid growth rates of the cannabis plant, they quickly cover the soil and therefore suppress weeds and some soil-borne pathogens. Hemp also restores nutrients to the soil that are available for the next crop planted in sequence. The cannabis plant, which has very deep roots, thus cleans the soil (Bismarck et al., 2005).

Although some minimum requirements must be met for optimal growth, the cannabis plant is actually a non-selective plant. When the areas where cannabis can be grown around the world are examined, it is possible to grow the plant ideally in a very wide area except deserts, cold regions and very high mountainous areas where most agricultural products cannot be grown in general. When we look at the spread of the most suitable areas and the most ideal areas around the world, it is seen that it covers a very wide area from the tropics to the Mediterranean Basin, from the monsoons to the southern and middle parts of Scandinavia (Taşlıgil and Şahin, 2019).

In the field of textiles, hemp fibre is used for the manufacture of products with high added value due to its superior properties such as high strength, high moisture absorption and breathability, no pilling, being an organic product, antibacterial, UV protection and good electrostatic properties (Musio et al., 2018).

Hemp is a thick, dark, and difficult-to-bleach fibre harvested from the cannabis plant. It has a strong and durable structure, and its threads can reach a length of six feet or more. Each hemp cell has a length of 0.5-1 inch (1.2-2.5 cm), and when the fibre cross-section is examined, it is observed that it is polygonal. Hemp fibre, which is quite tough, contains a significant amount of lignin. Although fine fabrics can be produced from selected hemp fibres, hemp is primarily used in coarse fabrics including sack material, canvas, ropes and twines (Needles, 1986,). Hemp fibres have a density of 1.48 g/cm3, elongation of 1.6%, a moisture regain of 12% and a Young's Modulus of 32 GPa. 77.07% of its weight consists of cellulose (Zakriya and Ramakrishnan, 2021).

There are supporting institutions for the production or trade of cannabis around the world. The prominent organizations are such as the European Industrial Hemp Association, Indian Industrial Hemp Association, Hemp Industries Association, International Hemp Building Association and Canadian Hemp Trade Alliance.

The cannabis plant is known as a narcotic substance in many countries, and for this reason, it is also called the 'sin plant' in the colloquial language. Therefore, the reason why cannabis cultivation is banned in many countries is because of its narcotic substance content. Its cultivation is also prohibited in Türkiye for the same reason.

Pursuant to Article 23 of the Law No. 2313 on the Control of Narcotic Drugs, a person who cultivates cannabis in order to obtain drug is sentenced to imprisonment from four to twelve years and a judicial fine from five hundred days to ten thousand days (Law on Control of Narcotic Substances, 1933).

Cannabis production in Türkiye is carried out in accordance with the provisions of the Regulation on Cannabis Cultivation and Control published in 2016. According to this regulation, in 19 provinces including Amasya, Antalya, Burdur, Bartın, Çorum, İzmir, Karabük, Kastamonu, Kayseri, Kütahya, Malatya, Ordu, Rize, Samsun, Sinop, Tokat, Uşak, Yozgat and Zonguldak, as shown in Figure 1, cannabis production is allowed provided that permission is obtained. Therefore, cannabis cultivation is prohibited outside the permitted provinces and their districts. However, the Ministry of Agriculture and Forestry may allow cannabis cultivation as a main or secondary plant for scientific research purposes, provided that it complies with the provisions determined within the framework of the relevant regulation. The lands allowed for cannabis cultivation are kept under constant control beginning from planting to harvesting by the technical personnel in the provincial or district directorates, and it is monitored whether these lands are cultivated within the scope of the purpose (Regulation on Cannabis Cultivation and Control, 2019).

In addition to these 19 provinces indicated in Figure 1, the cannabis planting permit for fibre, stem and seed purposes was also given to Sivas in 2021 by the Ministry of Agriculture and Forestry within the scope of industrial cannabis cultivation, and the number of provinces where hemp is cultivated has increased to 20.

When the hemp production process of Türkiye is examined, it is observed that 10,700 tons of fibre and 5,000 tons of fibre for seed purposes were produced in an area of 20,800 hectares in 1961. However, reasons such as high workforce, lack of mechanization, cheaper synthetic fibre and inability to compete with the cotton plant have caused hemp to lose power in our country as well as all over the world. In addition, since hemp is a plant that needs to be cultivated in a controlled manner due to the tetrahydrocannabinol (THC) substance present in its natural structure, producers who avoid control and follow-up preferred alternative products to hemp. Hemp agriculture and fibre sector in our country date back to ancient times, however, its cultivation has decreased and has come to the point of extinction. Although Kastamonu is a province with a reputation in this regard, unfortunately, no hemp cultivation was carried out in this region during the 2009-2018 period. Subsequently, the present rich genotype resource disappeared (Gizlenci et al., 2019).

According to the data obtained from Food and Agriculture Organization of the United Nations, change of hemp cultivation in terms of harvested area and yield in Türkiye over years is expressed in Figure 2.

As observed in Figure 2, hemp cultivation, which was 10,700 tons in an area of 7,100 hectares in 1961, reached its peak point in 1980, but started to show a dramatic downward trend as of this year and eventually declined to almost zero point in the year 2020.

Data for worldwide cannabis cultivation for the same time period are shown in Figure 3.

As expressed in Figure 3, the cultivation areas for hemp plant show a serious decreasing trend throughout the world over the years. However, the amount of production, which had a decreasing trend until the 1990s, started to increase again after this period.

Table 1 shows the yearly monetary values of the worldwide exports of the product "True hemp Cannabis sativa L., raw or processed, but not spun; tow and waste of true hemp, incl. yarn waste and garneted stock" with GTIP code of 5302.

Figure 1. Provinces Allowed for Cannabis Cultivation

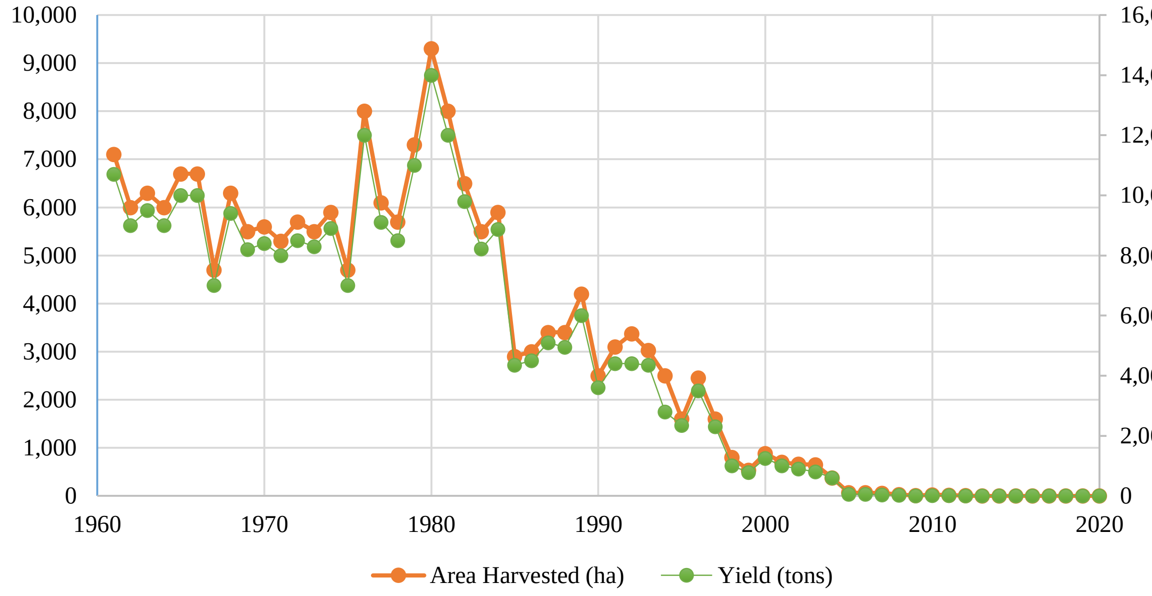

Figure 2. Change of Hemp Cultivation in Türkiye over Years (Source: FAOStat, 2021)

Figure 3. Change of Hemp Cultivation in the World over Years (Source: FAOStat, 2021)

Table 1. Yearly Monetary Values of the Worldwide Exports by Country (x1000 USD)

Exporters	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Switzerland	156	29	7	1	0	3	7	244	1,108	5,650	13,205
Netherlands	1,235	135	4,543	2,407	225	592	7,078	5,299	6,887	6,292	8,937
USA	159	106	117	118	223	295	389	3,087	1,070	370	5,873
Italy	1,513	324	388	220	182	310	119	162	110	2,721	3,744
Croatia	0	0	0	0	0	0	95	576	2,716	2,515	2,827
Luxembourg	1	0	0	0	0	0	0	18	1,066	1,417	2,681
Romania	5	10	13	20	25	21	199	1,176	3,100	1,016	2,665
Spain	41	41	136	145	17	8	99	115	270	1,057	2,368
China	943	670	688	652	861	1,029	564	335	339	444	1,451
Lithuania	0	1	0	0	1	0	0	247	544	561	1,040
Others	3,786	2,930	1,569	1,422	1,432	1,745	2,031	2,801	2,260	3,061	3,726
Total	7,839	4,246	7,461	4,985	2,966	4,003	10,581	14,060	19,470	25,104	48,517

Source: TradeMap, 2022

Table 2. Yearly Quantity Values of the Worldwide Exports by Country (tons)

Exporters	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Netherlands	106	180	141	254	333	544	11,051	7,514	8,711	10,228	10,601
Romania	0	1	1	2	1	1	422	1,849	2,397	1,509	2,659
Lithuania	0	1	0	0	8	0	0	22	61	423	1,308
Belgium	65	73	154	38	50	78	81	419	174	618	935
USA	186	58	132	74	254	234	71	117	65	146	888
Mauritius	191	659	587	457	372	383	522	676	800	554	388
Germany	77	162	85	139	219	805	1,172	433	473	346	369
China	110	171	70	47	34	51	47	34	27	30	195
Croatia	0	0	0	0	0	0	34	238	380	91	187
Nigeria	0	0	0	0	0	0	0	0	0	0	178
Others	2,856	2,567	1,196	498	504	486	529	607	422	836	906
Total	3,591	3,872	2,366	1,509	1,775	2,582	13,929	11,909	13,510	14,781	18,614

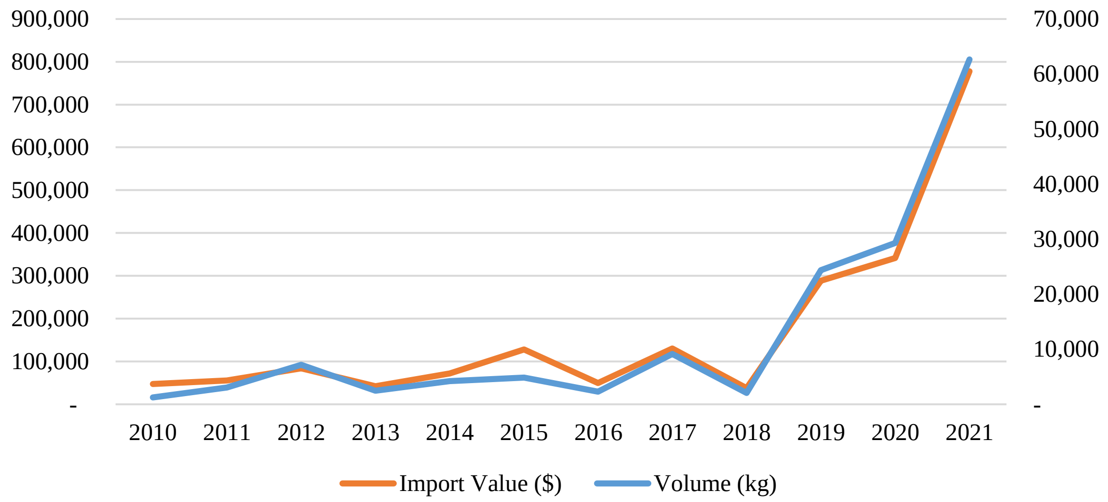

Figure 4. Change of Hemp Yarn Import Values of Türkiye over Years, Source: TÜİK (2021 values are temporal)

Considering the evaluation made according to the export data of 2020 in Table1, it is observed that Switzerland, Netherlands, United States of America, Italy, Croatia, Luxembourg, Romania, Spain, China and Lithuania rank in the top ten as exporters countries, respectively.

Table 2, on the other hand, shows the worldwide export amount of the same product in the same period, on the basis of countries.

In line with the data shown in the Table 2 Netherlands, Romania, Lithuania, Belgium, United States of America, Mauritius, Germany, China, Croatia and Nigeria are observed in the top ten countries in terms of export volume in 2020.

The import values of Türkiye between the years of 2010 and 2021 for "Hemp yarn; not put up for retail sale" with GTIP code of 530820100000 and "Hemp yarn; put up for retail sale" with GTIP code of 530820900000, are shown in Figure 4.

When the data in Figure 4 is analysed, it is observed that Türkiye's hemp yarn imports followed a low and horizontal course from 2010 to 2018, and beginning from this year, it showed a rapid upward trend. This situation gives preliminary signals that Türkiye will need more hemp yarn and may import this product in greater quantities in the upcoming years.

As a result of the meeting with the participation of the relevant units of the Ministry of Agriculture and Forestry, the units of the Ministry of Industry and Technology, the Ministry of Health, Samsun Ondokuz Mayıs University and TUBITAK officials held on January 11, 2019, "Industrial Hemp Growing Report and Action Plan in Türkiye" has been prepared in accordance with the policy of the expansion of industrial cannabis plant production in Türkiye and the supply of cannabis raw materials to the industrial sector from domestic production. Within the scope of this action plan, topics such as (TİGEM, 2019);

- Carrying out cannabis production in Türkiye with the local population in the short term,
- Reproducing seeds from the local Narlısaray population until the registration processes and seed reproduction processes of the local and national cannabis variety candidates identified as Vezir and Narlı are completed,
- Concluding the ongoing seed registration studies on local varieties and ensuring the transition to the use of certified seeds,
- Development of the cannabis-based industry and mechanization systems,
- Identification of priority investment areas

were included.

At the Local Administrations Symposium in the Presidential Government System held in 2019, the first signals of new attempts towards cannabis production in Türkiye were given and this issue has started to attract attention from individuals operating in the agricultural sector.

The rationales explained so far such as;

- The increase in hemp production throughout the world especially in the last two decades,
- The rapid increase in Türkiye's hemp yarn import values in recent years,
- The fact that hemp cultivation has become a state policy for Türkiye,
- Domestic action plans for hemp cultivation,
- Increase in permit requests for cannabis cultivation by provinces that are not included in the regulation

reveal the requirement for a probable fibre production facility in Türkiye.

Central Anatolian Development Agency, operating under the Ministry of Industry and Technology and addressing the requirements of investors regarding investment processes in proactive manner, conducted a pre-feasibility study (Yozgat İli Kenevir Elyafı Üretim Tesisi Ön Fizibilite Raporu, 2021) for a probable investment relevant with hemp fibre production. Within the scope of this study, it is aimed to select the optimal plant location among the organized industrial zones operating in the provinces of Kayseri, Sivas and Yozgat in the TR72 Region.

The unit parcel price, electricity unit price, service water unit price, waste water unit price and natural gas unit price in eight organized industrial zones located in all three provinces were obtained from the relevant directorates. The other important parameters taken into consideration for the selection of the plant location were the incentive measures applied for the relevant sector. Furthermore, access to raw material sources, access to market and qualified labour supply criteria are determined as the remaining parameters. These criteria are determined and weighted by means of SWARA method.

In line with these criteria determined for eight organized industrial zones in the TR72 Region; COCOSO, COPRAS and MAIRCA, which are among the Multi-Criteria Decision Making Methods, were applied and the most appropriate ranking is carried out aiming to selection for the location of hemp fibre production facility.

Some of the studies carried out in the past years within the scope of policies for cannabis production in Türkiye can be summarized as follows;

Aydoğan et al. (2020) aimed to determine the economic feasibility of industrial hemp production through the example of Vezirköprü district of Samsun province. By grouping the cannabis plant according to the production purposes, the profit rates obtained from the unit area were compared. According to the results of the study, in case of planting aiming to obtain both seeds and fibre from the same plant and marketing the fibres without separating them from the plant, it has been revealed that higher profit will be obtained than wheat, sugar beet, sunflower and silage corn farming. Impediments to the development of cannabis cultivation in Türkiye were identified and alternatives for the use of this product in different fields were presented.

Başer and Bozoğlu (2020) aimed to evaluate the developments regarding the current situation in the country by examining the hemp production policies and the legislation on cannabis production put forward by Türkiye. Starting from the characteristics of the cannabis plant, its usage areas, foreign trade practices related to the product and the international restrictions of the product are explained. By analysing the cultivation areas and production volume in Türkiye, the contributions of the cannabis plant to the country's industry have been revealed.

Taşlıgil and Şahin (2019) examined the characteristics of the cannabis plant, its agricultural requirements, processing and usage areas, and discussed the historical process of cannabis in the world and in our country from past to present. They put forward suggestions such as making short, medium and long-term plans that will contribute to the policies created on cannabis in recent years in Türkiye.

Some of the studies conducted in the past years for Multi-Criteria Decision Making Methods are as follows;

Demir (2021) used the Fuzzy DEMATEL and COCOSO methods to measure and evaluate the financial performance of Central and Eastern European countries for the year 2020, when the Covid-19 pandemic started.

Belke (2020) aimed to compare the macroeconomic performances of developed countries known as Group of Seven with CRITIC and MAIRCA methods using the criteria of real gross national product per capita, economic growth, investment rate, foreign trade, current account balance, budgetary equilibrium, public debt, unemployment rate and inflation rate between the years of 2010 and 2018.

Pamucar et al. (2018) aimed to select new level crossings by using the FUCOM-MAIRCA method according to seven criteria determined in line with the crossing traffic, literature review and expert opinions, since the level crossings where the road and railway traffic intersect at the same level cause traffic accidents.

Zavadskas et al. (2007) used the COPRAS method to evaluate the alternatives in road construction, which depends on many factors such as efficiency level, longevity, construction cost, environmental protection factors, economic validity and construction period.

Material and Method

The data needed to carry out this study were obtained from the eight Organized Industrial Zone (OIZ) Directorates located in the provinces of Kayseri, Sivas and Yozgat. Regarding the incentives that can be benefited from, the articles of Decision No. 3305 on State Aids in Investments were examined.

In order to determine the optimal establishment location for hemp fibre production facility; COCOSO, COPRAS and MAIRCA methods were used to rank among Organized Industrial Zones in Kayseri, Sivas and Yozgat provinces.

The COPRAS method was introduced to the literature by E. K. Zavadskas and A. Kaklauskas in 1994. This method assumes that the utility degree of the values of the alternatives according to the criteria has a direct and proportional dependence on the criterion weights (Salabun et al., 2020). MAIRCA method, which was presented to the literature by Pamucar, Vasin and Lukovac in 2014, is based on determining the gap between the theoretical solution and the actual result obtained (Pamucar et al., 2018). The COCOSO method, which is applied in the third order, is an up-to-date method proposed by Yazdani, Zarate, Zavadskas and Turskis in 2019. It is based on the principle of using Simple Additive Weighting and Exponentially Weighted Product methods together (Yazdani et al., 2018). These three multi-criteria decision making methods were preferred to compare the differences in terms of the approaches of the applied methods and to determine whether there is a significant difference between the old and new proposals. The determination and weighting of the criteria to be used in the ranking process was carried out with the SWARA Method, which was introduced by Kersuliene, Zavadskas and Turskis in 2010 (Alinezhad and Khalili, 2019).

***Obtaining the Dat*a**

The data obtained from the Organized Industrial Zone Directorates in the TR72 Region and the articles of the Decision No. 3305 on State Aids in Investments are taken into consideration together. For the investments to be made in the organized industrial zones in Yozgat province, the relevant values are taken as 100% since there is no limit on the investment contribution rate in terms of insurance premium employer's share support. Access to raw material sources, access to market and qualified labour supply criteria are scaled and the values including all alternatives and criteria are summarized in Table 3.

In this study carried out in 2020, the data obtained from the OIZ Directorates includes the year 2019, and the data of the incentive measures includes the 2020 amendments of the Decision on State Aids in Investments.

The locations of the organized industrial zones in the TR72 Region on the map are shown in Figure 5.

Table 3. OIZ Data Located in TR72 Region

	KAY	MIM	INC	SIV	SAR	GEM	YOZ	KAL
Unit Parcel Price (TL/m^2)	400.00	250.00	35.00	20.00	0.95	0.00	6.10	10.00
Electricity Unit Price (TL/kWh)	0.54	0.52	0.48	0.50	0.96	0.78	0.40	0.42
Service Water Unit Price (TL/m^3)	1.18	1.08	0.56	2.45	1.30	1.40	2.00	0.00
Waste Water Unit Price (TL/m^3)	0.68	1.30	0.59	0.40	0.90	0.40	0.60	0.70
Natural Gas Unit Price (TL/m^3)	1.90	1.82	1.79	1.83	2.40	1.82	1.33	0.74
Insurance Premium Employer's Share Support Period (year)	5	5	6	7	7	7	10	10
Investment Contribution Rate for Insurance Premium Employer Share Support (%)	20	20	25	35	35	35	100	100
Tax Reduction Rate (%)	60	60	70	80	80	80	90	90
Investment Contribution Rate for Tax Reduction (%)	25	25	30	40	40	40	50	50
Interest or Profit Share Support (Point)	0	0	4	4	4	4	5	5
Access to Raw Material Sources (1-5)	0.40	0.40	0.40	0.60	0.60	0.60	0.60	0.60
Access to Market (1-5)	0.60	0.60	0.60	0.40	0.40	0.40	0.40	0.40
Qualified Labour Supply (1-5)	0.60	0.60	0.60	0.40	0.40	0.40	0.20	0.20

KAY: Kayseri OIZ; MIM: Mimarsinan OIZ; INC: İncesu OIZ; SIV: Sivas Central OIZ; SAR: Şarkışla OIZ; GEM: Gemerek OIZ; YOZ: Yozgat OIZ; KAL: Kaleseramik Private OIZ; Source: TR72 Region OIZ Directorates (2019); State Aids in Investments with Decision No. 3305 (2020)

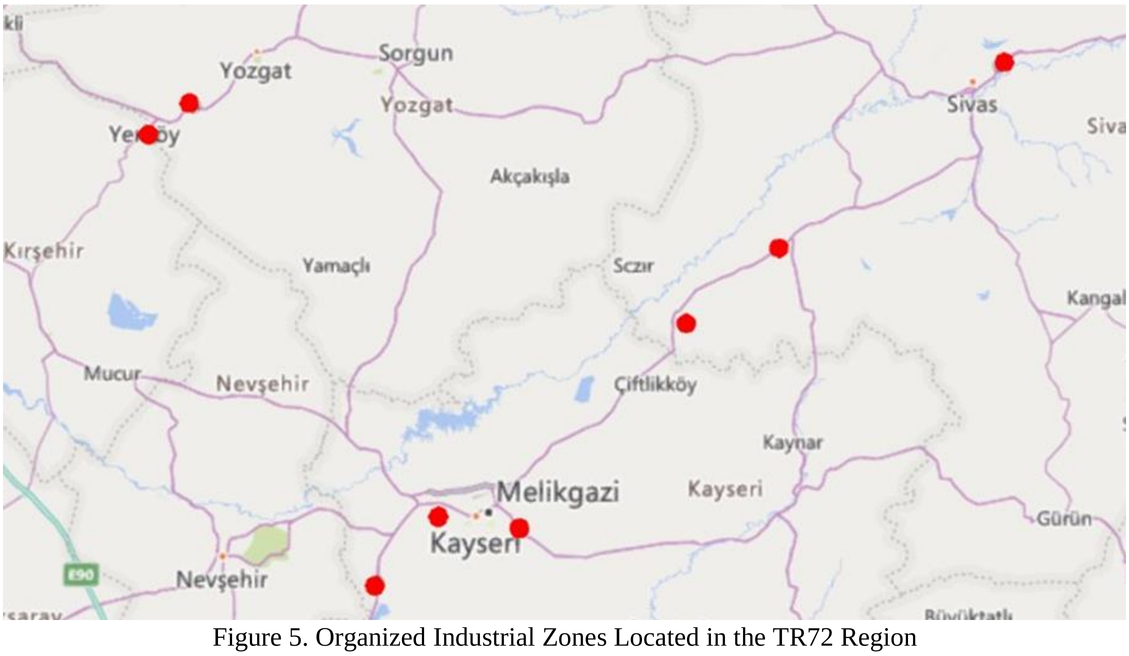

Figure 5. Organized Industrial Zones Located in the TR72 Region

Weighting of Criteria by SWARA (Stepwise Weight Assessment Ratio Analysis) Method

In the Stepwise Weight Assessment Ratio Analysis (SWARA) method, introduced by Kersuliene, Zavadskas and Turskis in 2010, the relative importance levels and prioritization of the alternatives for each criterion are determined according to the opinion of the decision makers, and then the relative weight of each criterion is calculated. In this technique, the stages for determining the final priorities and ranking the criteria are carried out according to the characteristics like the attributes being compensatory and the attributes being independent from each other (Alinezhad and Khalili, 2019).

The method consists of the following 5 steps (Stanujkic et al., 2015);

Step 1: Classification of Criteria by Degree of Significance

The criteria are sorted in descending order taking into account their expected significance.

Step 2: Determining the Relative Significance of the Criteria

Starting from the second criterion, a percentile comparison of importance is made with the previous criterion. In this way, the S_j value, which is the comparative significance of the mean value, is obtained.

Step 3: Calculation of the Coefficient; k_j

The process for calculating the coefficient k_j is expressed by Equation (1),

$$k_j = \begin{cases} 1 & , j = 1 \\ S_j + 1, & j > 1 \end{cases} \quad (1)$$

Step 4: Determination of Recalculated Weight; q_j

The process for calculating the weight q_j is expressed by Equation (2),

$$q_j = \begin{cases} 1 & , j = 1 \\ \frac{k_{j-1}}{k_j}, & j > 1 \end{cases} \quad (2)$$

Step 5: Calculation of Relative Weights

The process for calculating the relative weights is expressed by Equation (3),

$$\omega_j = \frac{q_j}{\sum_{k=1}^{n} q_k} \quad (3)$$

Ranking of Alternatives by COCOSO (COmbined COmpromise SOlution) Method

This approach, proposed as the mixed compromise solution, is based on integration of a simple additive weighting and an exponentially weighted product model. This model can be considered as a summary of other compromise solutions (Yazdani et al., 2018).

The method consists of the following 5 steps (Yazdani et al., 2018);

Step 1: Determination of Initial Decision Matrix

The process for determining the initial decision matrix in the COCOSO method is expressed by Equation (4).

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} i = 1,2,\ldots\ldots,m; \quad j = 1,2,\ldots\ldots,n \quad (4)$$

Step 2: Normalization of Decision Matrix

The normalization process is performed with Equation (5) if the criterion is beneficial, and with Equation (6) if the criterion is cost-oriented.

$$r_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \quad (5)$$

$$r_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \quad (6)$$

Step 3: Calculation of S_i and P_i Values

Based on the grey relational generation approach, the S_i value is calculated by Equation (7), and based on the WASPAS multiplicative attitude the P_i value is calculated by Equation (8).

$$S_i = \sum_{j=1}^{n} (\omega_j . r_{ij}) \quad (7)$$

$$P_i = \sum_{j=1}^{n} (r_{ij})^{\omega_j} \quad (8)$$

Step 4: Calculation of Relative Performance Scores of Alternatives

The three evaluation strategies, which are also expressed as the relative performance of the alternatives, are obtained by means of the Equations (9), (10) and (11), respectively.

$$\delta_{ia} = \frac{P_i + S_i}{\sum_{i=1}^{n} (P_i + S_i)} \quad (9)$$

$$\delta_{ib} = \frac{S_i}{\min_i S_i} + \frac{P_i}{\min_i P_i} \quad (10)$$

$$\delta_{ic} = \frac{\lambda.(S_i) + (1-\lambda).(P_i)}{\left(\lambda.\max_i S_i + (1-\lambda).\max_i P_i\right)} ; 0 \leq \lambda \leq 1 \quad (11)$$

The $\boldsymbol{\lambda}$ value is generally preferred as 0.5, but decision makers may also specify different values.

Step 5: Final Ranking of Alternatives

The final ranking of the alternatives is carried out by means of the Equation (12).

$$\delta_i = (\delta_{ia}.\delta_{ib}.\delta_{ic})^{1/3} + \frac{1}{3}.(\delta_{ia} + \delta_{ib} + \delta_{ic}) \quad (12)$$

The calculated δ_i values are ranked in descending order.

Ranking of Alternatives by COPRAS (COmplex PRoportional ASsessment) Method

This approach, introduced by Zavadskas, assumes a criteria system that adequately describes the decision variables, and a direct and proportional relationship on the values and weights of the criteria with the significance of the variants studied. This method ranks the proposed alternatives according to their relative importance, that is, by weight. The final ranking is based on positive and negative ideal solutions. (Salabun et al., 2020). The difference of the method from other techniques is that the alternatives can be compared with each other and their superiority over each other can be shown as a percentage (Demir et al., 2021).

The method consists of the following 5 steps (Zavadskas et al., 2007);

Step 1: Determination of Initial Decision Matrix

The process for creating the decision matrix in the COPRAS method is expressed with Equation (13).

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} i = 1,2,\ldots\ldots,m; \quad j = 1,2,\ldots\ldots,n \tag{13}$$

Step 2: Normalization of Decision Matrix

In this method, normalization is carried out without making any benefit-cost distinction. By performing the normalization process with Equations (14) and (15), the normalized decision matrix expressed in Equation (16) is obtained.

$$d_{ij} = \frac{x_{ij}.q_i}{\sum_{j=1}^{n} x_{ij}} \qquad i = 1,2,\ldots\ldots,m; \quad j = 1,2,\ldots\ldots,n \tag{14}$$

$$q_j = \sum_{j=1}^{n} d_{ij} \qquad i = 1,2,\ldots\ldots,m; \quad j = 1,2,\ldots\ldots,n \tag{15}$$

$$\bar{X} = \begin{bmatrix} \bar{x}_{11} & \bar{x}_{12} & \cdots & \bar{x}_{1n} \\ \bar{x}_{12} & \bar{x}_{22} & \cdots & \bar{x}_{2n} \\ \vdots & \vdots & & \vdots \\ \bar{x}_{m1} & \bar{x}_{m2} & \cdots & \bar{x}_{mn} \end{bmatrix} \qquad i = 1,2,\ldots\ldots,m; \quad j = 1,2,\ldots\ldots,n \tag{16}$$

Step 3: Calculating Sums of Normalized Indexes

S_{+i} value, which expresses the sum of the benefit criteria, and the S_{-i} value, which represents the sum of the cost criteria, are obtained by means of the Equations (17) and (18), respectively.

$$S_{+j} = \sum_{i=1}^{m} d_{+ij} \qquad \text{i=1,2,…..,m;} \quad \text{j=1,2,…..,n} \tag{17}$$

$$S_{-j} = \sum_{i=1}^{m} d_{-ij} \qquad \text{i=1,2,…..,m;} \quad \text{j=1,2,…..,n} \tag{18}$$

Step 4: Calculation of Relative Significance Values

Q_j value, which expresses the relative importance value of the j^th^ alternative, is obtained from the Equation (19).

$$Q_j = S_{+j} + \frac{S_{-min}.\sum_{j=1}^{n} S_{-j}}{S_{-j}.\sum_{j=1}^{n} \frac{S_{-min}}{S_{-j}}} \tag{19}$$

Step 5: Calculation and Ranking of Performance Index Values

The performance index value expressed as N_j, calculated by dividing the Q_j value of each alternative by the maximum Q_j value, is obtained by the Equation of (20).

$$N_j = \left[\frac{Q_j}{Q_{max}}\right].100\% \tag{20}$$

The calculated N_j value is sorted in descending order.

Ranking the Alternatives by MAIRCA (Multi-Attributive Ideal-Real Comparative Analysis) Method

It is possible to express the basic principle of the Multi-Attributive Ideal-Real Comparative Analysis (MAIRCA) method as defining the gaps between ideal ratings and empirical ratings. Summing up the gaps according to each criterion creates the total gap for each alternative. Ranking of alternatives is obtained at the end of the process, where the best ranking occurs with the alternative which has the lowest gap value. The alternative with the lowest total gap value is evaluated as the alternative with the closest values in the ideal order according to most of the criteria. (Pamucar et al., 2018).

The steps applied in this method are as follows (Pamucar et al., 2018); (Demir & Kartal, 2020);

Step 1: Determination of Initial Decision Matrix

The process of creating the decision matrix in the MAIRCA method is expressed with Equation (21).

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} i = 1,2,\ldots\ldots,m; \quad j = 1,2,\ldots\ldots,n \tag{21}$$

Step 2: Determination of Preferences for Selection of Alternatives

m indicates the total number of alternatives, and the determination of the preference values of the alternatives is obtained from Equation (22).

$$P_{A_i} = \frac{1}{m}; \sum_{i=1}^{m} P_{A_i} = 1; i = 1,2,\ldots\ldots,m \tag{22}$$

In a decision-making analysis with priori probability, we move from a point of neutrality to the probability of choosing each alternative separately. In this case, it is considered that all preferences are equal regarding the choice of each alternative as shown in the Equation (23).

$$P_{A_1} = P_{A_2} = \cdots = P_{A_m} \tag{23}$$

Step 3: Calculation of Theoretical Evaluation Matrix

n represents the number of criteria and the theoretical evaluation matrix expressed as $T_p$is obtained from Equation (24).

$$T_p = \begin{bmatrix} \omega_1.P_{A_1} & \omega_2.P_{A_1} & \cdots & \omega_n.P_{A_1} \\ \omega_1.P_{A_2} & \omega_2.P_{A_2} & \cdots & \omega_n.P_{A_2} \\ \vdots & \vdots & \ddots & \vdots \\ \omega_1.P_{A_m} & \omega_2.P_{A_m} & \cdots & \omega_n.P_{A_m} \end{bmatrix} = \begin{bmatrix} t_{p_{11}} & t_{p_{12}} & \cdots & t_{p_{1n}} \\ t_{p_{21}} & t_{p_{22}} & \cdots & t_{p_{2n}} \\ \vdots & \vdots & \ddots & \vdots \\ t_{p_{m1}} & t_{p_{m2}} & \cdots & t_{p_{mn}} \end{bmatrix} \tag{24}$$

Step 4: Calculation of Real Evaluation Matrix

After obtaining the standardized matrix with Equation (25) if the criterion is beneficial, and with Equation (26) if it is cost-oriented, the real evaluation matrix is obtained by Equation (27).

$$t_{r_{ij}} = t_{p_{ij}} \cdot \left(\frac{x_{ij} - x_i^-}{x_i^+ + x_i^-} \right) \tag{25}$$

$$t_{r_{ij}} = t_{p_{ij}} \cdot \left(\frac{x_{ij} - x_i^+}{x_i^- - x_i^+} \right) \tag{26}$$

$$T_r = \begin{matrix} P_{A_1} \\ P_{A_2} \\ \vdots \\ P_{A_m} \end{matrix} \begin{bmatrix} t_{r_{11}} & t_{r_{12}} & \cdots & t_{r_{1n}} \\ t_{r_{21}} & t_{r_{22}} & \dots & t_{r_{2n}} \\ \vdots & \vdots & \ddots & \vdots \\ t_{r_{m1}} & t_{r_{m2}} & \cdots & t_{r_{mn}} \end{bmatrix} \tag{27}$$

Step 5: Calculating the Total Gap Matrix

By subtracting the real evaluation matrix from the theoretical evaluation matrix, the difference matrix is obtained by the Equation (28).

$$G = T_P - T_r = \begin{bmatrix} g_{11} & g_{12} & \cdots & g_{1n} \\ g_{21} & g_{22} & \dots & g_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ g_{m1} & g_{m2} & \cdots & g_{mn} \end{bmatrix} = \begin{bmatrix} t_{p_{11}} - t_{r_{11}} & t_{p_{12}} - t_{r_{12}} & \cdots & t_{p_{1n}} - t_{r_{1n}} \\ t_{p_{21}} - t_{r_{21}} & t_{p_{22}} - t_{r_{22}} & \dots & t_{p_{2n}} - t_{r_{2n}} \\ \vdots & \vdots & \ddots & \vdots \\ t_{p_{m1}} - t_{r_{m1}} & t_{p_{m2}} - t_{r_{m2}} & \cdots & t_{p_{mn}} - t_{r_{mn}} \end{bmatrix} \tag{28}$$

Step 6: Calculating Criterion Function Values for Alternatives and Ranking

It is obtained by finding the sum of the difference values found in the 5th step separately for each alternative, using the Equation (29).

$$Q_i = \sum_{J=1}^{n} g_{ij} \qquad i = 1,2, \dots\dots, m \tag{29}$$

The calculated Q_i value is sorted in ascending order.

Findings and Discussion

Determination of Criterion Weights

Values such as parcel unit price (TL/m^2), electricity unit price (TL/kWh), service water unit price (TL/m^3), waste water unit price (TL/m^3) and natural gas unit price (TL/m^3) that could be determined for the evaluation of criterion weights were obtained from the Organized Industrial Zone Directorates in the TR72 Region.

Insurance premium employer's share support period (year), investment contribution rate for insurance premium employer share support (%), tax reduction rate (%), investment contribution rate for tax reduction (%) and interest or profit share support (point) parameters were taken into consideration according to the articles of Decision No. 3305 on State Aids in Investments.

Access to raw material sources (1-5), access to market (1-5) and qualified labour supply (1-5) criteria were evaluated separately for all three provinces.

The evaluation regarding the order of importance of the criteria was carried out with the participation of two textile engineers. The criteria set by the first decision maker (DM1) and the second decision maker (DM2) for the hemp fibre production facility are ranked according to the level of importance as shown in Table 4 through Equations (1), (2) and (3).

Ranking of Alternatives

The initial matrix to be used in the first step of each method for ranking alternatives for hemp fibre production plant location is shown in Table 5;

As a result of the application of all Equations (4) – (29) expressed in the COCOSO, COPRAS and MAIRCA methods, the final rankings for each method were as in Table 6, Table 7 and Table 8.

As it can be observed from Table 6, Table 7 and Table 8, the rankings obtained from all three methods applied indicate that Kaleseramik Private OIZ in Yozgat ranks as first, while Yozgat OIZ in the same province ranks as the second.

Table 4. Criteria Weights for Hemp Fibre Production Plant Location

Criteria	Average	Rank
C01 - Parcel Unit Price (TL/m^2)	0.090	4
C02 - Electricity Unit Price (TL/kWh)	0.119	3
C03 - Service Water Unit Price (TL/m^3)	0.040	12
C04 - Waste Water Unit Price (TL/m^3)	0.036	13
C05- Natural Gas Unit Price (TL/m3)	0.051	11
C06 - Insurance Premium Employer's Share Support Period (year)	0.078	5
C07 - Investment Contribution Rate for Insurance Premium Employer Share Support (%)	0.078	6
C08 - Tax Reduction Rate (%)	0.053	9
C09 - Investment Contribution Rate for Tax Reduction (%)	0.052	10
C10 - Interest or Profit Share Support (Point)	0.056	8
C11 - Access to Raw Material Sources (1-5)	0.158	1
C12 - Access to Market (1-5)	0.067	7
C13 - Qualified Labour Supply (1-5)	0.121	2

Table 5. Initial Matrix

	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13
w	0.090	0.119	0.040	0.036	0.051	0.078	0.078	0.053	0.052	0.056	0.158	0.067	0.121
KAY	400.0	0.54	1.18	0.68	1.90	5	20	60	25	0	0.40	0.60	0.60
MIM	250.0	0.52	1.08	1.30	1.82	5	20	60	25	0	0.40	0.60	0.60
INC	35.0	0.48	0.56	0.59	1.79	6	25	70	30	4	0.40	0.60	0.60
SIV	20.0	0.50	2.45	0.40	1.83	7	35	80	40	4	0.60	0.40	0.40
SAR	1.0	0.96	1.30	0.90	2.40	7	35	80	40	4	0.60	0.40	0.40
GEM	0.0	0.78	1.40	0.40	1.82	7	35	80	40	4	0.60	0.40	0.40
YOZ	6.1	0.40	2.00	0.60	1.33	10	100	90	50	5	0.60	0.40	0.20
KAL	10.0	0.42	0.10	0.70	0.74	10	100	90	50	5	0.60	0.40	0.20

KAY: Kayseri OIZ; MIM: Mimarsinan OIZ; INC: İncesu OIZ; SIV: Sivas Central OIZ; SAR: Şarkışla OIZ; GEM: Gemerek OIZ; YOZ: Yozgat OIZ; KAL: Kaleseramik Private OIZ

Table 6. Sorting Results of COCOSO Method

	δ_{ia}	δ_{ib}	δ_{ic}	δ_{i}	Ranking
Kayseri OIZ	0.0765	2.0095	0.5069	1.2915	8
Mimarsinan OIZ	0.0761	2.0499	0.5037	1.3048	7
İncesu OIZ	0.1478	3.5730	0.9788	2.3690	4
Sivas Central OIZ	0.1380	3.6215	0.9141	2.3281	5
Şarkışla OIZ	0.1246	3.1262	0.8253	2.0438	6
Gemerek OIZ	0.1483	3.6645	0.9823	2.4096	3
Yozgat OIZ	0.1436	4.0825	0.9512	2.5489	2
Kaleseramik Private OIZ	0.1451	4.2194	0.9609	2.6130	1

Table 7. Sorting Results of COPRAS Method

	S_{+j}	S_{-j}	S_{-min}	$\sum_{j=1}^{n} S_{-j}$	$\frac{S_{-min}}{S_{-j}}$	$\sum_{j=1}^{n} \frac{S_{-min}}{S_{-j}}$	Q_j	N_j	Ranking
KAY	0.068	0.080	0.020	0.336	0.248	4.513	0.086	0.497	8
MIM	0.068	0.064			0.309		0.091	0.523	7
INC	0.080	0.030			0.671		0.131	0.753	3
SIV	0.083	0.035			0.571		0.126	0.727	4
SAR	0.083	0.045			0.441		0.116	0.671	6
GEM	0.083	0.035			0.565		0.125	0.724	5
YOZ	0.099	0.028			0.707		0.151	0.874	2
KAL	0.099	0.020			1.000		0.173	1.000	1

KAY: Kayseri OIZ; MIM: Mimarsinan OIZ; INC: İncesu OIZ; SIV: Sivas Central OIZ; SAR: Şarkışla OIZ; GEM: Gemerek OIZ; YOZ: Yozgat OIZ; KAL: Kaleseramik Private OIZ

Table 8. Sorting Results of MAIRCA Method

	C01	C02	C03	C04	C05	C06	C07	
KAY	0.011228	0.003629	0.002306	0.001419	0.004454	0.009748	0.009738	
MIM	0.007016	0.003095	0.002092	0.004561	0.004147	0.009748	0.009738	
INC	0.000980	0.002028	0.000982	0.000963	0.004031	0.007799	0.009129	
SIV	0.000559	0.002642	0.005017	0.000000	0.004185	0.005849	0.007912	
SAR	0.000024	0.014836	0.002562	0.002534	0.006373	0.005849	0.007912	
GEM	0.000000	0.010033	0.002775	0.000000	0.004147	0.005849	0.007912	
YOZ	0.000168	0.000000	0.004056	0.001014	0.002254	0.000000	0.000000	
KAL	0.000278	0.000427	0.000000	0.001520	0.000000	0.000000	0.000000	
	C08	C09	C10	C11	C12	C13	Q_i	Ranking
KAY	0.006651	0.006462	0.007011	0.019801	0.000000	0.000000	0.082446	8
MIM	0.006651	0.006462	0.007011	0.019801	0.000000	0.000000	0.080322	7
INC	0.004434	0.005169	0.001402	0.019801	0.000000	0.000000	0.056719	5
SIV	0.002217	0.002585	0.001402	0.000000	0.008436	0.007569	0.048372	3
SAR	0.002217	0.002585	0.001402	0.000000	0.008436	0.007569	0.062298	6
GEM	0.002217	0.002585	0.001402	0.000000	0.008436	0.007569	0.052924	4
YOZ	0.000000	0.000000	0.000000	0.000000	0.008436	0.015139	0.031066	2
KAL	0.000000	0.000000	0.000000	0.000000	0.008436	0.015139	0.025799	1

KAY: Kayseri OIZ; MIM: Mimarsinan OIZ; INC: İncesu OIZ; SIV: Sivas Central OIZ; SAR: Şarkışla OIZ; GEM: Gemerek OIZ; YOZ: Yozgat OIZ; KAL: Kaleseramik Private OIZ

Conclusion

Studies on cannabis cultivation in Türkiye are increasing rapidly. For this reason, the subject of plant location selection for hemp fibre production facility, which has different areas of use, constituted the main objective of this study.

Both investment costs and post-investment operating costs are considered in this study for a probable venture for hemp fibre production. When reviewed from both perspectives; values such as parcel unit price, electricity unit price, service water unit price, waste water unit price, natural gas unit price, insurance premium employer's share support period, investment contribution rate for insurance premium employer's share support, tax reduction rate, investment contribution rate for tax reduction, interest or profit share support, access to raw material sources, access to market and qualified labour supply have emerged as the determinants in terms of plant location selection, respectively.

When all these parameters are examined, it is seen that Kaleseramik Private OIZ is not in the most advantageous position in terms of the parcel price that concerns the investment stage. Similarly, there is no inference that can be evaluated positively in terms of the supply of qualified labour and the unit price of waste water. However, especially during the operation period, the insurance premium employer's share support period and its investment contribution rate, tax deduction support and its investment contribution rate, and interest or profit share support to a labour-intensive sector such as fibre production play a decisive role in choosing such an investment location.

In this evaluation carried out using Multi-Criteria Decision Making Methods consisting of COCOSO, COPRAS and MAIRCA, it is observed that Yozgat OIZ, which has the same conditions as Kaleseramik Private OIZ, ranks second in terms of incentive measures. It is seen that the ranking difference between these two organized industrial zones is due to the unit prices of service water and natural gas.

The permitted areas for the cultivation of cannabis plants in our country vary in different periods, and in case of any attempt for an investment aiming hemp fibre production plant, the reference data should be updated again considering the current situation of the cultivation areas. The current values of unit prices applied in organized industrial zones should be followed regularly. Similarly, it is necessary to make changes in the relevant parameters by following the updates made in the incentive applications in the Decision on State Aids in Investments No. 3305.

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References

Alinezhad A, Khalili J. 2019. New Methods and Applications in Multiple Attribute Decision Making (MADM). USA: Springer. ISBN 978-3-030-15008-2

Aydoğan M, Terzi YE, Gizlenci Ş, Acar M, Esen A, Meral H. 2020. Economic Feasibility of Industrial Hemp Cultivation in Turkey: A Case Study of Vezirköprü District of Samsun Province. Anadolu Journal of Agricultural Sciences, 35(1): 35–50. https://doi.org/10.7161/omuanajas.602585

Başer U, Bozoğlu M. 2020. Türkiye'nin Kenevir Politikası ve Piyasasına Bir Bakış. Tarım Ekonomisi Araştırmaları Dergisi, 6(2): 127–135.

Belke M. 2020. CRITIC ve MAIRCA Yöntemleriyle G7 Ülkelerinin Makroekonomik Performansının Değerlendirilmesi. İstanbul Ticaret Üniversitesi Sosyal Bilimler Dergisi, 19(Temmuz 2020(Özel Ek)): 120–139.

Bismarck A, Mishra S, Lampke T. 2005. Natural Fibers, Biopolymers, and Biocomposites. In: Mohanty A, Misra M, Drzal L (editors). Plant Fibers as Reinforcement for Green Composites. USA: Taylor & Francis Group. pp. 37–108. ISBN: 978-1-135-49897-9

Demir G. 2021. Evaluation of Financial Performance of Central and Eastern European Countries with Fuzzy DEMATEL and COCOSO Methods. XXI. International Symposium on Econometrics, Operational Research and Statistics. Çanakkale, 8-10 September 2021, Holistence Publications, pp. 226.

Demir G, Kartal M. 2020. Güncel Çok Kriterli Karar Verme Teknikleri (1st ed., Vol. 1). Ankara: Akademisyen Kitabevi. ISBN: 978-605-258-936-6

Demir G, Özyalçın A T, Bircan H. 2021. Çok Kriterli Karar Verme Yöntemleri ve ÇKKV Yazılımı ile Problem Çözümü. Ankara: Nobel Yayınevi. ISBN: 978-6-254-39390-7

FAO, 2022. Food and Agriculture Organization of the United Nations. FAOSTAT. Available from: https://www.fao.org/faostat/en. [Accessed January 2022]

Gizlenci Ş, Acar M, Yiğen Ç, Aytaç S. 2019. Kenevir Tarımı . T.C. Tarım ve Orman Bakanlığı Tarımsal Araştırmalar ve Politikalar Genel Müdürlüğü Karadeniz Tarımsal Araştırma Enstitüsü Müdürlüğü. https://arastirma.tarimorman.gov.tr/ktae/belgeler/kenevir_tarimi_kitabi.pdf

Law on Control of Narcotic Substances, 2313. 1933.

Mohamed Zakriya G, Ramakrishnan G. 2021. Natural Fibre Composites—Manufacturing, Characterization, and Testing. USA: Taylor & Francis Group. ISBN: 978-0-367-34589-1

Musio S, Müssig J and Amaducci S. 2018. Optimizing Hemp Fiber Production for High Performance Composite Applications. Front. Plant Sci. 9:1702. doi: 10.3389/fpls.2018.01702

Needles HL.1986. Textile Fibers, Dyes, Finishes and Processes—A Concise Guide. USA: Nayes Publications. ISBN: 0-8155-1076-4

Pamucar D, Lukovac V, Božanić D, Komazec N. 2018. Multi-criteria FUCOM-MAIRCA model for the evaluation of level crossings: Case study in the Republic of Serbia. Operational Research in Engineering Sciences: Theory and Applications, 1(1): 108–129. doi:10.31181/oresta190120101108p

Regulation on Cannabis Cultivation and Control. 2019

Salabun W, Watrobski J, Shekhovtsov A. 2020. Are MCDA Methods Benchmarkable? A Comparative Study of TOPSIS, VIKOR, COPRAS, and PROMETHEE II Methods. Symmetry, 12(9): 1–55. https://doi.org/10.3390/sym12091549

Stanujkic D, Karabasevic D, Zavadskas EK. 2015. A framework for the Selection of a packaging design based on the SWARA method. The Engineering Economics, 26(2): 181–187. https://doi.org/10.13140/RG.2.1.1350.9603

Taşlıgil N, Şahin G. 2019. Developments and Restoration Of Hemp (Cannabis Sativa L.) Cultivation in Turkish Agriculture. In: Gönençgil B, Ertek TA, Akova İ, Elbaşı E (editors). 1st İstanbul International Geography Congress. İstanbul, 20-22 June 2019

TİGEM, 2019. Kenevir üretim çalışmalarına ilişkin kamuoyuna bilgilendirme. https://www.tigem.gov.tr/haber/haberdetay/9079d190-1793-44ec-958b-77d150b82094 Erişim: 16.09.2020. İstanbul University Press: pp. 457–478. TÜİK, 2022. Turkish Statistical Institute. Available from: www.tuik.gov.tr [Accessed January 2022]

TÜİK, 2022. Turkish Statistical Institute. Available from: www.tuik.gov.tr [Accessed January 2022]

Yazdani M, Zaraté P, Zavadskas EK, Turskis Z. 2018. A Combined Compromise Solution (CoCoSo) method for multi-criteria decision-making problems. Management Decision, 57(9): 2501-2519. https://doi.org/10.1108/MD-05-2017-0458

Yozgat İli Kenevir Elyafı Üretim Tesisi Ön Fizibilite Raporu. 2021. [Ön Fizibilite Raporu]. ORAN Kalkınma Ajansı.

Zavadskas EK, Kaklauskas A, Peldschus F, Turskis Z. 2007. Multi-Attribute Assesment of Road Design Solutions By Using The COPRAS Method. The Baltic Journal of Road and Bridge Engineering, 2(4): 195–203.