

Determinants of foreign direct investment in the textile sector: a research with IT2 Fuzzy TOPSIS methodology

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ABSTRACT – REZUMAT

Determinants of foreign direct investment in the textile sector: a research with IT2 Fuzzy TOPSIS methodology

This study aims to identify the determinants of foreign direct investment (FDI) in the textile sectors in Poland, Romania, Hungary, Slovakia, Czechia and Türkiye. The study assesses these criteria through paired comparisons conducted by experts who have a minimum of 10 years of professional experience in the field and analyses them using the IT2 Fuzzy Technique for Order of Preference by Similarity to the Ideal Solution (TOPSIS) technique. According to the findings, the criteria with the highest degree of importance are national security, inflation rate, patent and trademark protection, transportation networks and market size. On a country-by-country basis, Poland has a higher investment attraction potential compared to other countries according to the criteria of openness, corruption, legal regulations and privatization policies, import and export quotas, education and professional status, renewable energy resources, sustainability, intellectual property protection, patent and trademark protection and national security. Hungary scores highest on import and export quotas and tax rates, while Slovakia stands out on import and export quotas and waste management/environmental regulations. Romania scores highest on profitability and debt financing, labour costs and import and export quotas. Czechia scores highest on inflation rate, political stability, legal regulations and privatization policies, economic incentives, general trade policies, import and export quotas and cultural situation and lifestyle. Türkiye scores the highest in terms of market size, GDP growth rate, access to raw materials and markets, technological infrastructure and innovation, transport networks, production sites, energy production, import and export quotas and business-friendly approaches.

Keywords: foreign direct investment, textile industry, textile investment, IT2 Fuzzy TOPSIS

Determinanți ai investițiilor străine directe în sectorul textil: o cercetare cu metodologia IT2 Fuzzy TOPSIS

Acest studiu își propune să identifice factorii determinanți ai investițiilor străine directe (FDI) în sectoarele textile din Polonia, România, Ungaria, Slovacia, Cehia și Turcia. Studiul evaluează aceste criterii prin comparații în perechi efectuate de experți care au o experiență profesională de minimum 10 ani în domeniu și le analizează utilizând tehnica IT2 Fuzzy Technique for Order of Preference by Similarity to the Ideal Solution (TOPSIS). Conform rezultatelor, criteriile cu cel mai înalt grad de importanță sunt securitatea națională, rata inflației, protecția brevetelor și a mărcilor comerciale, rețelele de transport și dimensiunea pieței. Dintre toate țările analizate, Polonia are un potențial mai ridicat de atragere a investițiilor în comparație cu alte țări în funcție de criteriile privind deschiderea, corupția, reglementările juridice și politicile de privatizare, cotele de import și export, educația și statutul profesional, resursele de energie regenerabilă, durabilitatea, protecția proprietății intelectuale, protecția brevetelor și a mărcilor comerciale și securitatea națională. Ungaria obține cel mai mare punctaj în ceea ce privește cotele de import și export și ratele de impozitare, în timp ce Slovacia se evidențiază în ceea ce privește cotele de import și export și gestionarea deșeurilor/reglementările de mediu. România obține cel mai mare punctaj în ceea ce privește profitabilitatea și finanțarea datoriei, costurile forței de muncă și cotele de import și export. Cehia este cel mai bine cotate în ceea ce privește rata inflației, stabilitatea politică, reglementările juridice și politicile de privatizare, stimulentele economice, politicile comerciale generale, cotele de import și export, situația culturală și stilul de viață. Turcia obține cel mai mare punctaj în ceea ce privește dimensiunea pieței, rata de creștere a PIB-ului, accesul la materii prime și piețe, infrastructura tehnologică și inovarea, rețelele de transport, locurile de producție, producția de energie, cotele de import și export și abordările favorabile întreprinderilor.

Cuvinte-cheie: investiții străine directe, industria textilă, investiții textile, IT2 Fuzzy TOPSIS

INTRODUCTION

With the acceleration of globalization, the mobility and volume of capital, seen as the key to commercial activities and economic growth, have gradually increased. Although the increase in capital mobility and volume causes some problems, it generally provides positive

developments by creating opportunities for countries. In economically underdeveloped and developing countries, capital shortages due to insufficient national savings make it very difficult for these countries to achieve or sustain economic growth without FDI. In this context, governments often rely on FDI to meet their financing needs. Therefore, these countries

develop and implement attractive measures and incentive policies to attract capital to their countries [1, 2].

Manufacturing, as one of the fundamental components of industrialization, is a driving force for economic growth. Particularly, the textile sector within the manufacturing industry is crucial for achieving economic growth and development in some countries (especially developing countries). However, to realize growth and development goals in these countries, there is a need for Foreign Direct Investment (FDI) in the textile sector, as in other sectors. The textile sector is attractive for FDI due to its labour-intensive nature (beneficial for countries with low wage levels) and the lower production costs and higher profitability associated with its use of low technology [3]. Nevertheless, the complex structure of factors influencing FDI in the textile sector spans a wide range, from labour costs to tax rates. Despite this complexity, the incentive policies developed by governments to attract FDI contribute to the sector's appeal. This study aims to identify the determinants of FDI in the textile sector by providing empirical evidence to explain the complexity of factors influencing FDI decisions. In this context, the study consists of three sections. The first section reviews the literature, the second section presents the methodology used in the study, and the third section discusses and presents the findings obtained from the analysis.

In the literature examining the determinants of FDI inflows in the textile sector, which forms the core of this study, there are both theoretical and empirical studies that are either consistent with or diverge from each other on certain points. Upon reviewing these studies, it is observed that there are both micro-scale research specific to the textile sector and macro-scale studies that include multiple sectors or all sectors. Haque et al. [4] examined the role of cash flow in determining corporate investments by using unbalanced panel data of 159 textile firms listed on the Karachi Stock Exchange (KSE) from 1998 to 2011. Their findings show that cash flow has a significant and positive impact on corporate investments. Maharani and Wiagustini [5], by analysing 14 companies from the textile and apparel sub-sectors listed on the Indonesia Stock Exchange, revealed that growth opportunities, capital structure, and profitability positively affect investment decisions. Soeng and Supinit [6] identified that quota-free access to the US and EU markets, low wage rates, and free taxation advantages with large markets attract international investments in Cambodia's textile and apparel sector.

Ullah et al. [7] investigated the role of firm size in the relationship between financial factors and investment decisions of textile firms listed on the Pakistan Stock Exchange (PSX). They applied fixed effects regression analysis on a sample of 20 textile firms for the period 2009–2018. They found that financial leverage, cash flow, and firm size have a significant and positive impact on investment decisions, while profitability does not have a significant effect. Winn and Dardis [8] analysed post-World War II investment

behaviour in the US textile industry, considering liquidity constraints and the two components of investment, namely expansion and modernisation investments, using both cross-sectional and time series data. Time series data show that capital-labour substitution is a significant determinant of investment, and depreciation expenses have a meaningful impact on investment. Additionally, liquidity constraints play a crucial role in the textile sector in government policies.

Özkaya [9], in his study on the factors affecting intra-industry trade in the textile sector, associated the preference of foreign investors for Türkiye in textile investments with Türkiye's lower labour costs compared to the EU region. Additionally, findings from regression analysis indicate that foreign direct investments in the textile sector negatively impact the level of intra-industry trade. Polat and Payaslıoğlu [10] analysed the fundamental determinants of foreign investments in 13 sub-sectors of the manufacturing industry, including the textile sector in Türkiye, using data from the period 2007–2012. According to the findings, investment incentives and tax rates are determinants for FDI. Liu et al. [11] analysed FDI in the manufacturing industry, including the textile sector in China, across four main regions. They concluded that local market size, labour costs, and the agglomeration effect are determinants of attracting FDI in the low-technology textile sector. Wu et al. [12] found that China's outward FDI promotes growth in the middle segment of the textile industry. The World Bank's [13] 2015 study on Sub-Saharan African countries indicated that the main determinants of FDI in Ethiopia's textile sector are market size and political-social stability. Additionally, low labour and raw material costs and investment incentives were highlighted as other significant determinants. Bartels et al. [14] examined data on 758 foreign investors in 10 Sub-Saharan African countries using factor analysis. According to the findings, the provision of information and public services that reduce transaction costs regarding sectors and markets before and after investment influences investors' FDI decisions. Moreover, it was determined that the choice of location for FDI is strongly affected by political economy factors.

Saravanan [15] suggests that the Indian government's flexible rule, known as the automatic route, which allows international investors to invest without prior approval from the government or the Reserve Bank of India, has encouraged FDI inflows into the textile sector. Danciu and Strat [16] examined the main determinants of foreign direct investments across different regions in Romania using a sample of 235 companies. According to the findings from the analysis conducted through two main clusters, factors such as the availability and quality of the workforce, labour and operational costs, market seeking, low rent and land prices, production site, and the distance between the production site and potential customers influence foreign investors' investment decisions. Cieřlik [17] used panel data methods to

empirically investigate the reasons for FDI inflows from OECD countries to Poland between 1996–2015. The findings indicate that the primary reason for FDI inflows into Poland is the search for efficiency, with a preference for the pure vertical integration model of multinational companies. For the sub-sample period of 1996–2004, both market-seeking and efficiency-seeking factors were prominent.

Wang and Swain [18] linked the determinants of FDI inflows into Hungary and China during 1978–92 to market size, low-cost labour, and currency depreciation. Additionally, a positive correlation between OECD growth rates and FDI in Hungary was identified. Tsaurai [19], using data from 1991–2015 and an OLS multiple regression model, empirically tested the determinants of FDI in Hungary. Contrary to common belief, the findings indicate that inflation has a positive impact on FDI. Furthermore, exchange rates, education, and economic growth have a positive but not significant effect on FDI in Hungary.

Bobenič et al. [20] applied correlation and regression analyses to country-level data from the Visegrad countries (the Czech Republic, Hungary, Poland, and Slovakia) for the period 1989–2016. They found that gross wage levels and an educated labour force positively affect FDI inflows in the Visegrad countries. Additionally, corporate tax rates, trade openness, and research and development expenditures have a negative effect on FDI. Su et al. [21] examined several macroeconomic factors influencing FDI in the Visegrad group countries after the European Union's (EU) enlargement in 2004. They found that perceived corruption is a significant factor affecting FDI in all countries. Furthermore, a significant long-term relationship was identified between FDI, the corruption index, and the highly educated workforce. Darmo et al. [22] aimed to identify the determinants of FDI flows for the Visegrad countries for the period 2001–2014. They concluded that economic size, corporate tax rates, inflation, trade openness, the level of corruption, and labour cost-productivity and quality are significant determinants.

The studies reveal that the factors shaping corporate and international investment decisions in the textile sector are multidimensional and complex. The findings emphasize various factors that need to be considered in developing strategies to attract investment in the textile sector. For the sustainable growth and increased competitiveness of the sector, a holistic analysis of the factors influencing investment decisions at both micro and macro levels is required. In this context, our study aims to contribute to the development of more effective and strategic investment policies in the textile sector. Fuzzy logic research is scarce in the literature that specifically focuses on the textile area. Hence, this study will make a valuable contribution to the existing body of knowledge in the textile industry.

The remainder of this paper is structured as follows: A description of the problem is provided, and the IT2 Fuzzy TOPSIS method is examined in the following

section. A textile investment factor evaluation using the IT2 fuzzy TOPSIS methodology. Furthermore, computational results and comparisons are provided. In the conclusion section, the results are discussed, evaluations are made, and prospective future research directions are highlighted.

IT2 FUZZY TOPSIS METHODOLOGY

The primary goal of this study is to examine the factors affecting textile investments and emphasize the importance of effectively overcoming the diverse challenges that emerge throughout the decision-making process. The study used the trapezoidal Interval Type-2 (IT2) Fuzzy Technique for Order of Preference by Similarity to the Ideal Solution (TOPSIS) technique. This research is focused on the selection of a country to invest in. The decisions were taken by three individuals who hold positions of authority and responsibility within the organization and business. Each expert in the research was assigned equal weight. Five crucial factors and twenty-six sub-factors were chosen in this problem, and each of these criteria was assigned the necessary weight. Furthermore, six alternatives were selected, as seen in figure 1.

The arrows in figure 1 illustrate the problem's hierarchy. Economic factors criteria (MC1) include the following subcriteria: openness to the outside (SC11), profitability and debt financing (SC12), inflation rate (SC13), labour costs (SC14), market size (SC15), and GDP growth rate (SC16). Infrastructure and Logistics criteria (MC2) include the following subcriteria: access to raw materials and markets (SC21), technological infrastructure and innovation (SC22), transportation networks (SC23), production sites (SC24), and energy production (SC25). The following subcriteria are included in Political Factors (MC3): political stability (SC31), corruption (SC32), legal regulations and privatization policies (SC33), economic incentives and general trade policies (SC34), import and export quotas (SC35), and tax rates (SC36). Social and Environmental Factors (MC4) includes the following subcriteria: cultural situation and lifestyle (SC41), education and professional status (SC42), business-friendly/friendly approaches (SC43), renewable energy resources (SC44), waste management/environmental regulations (SC45), sustainability (SC46). Safety (Risk) Factors (MC5) includes the following subcriteria: intellectual property protection (SC51), patent and trademark protection (SC52), and national security (SC53). Alternatives from A1 to A6 were identified as Poland, Romania, Hungary, Slovakia, Czechia, and Türkiye, respectively.

Experts 1–3 are D1, D2, and D3. This study used trapezoidal interval type-2 fuzzy sets (IT2 FSs) and TOPSIS [23–26].

In 2008, Lee and Chen first presented the IT2 fuzzy TOPSIS technique. The current study used the IT2 fuzzy TOPSIS approach conducted by Lee and Chen [27] and Cengiz [28] to choose the most suitable textile. The problem was resolved by employing the IT2

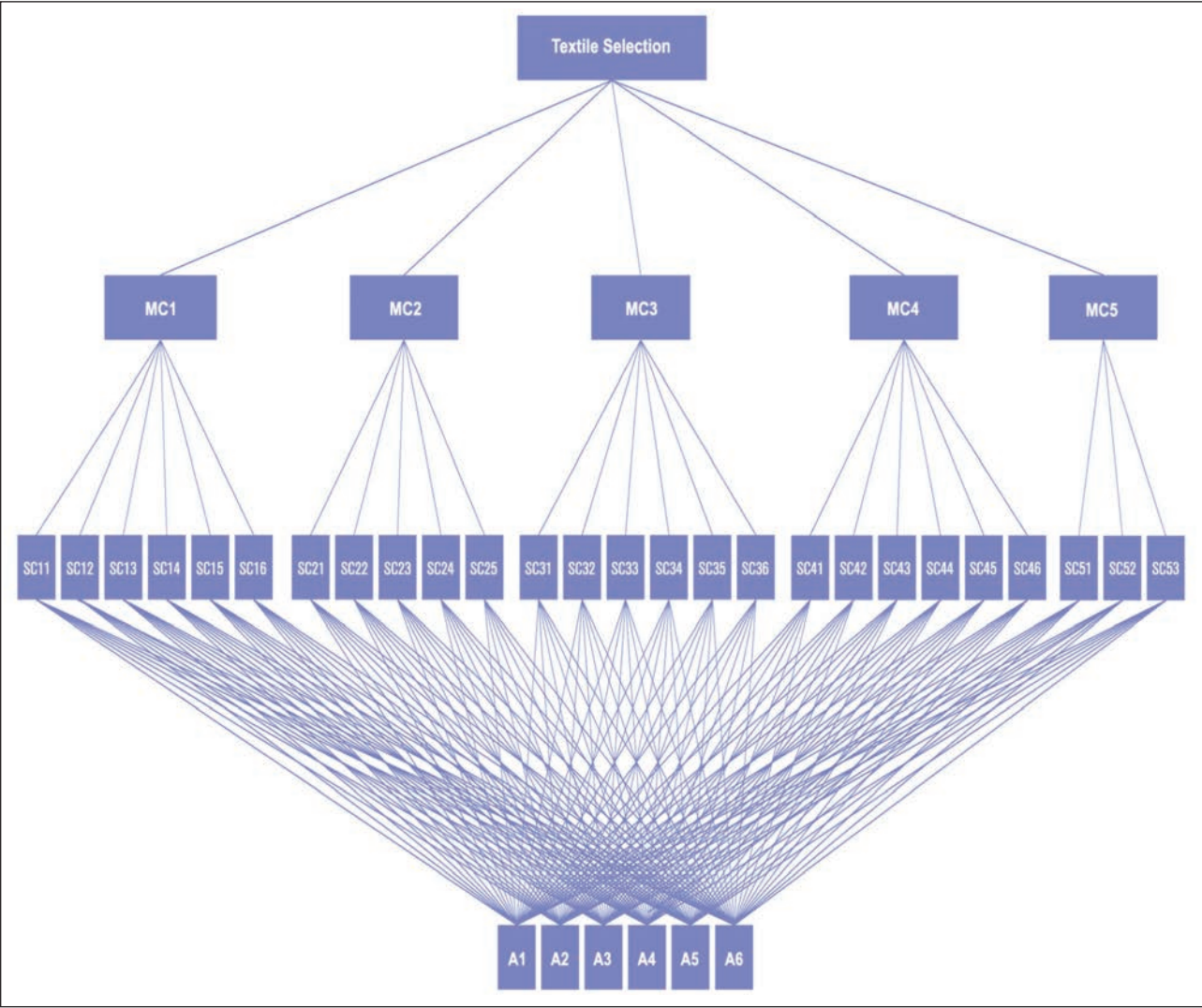


Fig. 1. A hierarchical framework of the textile investment factors problem

fuzzy TOPSIS approach, which used fuzzy numbers, as shown in table 1. Chen and Lee used table 1 to display the seven linguistic characteristics connected to IT2 FSs [29]. Table 1 displays the linguistic expressions and interval fuzzy numbers used in the process of identifying the main criterion, sub-criteria, and alternatives. The IT2 fuzzy TOPSIS algorithm was utilized for the entire process of alternative selection. This solution was

implemented to resolve the problem of square matrices that occur while using alternative matrices for sub-criteria. A comprehensive matrix was executed using the average weighting method, which incorporated the significance weights of each criterion. Afterwards, the decision matrix was calculated using the supplied weights. The procedure of assigning values to rank IT2 FS was carried out. Furthermore, the calculation of the positive ideal solution (PIS) and

Table 1

THE LINGUISTIC EXPRESSIONS RELATED TO INTERVAL TYPE-2 FUZZY SYSTEMS [29, 30]	
Linguistic expressions	Trapezoidal IT2 fuzzy numbers
Very Low (VL)	((0, 0, 0, 0.1; 1, 1) (0, 0, 0, 0.05;0.9, 0.9))
Low (L)	((0, 0.1, 0.1, 0.3; 1, 1) (0.05, 0.1, 0.1, 0.2; 0.9, 0.9))
Medium Low (ML)	((0.1, 0.3, 0.3, 0.5; 1, 1) (0.2, 0.3, 0.3, 0.4; 0.9, 0.9))
Medium (M)	((0.3, 0.5, 0.5, 0.7; 1, 1) (0.4, 0.5, 0.5, 0.6; 0.9, 0.9))
Medium High (MH)	((0.5, 0.7, 0.7, 0.9;1, 1) (0.6, 0.7, 0.7, 0.8; 0.9, 0.9))
High (H)	((0.7, 0.9, 0.9, 1; 1, 1) (0.8, 0.9, 0.9, 0.95; 0.9, 0.9))
Very High (VH)	((0.9, 1, 1,1; 1, 1) (0.95, 1, 1,1; 0.9, 0.9))

negative ideal solution (NIS) was executed. The next section provides a thorough examination of the prescribed procedures that must be adhered to effectively utilize this methodology. The distances between each choice were computed. After completing a thorough study, the proximity coefficient was calculated, leading to the identification and selection of the most beneficial option.

The conventional method is to use a number scale, often spanning from 1 to 9, to evaluate many alternatives based on a predetermined set of criteria. Table 1 displays the numerical values assigned to the language variables. The decision-makers, who were responsible for making the final choice, were assigned the task of evaluating each criterion for every alternative. The IT2 fuzzy TOPSIS approach is utilized to address the assessment of the foreign direct investment problem. The derived weighted decision matrix is the outcome of using IT2 fuzzy TOPSIS. The distances between each possible alternative are calculated. Afterwards, the proximity coefficient is computed and used to choose the most advantageous choice. According to the data presented in table 2, the observed order is $x_1 > x_6 > x_5 > x_2 > x_3 > x_4$.

Table 2		
RESULTS OF THE IT2 FUZZY TOPSIS		
Country	Weights	Normalized values
x1 (Poland)	0.69	25.20%
x2 (Romania)	0.39	14.33%
x3 (Hungary)	0.34	12.49%
x4 (Slovakia)	0.29	10.52%
x5 (Czechia)	0.47	17.20%
x6 (Türkiye)	0.55	20.25%

The membership functions of type-1 fuzzy sets (FSs) are composed of two dimensions, whereas the membership functions of type-2 fuzzy sets (FSs) are composed of three dimensions. Because it gives extra degrees of freedom, the new third dimension makes it feasible to directly simulate uncertainty. This is because the dimension offers additional degrees of freedom [31]. The T2 fuzzy set approach, in contrast to T1 FSs, offers flexibility and represents uncertainty. Moreover, a T2 fuzzy set ensures an adequate representation of uncertainty. T2 FSs enable rule-based fuzzy logic systems to model and minimize delays [32–34]. There are some recent studies in the literature using IT2 fuzzy TOPSIS [35,36].

CONCLUSION

The main purpose of this study is to determine the investment potential of six different European countries by addressing the factors affecting textile investments. Using a trapezoidal IT2 fuzzy TOPSIS approach made completing this challenge easier.

Based on the supplied weights for textile country alternatives, the analysis shows that alternative x1 (Poland) has achieved a score of 25.20%. Comparatively, alternative x6 (Türkiye) has obtained a score of 20.25%, while alternative x5 (Czechia) has acquired a score of 17.20%. Alternative x2 (Romania) has attained a score of 14.33%, followed by alternative x3 (Hungary) with a score of 12.49%, and alternative x4 (Slovakia) with a score of 10.52%. x1 (Poland) was selected as the best alternative. The fact that these countries are located in Europe and the ratios of their textile production levels to GDP are close to each other, these two criteria were taken into account in the sample selection. According to the findings, SC53 (national security) > SC13 (inflation rate) > SC52 (patent and trademark protection) > SC23 (transportation networks) > SC15 (market size) constitute the top 5 criteria in terms of importance. The results are consistent with the literature. In terms of countries, A1 (Poland) has a higher investment attraction potential compared to other countries based on SC11 (openness), SC32 (corruption), SC33 (legal regulations and privatization policies), SC35 (import and export quotas), SC42 (education and professional status), SC44 (renewable energy sources), SC46 (sustainability), SC51 (intellectual property protection), SC52 (patent and trademark protection) and SC53 (national security). A2 (Romania) is the highest scoring country according to criteria SC12 (profitability and debt financing), SC14 (labour costs) and SC35 (import and export quotas). A3 (Hungary) scored the highest according to SC35 (import and export quotas) and SC36 (tax rates), and A4 (Slovakia) scored the highest according to SC35 (import and export quotas) and SC45 (waste management/environmental regulations). A5 (Czechia) scored the highest on SC13 (inflation rate), SC31 (political stability), SC33 (legal regulations and privatization policies), SC34 (economic incentives and general trade policies), SC35 (import and export quotas) and SC41 (cultural situation and lifestyle). A6 (Türkiye) is the highest scoring country according to SC15 (market size), SC16 (GDP growth rate), SC21 (access to raw materials and markets), SC22 (technological infrastructure and innovation), SC23 (transportation networks), SC24 (production sites), SC25 (energy production), SC35 (import and export quotas) and SC43 (business friendly/friendly approaches). The level of importance of the criteria, which are weighted by using the expert opinions and ratings of three senior executives operating in the textile sector, differs within each country. Each country is differentiated from other countries according to some criteria. Looking at the overall weighted scoring, the ranking of the countries is as shown in Table 2. The findings may give important ideas to potential investors for foreign direct investment inflows to the textile sectors of these countries.

Different IT2 fuzzy methodologies (DEMATEL-ANP, FANP, FAHP) may be implemented in future investigations that pertain to foreign direct investment in the textile sector. Additionally, fuzzy methods that are

incorporated with IT2 can be employed to evaluate the effectiveness of different methods. This issue is addressed using the IT2 fuzzy TOPSIS method, which is the preferred approach. The effectiveness of the IT2 trapezoidal fuzzy TOPSIS approach has been shown by its successful application in optimizing the

assessment process. Potential areas for future research to expand upon our findings are focused on IT2 fuzzy methods. Some programs can be written to simplify the calculation process for IT2 fuzzy logic methods. Solution processes can achieve quicker results with these programs.

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