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Selection of best leather item using a FAHP method to launch new leather industry in Ethiopia: A case study

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A B S T R A C T

The ready-to-wear sector is expanding quickly and already accounts for a significant contribution to Ethiopia's export revenue. Due to its lower labor and investment costs, availability of resources, government assistance, etc. than other sectors, this industry attracts young entrepreneurs from around the nation as investment destinations. However, while investing in the leather industry, there are frequently many more aspects to consider. Again, there are numerous leather investment opportunities in the leathers sector, including handbags, jackets, belts, shoes, gloves, etc. Different sorts of leather items necessitate various levels of capital investment, operator skill sets, and resource requirements, among many other things. Again, based on their capacity for managing businesses, available capital, business location, and other factors, not all investors are in the same position. To assist investors in making decisions on the opening of a new leather industry, this paper presents a FAHP methodology for choosing the best leather item among various possibilities in a fuzzy environment. The methods enable the decision-maker to incorporate language expressions of expert judgment into the evaluation process. Using the suggested process, the ideal leather item is chosen for the launching of a leather industry in Ethiopia under the current circumstances.

1. Introduction

Leather industries in Ethiopia have great advantages to the investors as a business, employees as an employment opportunity and the Ethiopian government as a source of hard currency. The Ethiopian government has focused on the leather sector that has the greatest market potential in Africa, Europe and the western. Ethiopia has the capacity to offer 16 to 18 million hides and skins annually, which are the primary raw materials for the leather industry. For both domestic and international markets, the leather industry processes raw hides and skins to create semi-finished and finished leather. Sustaining in the market is crucial for continuing in the business, to be beneficial from the sector. The investors and businessmen are going to build their own business firm with the level of their learned skills because it is a large sector for employment opportunities and gaining work experiences. However, choosing the right kind of product to launch a new sector in line with demands careful consideration to be more successful and resilient in the market. Because there are less options for new investors and businesspeople to receive training, they frequently launch their industry using their prior work experiences, which results in underperformance in the industry. Due to knowledge gaps, capital constraints, resource-related issues, and the need for various kinds of human and non-human resources when starting a new industry with a distinct product, many of them are unable to thrive in the highly competitive business environments. As a result, the success factor in the industry may be the selection of the appropriate item from each person's standpoint of knowledge, finances, location, etc.

This study aims to create a process for selecting the best leather product for launching a new leather industry from a personal standpoint. The decision-making of new investors and businesspeople will be aided by this process, which is crucial for the leather industry's survival and growth. Here, the analytical hierarchy process (AHP), a method for multi-criteria decision making (MCDM) based on linguistic evaluations, may aid in selecting a better choice. A fuzzy-analytical hierarchy process

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(FAHP) methodology has been suggested in this study to select the best leather item. Due to the imperfection and fuzziness of the evaluation process and the use of FAHP weights, fuzzy logic and AHP are coupled in this study to make the application more realistic and reliable.

In the literature review, most studies on MCDM were conducted using the traditional AHP method. However, a few studies were conducted using the FAHP method, and these studies were supported by several earlier studies, leading to the conclusion that the FAHP method can be used and is efficient for a variety of real-world issues. Particularly for emerging nations like Ethiopia, the research done on the FAHP in the manufacturing sector was insufficient. Because FAHP application is still in its infancy in Ethiopia, which is a developing nation, it is essential to employ FAHP methodology in the manufacturing sector to make decisions prior to the launch of an industry. As a result, the research has had a considerable impact on how new entrepreneurs choose which product to develop to boost sales and maintain their competitive edge.[1] In this sense, section 2's description of literature reviews about the key subjects and their constraints. The remaining paper components are arranged as follows: Research material and methods have been presented in Section 3 based on which a case study on the selection of leather items is given in Section 4, results, and discussion, in Section 5, conclusions.

2. Literature Review

Investors and businesses alike have experienced difficulties in making decisions pertaining to the commercial and personal domains in the current competitive business environment. When facing any decision challenges, they require a practical and trustworthy way to obtain superior decision help (Hadad & Hanani, 2011). Numerous MCDM techniques have been developed from earlier investigations, including AHP, ANP, VIKOR, PROMETHEE, ELECTRE, GRA, TOPSIS, etc. (Oguztimur, 2011). The most popular MCDM technique among them is AHP, which Saaty first proposed in 1977 (Lee, 2016). The AHP's precise mathematical features and relative ease of getting the input data have drawn the attention of numerous academics. The relative values established by wise judgment or qualified opinions have been used to develop the answers in this case. Saaty, T. L. (1980), showed that while the traditional AHP is effective at eliciting expert knowledge, it is still unable to accurately capture the way people think. This is because exact data on human qualities is difficult to extract. For instance, the AHP technique does not account for the ambiguity brought on by natural language when converting human judgment into a precise number(Sun, 2010). As a result, FAHP was created to address hierarchical fuzzy problems. According to Yaghoobi, T. (2018), the pairwise comparisons in the judgment matrix used in the FAHP technique are fuzzy numbers so that the decision-maker can express their preferences in terms of the relative weights of the various criteria. Because of this, fuzzy logic provides a methodical foundation for handling circumstances that are unclear or ambiguous(Kahraman et al., 2004).

FAHP is an expansion of the traditional AHP approach, which considers the uncertainty or lack of information when making decisions. The breadth of applications for FAHP means that many researchers favor the method for a variety of purposes. We use FAHP in a variety of contexts, including supplier selection issues (Ayhan, 2013; Astanti et al., 2020), reshoring decisions (Sequeira & Hilletofth, 2019), quality management (Nguyen, 2021;Putra et al., 2018; Gopalan et al., 2015), health care system management (Ameryoun et al., 2014), project evaluation (Ayca & Hasan, 2017; Khoshfetrat & Hosseinzadeh-Lotfi, 2016), inventory management (Kabir & Ahsan Akhtar Hasin, 2011), business plan development (Khorramrouz et al., 2019), risk assessment (Tian & Yan, 2013), contractor and bidding decisions(Leśniak et al., 2018;(Zamani et al., 2013), evaluation of system-affecting factors (Halder et al., 2018; Hoseini et al., 2021), and facility location selection (Rahman et al., 2018). The imprecision in determining the relative relevance of attributes and the performance ratings of alternatives with respect to attributes has led to the development of fuzzy multiple attribute decision-making approaches(Kahraman et al., 2004). Unquantifiable information, incomplete information, unavailability of information, and partial ignorance could all contribute to these errors. These issues cannot be effectively solved by traditional multiple attribute decision-making techniques (Oguztimur, 2011). According to Petkovic, J. et al. (2012), the FAHP method is a standard AHP method that has been expanded into a fuzzy domain by using fuzzy numbers rather than real numbers when computing. When both the qualitative and the quantitative aspects of a decision problem need to be considered, Saaty, T. L. (1980) described the AHP as a strong and flexible decision-making process to assist decision-makers in making the best choice.

According to Chang, D. Y. (1992), who studied extent analysis and synthetic decision making, considering fuzziness results in fewer dangerous decisions because linguistic concepts' values change from person to person. To deal with issues of expert opinion uncertainty and ambiguity, Zadeh (1996) developed the fuzzy sets theory. According to Bellman and Zadeh (1970), fuzzy set theory can be used as a modeling tool for complex systems that are hard to define precisely but that can be managed by people to deal with the kind of qualitative, imprecise information or even poorly structured decision-making difficulties. Many decision-making situations have fuzziness and vagueness, which could be a factor in the conventional AHP process' decision-makers' imprecise conclusions. This is accurate even though AHP is practical for

[1] The export potentials of Ethiopian leather and leather products have been considered to select the title for this research. https://www.oefse.at/fileadmin/content/Downloads/Publikationen/Studien/11_Sustainable_Sourcing_Ethiopia_Leather_March2019.pdf

handling the qualitative and quantitative criteria of MCDM problems depending on decision maker's judgements. Using triangular membership functions for pairwise comparison scales and the extent analysis method for artificial extent values for pairwise comparisons is a novel approach to controlling FAHP (Oguztimur, 2011). In his study, Chang offered a technique that made use of fuzzy integers as comparison matrices' constituent parts, but the main difficulty lay in figuring out the fuzzy weights that functioned as these matrices' eigenvectors (Chang, 1996). since fuzzy weights are more challenging to calculate than crisp ones. Wang and Chin developed the Fuzzy Preference Programming method for the nonlinear, fuzzy AHP weight derivation(Wang & Chin, 2011). A logarithm scale was used in this study to assess relative weights in paired comparisons more accurately. AHP and FTOPSIS were used with other MCDM techniques by several writers in addition to those who published these works (Kusumawardani & Agintiara, 2015; Esmaili-dooki et al., 2017). In these cases, the alternatives are ordered using FTOPSIS after the relative weights of the two levels of criteria evaluation are established using FAHP. Ayhan investigated the gear motor market to find the best source. Quality, pricing, reputation, and other variables were among those considered (Ayhan, 2013). Saad et al. used Fuzzy-AHP to determine which procurement method was best (Saad et al., 2016). Kwong and Bai used a combination of Quality Function Deployment and Fuzzy-AHP techniques to order client requirements (Kwong & Bai, 2003). Hadad and Hanani proposed a paradigm that incorporated the AHP and Data Envelopment Analysis (DEA) approaches, two commonly used methodologies (Hadad & Hanani, 2011).

The primary goal of this research is to use a FAHP approach to rank leather items for supporting the decision of opening a leather industry. The literature review section examines several research studies that are pertinent to this topic. Numerous academics have used the FAHP method in their studies to show how this strategy functions and how successful it is when choosing the best option from a list of options. This study explores a FAHP approach for choosing the best leather item to start-up a new leather industry. A MCDM process based on FAHP is recommended for choosing the best leather item to start-up with a new industry. For this research, five various options are analyzed along with four primary criteria to identify the ideal leather item for a new leather business.[2]

3. Materials and Method

3.1. Theoretical framework

3.1.1. Fuzzy set and Fuzzy Numbers

To draw inferences from ambiguous, dubious, or imprecise information, Zadeh (1996) proposed the idea of fuzzy logic. A fuzzy set of objectives having gradations of membership along a continuum was created to mathematically explain this information. Each item is given a membership grade in the fuzzy set [0, 1] by a membership function. If a sign denotes a fuzzy set, a tilde ("~") will be added above the symbol. Fig.1 displays the triangular fuzzy number (TFN), $\widetilde{M}$. A TFN is simply identified as (l, m, u). The parameters l, m, and u represent the smallest, most promising, and largest feasible values that can be used to define a fuzzy event, respectively (Saaty, 1994). Conventionally speaking, a number is not fuzzy when l = m = u (Chan & Kumar, 2007; Kilincci & Onal, 2011). Each TFN has linear representations on its left and right sides, allowing the following definition to be used to describe its membership function (Saaty, 1994):

$$\mu_{\widetilde{M}} = \begin{Bmatrix} 0, x < 1, \\ \frac{(x-1)}{(m-1)}, 1 \le x \le m, \\ \frac{(u-x)}{(u-m)}, m \le x \le u, \\ 0, \quad x > u. \end{Bmatrix} \tag{1}$$

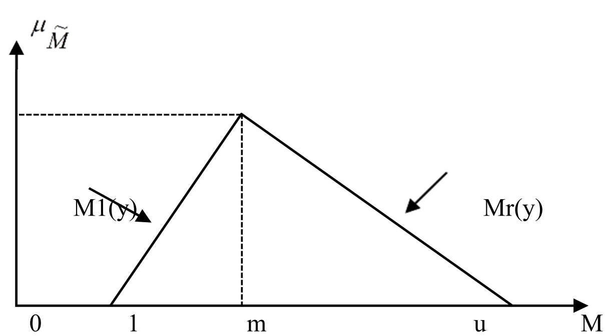

Fig. 1. A triangular fuzzy number, $\widetilde{M}$ (Kilincci & Onal, 2011)

[2] The state of the art and application areas of AHP have been clearly reviewed to get a clear understanding about the method and to apply in Ethiopian leather investment decisions.

To communicate the decision maker's thoughts, fuzzy numbers are intuitively simple to utilize. The left and right representations of each degree of membership can always be used to provide a fuzzy number (Sun, 2010),

$$\widetilde{M} = (M^{1(y)}, M^{r(y)}) = (1+(m-1)\,y,\ u+(m-u)\,y),\ y\varepsilon[0,1]. \quad (2)$$

where l(y) and r(y) stand for a fuzzy number's left side representation and right-side representation, respectively. The fuzzy number algebraic operations have been employed by Kahraman et al. (Lee, 2014).

3.1.2. FAHP over the Classical AHP

AHP is troublesome since it employs a scale of one to nine, which cannot handle unclear decisions in comparison to the characteristics, while being widely utilized to solve MCDM difficulties. The application of AHP may prevent all comparisons from including a certainty; as a result, a scale with more than nine points must be used to express uncertainty. Linguistic variables and TFNs can be employed in this situation to determine which choice variable should take precedence over others. The fuzzy extended analytical hierarchy process (FEAHP) approach, which uses synthetic extent analysis to determine the final priority weights based on TFNs, is used (Chan & Kumar, 2007). To effectively handle the fuzziness in the decision-making process, the FEAHP uses both qualitative and quantitative data in problems involving several attributes. This method TFNs for the classic AHP's nine-point scale before computing the pairwise comparison's synthetic extent value using the extent analysis method. Following the establishment of the weight vectors and the determination of the normalized weight vectors, the final priority weights for each option are calculated utilizing the various weights of the criteria and characteristics. The option with the largest weight is therefore chosen as the best one (Kilincci & Onal, 2011).

3.1.3. Extent Analysis on FAHP

While FAHP uses fuzzy numbers or linguistic variables, traditional AHP uses a fundamental scale of 1 to 9 to determine which choice variable should be given priority over another(Chang, 1996). TFNs are highly preferred by decision-makers. Applications of fuzzy AHP employ fuzzy numbers, which necessitate different solution techniques than those employed in conventional AHP(Chang et al, 2011). The extent analysis method provided by Chang(Esmaili-dooki et al., 2017; Kwong & Bai, 2003) is the approach utilized the most frequently to resolve FAHP applications. The extent of an object that must be satisfied for the purpose, or extent that is satisfied, is taken into consideration using the extent analysis approach. A fuzzy number is used in the procedure to quantify the extent. A fuzzy synthetic degree value can be created based on the fuzzy values for each object's extent analysis, and it has the following definition.

In an issue of choosing a product category, let X= $\{x_1, x_2, \ldots\ldots x_n\}$ represent the elements of the alternatives as an object set and U= $\{u_1, u_2, \ldots\ldots u_m\}$ represent the elements of the supplier selection criteria as a target set. The extent analysis for each objective, gi, is carried out individually for each object, in accordance with the Chang's extent analysis approach(Wang & Chin, 2011). The following signs can be used to determine the m extent analysis values for each object:

$$M_{gi}^1, M_{gi}^2, \ldots, M_{gi}^m \qquad i = 1,2,\ldots,n \quad (3)$$

where all the M_{gi}^j, (j= 1, 2…, m) are triangular fuzzy numbers. The steps of Chang's extent analysis (Sun, 2010) can be given as in the following.

Step One: According to its object, fuzzy synthetic extent is defined as having the following value:

$$s_i = \sum_{j=1}^{m} M_{gi}^j \otimes [\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^j]^{-1} \quad (4)$$

To obtain$\sum_{j=1}^{m} M_{gi}^j$ perform the fuzzy addition operation of m extent analysis values for a particular matrix such that

$$\sum_{j=1}^{m} M_{gi}^j = (\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j) \quad (5)$$

and to obtain $[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^j]^{-1}$ perform the fuzzy addition operation of M_{gi}^j, (j=1, 2…, m) values such that

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^j = (\sum_{i=1}^{n} l_j, \sum_{i=1}^{n} m_j, \sum_{i=1}^{n} u_j) \quad (6)$$

and then compute the inverse of the vector in Eq. (6) such that

$$[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}]^{-1} = (\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}) \quad (7)$$

Step Two: The degree of possibility of $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ is defined as:

$$V(M_2 \geq M_1) = \sup\,[\min(\mu M_1(X), \mu M_2(y))] \quad (8)$$

and this can be equivalently expressed as follows:

$$V(M_2 \geq M_1) = highest(M_1 \cap M_2) = \mu M_2(d) = \begin{cases} 1, if\ m_2 \geq m_1 \\ 0, if\ l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, otherwise \end{cases} \quad (9)$$

where d is the ordinate of the highest intersection point D between μM1 and μM2. In Fig.2, the intersection between M1 and M2 can be seen. To compare M1 and M2, we need both the values of V (M1 ≥ M2) and V (M2 ≥ M1).

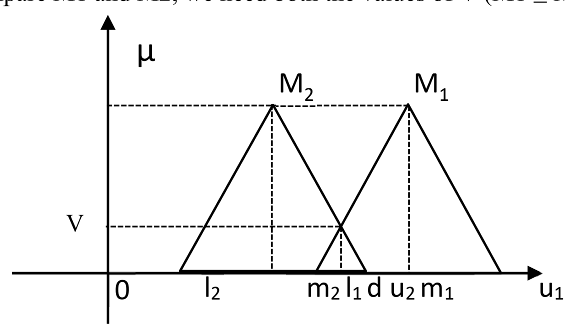

Fig. 2. The intersection between $M_1, and\ M_2$

Step Three: The degree of possibility for a convex fuzzy number to be larger than k convex fuzzy numbers Mi (i = 1, 2…, k) can be defined by

$$V(M \geq M_1, M_2, \ldots M_k) = V[(M \geq M_1)\ and\ (M \geq M_2) and \ldots and (M \geq M_k)] = minV(M \geq M_i), i = 1,2,3, \ldots k \quad (10)$$

Assume that

$$d'(A_i) = \min V(S_i \geq S_k \quad (11)$$

For k = 1, 2……, n; k ≠ i. Then the weight vector is given by μ

$$W' = (d'(A_1), d'(A_2), \ldots, d'(A_n))^T \quad (12)$$

where Ai (i = 1, 2…., n) are n elements.

Step Four: Via normalization, the normalized weight vectors are

$$W = (d(A_1), d(A_2), \ldots, d(A_n))^T \quad (13)$$

where W is a non-fuzzy number. That gives the priority weights of one alternative over another.

4. Result and Discussion

4.1. Finding the best leather item: A case study

The relative weighting of various selection factors in this problem of product priority includes a great deal of personal preference and subjective judgment. Human emotions and judgments cannot be accurately expressed in terms of precise numbers due to the ambiguity of language. Giving interval assessments feels more assured. Thus, TFNs are employed to determine which choice variable should be given precedence over which. Based on a survey of the literature, the TFNs are created. The final priority weights are then determined using the synthetic extent analysis method, also known as the FAHP approach, and based on TFNs. The method's key steps have been thoroughly discussed in the sections that follow.[3]

Step One: Establishes the key characteristics and available options for choosing the product category to be used in designing the FAHP tree structure. First, it has been determined that the problem of product category prioritization's main goal was to prioritize the best product category for opening a leather industry. Due to the intense competitiveness in the leather industry, many factors need to be considered. An expert from the production planning department has discussed all the potential significant criteria that could have an impact on the availability of the crucial component. The expert and I also read through previous product category selection studies that had been published in the literature. The major attributes and alternatives in the study are decided by integrating the attributes that have been selected by the expert and the attributes that have been used in the literature. There are five choices and four primary attributes. The primary factors that were considered were profitability, initial investment, raw material availability, and customer demand. The alternate attributes include handbags, jackets, belts, shoes, and gloves.

4.2. Decision criteria to launch new garment industry[4]

a. **Profitability criteria**: One of the most crucial factors determining which investor decides to invest is the profitability of any product, which should be considered before choosing a product category. Investors won't be prepared to pay for a product if they believe there is a smaller probability of profitability.
b. **Initial investment criteria**: It is an important factor that must be considered before purchasing/creating something. It can occasionally influence a decision-choice maker's not to implement a novel plan. The buyer may not be able to fund it or develop it, or they may have discovered that the idea is not worth it in some other way. Regardless, they will pay.
c. **Availability of raw material criteria**: The initial substance that enters a production process as an input for later modification and eventual modification into a finished good is called the raw material. In a leather industry, resources like hides or skins of goat, sheep and cattle are typically used as raw materials. Nevertheless, regardless of the raw resources employed, the company may suffer significantly if there were a scarcity of them. The factory's production may be halted as a result. There is hence a great demand for raw material availability.
d. **Customer demand criteria:** It is common practice for even small businesses to consider the demand for their product among consumers when they first launch. If everything is fine but the company isn't getting the orders or responses they're hoping for. As a result, the value of the product's demand is quite low. Running the business would therefore be impossible. So, choosing a category of products for the launching of a leather industry, requires careful consideration of the product demand from the customers.

4.3. Alternative products

In this study, five options are considered: handbags, jackets, belts, shoes, and gloves. To maintain a competitive worldwide business market, these are utilized to decide what type of item to produce in a new industry. The hierarchy of the problem of product category prioritization is created after identifying the key attributes and alternatives. The structure of the four-level hierarchy for the product category selection problem is shown in Fig.3. Prioritization of a product category is the problem's ultimate objective, and it is represented by the top level of the hierarchy. Four categories, including profitability attribute, initial investment attribute, raw material availability, and buyer demand attribute, make up the second level of the hierarchy. The five different product categories are represented by the hierarchy's bottom level. They come in the form of handbags, jackets, belts, shoes, and gloves.

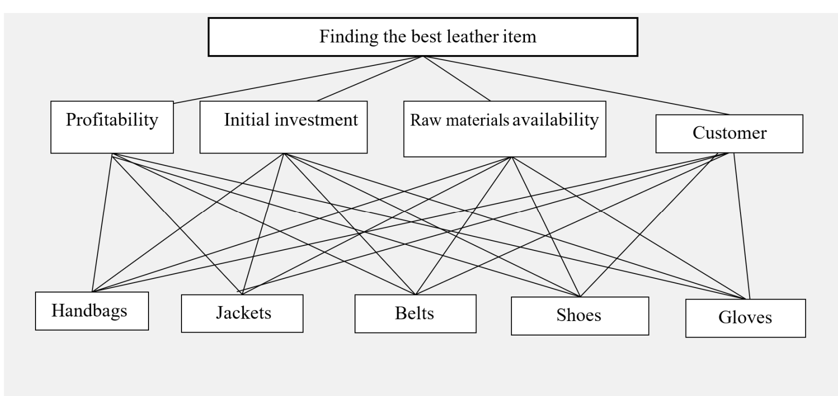

Fig. 3. Item selection problem using MCDM

[3] The current demanded leather products have been considered as an alternative in the hierarchical decision to select the best among them.
[4] Both human and non-human resource potentials as well as the most prominent criteria used by Ethiopian investment Bureau has been considered as decision criteria.

Step Two: determines the relative importance of the primary attributes and alternatives. The FAHP method is used to determine the various priority weights for each main attribute and alternative after the hierarchy has been constructed. The questionnaire makes it possible to compare the weighting of one primary attribute and alternative to another (The hierarchy has been developed in consideration of the attributes/criteria and the available alternatives to determine priority in relative weight comparisons.).

The questionnaires make it easier to respond to questions involving pairwise comparisons. As a result, the choice of one metric over another is determined by the available research and the expert's experience (Kilincci & Onal, 2011). The expert starts by contrasting the key characteristics in relation to the major objective. The expert then evaluates the choices considering each key attribute. For the pairwise comparisons, the expert makes use of the linguistic variables. The linguistic variables are then transformed into TFNs. The linguistic variables and their corresponding TFNs are displayed in Table 1. The major attribute pairwise comparison matrix with respect to the aim will be displayed here due to the space constraints. The consistency of the paired judgment of each comparison matrix is then verified using the computation procedure of the consistency index (RI) and consistency ratios (CR) in crisp AHP.

Using M Crisp (l+4m+u)/6, each TFN, M = (l, m, u), in the pairwise comparison matrix is transformed into a crisp number. The procedure in crisp AHP (Gumus, 2009) is used to check each matrix's consistency once the fuzzy comparison matrices have been transformed into crisp matrices. To do this, multiply all the entries in a matrix's rows together first, and then take the nth root of the resulting product. To normalize the Eigenvalue, the n^{th} are added up. Calculating λ_{max} or multiplying the sum of each column's values by their Eigenvalues, comes next. (λ_{max} - n)/ (n-1) is used to compute a matrix's RI.

Table 2 displays several values for the RI that were produced at random. CR= is used to assess the acceptability of an alternative or attribute. Each comparison matrix's consistency ratio is determined to be less than 0.10 after calculation. Since all matrices' pairwise judgments are consistent, we can draw the conclusion that this is acceptable.

Table 1
Linguistic terms and the corresponding TFNs

Linguistic scale	Triangular fuzzy scale	Reciprocal scale of triangular fuzzy
Equally important	(1,1,1)	(1,1,1)
Weakly important	(2/3,1,3/2)	(3/2, 1, 2/3)
Fairly important	(3/2,1,5/2)	(2/5,1/2,2/3)
Strongly important	(5/2,1/7/2)	(2/7,1/3,2/5)
Absolutely important	(7/2,1/9/2)	(2/9,1/4,2/7)

Table 2
Randomly generated consistency index, RI

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Table 3 illustrates the triangular matrix's evaluation of the fuzzy evaluation matrix in relation to the primary attribute. Prior to determining the priority weight of the key attributes, Consistency Ratio (CR) must be examined.

Table 3
The fuzzy evaluation matrix with respect to goal with TFNs

Goal/decision criteria	Profitability	Initial investment	Raw material availability	Customer demand
Profitability	(1,1,1)	(3/2,2,5/2)	(2/3,1,3/2)	(1,1,1)
Initial investment	(2/5,1/2,2/3)	(1,1,1)	(2/3,1,3/2)	(2/3,1,3/2)
Raw material availability	(2/3,1,3/2)	(2/3,1,3/2)	(1,1,1)	(3/2,2,5/2)
Customer demand	(1,1,1)	(2/3,1,3/2)	(2/5,1/2,2/3)	(1,1,1)

Table 4
Using the Crisp AHP approach, compute the geometric mean and Eigen value for Table (3)

Attributes	Profitability	Initial investment	Raw material availabili	Customer demand	Geometric mean	Eigen value
Profitability	1.0000	2.0000	1.0278	1.0000	1.0138	0.2714
Initial investment	0.5111	1.0000	1.0278	1.0278	0.8572	0.2295
Raw material availabi	1.0278	1.0278	1.0000	2.0000	1.0124	0.2711
Customer demand	1.0000	1.0278	0.5111	1.0000	0.8513	0.2280
Total	3.5389	5.0556	3.5667	5.0278	3.7347	

Note: Pairwise comparison matrix result has been collected through respondent's response to set relative importance/ wight of main attributes and alternatives using Ethiopian experts in the field of the leather and textile industry, other tables have been developed using relevant equations, and TFN figures to decide in the fuzzy environment. This computation is conducted here and in the following two pages to arrive at final decision in selecting the best ideal leather product which is viable for investment in Ethiopian current circumstances to be more profitable and competitive in the sector market.

λ_{max} = (3.5389 * 0.2714) + (5.0556 *0.2295) + (3.5667 * 0.2711) + (5.0278 * 0.2280) = 4.2339,

CI = (4.2339-4)/ (4-1) = 0.0780, RI = 0.90, CR= 0.0866 = 8.67%
As CR < 10%, the level of inconsistency of comparison matrix is satisfactory.

Prior to determining the priority weights for the primary attributes, Eq. (4) is used to determine the fuzzy synthetic extent values for the attributes. S_P, S_I, S_R, and S_C are designated for the various values of fuzzy synthetic extent for the four distinct major attributes of profitability, initial investment, raw material availability and customer demand respectively.

$S_P = (4.1667, 5, 6) \otimes (1/21.3333, 1/17.0000, 1/13.8000) = (0.1953, 0.2941, 0.4348)$
$S_I = (2.7333, 3.5, 4.667) \otimes (1/21.3333, 1/17.0000, 1/13.8000) = (0.1281, 0.2059, 0.3382)$
$S_R = (3.833, 5, 6.5) \otimes (1/21.3333, 1/17.0000, 1/13.8000) = (0.1797, 0.2941, 0.4710)$
$S_C = (3.0667, 3.5, 4.1667) \otimes (1/21.3333, 1/17.0000, 1/13.8000) = (0.1438, 0.2059, 0.3019)$

The degree possibility of Si over Si ($i \neq j$) is determined by using Equation (9) and Equation (10).
$V(S_P \geq S_I) = 1.000$ $V(S_I \geq S_R) = 0.6424$ $V(S_R \geq S_C) = 1.000$ $V(S_C \geq S_P) = 0.5472$
$V(S_P \geq S_R) = 1.000$ $V(S_I \geq S_C) = 1.000$ $V(S_R \geq S_P) = 1.000$ $V(S_C \geq S_I) = 1.000$
$V(S_P \geq S_C) = 1.000$ $V(S_I \geq S_P) = 0.6182$ $V(S_R \geq S_I) = 1.000$ $V(S_C \geq S_R) = 0.5808$

With the help of Equation (11), the minimum degree of possibility is stated as below:
d' (P) = min (1.000, 1.000, 1.000) = 1.000
d' (I) = min (0.6424, 1.000, 0.6182) = 0.6182
d' (R) = min (1.000, 1.000, 1.000) = 1.000
d' (C) = min (0.5472, 1.000, 0.5808) = 0.5472
Weight vector, W'= (1, 0.6182, 1, 0.5472)

The weight is therefore expressed as W'= (1.000, 0.6182, 1.000, 0.5472). After the normalization process, it is discovered that the weight vector for the key attributes- profitability, initial investment, raw material availability, and customer demand is $W = (0.3159, 0.1953, 0.3159, 0.1729)^T$. Profitability and raw material availability attributes have the highest priority weight, thus we may infer that these are the most significant attributes in the product selection process. The following recommended attribute is initial investment and customer demand.

Step Three: Compares options individually for each criterion. Tables (5–8) illustrate this. TFN consistency can be examined, and the CR can be determined.

Table 5
The fuzzy comparison matrix for profitability criterion

Attributes	Handbags	Jackets	Belts	shoes	Gloves	De-fuzzified normalized weight	Percentage
Handbags	(1, 1, 1)	(2/3,1,3/2)	(2/5,1/2,2/ 3)	(2/3,1,3/2)	(3/2,2,5/ 2)	0.2022	20%
Jackets	(2/3,1,3/2)	(1,1,1)	(3/2,2,5/2)	(1,1,1)	(2/3,1,3/ 2)	0.2285	23%
Belts	(3/2,2,5/2)	(2/5,1/2,2/3)	(1, 1, 1)	(2/7,1/3,2/5)	(2/3,1,3/ 2)	0.1421	14%
Shoes	(2/3,1,3/2)	(1,1,1)	(5/2,3,7/2)	(1, 1, 1)	(3/2,2,5/ 2)	0.3415	34%
Gloves	(2/5,1/2,2/3)	(2/3,1,3/2)	(2/3,1,3/2)	(2/5,1/2,2/3)	(1, 1, 1)	0.0857	9%

λ_{max} = 5.4048, CI= 0.1012, RI= 1.1200, CR= 9.04%

Table 6
The fuzzy comparison matrix for initial investment criterion

Attributes	Handbags	Jackets	Belts	shoes	Gloves	De-fuzzified normalized weight	Percentage
Handbags	(1, 1, 1)	(1,1,1)	(3/2,2,5/2)	(3/2,2,5/2)	(2/3,1,3/2)	0.2971	30%
Jackets	(1, 1, 1)	(1,1,1)	(2/3,1,3/2)	(2/3,1,3/2)	(5/2,3,7/2)	0.2971	30%
Belts	(2/5,1/2,2/3)	(2/3,1,3/2)	(1, 1, 1)	(2/5,1/2,2/3)	(1,1,1)	0.0783	8%
Shoes	(2/5,1/2,2/3)	(2/3,1,3/2)	(3/2,2,5/2)	(1, 1, 1)	(3/2,2,5/ 2)	0.2706	27%
Gloves	(2/3,1,3/2)	(2/7,1/3,2/5)	(1,1,1)	(2/5,1/2,2/3)	(1, 1, 1)	0.0857	6%

λ_{max} = 5.4144, CI= 0.1036, RI= 1.1200, CR= 9.25%

Table 7
The fuzzy comparison matrix for raw material availability criterion

Attributes	Handbags	Jackets	Belts	shoes	Gloves	De-fuzzified normalized weight	Percentage
Handbags	(1, 1, 1)	(3/2,2,5/2)	(5/2,3,7/2)	(1,1,1)	(2/3,1,3/2)	0.3825	38%
Jackets	(2/5, 1/2, 2/3)	(1,1,1)	(3/2,2,5/2)	(2/5,1/2,2/3)	(3/2,2,5/2)	0.2349	23%
Belts	(2/6,1/3,2/5)	(2/5,1/2,2/3)	(1, 1, 1)	(2/3,1,3/2)	(1,1,1)	0.0000	0%
Shoes	(1,1,1)	(3/2,2,5/2)	(2/3,1,3/2)	(1, 1, 1)	(5/2,3,7/2)	0.3825	38%
Gloves	(2/3,1,3/2)	(2/5,1/2,2/3)	(1,1,1)	(2/7,1/3,2/5)	(1, 1, 1)	0.0000	0%

λ_{max} = 5.3918, CI= 0.0980, RI= 1.1200, CR= 8.75%

Table 8
The fuzzy comparison matrix for customer demand criterion

Attributes	Handbags	Jackets	Belts	shoes	Gloves	De-fuzzified normalized weight	Percentage
Handbags	(1, 1, 1)	(2/5,1/2,2/3)	(2/5,1/2,2/3)	(3/2,2,5/2)	(2/3,1,3/2)	0.1559	16%
Jackets	(3/2,2, 5/2)	(1,1,1)	(2/5,1/2,2/3	(2/3,1,3/2)	(2/7,1/3,2/5)	0.1402	14%
Belts	(3/2,2,5/2)	(3/2,2,5/2)	(1, 1, 1)	(3/2,2,5/2)	(1,1,1)	0.3361	34%
Shoes	(2/5,1/2,2/3)	(2/3,1,3/2)	(2/5,1/2,2/3)	(1, 1, 1)	(2/3,1,3/2)	0.0852	9%
Gloves	(2/3,1,3/2)	(5/2,2,2/3)	(1,1,1)	(2/3,1,3/2)	(1, 1, 1)	0.2826	28%

λ_{max} = 5.3855, CI= 0.0964, RI= 1.1200, CR= 8.60%

As mentioned before, these matrices are used to estimate weights, in this case, the weights of each alternative under each criterion separately. The results are given in Table 9.

Table 9
Weight of each alternative to each criterion

Attributes	Profitability	Initial investment	Raw material availability	Customer demand
Handbags	0.2022	0.2971	0.3825	0.1559
Jackets	0.2285	0.2971	0.2349	0.1402
Belts	0.1421	0.0783	0	0.3361
Shoes	0.3415	0.2706	0.3825	0.0852
Gloves	0.0857	0.057	0	0.2826

Finally, a final score is calculated for each candidate by multiplying the weights of the relevant criteria and adding the weights per candidate. Table 10 displays these results.

Table 10
Final ranking of items using FAHP

Attributes	Profitabilit	Initial investmen	Raw materi availability	Customer demand	Composite weight	Percentage of composite weight	Ranking
	0.3159	0.1953	0.3159	0.1729			
Handbags	0.2022	0.2971	0.3825	0.1559	0.2696	27%	2
Jackets	0.2285	0.2971	0.2349	0.1402	0.2286	23%	3
Belts	0.1421	0.0783	0	0.3361	0.1182	12%	4
Shoes	0.3415	0.2706	0.3825	0.0852	0.2962	29%	1
Gloves	0.0857	0.057	0	0.2826	0.0870	9%	5

Table 10 lists the order of five fundamental pieces of leather products based on the values of composite weights. According to this research the most profitable leather item to invest in in Ethiopia is the shoe. Handbags, jackets, belts, and gloves are ranked second, third, fourth, and fifth in the ranking, accordingly. It should be noted that any adjustments to the criteria could affect the outcome. For instance, in this scenario, a shoe is chosen as the best investment leather item due to lower capital investment capacity, but if the investor has no issues with raw capital, the best outcome may change to another type of leather item. The case study of choosing the best piece of leather, produced the following conclusion once the recommended methodology was applied to it. The strategy was able to offer investors and business owners decision-support for launching a new leather manufacturing. Since different investors have varying levels of resources, the procedure produced a range of results.

5. Conclusion

In all business sectors, using a systematic approach to make the best decision was chosen. Young people in Ethiopia had a propensity to leave monotonous jobs and start their own businesses. They look for business in this industry because there are so many prospects, and they have some experience working in the leather industry. It is quite difficult to maintain success in this industry with a new leather manufacturer in a cutthroat market. The choice of where to invest was crucial because the industries for various leather goods demand various types of skill, knowledge, and resources. Making wise decisions was a major component of success. The major objective of this paper was to assist the investor in making decisions by helping them choose the ideal leather item for their new business. Shoes were found to be the best item in this article, although results could differ with other investors because they have varying levels of financial resources. The outcome, however, showed that the proposed approach was highly capable of resolving dilemmas pertaining to product selection in a startup company. The suggested approach was quite all-encompassing and enabled investors to analyze the decision problem from a variety of angles. With relatively modest adjustments, the approach was also able to resolve any kind of real-world situation involving decision-making.

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Conflicts of Interest

The author declares no conflicts of interest.

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