Prioritising the determinants entrepreneurial firms in the sustainable supply chain networks using fuzzy TOPSIS method

Mahtab Sherafati
Department of Industrial Engineering
Kermanshah Branch, Islamic Azad University
Kermanshah, Iran
Mahtabsherafati@gmail.com

Mahdi Bashiri
School of Strategy and Leadership
Faculty of Business and Law,
Coventry, United Kingdom
ad2594@coventry.ac.uk

Piyya Rafi-Ul-Shan
School of Strategy and Leadership
Faculty of Business and Law,
Coventry, United Kingdom
ac9999@coventry.ac.uk

Vahid Jafari-Sadeghi *(Corresponding author)*
School of Strategy and Leadership
Faculty of Business and Law,
Coventry, United Kingdom
Vahid.Jafari-Sadeghi@coventry.ac.uk

Authors' Bio

Mahtab Sherafati received the B.E. degree in Industrial Engineering from Kermanshah Branch, Islamic Azad University, Kermanshah, Iran, in 2010, and the M.E. and Ph.D. degrees in Industrial Engineering from Shahed University, Tehran, Iran, in 2013 and from South Tehran Branch, Islamic Azad University, Tehran, Iran, in 2019, respectively.

Dr Mahdi Bashiri is an Assistant Professor in Business Analytics at Coventry University. He holds a BSc degree in Industrial Engineering from Iran University of Science and Technology as well as MSc and PhD degrees from Tarbiat Modarres University. He is a recipient of the 2013 young national top scientist award from the Academy of Sciences of the Islamic Republic of Iran. He serves as a reviewer for some reputable academic journals. His research interests are supply chain network design, stochastic optimization, meta-heuristics, and multi-response optimization.

Dr Piyya Rafi-Ul-Shan is a lecturer in Operations and supply Chain Management at the Coventry University. Previously, he worked for the University of Hull and the Sheffield University. His research areas include supply chain risk management, sustainable supply chain management, agile, responsive and resilient supply chains, supply chain relationship management, and the garment and fashion and halal meat industry.

Dr Vahid Jafari-Sadeghi is a Lecturer in Strategy in the School of Strategy and Leadership at Coventry University. Vahid holds his PhD in international entrepreneurship from the University of Turin where he has served as a post-doctoral fellow for one year. Also, he has been a visiting research scholar at the University of Regina and contributed to different research projects with various scholars and universities. Vahid has published papers in several international journals and publications such as Journal of Business Research, International Business Review, Journal of International Entrepreneurship, International Journal of Entrepreneurship and Small Business, etc. He acted as guest editor and reviewer for several academic journals and performed as track chair and presenter for a number of international conferences.

Abstract- Entrepreneurial ventures play as key pillars in the supply chain networks. Therefore, through the decision-making method, this study aims to prioritise entrepreneurial firms in the supply chain and to select the ones that perform properly in the network. In this regard, three main criteria are taken into account: Surrounding environmental, Entrepreneurial firm capabilities and Individual entrepreneurial capabilities and characteristics; including several sub-criteria for each. As for the methodology, a fuzzy Technique for Order Preferences by Similarity to Ideal Solution (TOPSIS) method is used to prioritise entrepreneurial firms, which considers the ideal solution with linguistic weights. As such, a sample of 141 Australian firms has been taken from the Global Entrepreneurship Monitor (GEM) database. Our findings confirm that the proposed method for prioritising the determinants entrepreneurial firms lead to designing a sustainable supply chain.
Keyword- Prioritising, Entrepreneurial firms, Sustainable supply chain, Fuzzy TOPSIS method

Introduction

Today, sustainable supply chains have gained considerable attention from both managers and researchers because most of the global problems can be solved by promoting sustainable development (Sherafati et al. 2019). One of the important aspects of sustainability can be entrepreneurship, which has a social and economic impact on countries (Anderson, et al., 2006; Dana et al., 2001; Garousi Mokhtarzadeh et al., 2020). The importance of entrepreneurship in countries has recently been highlighted (Mazdeh et al. 2013 Jafari-Sadeghi et al 2020a,b). It is imperative that firms obtain entrepreneurial competencies in order to survive (Rezaei et al. 2013; Dana 2001) and they have a major effect on the success or failure of firms (Sadeghi 2018; Mokhtarzadeh et al 2020). Entrepreneurial actions are increasingly playing an important role in the development and improvement of the entire society (Dean and McMullen 2007; Patzelt and Shepherd 2011). Many researchers have addressed the sustainability concerns in entrepreneurship studies such as (Matos and Hall 2007; Sukumar et al., 2020). The entrepreneurship is cited as a panacea for many social and environmental concerns (Hall et al. 2010; Groenland & Dana, 2019). Cohen and Winn (2007) presented that entrepreneurial opportunities can improve the earth's ecosystems. Sustainability and entrepreneurship can guarantee the future development of the whole society (Dana *et al*., 2005; Leclair, 2017; Jafari-Sadeghi, 2020). Dhahri and Omri (2018) proved that entrepreneurship can create economic growth and improve social conditions.

In this paper, the firms entrepreneurial are considered, who are the key pillars in the supply chains. By this strategy, the performance of the supply chain can be more efficient. In this paper, it is proposed that the entrepreneurial firms are prioritised and ranked according to influential criteria. Indeed, three main criteria are taken into account: Surrounding environmental, Entrepreneurial firm capabilities and Individual entrepreneurial capabilities and characteristics, which every criterion concerns some sub-criteria. These are obtained from the Global Entrepreneurship Monitor (GEM). GEM is a consortium of country teams, primarily affiliated with top academic institutions, that conducts surveys research on entrepreneurship around the world[1].

The mentioned main criteria are considered in the related papers. For example, Sadeghi et al. (2019), Ugalde-Binda et al. (2014), and Groşanu et al. (2015) focused on the significant role of surrounding environmental determinants on the entrepreneurship. Furthermore, some scholars such as Matsuno et al. (2002), White et al. (2003), Hult et al. (2004), and Griffith et al. (2006) addressed Entrepreneurial firm capabilities in their studies. On the other hand, Gladwell (2008), Morris et al. (2010), Hornsby and Goldsby (2009) and so on examined individual entrepreneurial capabilities and characteristics. Considering these three criteria together is a research gap, that objective of this research is to cover it. Moreover, the main research question is what are the factors that are most important and influential in choosing the best entrepreneurial firms and which ones are selected based on these criteria?

In this paper, the entrepreneurial firms are prioritised and ranked according to main criteria (mentioned above) and by application of the fuzzy TOPSIS method. It is proved that the TOPSIS

[1] https://www.gemconsortium.org/

method can be a suitable tool for optimal selection (Tzuc et al. 2020). Moreover, TOPSIS is a more accurate and reliable approach (Hasan et al. 2020) and is a very effective method for decision analysis (Wang et al. 2020). Since weights of criteria are not certain and precise, fuzzy numbers are used to handle uncertainties. If supply chain problems are considered in a fuzzy environment, flexible and efficient results can be obtained (Sherafati and Bashiri 2016).

The main contribution of this study is prioritising of the entrepreneurial firms using fuzzy TOPSIS method based on the important and efficient determinants.

The rest of this study is structured as follows. A literature review is presented in section 2. Then the proposed method for prioritising of the entrepreneurial firms is described in section 3. A data extracted from the GEM for Australia firms are analysed to verify the proposed method in section 4. Finally, the concluding remarks and the future study directions are provided in section 5.

Literature review

The literature review is presented in three perspectives as follows.

Fuzzy TOPSIS

Recently, Salih et al. (2018) in a review paper, analyses and categorised studies considering the fuzzy TOPSIS method. The interested readers can refer to that which presents a coherent taxonomy for the literature. In the following, some researches appeared after the mentioned review paper are presented. Kharat et al. (2019) selected the appropriate, environmentally conscious treatment and disposal technology alternative by the fuzzy TOPSIS approach. Memari et al. (2019) presented a fuzzy TOPSIS method to select the right sustainable suppliers through a real-world case study. Rashidi and Cullinane (2019) applied fuzzy TOPSIS and fuzzy data envelopment analysis (DEA) in a sustainable supplier selection, and they concluded that TOPSIS outperforms DEA in terms of complexity of calculation as well as sensitivity to variations in the number of suppliers. dos Santos et al. (2019) assessed and selected the green suppliers using the environmental criteria and the fuzzy TOPSIS algorithm. The evaluation of suppliers based on environmental and social concerns is carried out by Yadavalli et al. (2019) beyond the previous related papers. Hasan et al. (2020) adopted a fuzzy-based TOPSIS method to generate the ranking score of alternative suppliers and then the optimal order allocation was determined by the ranking scores and multi-choice goal programming.

To the best of the authors' knowledge, the considering entrepreneurial field, the prioritising of the entrepreneurial firms by application of the fuzzy TOPSIS method (despite its numerous advantages that widely have been said and proved by many researchers) has been seldom studied in the literature.

Sustainability

Today's global business environment is characterised by intense competition, outsourcing, offshore manufacturing, globalisation and an increased quest for better living standards by nations (Carter and Rogers 2008). To satisfy growing demands for multiple products and services, global businesses ventured into risky yet efficient modes of production (Carter and Rogers 2008), often

compromising environmental and social impacts in the business decision making. Consequently, businesses are under immense pressure from multiple stakeholders to manage the social and environmental impacts of their operations (Rafi-Ul-Shan et al. 2018). This led to an increased interest of academics and corporate alike in sustainability that requires businesses to minimise the environmental and social impact into their economic (Carter and Rogers 2008).

A large number of related papers addresses economic and environmental issues, while there is a limited literature review about the social impacts (Eskandarpour et al. 2015). Considering this concern is a research gap. Studies of this field are divided into two general categories. Most studies in this field have either taken into account the people's welfare (customers, employees, etc.) or dealt with societal commitments. For example, Mota et al. (2015) and Mota et al. (2018) maximised job creation in countries with lower economic development. Tsao et al. (2016) addressed working conditions and social commitments. Zhalechian et al. (2016) regarded created job opportunities and economic development. Arampantzi and Minis (2017) considered prioritising societal community development and improved labour conditions. Zahiri et al. (2017) increased employment opportunities and provided a balanced economic development for local communities. Ghaderi et al. (2018) regarded consumers, employees, value chain actors, local community, and society. The social impacts include job opportunities and work's damages in the paper presented by Sahebjamnia et al. (2018). Sherafati et al. (2020) tried to improve the regional development level in a supply chain network design problem.

Based on the previous studies, it can be concluded that taking into account the concept of entrepreneurship in supply chain management problems can both alleviate people's concerns and help improve community development (Dean and McMullen 2007; Patzelt and Shepherd 2011). Therefore, we aim to consider this strategy in this paper to achieve economic and social goals.

Entrepreneurship

Some scholars applied the multi-criteria decision making (MCDM) tools in entrepreneurial problems; some of them are introduced as follows. Tsai and Kuo (2011) developed an integrated evaluation model for entrepreneurship policy by consideration of relations between criteria and alternatives by application of the Decision Making Trial and Evaluation Laboratory (DEMATEL), analytic network process (ANP), and zero-one goal programming (ZOGP) methods. A framework consisting of MCDM methods is proposed to evaluate the entrepreneurship intensity of Iranian state universities Mazdeh et al. (2013). Sadeghi and Biancone (2018) and Rostamzadeh et al. (2014) considered the critical factors of entrepreneurship and evaluated entrepreneurial intensity among the small and medium-sized enterprises using MCDM in fuzzy environment. Tsai et al. (2014) proposed an entrepreneurship policy evaluation model to help practitioners prioritise improvement actions. They integrated the ANP approach and the VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) method. Kitsios and Sitaridis (2017) assessed and ranked the entrepreneurial ecosystem of some countries by application of MCDM, based on a common set of criteria.

Korber and McNaughton (2018) analysed a literature review on the intersection of entrepreneurship and resistance. Terán-Yépez et al. (2020) presented a bibliographic analysis of the state of the discipline, identify key topics from existing research, and create future challenges for research. Sadeghi et al. (2019a) and Champenois et al. (2020) reviewed the entrepreneurial articles that use the practice(s) as a unit of analysis or use the theory of practice as a theoretical background and make these methods relational, process and material. Muñoz et al. (2020) examined the decision-making process of social entrepreneurs in a failing venture. In the paper presented by Narwane et al. (2020), the main obstacles to the sustainable development of the biofuels sector are identified and modelled through an integrated MCDM process. It is shown that one of the biggest hurdles is the lack of entrepreneurship support. Sadeghi and Biancone (2017) and Cojoianu et al. (2020) studied the impacts of country-level environmental policies on regional entrepreneurship, because environmental policy decisions are made at the national level, while entrepreneurship depends on regional clusters and characteristics.

Main determinants to select the entrepreneurial firms have been considered in the previous researches as follows:

Surrounding environmental

Ugalde-Binda et al. (2014) and Sadraei et al (2018) addressed some social and organisational capital incorporating culture, values, corporate learning technological developments, access to sources of information, etc. Groşanu et al. (2015) regarded the influence of governance indicators on the business environment and entrepreneurship. Sadeghi et al. (2019b) retained three factors among the components of the environment in the proposed entrepreneurship model, namely economic, political, and socio-cultural factors.

Entrepreneurial firm capabilities

Matsuno et al. (2002) specified the relationships among the building blocks in the proposed conceptual model as follows: entrepreneurial proclivity, organisational structural dimensions (formalisation, centralisation and departmentalisation), market orientation, and business performance. White et al. (2003) examined implementation capabilities and firm performance driven by entrepreneurial actions. Griffith et al. (2006), based on a survey of 269 retailers, provided a better understanding of the relationships among entrepreneurial proclivity, the firm's capabilities, and retailer performance.

Individual entrepreneurial capabilities and characteristics

White et al. (2003) presented that individual's personal actions can affect entrepreneurship. Morris et al. (2010) believed that there are also many significant differences between the entrepreneurship process with various individual entrepreneurial capabilities and characteristics. Thus, this determinant is very effective and it should be considered in the proposed model to evaluate of the entrepreneurial firms (Rezaei et al. 2020; Gurău & Dana 2018 Jafari-Sadeghi et al 2019).

Based on the related literature review, prioritising of the entrepreneurial firms is a remarkable research opportunity, and this can help to supply chain stockholders to make the most appropriate and the most reliable decisions. Table 1 shows some related studies and the superiority of this paper over them. To the best of the authors' knowledge, no paper so far considers all three determinants together.

Please insert **Table 1** about here

The proposed method for prioritising

TOPSIS is the most popular method among the mathematical MCDM methods (Salih et al. 2018), and it has been widely used during the previous few decades (Rashidi and Cullinane 2019). This technique is chosen and applied in this research because it establishes a more accurate and reliable method to help the stakeholders (Hasan et al. 2020). Moreover, TOPSIS appears to simpler understand and easier to implement in comparison to outranking approaches like ELimination Et Choice Translating REality (ELECTRE) and Preference Ranking Organization METHod for Enrichment of Evaluations (PROMETHEE). In addition, there is no limit to the number of alternatives and criteria that it can cope with, and in its algorithm, it distinguishes between profit and cost criteria (Rashidi and Cullinane 2019). Indeed, TOPSIS is a multi-attribute decision-making method wherein the alternatives are evaluated according to their Euclidian Distance to the ideal solution. Its core idea is to select the optimal solution by the closest distance from the positive ideal solution and longest distance from the negative ideal solution.

Since MCDM approaches include DM preferences and subjective judgments and these issues are often indefinite, imprecise and uncertain, thus complicating the decision-making process when applied to real-world situations. It is proposed that fuzzy set theory is applied which can handle subjective judgment. This paper adopts the fuzzy TOPSIS method following these steps:

Step 1: Obtaining information from decision-makers about the importance of the criteria and the degree of fulfilment of the alternatives by the criteria.

Step 2: Calculating the fuzzy weight and importance of ranking criteria.

Step 3: Normalising the decision matrix.

$$r_{ij} = \frac{x_{ij}}{x_i^+} \quad i \in B; \quad x_i^+ = \max_j x_{ij} \quad i \in B \tag{1}$$

$$r_{ij} = \frac{x_i^-}{x_{ij}} \quad i \in C; \quad x_i^- = \min_j x_{ij} \quad i \in C \tag{2}$$

Where x_{ij} displays the degree of fulfilment of the i_{th} criteria by the j_{th} alternative, and B and C are a set of positive (benefit) criteria and a set of negative (cost) criteria, respectively.

Step 4: Computing the weighted normalised fuzzy decision matrix. Each cell should be multiplied by its corresponding fuzzy weight. It is assumed that the fuzzy weight is in the form of triangle fuzzy number (w^l, w^m, w^u).

$$r_{ij} \otimes \tilde{w} = (r_{ij} \times w^{l}, r_{ij} \times w^{m}, r_{ij} \times w^{u}) = (a_{ij}, b_{ij}, c_{ij}) \quad (3)$$

Step 5: Specifying a fuzzy positive ideal solution (FPIS) and a fuzzy negative ideal solution (FNIS).

$$\tilde{v}_i^{+} = \begin{Bmatrix} \left(a_i^{+} = \max_j a_{ij}; b_i^{+} = \max_j b_{ij}; c_i^{+} = \max_j c_{ij}\right), \quad i \in B \\ and \left(a_i^{+} = \min_j a_{ij}; b_i^{+} = \min_j b_{ij}; c_i^{+} = \min_j c_{ij}\right), \quad i \in C \end{Bmatrix} \quad (4)$$

$$\tilde{v}_i^{-} = \begin{Bmatrix} \left(a_i^{-} = \min_j a_{ij}; b_l^{-} = \min_j b_{ij}; c_i^{-} = \min_j c_{ij}\right), \quad i \in B \\ and \left(a_i^{-} = \max_j a_{ij}; b_l^{-} = \max_j b_{ij}; c_i^{-} = \max_j c_{ij}\right), \quad i \in C \end{Bmatrix} \quad (5)$$

Step 6: Calculating the distance of each alternative from FPIS and FNIS using the following equations:

$$d(\tilde{v}_{ij}, \tilde{v}_i^{+}) = \sqrt{\frac{1}{3}\left[\left(a_{ij} - a_i^{+}\right)^2 + \left(b_{ij} - b_i^{+}\right)^2 + \left(c_{ij} - c_i^{+}\right)^2\right]} \quad (6)$$

$$d(\tilde{v}_{ij}, \tilde{v}_i^{-}) = \sqrt{\frac{1}{3}\left[\left(a_{ij} - a_i^{-}\right)^2 + \left(b_{ij} - b_i^{-}\right)^2 + \left(c_{ij} - c_i^{-}\right)^2\right]} \quad (7)$$

To subtract two triangular fuzzy numbers, the subtracting of triangular fuzzy numbers is used.

Distance between each alternative from the positive and negative ideal solutions is calculated as follows.

$$d_j^{+} = \sum_{i=1}^{m} d(\tilde{v}_{ij}, \tilde{v}_i^{+}), \quad j = 1, 2, ..., n \quad (8)$$

$$d_j^{-} = \sum_{i=1}^{m} d(\tilde{v}_{ij}, \tilde{v}_i^{-}), \quad j = 1, 2, ..., n \quad (9)$$

Step 7: Computing closeness coefficient (CC_j) for each alternative.

In order to prioritise alternatives, the closeness coefficient is calculated as follows.

$$CC_j = \frac{d_j^{-}}{d_j^{-} + d_j^{+}} \quad j = 1, 2, ..., n \quad (10)$$

Results and Discussion: Case of Australia

The researchers acknowledge that entrepreneurial activity has developed against an important driving force for economic development, but most studies have focused on the role of entrepreneurship in urban contexts. Considering a case study about the country is a significant

research gap (M. Basson and Erdiaw-Kwasie 2019). In Australia, along with employment and investment in public infrastructure, there is an opportunity for economic activity, particularly for entrepreneurial activity (Ivanova 2014). Numerous articles have highlighted the impact of entrepreneurship on the Australian economy, for example, Van Stel et al. (2005) and M. I. Basson (2016). In this section, data is extracted from the GEM for Australia firms. 3 main determinants (criteria) and 13 sub-criteria are considered for prioritising 141 entrepreneurial firms. Figure 1 shows the criteria and their related sub-criteria. Five sub-criteria were selected for Surrounding environmental and Individual entrepreneurial characteristics, while three sub-criteria were selected for Entrepreneurial firm capabilities main determinant.

Please insert **Figure 1** about here

After the mentioned steps, the priorities can be achieved as Table 2 reports first to the fifth of them.

Please insert **Table 2** about here

The closeness coefficient of the entrepreneurial firms sorted is shown in Figure 2. Four clusters can be considered for the entrepreneurial firms based on their corresponding closeness coefficients as follows. (a) closeness coefficients between (0.7-0.9) (57 firms), (b) closeness coefficients between (0.5-0.7) (55 firms), (c) closeness coefficients between (0.3-0.5) (26 firms) and (d) closeness coefficients between (0.1-0.3) (3 firms). It is clear the first cluster is related to the preferred entrepreneurial firms because they have the highest entrepreneurial scores, and they are the best in entrepreneurship.

Please insert **Figure 2** about here

For further analysis, the values of the top entrepreneurial firm (E110) in each criterion are changed to the worst value and the closeness coefficients are obtained.

Please insert **Figure 3** about here

Figure 3 shows the difference between optimal CC (0.865749) and CC obtained by the deterioration of each sub-criterion for a top firm. In addition, new ranks for the top entrepreneurial firm by the deterioration of each sub-criterion are illustrated in Figure 4. It can be concluded that Surrounding environmental, Individual entrepreneurial capabilities and characteristics and Entrepreneurial firm capabilities respectively affect the closeness coefficients and consequently, the rank of the entrepreneurial firm. Moreover, the most effective criterion is the public media support.

Please insert **Figure 4** about here

It should be noted that the proposed approach to select and prioritise the entrepreneurial firms can be applied for other possible cases as well. Finally, some practical implications of the paper are presented as follows.

Since entrepreneurial firms are so influential in the sustainable supply chain, they benefit the entire supply chain when they are prioritised and the best is selected. In addition, among the growing number of entrepreneurial firms, if no prioritisation is done, it may lead to the failure of the supply chain or that industry. That is why it is very important to prioritise and select entrepreneurial firms. Moreover, in this paper, several criteria are considered together. Another practical implication of the proposed method is in any industry or set whose objectives are not unique. Especially in countries or sets that have several important concerns, in those situations, multi-criteria decision-making methods should be used. Furthermore, in situations where we do not have certain and precise quantitative information available or the data is fuzzy in nature and we have a vague idea of the situation, fuzzy consideration helps a lot to get an idea of the company. Where the industry is new or data are ambiguous, Fuzzy numbers can be investigated. Finally, at the end of the paper, the most effective determinants were found that have a greater role in selecting entrepreneurial firms. This advantage helps entrepreneurial firms to identify which areas to focus more on.

Conclusion

One of the important aspects of sustainability is entrepreneurship, which has a social and economic impact on countries, and it can both alleviate people's concerns and help improve community development. In this paper, entrepreneurial firms are prioritised and ranked according to the criteria and by application of the fuzzy TOPSIS method. The main contribution of this study is prioritising of the entrepreneurial firms using fuzzy TOPSIS method based on the important and efficient determinants. The decision-making method has huge benefits that widely have been said and proved by many researchers. Data extracted from the GEM is used to prioritise entrepreneurial firms in Australia. It is shown that a sustainable supply chain can be created using the proposed method. One of the limitations of the article is that the information was scarce. If more complete data were available, the value of our work would be better represented. For future study, the researchers can add other important criteria or formulate a mathematical model to select the best firms.

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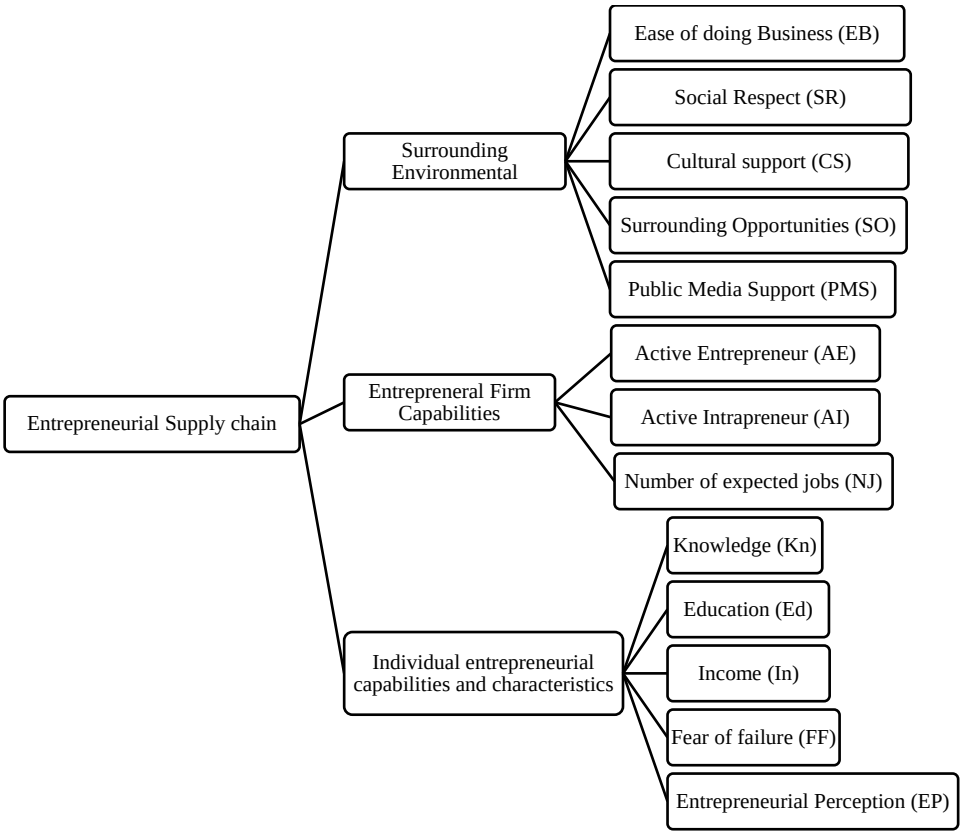

Figure 1. Main determinants (criteria) and sub-criteria for prioritising of the entrepreneurial firms

Figure 2. Closeness coefficient of the entrepreneurial firms

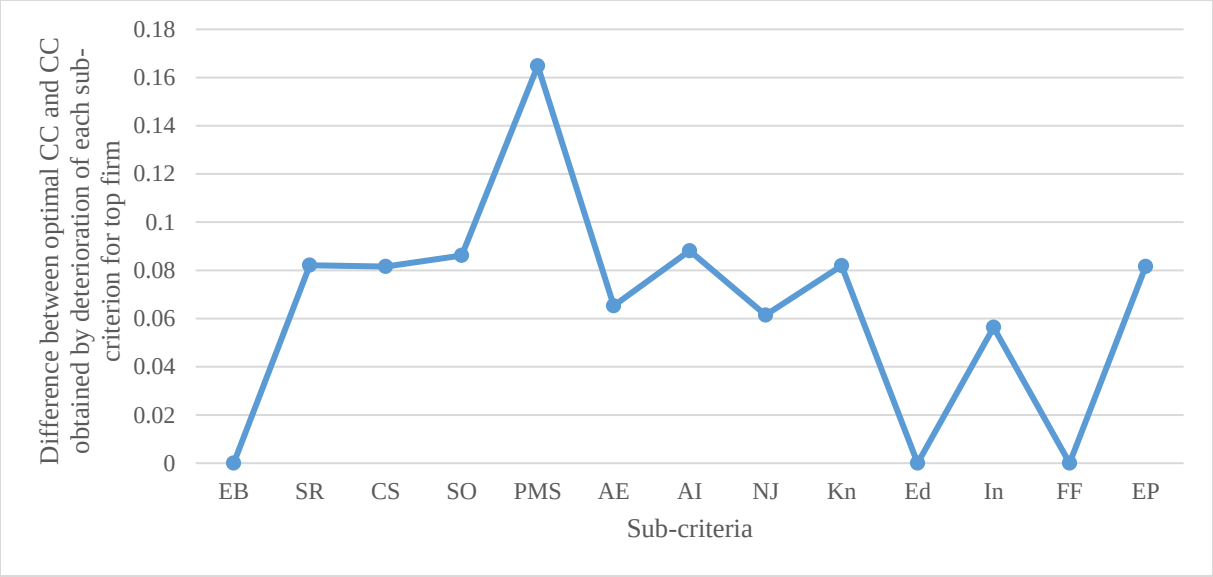

Figure 3. Difference between optimal CC and CC obtained by the deterioration of each sub-criterion for top firms

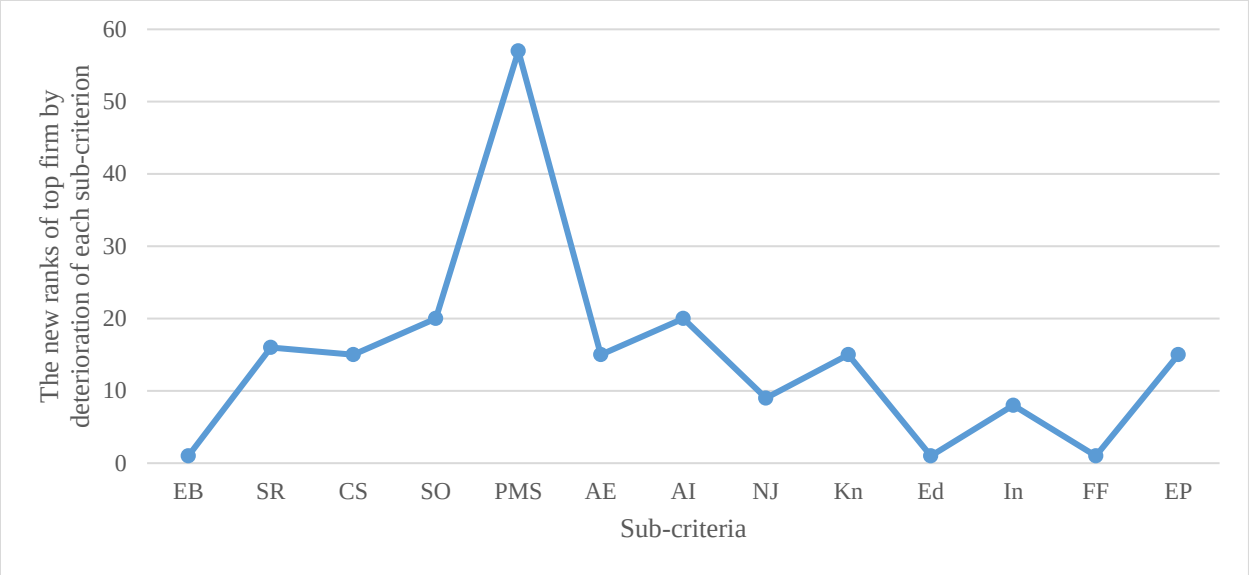

Figure 4. New ranks of top firms by the deterioration of each sub-criterion

Table 1. Related paper about Entrepreneurship and MCDM methods.

	Main determinants			Analytical methods / Decision making methods
	SE	EFC	IECC	
White et al. (2003)		✓		Regression Estimates
Griffith et al. (2006)		✓		Descriptive statistics
Tsai and Kuo (2011)			✓	DEMATEL, ANP and ZOGP
Mazdeh et al. (2013)			✓	ANP and VIKOR
Rostamzadeh et al. (2014)	✓			Fuzzy VIKOR
Tsai et al. (2014)			✓	ANP and VIKOR
Ugalde-Binda et al. (2014)	✓			Quantitative and qualitative methodologies
Groşanu et al. (2015)	✓			Generalized least square method
Kitsios and Sitaridis (2017)			✓	Non-Weight Method
Jafari-Sadeghi et al. (2019b)	✓			Descriptive statistics
Narwane et al. (2020)			✓	DEMATEL
Cojoianu et al. (2020)			✓	Descriptive statistics
Rezaei et al. (2020)			✓	Fuzzy AHP
Current research	✓	✓	✓	Fuzzy TOPSIS

SE: Surrounding environmental

EFC: Entrepreneurial firm capabilities

IECC: Individual entrepreneurial capabilities and characteristics

Table 2- Prioritising of top entrepreneurial firms in the considered supply chain.

Entrepreneurial firms	**CC**
E110	0.865749
E93	0.830872
E46	0.830427
E103	0.820883
E141	0.818715