Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 60 (2015) 63 – 72

Procedia Computer Science

19th International Conference on Knowledge Based and Intelligent Information and Engineering Systems

Selecting Start-Up Businesses in a Public Venture Capital Financing using Fuzzy PROMETHEE

Eric Afful-Dadzie[a*], Zuzana Komínková Oplatková[a], Stephen Nabareseh[b]

[a]Faculty of Applied Informatics, Tomas Bata University, T.G Masaryka 5555, 760 01, Zlin - Czech Republic
[b]Faculty of Management and Economics, Tomas Bata University, T.G Masaryka 5555, 760 01, Zlin - Czech Republic

Abstract

Public Venture Capital financing often fail rigorous scrutiny in their selection of high-potential start-ups as compared to Private Venture capital. In some developing countries, decision making on final selection for financial support of early stage but high potential Small and Medium sized Enterprises (SMEs) are often 'clouded' by several factors including consideration of political party affiliations. This results in low capital recovery rate and a mischance in choosing deserving start-ups. This paper applies Fuzzy Preference Ranking Organization METHod for Enrichment Evaluation (Fuzzy PROMETHEE) method to evaluate and select early-stage but high potential start-up businesses in a government high priority area such as in Information and Communications Technology. A numerical example with pre-defined linguistic terms parameterized by triangular fuzzy numbers is provided. The framework could serve as a useful tool for decision makers in scrutinizing selection of start-ups in other government priority areas.

Peer-review under responsibility of KES International

Keywords: Public Venture Capital; Start-Up companies; Fuzzy PROMETHEE; Fuzzy MCDM; Evaluation; Ghana.

1. Introduction

According to [1], [2], [3] and [4] there is enough research evidence to show that start-up businesses that are supported by Venture Capital (VC) generally tend to be successful than those that do not receive VC support. Public Venture Capital (PVCs) financing, especially those initiated by Governments, play a key role in meeting the financial demands of early-stage young entrepreneurs who are often unsuccessful at securing funds through the traditional investment sources such as the banks [5]. PVCs are even more embraced in developing countries where lending rates for Small Medium Enterprises (SMEs) by the financial sector tend to be relatively high partly due to non-performing loans [5]. In view of this, government backed VCs are becoming increasingly popular in most developing countries in

Peer-review under responsibility of KES International
doi:10.1016/j.procs.2015.08.105

spite of the low capital recovery rates from debtors [6]. Some of the criticisms of government led Venture Capital initiatives are the apparent lack of a robust selection criteria [1], lack of due diligence in the selection process [7], poor design and implementation challenges [8]. Additionally, it is also realized that government led VCs often fail in developing countries compared to developed nations partly because candidates for such capital financing schemes are sometimes chosen based on their political and social affiliations. To help cure some of these challenges in the selection of start-ups especially in developing countries, this paper first designs a selection criteria for start-ups in the Information Systems (IS)/Information Communications Technology (ICT) sectors. Subsequently, a decision making framework based on fuzzy PROMETHEE is applied in selecting potential candidates in a highly competitive but limited funds in government venture capital programmes. This methodological approach is considered suitable because in a high risk area such as public venture capital financing, selecting the right candidate can be very challenging and complex since most of the criteria involved are subjective or hold uncertain data. The criteria considered in this research which are mainly culled from [9], [10], [11] and [12], [13], [14] and [15] uses the fuzzy PROMETHEE approach in demonstrating how an ideal selection could be realized in a public Venture capital financing. The rest of the paper is organized as follows. A brief introduction of fuzzy set theory and the PROMETHEE method are presented. Next, relevant literature on various fuzzy PROMETHEE applications is also presented followed by a systematic outline with definitions and formulas of the fuzzy PROMETHEE method. Finally, a numerical example of how fuzzy PROMETHEE could be used to rank and select high-potential start-ups in a public venture capital is demonstrated.

2. Modelling Uncertainty with Fuzzy Sets

The concept of Fuzzy set theory introduced by Zadeh [16] serves as a mathematical tool that addresses issues of uncertainty, subjectivity, vagueness and imprecision in human judgements [17]. Fuzzy set is widely used in Multi-criteria decision making (MCDM) to extend stochastic and deterministic MCDM methods into useful applications in situations of uncertainty. Based on the concept of relative graded membership, fuzzy set is very efficient at modeling human decisions and judgments [18], [19], [20]. In the following, basic operations of the fuzzy set theory are briefly introduced.

2.1. Definition 1: Fuzzy Set.

Let X be a nonempty set. A fuzzy set A in X is characterized by membership functions that map elements of an assigned universal set X into real numbers in the range [0, 1]. The membership function is expressed as $\mu_A : X \rightarrow [0,1]$ where μ_A stands for the membership degree x in A denoting linguistic terms of a linguistic variable [21]. Fuzzy numbers are used to convey the linguistic terms between [0, 1] which captures the subjectivity, vagueness and imprecision of a subjective rating [20]. Triangular and Trapezoidal fuzzy numbers are the two most popular techniques of translating the linguistic information. This paper adopts the Triangular Fuzzy Number (TFN) as defined below.

2.2. Definition 2: Triangular Fuzzy Number (TFN)

A Triangular fuzzy number (TFN) is defined as a fuzzy set with membership function $y = f(x)$ expressed as a triplet (r, u, v) having the form as shown in Fig. 1. In Figure 1, the value of x at u gives the maximal value of $\mu_A(x)$, that is $\mu_A(x) = 1$. The value of x at r represents the minimal grade of $\mu_A(x)$, i.e $\mu_A(x) = 0$. The constants r and v stand for the lower and upper bounds of the area data respectively and reflect the fuzziness of the data under consideration [17]. In Eq. 1, the membership function $\mu_A(x)$ of the triangular fuzzy number is defined. Subsequently in figure 2, a demonstration of how two triangular fuzzy numbers yield the arithmetic operations underlying TFNs is presented in Eq. 2 to 6.

$$\mu_A(x) = \begin{cases} 0 & x < r, x > u \\ \dfrac{x-r}{u-r}, & r \le x \le u \\ \dfrac{v-x}{v-u}, & u \le x \le v \end{cases} \tag{1}$$

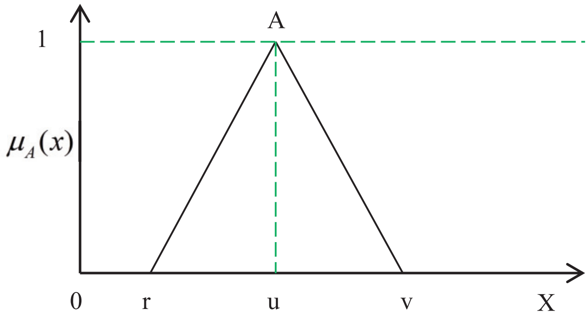

Fig. 1. Membership function of triangular fuzzy number

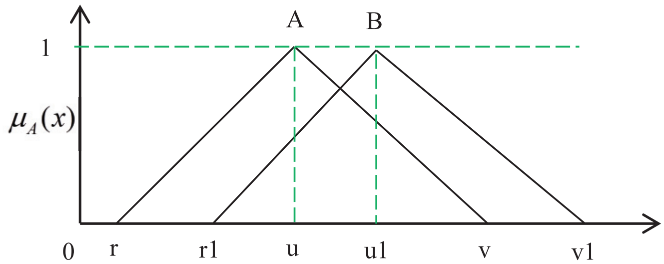

Fig. 2. Two triangular fuzzy numbers

Definition 3: Arithmetic Operations of TFNs

Let $A = (r, u, v)$ and $B = (r_1, u_1, v_1)$ be two triangular fuzzy numbers. The basic operations on these two fuzzy triangular numbers are expressed as follows:

$$A \oplus B = (r,u,v) + (r_1,u_1,v_1) = (r + r_1, u + u_1, v + v_1) \tag{2}$$

$$A - B = (r,u,v) - (r_1,u_1,v_1) = (r - v_1, u - u_1, v - r_1) \tag{3}$$

$$A \times B = (r,u,v) \times (r_1,u_1,v_1) = (rr_1, uu_1, vv_1) \tag{4}$$

$$A \div B = (r,u,c) \div (r_1,u_1,v_1) = \left(\frac{r}{v_1}, \frac{u}{u_1}, \frac{v}{r_1} \right) \tag{5}$$

3. Fuzzy PROMETHEE

The Preference Ranking Organization Method for Enrichment (PROMETHEE) has become one of the most popular and widely accepted outranking methods in Multiple Criteria Decision Making (MCDM). Proposed by Brans and Vincke in 1985[22], it uses a preference function to perform a pairwise comparison of pairs of alternatives and grades them between a [0, 1] interval [23]. As an outranking method, the PROMETHEE method is preferred in ranking and selection problems because of its ability to compare the performances of pairs of alternatives and factor that into the composite ranking. It is widely considered a robust technique and therefore used in industry as well as in academia. Similar to most of the MCDM methods, fuzzy set extends the PROMETHEE technique in situations of uncertainty and subjectivity in data. The Fuzzy PROMETHEE has seen applications in varied areas such as health care management [24], information systems outsourcing [23], logistics [25], customer reviews [26], landslide susceptibility mapping [27] among many others. Additionally the technique has been improved with several variants, versions (PROMETHEE I, II, III, IV, V, VI), integrations and in some instances extensions as seen in [28], [29], [30] and [31].

A combination of PROMETHEE I and II is used in this paper. In PROMETHEE I, a partial raking of alternatives is provided based on the following metrics [22], [29] and [30]. First, the sum of indices, $\pi(m,l)$ determine the preference of alternative m over the rest of the alternatives considered. This is referred to as the 'leaving flow' $\phi^{+}(m)$, and implies the relative good performance of m over the other alternatives. The alternative with the highest 'leaving flow' is adjudged the best in the evaluation. Similarly, the sum of indices, $\pi(l,m)$ is computed to indicate the preferences of all other alternatives measured against m. This is also referred to as the 'entering flow' $\phi^{-}(m)$, and implies the inferiority of alternative m in relation to the rest of the alternatives. In PROMETHEE II however, an introduction of a net flow $\phi(m)$ which is basically the difference between the leaving and the entering flows, helps to achieve a complete or full ranking. At this stage, the alternative with the highest net flow is adjudged the best alternative.

In the following section, a systematic outline with formulas and definitions of the fuzzy PROMETHEE methodology as culled from [22], [23] and [29] and [30], is presented and then used for the selection of start-up businesses in a Public Venture Capital (PVC) setting. The procedure outlined below would guide the study.

Step 1: Determining linguistic Variables (criteria), linguistic terms, alternatives and decision makers

The first in a series of stages in a typical fuzzy MCDM approach is the determination of linguistic variables and its associated linguistic terms; determination of the alternatives and the number of decision makers to be involved in the decision making process. This set of information is what is used to construct the decision matrix as shown in step 2. Basically, the linguistic terms which are translated into fuzzy numbers are what is used to rate the linguistic variables. The linguistic terms are therefore qualitative words that reflect the subjective view of an expert or decision maker about the criteria per each alternative under consideration [17], [18]. In this paper, the linguistic terms and their associated TFNs are shown in Table 1 and 2 respectively to capture the ratings of the importance criteria and the alternatives on a scale of 0-1.

Step 1a: Determining Importance Criteria Weights

In this step, decision makers rate to determine the importance or the weight of each criterion with the help of the linguistic terms in Table 1. In equation 6 below, w_j denotes the weight of criterion C_j based on the linguistic preference assigned by a decision maker. It is noted that each weight $\tilde{w}_j^k = (w_{j1}^k, w_{j2}^k, w_{j3}^k)$ is expressed as a triangular fuzzy number.

$$\tilde{W} = \left[\tilde{w}_1, \tilde{w}_2, \ldots, \tilde{w}_n\right], \; j=1, 2, \ldots, n \tag{6}$$

Step 2a: Constructing a fuzzy decision matrix

In a situation where m alternatives and n criteria are presented to k decision-makers, ($D_1, D_2, \ldots, D_k$) to choose the best alternative, a fuzzy MCDM problem can be expressed in a matrix format as shown in Eq. 7 below.

$$\tilde{D} = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & & C_n \end{array} \\ \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix} \end{array}, \; i = 1, 2, \ldots, m; \; j = 1, 2, \ldots, n \tag{7}$$

where $\tilde{x}_{ij}$ is the rating of alternative A_i with respect to criterion C_j both expressed in triangular fuzzy numbers(TFNs). This implies that the rating of a decision maker k is $\tilde{x}_{ij}^k = \left(r_{ij}^k, u_{ij}^k, v_{ij}^k\right)$.

Step 2b: Aggregating decisions

In this step, the fuzzy weights of the criteria as well as the ratings of the alternatives are aggregated using the interval valued technique as defined in Eq. 8 and 9 respectively.

$$\tilde{w}_j = \frac{1}{n}\left[\tilde{w}_j^1 + \tilde{w}_j^2 + \ldots, + \tilde{w}_j^n\right] \tag{8}$$

$$\tilde{x}_{ij} = \frac{1}{n}\left[\tilde{x}_{ij}^1 + \tilde{x}_{ij}^2 + \ldots, + \tilde{x}_{ij}^n\right] \tag{9}$$

Step 3: Normalizing decision matrix

The next step normalizes the aggregated fuzzy decision matrix obtained from step 2b. The normalized fuzzy decision matrix is defined as in Eq.10.

$$\tilde{S} = \left[\tilde{s}_{ij}\right]_{m\times n}, \; i = 1,2,\ldots, m; j = 1,2, \ldots, n \tag{10}$$

The normalization of the fuzzy decision matrix is computed using Eq. 11 below:

Where $$\tilde{s}_{ij} = \left(\frac{\tilde{r}_{ij}}{v_j^+}, \frac{\tilde{u}_{ij}}{v_j^+}, \frac{\tilde{v}_{ij}}{v_j^+}\right) v_j^+ = \max_i v_{ij} \tag{11}$$

It must be noted that at this stage the normalized matrix is still a triangular fuzzy number.

Step 4: Constructing fuzzy preference function

In this step, the preference function $\tilde{P}_j(m,n)$ is computed to describe the decision-makers' preference between pairs of alternatives. Brans and Vincke [22] introduced six types of preference functions ranging between [0, 1]. These are the usual-criterion, quasi-criterion, criterion with linear preference, level-criterion, criterion with Linear Preference and indifference area and the Gaussian-criteria. In this paper, we used the usual-criterion function (Type I) which is very simple to implement and yield the needed result. The usual criterion function is defined below in Eq. 12.

$$\tilde{P}_j(m,n) = \begin{cases} 0, & \tilde{s}_{mj} \le \tilde{s}_{nj} \\ 1 & \tilde{s}_{mj} > \tilde{s}_{nj} \end{cases} \quad j = 1,2,\ldots,k \tag{12}$$

Step 5: Computing weighted aggregated preference function

The next step computes the weighted aggregated preference function using Eq. 13 below.

$$\tilde{\pi}(m,l) = \sum_{j=1}^{k} \tilde{P}_j(m,n)\tilde{w}_j \tag{13}$$

where $\tilde{w}_j$ denotes the importance weight of the criteria

Step 6: Compute the leaving, entering and net flows

In this step, each alternative is related to $(n-1)$ alternatives that results in either a positive or negative flow [24], [31]. This approach helps to calculate both the leaving and entering flows and by extension the net flow.

Leaving flow: $$\tilde{\phi}^{+}(m) = \frac{1}{n-1}\sum_{m \neq l}\tilde{\pi}(m,l), \ \forall m,l \in A, \tag{14}$$

Entering flow: $$\tilde{\phi}^{-}(m) = \frac{1}{n-1}\sum_{m \neq l}\tilde{\pi}(l,m), \quad \forall m,l \in A, \tag{15}$$

where n is the number of alternatives. As stated above, the Leaving flow measures the superiority of m over the other alternatives whiles the entering flow shows the weakness or the inferiority of m compared to the rest of the alternatives.

Step 8: Establishing ranking

The final step, uses PROMETHEE II to provide a complete or full ranking using the net flow as shown in Eq, 16

Net flow: $$\tilde{\phi}(m) = \tilde{\phi}^{+}(m) - \tilde{\phi}^{-}(m)\ , \ \forall m \in A\,. \tag{16}$$

4. Application

The study uses the Government of Ghana publicly run venture capital scheme as a case study. The Venture Capital Trust Fund (VCTF) was established by an ACT of parliament 680 in 2004 to offer 'low cost financing' to start-up businesses to help grow, create jobs and wealth [32]. In an environment where political, social, tribal and religious affiliations often influence key decisions such as public allocation of funds [33], [34], this fuzzy PROMETHEE MCDM framework is adopted to ensure fairness and transparency in the selection of start-ups in the face of limited funds in the public venture capital. The relevant criteria for the evaluation process were thoroughly studied in literature and culled from [9], [10], [11] and [12], [13], [14] and [15]. In this paper, four sets of alternatives (start-up businesses) and five decision makers are used in the evaluation and selection process. In the following section, an outline of the evaluation procedure is presented.

The first step involved the determination of the linguistic variables, linguistic terms, the alternatives and the decision makers. In Table 1, the linguistic terms for both the importance criteria and the alternative ratings are expressed in their TFN format. Additionally, figure 3 presents the relevant criteria used in the study of selecting start-up businesses in a publicly run venture capital scheme. Lastly, the importance criteria is also computed.

Table 1: Linguistic scale for the importance of criterion and alternative ratings

Linguistic terms	Triangular fuzzy number	Ratings of Alternatives
Very Low (VL)	(0.0,0.1,0.3)	Not Feasible (NF)
Low (L)	(0.1,0.3,0.5)	Feasible with changes (FC)
Medium(M)	(0.3,0.5,0.7)	Likely to be achieved (LA)
High (H)	(0.5,0.7,0.9)	Feasible (F)
Very High (VH)	(0.7,0.9,1.0)	Highly Achievable (HA)

The importance criterion is determined by the ratings of the decision makers as shown in Table 2. The ratings for the determination of the important criterion is expressed by Eq. 6 and aggregated using Eq. 8. In this study, criterion 1 (**C_1**) was adjudged the most important criterion in the selection of start-up businesses in a public venture capital.

The second step involved the construction of a decision matrix expressed in Eq. 7 and was subsequently aggregated using Eq. 9. The ratings were carried out using well-constructed sets of linguistic terms to adequately describe each criterion. The 5-set linguistic terms are *Not Feasible* (NF), *Feasible with changes* (FC), *Likely to be achieved* (LA), *Feasible* (F) and *Highly Achievable* (HA) to describe the potential and preparedness of each start-up business seeking a public venture capital support. In Table 3, the decision matrix is shown with the various ratings assigned by decision makers. The third step normalized the aggregated decision matrix using Eq. 11.

Table 2: Importance Weight Criterion

	D_1	D_2	D_3	D_4	D_5	Aggregated Weight
C_1	VH	VH	VH	VH	H	(0.66,0.86,0.98)
C_2	H	M	H	M	M	(0.38,0.58,0.78)
C_3	H	H	H	H	M	(0.46,0.66,0.86)
C_4	VL	L	L	M	L	(0.12,0.30,0.50)
C_5	L	L	M	M	M	(0.22,0.42,0.62)
C_6	M	H	M	M	M	(0.34,0.54,0.74)

The fourth step computes the preference function to describe the decision-makers' aggregated preference between pairs of alternatives. This paper used the 'usual criterion' as expressed in Eq. 12. In table 4, the pair wise preferences are presented.

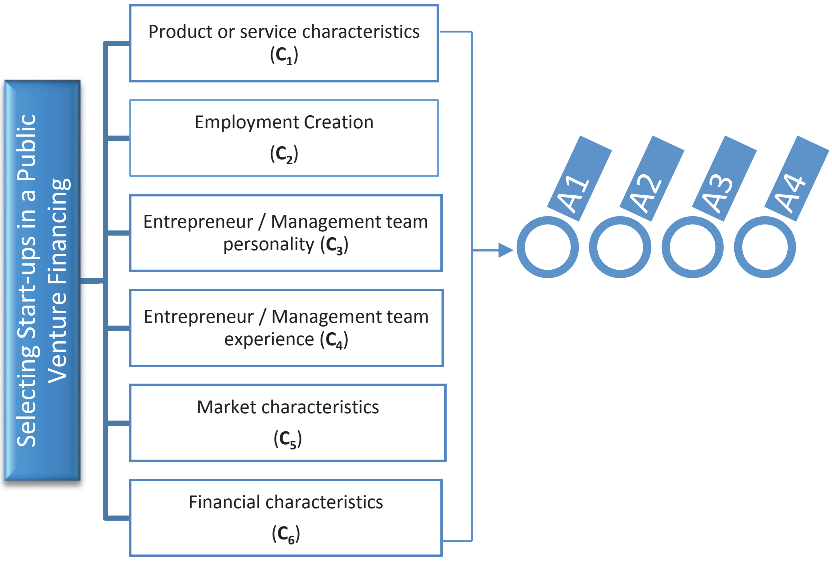

Fig. 3. Conceptual framework for Selecting Start-ups in Public Venture Capital

Subsequently in step five, the weighted aggregated preference function is calculated using Eq. 13 resulting in Table 5.

In step six, the leaving and entering flows as well as their net flows are computed using Eq. 14, 15 and 16 respectively. This generated the ranking of the alternatives. In Table 6, the leaving, entering and net flows are presented. The ranking depicts alternative 4 as the best alternative.

Table 3: Alternative Ratings by Decision-Makers

Criteria	Alternatives	Decision-Makers				
		D_1	D_2	D_3	D_4	D_5
C_1	A_1	FC	NF	NF	LA	LA
	A_2	FC	FC	LA	LA	LA
	A_3	LA	FC	FC	FC	LA
	A_4	HA	F	HA	LA	F
C_2	A_1	LA	LA	NF	FC	FC
	A_2	LA	FC	F	F	F
	A_3	F	F	F	F	FC
	A_4	F	F	HA	F	LA
C_3	A_1	FC	F	FC	LA	F
	A_2	LA	F	LA	LA	F
	A_3	HA	F	HA	HA	HA
	A_4	HA	HA	HA	HA	F
C_4	A_1	F	F	LA	F	LA
	A_2	F	LA	F	LA	F
	A_3	HA	F	F	F	F
	A_4	F	F	F	F	HA
C_5	A_1	F	FC	FC	FC	FC
	A_2	LA	LA	LA	LA	FC
	A_3	LA	LA	LA	LA	LA
	A_4	LA	F	F	LA	F
C_6	A_1	NF	FC	FC	LA	FC
	A_2	F	LA	F	F	LA
	A_3	F	LA	F	HA	LA
	A_4	HA	F	F	F	HA

Table 4: Pairwise Preference Functions for the Alternatives

	C_1	C_2	C_3	C_4	C_5	C_6
P(A1,A2)	0	0	0	0	0	0
P(A1,A3)	0	0	0	0	0	0
P(A1,A4)	0	0	0	0	0	0
P(A2,A1)	1	1	1	0	1	1
P(A2,A3)	1	0	0	0	0	0
P(A2,A4)	0	0	0	0	0	0
P(A3,A1)	1	1	1	1	1	1
P(A3,A2)	0	1	1	1	1	1
P(A3,A4)	0	0	0	0	0	0
P(A4,A1)	1	1	1	1	1	1
P(A4,A2)	1	1	1	1	1	1
P(A4,A3)	1	1	0	0	1	1

Table 5: Weighted Aggregated Preference Function

	A1	A2	A3	A4
A1		0	0	0
A2	9.1		2.5	0
A3	10.02	7.52		0
A4	10.02	10.02	7.12	

Table 6: The leaving/entering, net flows and alternatives ranking

	Leaving Flow $\left(\phi^{+}(m)\right)$	Entering Flow $\left(\phi^{-}(m)\right)$		Net Flow	Ranking
A1	0	9.713333		-9.71333	4
A2	3.866667	5.846667		-1.98	3
A3	5.846667	3.206667		2.64	2
A4	9.053333	0		9.053333	1

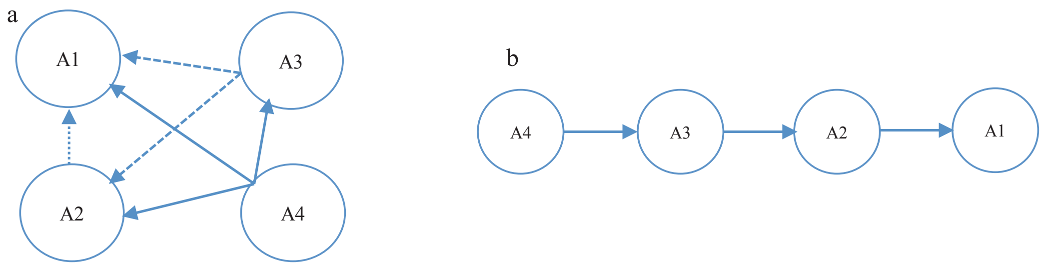

Fig. 4. (a) Partial preorder outranking; (b) Full preorder outranking

5. Conclusion

The research aimed at applying a fuzzy PROMETHEE framework to select and evaluate start-up businesses in a Public Venture Capital (PVC) scheme. In selection problems especially where public funds are involved, several peripheral considerations are sometimes made which do not inure to the benefit of the parties involved. To ensure fairness and transparency in the selection of start-up businesses in a publicly run venture capital, this framework seeks to also minimize the occurrences of low funds recovery rates as a result of selecting unsuitable candidates especially in a micro financing scheme. The Fuzzy PROMETHEE method was chosen primarily because of its ‘preference function’ approach of conducting pairwise comparison of alternatives involved in the selection process. This decision making framework applied in this study demonstrates how in a highly uncertain field such as venture capital schemes, a fuzzy PROMETHEE method can be handy in choosing businesses that have the high propensity to succeed. The criteria and the decision making approach could be reviewed in future and extended to evaluate start-up businesses in a private venture capital.

Acknowledgements

This work was supported by Grant Agency of the Czech Republic - GACR P103/15/06700S, further by financial support of research project NPU I No. MSMT-7778/2014 by the Ministry of Education of the Czech Republic and also by the European Regional Development Fund under the Project CEBIA-Tech No. CZ.1.05/2.1.00/03.0089. Further, this work was supported by Internal Grant Agency of Tomas Bata University under the project No. IGA/FAI/2015/054.

References

[1] Alperovych, Yan, Georges Hübner, and Fabrice Lobet. "How does governmental versus private venture capital backing affect a firm's efficiency? Evidence from Belgium." Journal of Business Venturing (2014).
[2] Gompers, Paul Alan, and Joshua Lerner. The venture capital cycle. MIT press, 2004.
[3] Chemmanur, Thomas J., Karthik Krishnan, and Debarshi K. Nandy. "How does venture capital financing improve efficiency in private firms? A look beneath the surface." Review of financial studies (2011): hhr096.
[4] Bertoni, Fabio, Massimo G. Colombo, and Luca Grilli. "Venture capital financing and the growth of high-tech start-ups: Disentangling treatment from selection effects." Research Policy 40, no. 7 (2011): 1028-1043.
[5] Nkusu, Mwanza. "Nonperforming loans and macrofinancial vulnerabilities in advanced economies." IMF Working Papers (2011): 1-27.

[6] Biekpe, Nicholas. "Financing small businesses in Sub-Saharan Africa: Review of some key credit lending models and impact of venture capital provision." Journal of African Business 5, no. 1 (2004): 29-44.
[7] Baeyens, Katleen, Tom Vanacker, and Sophie Manigart. "Venture capitalists' selection process: the case of biotechnology proposals." International Journal of Technology Management 34, no. 1 (2006): 28-46.
[8] Lerner, Josh. Boulevard of broken dreams: why public efforts to boost entrepreneurship and venture capital have failed--and what to do about it. Princeton University Press, 2009.
[9] Fried, Vance H., and Robert D. Hisrich. "Toward a model of venture capital investment decision making." Financial management (1994): 28-37.
[10] MacMillan, Ian C., Robin Siegel, and PN Subba Narasimha. "Criteria used by venture capitalists to evaluate new venture proposals." Journal of Business venturing 1, no. 1 (1986): 119-128.
[11] Hall, John, and Charles W. Hofer. "Venture capitalists' decision criteria in new venture evaluation." Journal of Business Venturing 8, no. 1 (1993): 25-42.
[12] Wells, William Arthur. "Venture capital decision-making." PhD diss., Carnegie-Mellon University, 1973.
[13] Petty, Jeffrey S. "THE DYNAMICS OF VENTURE CAPITAL DECISION MAKING." In Academy of Management Proceedings, vol. 2009, no. 1, pp. 1-6. Academy of Management, 2009.
[14] Mainprize, Brent, Kevin Hindle, and Ron Mitchell. "Toward the standardization of venture capital investment evaluation: decision criteria for rating investee business plans." In Proceedings of the 22rd Frontiers of Entrepreneurship Research conference, pp. 1-16. Babson College, 2002.
[15] Mainprize, Brent, Kevin Hindle, and Ron Mitchell. "Toward the standardization of venture capital investment evaluation: decision criteria for rating investee business plans." In Proceedings of the 22rd Frontiers of Entrepreneurship Research conference, pp. 1-16. Babson College, 2002.
[16] Zadeh, Lotfi A. "Fuzzy sets." Information and control 8, no. 3 (1965): 338-353.
[17] Afful-Dadzie, Eric, Stephen Nabareseh, Anthony Afful-Dadzie, and Zuzana Komínková Oplatková. "A fuzzy TOPSIS framework for selecting fragile states for support facility." Quality & Quantity (2014): 1-21.
[18] Klir, George, and Bo Yuan. Fuzzy sets and fuzzy logic. Vol. 4. New Jersey: Prentice Hall, 1995.
[19] Wang, Li-Xin. A course in fuzzy systems. Prentice-Hall press, USA, 1999.
[20] Afful-Dadzie, Anthony, Eric Afful-Dadzie, Stephen Nabareseh, and Zuzana Komínková Oplatková. "Tracking progress of African Peer Review Mechanism (APRM) using fuzzy comprehensive evaluation method." Kybernetes 43, no. 8 (2014): 1193-1208.
[21] Asady, B., and A. Zendehnam. "Ranking fuzzy numbers by distance minimization." Applied Mathematical Modelling 31, no. 11 (2007): 2589-2598.
[22] Vincke, J. P., and Ph Brans. "A preference ranking organization method. The PROMETHEE method for MCDM." Management Science 31, no. 6 (1985): 647-656.
[23] Chen, Ying-Hsiu, Tien-Chin Wang, and Chao-Yen Wu. "Strategic decisions using the fuzzy PROMETHEE for IS outsourcing." Expert Systems with Applications 38, no. 10 (2011): 13216-13222.
[24] Amaral, Thiago M., and Ana PC Costa. "Improving decision-making and management of hospital resources: An application of the PROMETHEE II method in an Emergency Department." Operations Research for Health Care 3, no. 1 (2014): 1-6.
[25] Elevli, Birol. "Logistics freight center locations decision by using Fuzzy-PROMETHEE." Transport 29, no. 4 (2014): 412-418.
[26] Peng, Yi, Gang Kou, and Jun Li. "A fuzzy promethee approach for mining customer reviews in chinese." Arabian Journal for Science and Engineering 39, no. 6 (2014): 5245-5252.
[27] Roodposhti, Majid Shadman, Saeed Rahimi, and Mansour Jafar Beglou. "PROMETHEE II and fuzzy AHP: an enhanced GIS-based landslide susceptibility mapping." Natural Hazards 73, no. 1 (2014): 77-95.
[28] Tian, Xiaojuan, Xiaodong Liu, and Lidong Wang. "An improved PROMETHEE II method based on Axiomatic Fuzzy Sets." Neural Computing and Applications 25, no. 7-8 (2014): 1675-1683.
[29] Chen, Ting-Yu. "A PROMETHEE-based outranking method for multiple criteria decision analysis with interval type-2 fuzzy sets." Soft Computing 18, no. 5 (2014): 923-940.
[30] Hajlaoui, Sonia, and Nesrin Halouani. "Hesitant-fuzzy-promethee method." In Modeling, Simulation and Applied Optimization (ICMSAO), 2013 5th International Conference on, pp. 1-6. IEEE, 2013.
[31] Li, Wei-xiang, and Bang-yi Li. "An extension of the Promethee II method based on generalized fuzzy numbers." Expert Systems with Applications 37, no. 7 (2010): 5314-5319.
[32] Government of Ghana. “The Venture Capital Trust Fund (VCTF)” . http://www.venturecapitalghana.com.gh/?launch=aboutus
[33] André, Pierre, and Sandrine Mesplé-Somps. "Politics and the geographic allocation of public funds in a semi-democracy: The case of Ghana, 1996-2004." (2011).
[34] Tonah, Steve. "Democratization and the Resurgence of Ethnic Politics in Ghana, 1992-2006." Ethnicity, belonging and biography: ethnographical and biographical perspectives 16 (2009): 63.