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# APPLICATION OF THE MARS METHOD TO THE EVALUATION OF GRANT APPLICATIONS AND NON-RETURNABLE INSTRUMENTS OF START-UP BUSINESS FINANCING[1]

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**Abstract**

This paper discusses the issue of evaluation of grant and loan proposals submitted by start-up businesses. A multi-criteria model for the evaluation of proposals for start-up business financing is proposed, based on the MARS method and taking into account three criteria: professional experience of the person planning to start a business, evaluation of the business plan, and evaluation of credit history of the applicant. Modelling of the expert's preferences was based on verbal comparisons of decision variants from the reference set consisting of solutions close to the ideal solution. The usefulness of the model has been verified using data from loan applications submitted to the Business Friendly Fund, operating in one of cooperative banks in the Podlaskie voivodeship.

**Keywords:** MARS, MACBETH, ZAPROS, credit application, start-up business financing, holistic approach.

## 1 Introduction

The development of the business sector, especially of Small and Medium-sized Enterprises (SMEs) and of micro-enterprises is an important factor affecting the financial situation of countries. According to a report of the European Commis-

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sion (www 2), the SME sector, with the exclusion of the financial branch, constituted 99.8% of all enterprises in the European Union (the EU-28 countries). For each square kilometer of the current area of the EU there are five enterprises from this sector, and almost 90 million people are employed in this sector, which constitutes 67% of the total employment. The SME sector creates 58% of the added value in the EU. According to the statistics of the World Bank (www 3), the SME sector creates 45% employment in the world and 33% of the world added value. If we take into account businesses from the "grey zone" (non-registered businesses), the numbers are even larger. The World Bank estimates that within the next 15 years this sector will contribute to the creation of 600 million work places in the entire world and points out that the main problem in the development of this sector is the lack of access to the financing of the investments. Fifty percent of businesses from SME in the world have problems with obtaining bank credit, and this number grows to 70% if we take into account non-registered businesses. These data show the very important role of the micro-enterprises and SMEs in the development of the world economy, while it is also pointed out that the main obstacle in the development of this sector is the lack of access to capital for new investments (Beck, Demirguc-Kunt, Martinez Peria, 2011).

One of measures of investment appeal of a country or region is the balance of newly opened and closing businesses. In 2014 in Poland, the number of newly created enterprises was almost twice as high as compared with 2003-2005[2], which is related, to a large extent, with the distribution of EU funds in Poland. Start-up businesses can now be financed using various types of financial instruments, such as grants or preferential loans within various assistance programs. Since a start-up is a new entity, which has no history of its operation, evaluation of its applications for funds is a difficult task. The problem of evaluation of such applications can be regarded as a weakly or non-structured multiple criteria problem, with incomplete or imprecise available preference information and with data of various types, and such that assessing the application requires expert knowledge. Several tools which can be used to solve this problem can be found among methods of multi-criteria analysis of decision problems (Figueira, Greco, Ehrgott, 2005; Roy, 1990; Trzaskalik, 2014). Among the applicable methods are: fuzzy methods, such as fuzzy TOPSIS or fuzzy SAW (Chen, Hwang, 1992) which take into account incomplete information and allow to handle data of various types; fuzzy methods based on linguistic approach (Herrera, Alonso, Chiclana, Herrera-Viedma, 2009; Herrera, Herrera-Viedma, 2000); methods us-

[2] Data from GUS BDL.

ing verbal scores, e.g., MACBETH (Bana e Costa, Vansnick, 1999), ZAPROS (Larichev, Moshkovich, 1997), or preference information given indirectly in the form of decision examples for a reference set of decision variants, such as UTA (Siskos, Grigoroudis, Matsatsinis, 2005; Jacquet-Lagrèze, Siskos, 1982; 2001), GRIP (Figueira, Greco, Słowiński, 2009; Greco, Mousseau, Słowiński, 2008), MARS (Górecka, Roszkowska, Wachowicz, 2014, 2016; Roszkowska, Wachowicz, 2015), fuzzy modeling (Jagielska, Matthews, Whitfort, 1999). Also, the theory of rough sets is used in research on risk involved in start-up business financing (Pawlak, 1982). The decision problem consisting in granting or not granting funding can be represented using a decision system in which the conditional attributes are variables from the model, and the conclusion (the system decision) is a dichotomic variable denoting a "good" client and a "bad" one (Medina, Cueto, 2013). Fuzzy concluding can be a useful tool in the assessment of risk involved in starting an individual business, where those assessing a grant or loan application have limited information on both the applicant and the microeconomic environment of the future businessperson (Konopka, 2013).

In the present study the MARS method (Górecka, Roszkowska, Wachowicz, 2014) is used to solve the problem of evaluating grant and loan applications of start-up businesses. A multi-criteria model of evaluating applications of this type is used, with three criteria: professional experience of the person planning to start the business, evaluation of the business plan for the start-up, and assessment of the applicant's credit history. The MARS (*Measuring Attractiveness near Reference Solutions*) method, which is a hybrid of the methods ZAPROS and MACBETH, is used to aggregate those criteria, and therefore to classify and evaluate the applications on the basis of verbal assessments by experts. The usefulness of the model proposed has been verified using data from loan applications from the Business-Friendly Fund in one of the largest cooperative banks in the Podlaskie voivodeship.

The paper consists of six sections. In Section 2 the problem of start-up business financing in Poland is presented. Section 3 points out the specific nature of the evaluation of the applications for start-up business financing, with particular emphasis on the assessment of risk involved in the evaluation of such applications; included is also a justification of the choice of the MARS method for the construction of a multi-criteria model of such applications. Section 4 presents the basic assumptions of the MARS method. A theoretical model of risk assessment of start-up business financing based on this method is presented in Section 5. The usefulness of this model has been verified using data from loan applications from the Business-Friendly Fund in one of the largest cooperative banks in the Podlaskie voivodeship. The last section presents conclusions.

## 2 Start-up business financing

The economic development of a country depends to a large extent on the business sector. According to the statistics of GUS (Central Statistical Office, Poland), the SME sector contributes ca. 48% of Poland's GNP (Raport o stanie sektora…, 2014) and employs 6.2 million of working population of Poland. From the time of Poland's accession to the EU, the number of newly created enterprises has grown and at present it is equal to ca. 400 thousand annually. This index has increased almost twice as compared with the years 2003-2005. One should stress, however, that the number of closed down businesses also increased. The phenomenon of increasing appeal of starting and conducting one's own business is related, to a large extent, to the access to capital for investments or with funding for start-up businesses. Non-returnable grants or returnable capital with preferential interest rates stimulate entrepreneurship of both small business and large enterprises. At the moment, 30% of newly created businesses in Poland close down within the first year of operation.

In the case of financing a start-up business with non-returnable grants, this index grows (in the Podlaskie voivodeship, for instance, it is ca. 50%). Two years after the financing with a non-returnable grant, 70% businesses created this way close down. This is a relatively large number, resulting both from the circumstances in which businesses operate in Poland and from the lack of professional experience which could be used in managing a business independently. A start-up business is by definition an enterprise with a high probability of failure, particularly vulnerable to various risk factors: those related to business climate and market, political and system-related, socio-demographic, and technical (De Servigny, Renault, 2004). From this discussion it follows that one should search for tools for the evaluation of grant applications and returnable instruments of start-up business funding which take into account the specific nature of creating and operating a start-up business. An apt decision as to granting funding to a business is also simply in the public interest.

## 3 Assessment of risk involved in financing a start-up business

Assessment of risk involved in financing a business is closely related to the assessment of the creditworthiness of the business. Creditworthiness is here understood as the legal and financial ability to take out and repay credit instruments on time (Cleary, 1999). The relationship between the credit risk involved in granting credit and creditworthiness of a business can be expressed as follows: the greater the creditworthiness of a business, the smaller the risk involved in financing the business. The assessment of creditworthiness of an existing business is based on an analysis of the current and past financial condition of the busi-

ness, including its financial results, balance analysis, and cash flow analysis; analysis of the business plan of the enterprise to be financed; security analysis, as well as legal analysis of the investment. To simplify and shorten the time of the evaluation of applications, in the case of businesses already existing, credit scoring methods are used (Altman, Sabato, Wilson, 2010; Altman, Sabato, 2007; Thomas, Edelman, Crook, 2002). Risk analysis of existing businesses is a difficult problem which becomes even more difficult in the case of the evaluation of a start-up business. Commercial banks in Poland do not, by definition, grant financial assistance to businesses which have not been operating for at least 6 to 12 months. Hence typical commercial solutions for the assessment of start-up risk, such as assessment of financial condition by means of Altman's model (Altman, 1968), are lacking. Lack of available information on the history of business operations is the key factor complicating the evaluation of a credit application.

As mentioned above, the decision to finance or to refuse financing a start-up business should be based on objective, accessible information, that is, on information on the professional experience of the applicant, on the business plan of the start-up and on information from the BIK, BIG, and KRD databases. This list does not include information on financial security of the start-up business which should be, because of increased risk, a binary variable. Since the information obtained is mostly qualitative, declared by the applicant him- or herself[3], this knowledge should be regarded as incomplete and uncertain. Therefore, the assessment of start-up business financing can be regarded as a unique problem, weakly structured or non-structured, requiring expert knowledge, and based to a large extent on verbal scores in decision making (Larichev, Moshkovich, 1995; Nemery, Ishizaka, Camargo, Morel, 2012).

These assumptions justify the choice of the MARS method, which is a hybrid of the ZAPROS and MACBETH methods (Górecka, Roszkowska, Wachowicz, 2014) for the solution of this problem. In the MARS method, as in the MACBETH method (Bana e Costa, Vansnick, 1999) verbal scores are used to compare decision variants from the given reference set. Next, these scores are used to aggregate the criteria, and therefore to classify and evaluate the applications.

## 4 General assumptions of the MARS method

The MARS method (*Measuring Attractiveness near Reference Solutions*) (Górecka, Roszkowska, Wachowicz, 2014; 2016) is based on two methods: ZAPROS (acronym of the Russian name *Closed Procedures near Reference*

[3] The applicant should submit and sign a statement certifying, under penalty of perjury, that the information in the documents presented are factually correct.

*Situations*) (Larichev and Moshkovich, 1995) and MACBETH (*Measuring Attractiveness by a Categorical Based Evaluation Technique*) (Bana e Costa, Vansnick, 1999) and allows to completely rank decision variants evaluated on an interval scale. It is based on the disaggregation-aggregation paradigm (Greco, Mousseau, Słowiński, 2008), which means that a pre-order is created on the set of reference variants, and then assessment is made on the basis of this information. Next, a ranking of decision variants, defined on the entire set, is created. The order on the reference set is constructed using verbal scores on a 6-degree semantic scale; quantitative information on the characteristics of the decision variants evaluation is not used.

The following notation is used:

- $F = \{f_1, f_2, \ldots, f_n\}$ is the set of criteria,
- $X_k$ is a finite set of verbal scores with respect to $k$th criterion, $k = 1, 2, \ldots, n$, where $|X_k| = n_k$,
- $X = \prod_{k=1}^{n} X_k$ is the set of all possible vectors in the $n$-criteria space,
- $Y \subseteq X$ is the reference set of vectors, that is, the set of vectors whose all components except one have the best values possible, and the vector whose all components have the best values possible.

The MARS procedure consists of the following stages (Górecka, Roszkowska, Wachowicz, 2014; 2016):

**Stage 1.** Determination of the ordering scales for all the criteria considered in the decision problem.

**Stage 2.** Pairwise comparison of hypothetical vectors from the set $Y \subseteq X$, whose all components except one have the best values possible, with a vector whose all components have the best values possible.

The comparison consists in the qualitative assessment of the difference in attractiveness between two vectors from the reference set using six semantic categories: $d_1$ – the difference in attractiveness between the vectors is "very small", $d_2$ – "small", $d_3$ – "moderate", $d_4$ – "large", $d_5$ – "very large", and $d_6$ – "extremely large". Pairwise comparisons are performed using the M-MACBETH program which additionally verifies the consistency of the information given by the decision maker, suggesting changes in the case of inconsistency (www 1).

**Stage 3**. Solution of the PL-MACBETH problem and determination of point scores from 0 to 100 for the decision variants compared.

To solve the linear programming problem PL we can use the M-MACBETH program.

**Stage 4.** Determination of the final scores of decision variants and their ordering with respect to the ideal variant.

The final scores of decision variants $L_i$ for $i = 1, 2, \ldots, m$ are calculated as follows: As the score in the decision variant we take the point score $p_{ik}$ from the

0-100 scale assigned to the options within each criterion. Next, the distance $L_i$ from the ideal variant is calculated as follows:

$$L_i = \sum_{k=1}^{n} (100 - p_{ik}) \tag{1}$$

where $p_{ik}$is the point score of $i$th alternative with respect to $k$th criterion, $k = 1, 2, \ldots, n$, $i = 1, \ldots, n_k$.

The decision variants are sorted in increasing order according to their distance from the ideal variant. The best variant is that for which the final score is lowest.

The last stage is the determination of the normalized distance $L_i(norm)$.

**Stage 5.** Normalization of the final scores of decision variants follows the formula:

$$L_i(norm) = \frac{L_i}{\max\limits_i L_i}. \tag{2}$$

where $0 \le L_i(norm) \le 1$.

## 5 A model of risk assessment involved in start-up business financing based on the MARS method

The starting point in the construction of our model was the assumption of the criteria for the evaluation of credit applications and the determination of their scope taking into account the specific nature of granting credit to start-up businesses, as well as the possibilities of obtaining relevant information. Three criteria were taken into account in the model, related to: professional experience of the applicant, the business plan of the start-up, and the banking history of the applicant.

During the interview with the coordinator and with experts on risk who evaluate credit applications for the Business-Friendly Fund (an interview with three people), levels of criteria implementation have been determined and described verbally. Table 1 presents the set of criteria for the evaluation of credit applications, developed on the basis of the interview together with evaluation scales for each criterion.

Table 1: Description of the criteria and scales used in the model

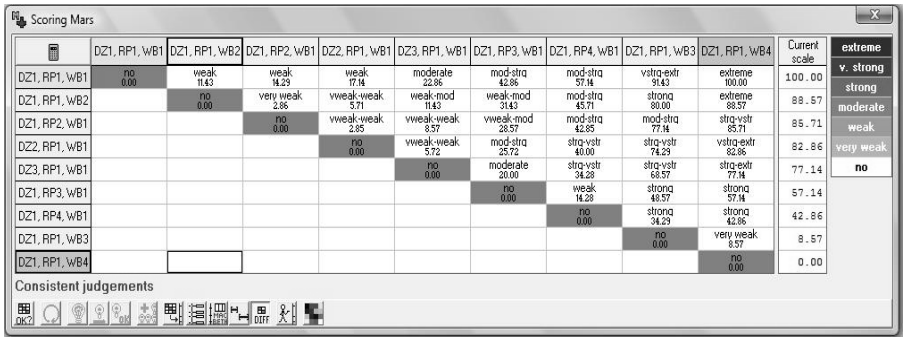
| Criterion | Characteristic | Evaluation scale |
|---|---|---|
| $f_1$ | Professional experience (DZ) | DZ1: Fully consistent with the business idea |
| | | DZ2: Has at least one year of experience in the relevant industry |
| | | DZ3: No professional experience relevant for the business idea |
| $f_2$ | Feasibility of the business idea (RP) | RP1: Cautious and realistic assumptions |
| | | RP2: Assumptions too optimistic, but realistic even in an unfavorable business climate |
| | | RP3: Assumptions realistic in an exceptionally favorable business climate |
| | | RP4: Unrealistic financial and business assumptions |
| $f_3$ | Credit history (WB) | WB1: The applicant has credit obligations without delinquencies |
| | | WB2: The applicant has no credit obligations or has obligations with delinquencies not exceeding 10 days |
| | | WB3: The applicant has credit obligations with delinquencies of 10 to 30 days |
| | | WB4: The applicant has credit obligations with delinquencies exceeding 30 days |

Source: Authors' own elaboration.

The reference set $X$ consists of nine variants: (DZ1, RP1, WP1), (DZ1, RP1, WP2), (DZ1, RP1, WP3), (DZ1, RP1, WP4), (DZ1, RP2, WP1), (DZ1, RP3, WP1), (DZ1, RP4, WP1), (DZ2, RP1, WP1), (DZ1, RP1, WP1).

In the next step, according to the MARS procedure, each expert compared decision variants from the reference set using the M-MACBETH program.

Table 2: Comparison of variants from the reference set using the M-MACBETH program, made by one expert




Source: Authors' own elaboration using the M-MACBETH program.

A list of point scores of the levels of implementation of criteria obtained by the experts using the M-MACBETH method is shown in Table 3.

It is worth noting that the experts agreed as to the ranking of the decision variants from the reference set, and they differed only in their scores assigned to the individual levels of implementation of decision variants and in the rankings of all decision variants obtained from them. The MARS method does not require that the decision maker directly determines the relevance of each criterion.

Table 3: Expert evaluations $p_{ik}$ 0-100

| **Expert no** | **Point score of the levels of implementation of decision variants** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DZ1 | DZ2 | DZ3 | RP1 | RP2 | RP3 | RP4 | WB1 | WB2 | WB3 | WB4 |
| 1 | 100 | 82,86 | 77,14 | 100 | 85,71 | 57,14 | 42,86 | 100 | 88,57 | 8,87 | 0 |
| 2 | 100 | 78,57 | 66,67 | 100 | 90,48 | 35,71 | 30,95 | 100 | 95,24 | 8,33 | 0 |
| 3 | 100 | 90,62 | 84,38 | 100 | 93,76 | 78,12 | 68,75 | 100 | 96,88 | 53,12 | 0 |
| Average | 100 | 84,02 | 76,06 | 100 | 89,98 | 56,99 | 47,52 | 100 | 93,56 | 23,44 | 0 |

Source: Authors' own elaboration based on the information obtained.

Distances $L_i$ from the ideal variant and the normalized distances for each decision variant determined on the basis of the experts' average point score are shown in Table 4.

Table 4: Distance of each decision variant from the ideal decision variant

| Variant | Criterion | | | Point score on the 0-100 scale | | | Distance | Distance | Position |
|---|---|---|---|---|---|---|---|---|---|
| | $f_1$ | $f_2$ | $f_3$ | $f_1$ | $f_2$ | $f_3$ | $L_i$ | $L_i$(*norm*) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| **W1** | DZ1 | RP1 | WB1 | 100,00 | 100,00 | 100,00 | 0,00 | 0,00 | 1 |
| **W2** | DZ1 | RP1 | WB2 | 100,00 | 100,00 | 93,56 | 6,44 | 0,04 | 2 |
| **W3** | DZ1 | RP1 | WB3 | 100,00 | 100,00 | 23,44 | 76,56 | 0,43 | 24 |
| **W4** | DZ1 | RP1 | WB4 | 100,00 | 100,00 | 0,00 | 100,00 | 0,57 | 28 |
| **W5** | DZ1 | RP2 | WB1 | 100,00 | 89,98 | 100,00 | 10,02 | 0,06 | 3 |
| **W6** | DZ1 | RP2 | WB2 | 100,00 | 89,98 | 93,56 | 16,45 | 0,09 | 5 |
| **W7** | DZ1 | RP2 | WB3 | 100,00 | 89,98 | 23,44 | 86,58 | 0,49 | 26 |
| **W8** | DZ1 | RP2 | WB4 | 100,00 | 89,98 | 0,00 | 110,02 | 0,62 | 31 |
| **W9** | DZ1 | RP3 | WB1 | 100,00 | 56,99 | 100,00 | 43,01 | 0,24 | 13 |
| **W10** | DZ1 | RP3 | WB2 | 100,00 | 56,99 | 93,56 | 49,45 | 0,28 | 14 |
| **W11** | DZ1 | RP3 | WB3 | 100,00 | 56,99 | 23,44 | 119,57 | 0,68 | 34 |
| **W12** | DZ1 | RP3 | WB4 | 100,00 | 56,99 | 0,00 | 143,01 | 0,81 | 40 |
| **W13** | DZ1 | RP4 | WB1 | 100,00 | 47,52 | 100,00 | 52,48 | 0,30 | 15 |
| **W14** | DZ1 | RP4 | WB2 | 100,00 | 47,52 | 93,56 | 58,92 | 0,33 | 16 |
| **W15** | DZ1 | RP4 | WB3 | 100,00 | 47,52 | 23,44 | 129,04 | 0,73 | 37 |
| **W16** | DZ1 | RP4 | WB4 | 100,00 | 47,52 | 0,00 | 152,48 | 0,86 | 43 |
| **W17** | DZ2 | RP1 | WB1 | 84,02 | 100,00 | 100,00 | 15,98 | 0,09 | 4 |
| **W18** | DZ2 | RP1 | WB2 | 84,02 | 100,00 | 93,56 | 22,42 | 0,13 | 6 |
| **W19** | DZ2 | RP1 | WB3 | 84,02 | 100,00 | 23,44 | 92,54 | 0,52 | 27 |
| **W20** | DZ2 | RP1 | WB4 | 84,02 | 100,00 | 0,00 | 115,98 | 0,66 | 33 |
| **W21** | DZ2 | RP2 | WB1 | 84,02 | 89,98 | 100,00 | 26,00 | 0,15 | 8 |
| **W22** | DZ2 | RP2 | WB2 | 84,02 | 89,98 | 93,56 | 32,44 | 0,18 | 10 |
| **W23** | DZ2 | RP2 | WB3 | 84,02 | 89,98 | 23,44 | 102,56 | 0,58 | 30 |
| **W24** | DZ2 | RP2 | WB4 | 84,02 | 89,98 | 0,00 | 126,00 | 0,71 | 36 |
| **W25** | DZ2 | RP3 | WB1 | 84,02 | 56,99 | 100,00 | 58,99 | 0,33 | 17 |
| **W26** | DZ2 | RP3 | WB2 | 84,02 | 56,99 | 93,56 | 65,43 | 0,37 | 18 |
| **W27** | DZ2 | RP3 | WB3 | 84,02 | 56,99 | 23,44 | 135,55 | 0,77 | 39 |
| **W28** | DZ2 | RP3 | WB4 | 84,02 | 56,99 | 0,00 | 158,99 | 0,90 | 45 |
| **W29** | DZ2 | RP4 | WB1 | 84,02 | 47,52 | 100,00 | 68,46 | 0,39 | 20 |
| **W30** | DZ2 | RP4 | WB2 | 84,02 | 47,52 | 93,56 | 74,90 | 0,42 | 22 |
| **W31** | DZ2 | RP4 | WB3 | 84,02 | 47,52 | 23,44 | 145,02 | 0,82 | 42 |
| **W32** | DZ2 | RP4 | WB4 | 84,02 | 47,52 | 0,00 | 168,46 | 0,95 | 47 |
| **W33** | DZ3 | RP1 | WB1 | 76,06 | 100,00 | 100,00 | 23,94 | 0,14 | 7 |
| **W34** | DZ3 | RP1 | WB2 | 76,06 | 100,00 | 93,56 | 30,37 | 0,17 | 9 |
| **W35** | DZ3 | RP1 | WB3 | 76,06 | 100,00 | 23,44 | 100,50 | 0,57 | 29 |
| **W36** | DZ3 | RP1 | WB4 | 76,06 | 100,00 | 0,00 | 123,94 | 0,70 | 35 |
| **W37** | DZ3 | RP2 | WB1 | 76,06 | 89,98 | 100,00 | 33,95 | 0,19 | 11 |
| **W38** | DZ3 | RP2 | WB2 | 76,06 | 89,98 | 93,56 | 40,39 | 0,23 | 12 |
| **W39** | DZ3 | RP2 | WB3 | 76,06 | 89,98 | 23,44 | 110,51 | 0,63 | 32 |
| **W40** | DZ3 | RP2 | WB4 | 76,06 | 89,98 | 0,00 | 133,95 | 0,76 | 38 |
| **W41** | DZ3 | RP3 | WB1 | 76,06 | 56,99 | 100,00 | 66,95 | 0,38 | 19 |
| **W42** | DZ3 | RP3 | WB2 | 76,06 | 56,99 | 93,56 | 73,38 | 0,42 | 21 |
| **W43** | DZ3 | RP3 | WB3 | 76,06 | 56,99 | 23,44 | 143,51 | 0,81 | 41 |

Table 4 cont.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
|---|---|---|---|---|---|---|---|---|---|
| **W44** | DZ3 | RP3 | WB4 | 76,06 | 56,99 | 0,00 | 166,95 | 0,95 | 46 |
| **W45** | DZ3 | RP4 | WB1 | 76,06 | 47,52 | 100,00 | 76,42 | 0,43 | 23 |
| **W46** | DZ3 | RP4 | WB2 | 76,06 | 47,52 | 93,56 | 82,85 | 0,47 | 25 |
| **W47** | DZ3 | RP4 | WB3 | 76,06 | 47,52 | 23,44 | 152,98 | 0,87 | 44 |
| **W48** | DZ3 | RP4 | WB4 | 76,06 | 47,52 | 0,00 | 176,42 | 1,00 | 48 |

Source: Authors' own elaboration.

On the basis of point scores and an interview with the expert, the decision variants have been grouped with respect to the degree of risk involved in granting funds. The grouping is shown in Table 5. Various shades of grey denote the four groups of risk involved in start-up business financing.

Table 5: Grouping of decision variant with respect to financing risk

| **Position** | **Variant** | **Distance** | **Position** | **Variant** | **Distance** | **Position** | **Variant** |
|---|---|---|---|---|---|---|---|
| 1 | W1 | 0,000 | 17 | W25 | 0,3344 | 33 | W20 |
| 2 | W2 | 0,036 | 18 | W26. | 0,371 | 34 | W11 |
| 3 | W5 | 0,057 | 19 | W41 | 0,379 | 35 | W36 |
| 4 | W17 | 0,091 | 20 | W29 | 0,388 | 36 | W24 |
| 5 | W6 | 0,093 | 21 | W42 | 0,416 | 37 | W15 |
| 6 | W18 | 0,127 | 22 | W30 | 0,425 | 38 | W40 |
| 7 | W33 | 0,136 | 23 | W45 | 0,433 | 39 | W27 |
| 8 | W21 | 0,147 | 24 | W3 | 0,434 | 40 | W12 |
| 9 | W34 | 0,172 | 25 | W46 | 0,470 | 41 | W43 |
| 10 | W22 | 0,184 | 26 | W7 | 0,491 | 42 | W31 |
| 11 | W37 | 0,192 | 27 | W19 | 0,525 | 43 | W16 |
| 12 | W38 | 0,229 | 28 | W4. | 0,567 | 44 | W47 |
| 13 | W9 | 0,244 | 29 | W35 | 0,570 | 45 | W28 |
| 14 | W10 | 0,280 | 30 | W23 | 0,581 | 46 | W44 |
| 15 | W13 | 0,297 | 31 | W8 | 0,624 | 47 | W32 |
| 16 | W14 | 0,334 | 32 | W39 | 0,626 | 48 | W48 |

Source: Authors' own elaboration.

The assignment of decision variants to groups is as follows:

**Group 1** (items 1-6 in Table 5, $L(norm) \in [0;0,127)$). This group contains applicants with level DZ1 professional experience; with business plan evaluated as level RB1 or RB2; and with credit history at levels WB1 or WB2. Applicants with level DZ2 professional experience, level RB1 business plan, and level WB2 credit history have also been assigned to this group. These are, therefore, applicants with **very low financing risk**.

**Group 2** (items 7-16 in Table 5, $L(norm) \in [0{,}136;0{,}334)$). This group contains applicants with level DZ1 business experience, level RB3 business plan, and with credit history at level WB1 or WB2. Applicants with level DZ2 business experience, level RB2 business plan, and level WB2 credit history have also been assigned to this group. The third subgroup here consists of loan-takers with level DZ3 business experience, business plan assessed at level RB1 or RB2, and level WB1 or WB2 credit history. These applicants represent, therefore, a **low financing risk**.

**Group 3** (items 17-23 in Table 5, $L(norm) \in [0{,}334;0{,}433)$). This group contains applicants with level DZ1 business experience, level RB4 business plan, and with credit history at level WB1 or WB2. A second subgroup here consists of applicants with level DZ2 business experience, level RB3 or RP4 business plan, and level WB1 or WB2 credit history. The third subgroup here consists of applicants with level DZ3 business experience, business plan evaluated at level RB3, and level WB1 or WB2 credit history. The fourth subgroup consists of applicants with level DZ3 business experience, level RB4 business plan, and level WB1 credit history. These applicants represent, therefore, a **moderate financing risk**.

**Group 4** (items 24-48 in Table 5, $L(norm) \in [0{,}433;1)$). This group consists of applicants whose credit history was evaluated at WB3 or WB4 level, irrespective of the levels of implementation of the remaining evaluation criteria. Furthermore, this group contains applicants with level DZ3 business experience, level RB4 business plan, and level WB2 credit history. This group is, therefore, one with a **high financing risk**.

The next step consisted in empirical verification of the model using data on the payback quality of 64 loans taken to finance start-up businesses in the Podlaskie voivodeship between January 2013 and February 2015 (Table 6). Among the companies that obtained such a loan, seven had at least one delinquency. The model presented here indicated correctly five of them. When identifying companies which had no problems paying off their loans, the model erred once, assigning a good loan-taker to Group 4 (variant (DZ1, RB1, WB3)).

Table 6: Assigning companies to the groups and decision variants

| Group 1 | | | Group 2 | | | Group 3 | | | Group 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **position** | **variant** | **number of companies** | **position** | **variant** | **number of companies** | **position** | **variant** | **number of companies** | **position** | **variant** | **number of companies** |
| 1 | W1 | 8 | 8 | W21 | 7 | 15 | W13 | 1 | 24 | W3 | 1 |
| 2 | W2 | 8 | 10 | W22 | 5 | 17 | W25 | 1 | 25 | W46 | 1 |
| 3 | W5 | 18 | 11 | W37 | 1 | 18 | W26 | 2 | 30 | W23 | 2 |
| 5 | W6 | 4 | 13 | W9 | 2 | 21 | W42 | 1 | 34 | W11 | 1 |
| | | | 14 | W10 | 1 | | | | | | |

Source: Authors' own elaboration based on bank data.

The structure of loan-takers is shown on Figures 1a and 1b. It is worth noting that 38 of 64 businesses (59.4%) have been qualified as belonging to Group 1, 16 companies (25%), to Group 2, five companies (7.8%), to Group 3, and five companies to Group 4.

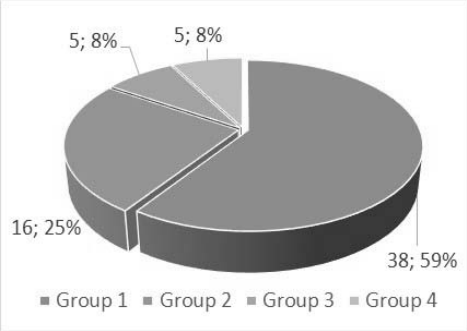



Figure 1a. Loan-takers divided into groups

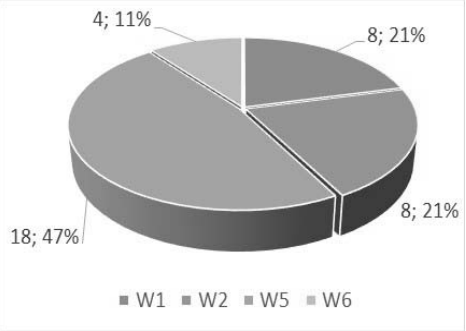



Figure 1b. Loan-takers divided into decision variants in Group 1

Source: Authors' own elaboration based on data in Table 6.

In the analysis of the number of loan-takers assigned to each decision variant, variants W5, W1, and W2 are worth noting. The loan-takers occurring most often have experience entirely consistent with their business idea, business assumptions calculated too optimistically, but feasible even in a disadvantageous economic climate; they have also credit obligations without delinquencies (variant W5). Second (eight people) are "ideal" loan-takers (variant W1) and loan-takers whose experience is entirely consistent with their business idea, who have cautious and realistic business assumptions and either have no credit obligations or have obligations with delinquencies of ten days or less (variant W2).

## 6 Final conclusions

Deciding whether to grant financing to a start-up business is a difficult task, primarily because of a lack of historical data on which one could base the evaluation. The problem of selecting the appropriate beneficiary for financial support in starting a business becomes complicated if we take into account the fact that preferential loans and non-returnable grants are directed mostly at unemployed, young people with modest professional experience (people up to 25 or 30 years old), handicapped people, as well as people living in rural areas – that is, at people who cannot obtain a loan from a commercial bank. On the other hand, institutions implementing European programs require that exorbitantly high indicators as regards the quality of the loan portfolio be achieved, for instance, as regards funds irretrievably lost or the number of agreements termi-

nated. The minimization of losses can be achieved only with help of appropriate tools which allow to include expert knowledge in the evaluation of loan or grant applications. Research (Peters, 1990) indicates that when experts assess the risk, they do it not in numerical quantities but, to a large extent, using natural language. Therefore research on the inclusion of tools handling incomplete data and data in linguistic or fuzzy form, in the evaluation of applications for start-up business financing should be conducted on a larger scale.

In our paper we have presented our own proposal of using the MARS method in the evaluation and ranking of credit applications. An advantage of our approach is the possibility of taking into account expert scores expressed verbally in the evaluation of start-up business financing. This holistic approach allows, moreover, for comparing decision variants from the reference set only, and, on this basis, to evaluate the decisions in the entire set of decision variants. It is worth noting that the construction of the reference set, related to the ZAPROS procedure, is transparent and comprehensible for the expert, and pairwise comparisons of entire decision variants are natural from the point of view of the problem under discussion (a decision variant is identified with the description of the situation of a specific applicant). Another advantage of our approach is that it does not require an assessment of the relevance of the criteria (weights) of the credit application evaluations, which could constitute an additional difficulty for the expert. Further research will deal with verification of the empirical usefulness of the model proposed, as well as with identification of other methods using verbal scores, such as MACBETH, ZAPROS, methods based on holistic approach such as UTA, GRIP (Figueira, Greco, Słowiński, 2008, 2009), applications of rough sets (Pawlak, 1982; Medina, Cueto, 2013), or fuzzy reasoning (Konopka, 2013) for the evaluation of credit applications.

## References

Altman E.I. (1968), *Financial Ratios Discriminant Analysis and the Prediction of Corporate Bankruptcy*, Journal of Finance, 23, 589-609.

Altman E.I., Sabato G. (2007), *Modelling Credit Risk for SMEs: Evidence from the U.S. Market*, Abacus, 43(3), 332-357.

Altman E.I., Sabato G., Wilson N. (2010), *The Value of Non-financial Information in Small and Medium-sized Enterprise Risk Management*, The Journal of Credit Risk, 6(2), 1-33.

Bana e Costa C., Vansnick J.-C. (1999), *The MACBETH Approach: Basic Ideas, Software, and an Application* [in:] N. Meskens and M. Roubens (eds.), *Advances in Decision Analysis*, Springer, 131-157.

Beck T., Demirguc-Kunt A., Martinez Peria M.S. (2011), *Bank Financing for SMEs: Evidence across Countries and Bank Ownership Types*, Journal of Financial Services Research, 39(1-2), 35-54.

Chen C.T., Hwang C.L. (1992), *Fuzzy Multiple Attribute Decision Making Methods and Applications*, Springer-Verlag, Berlin.

Cleary S. (1999), *The Relationship between Firm Investment and Financial Status*, Journal of Finance, Vol. 54(2), 673-692.

Figueira J., Greco S., Słowiński R. (2008), *Identifying the "Most Representative" Value Function among All Compatible Value Functions in the GRIP Method*, Proceedings of 68th Meeting of the European Working Group on Multiple Criteria Decision Aiding, Chania.

Figueira J., Greco S., Ehrgott M. (eds.) (2005), *Multiple Criteria Decision Analysis: State of the Art Surveys*, Springer, New York, 609-637.

Figueira J.R., Greco S., Słowiński R. (2009), *Building a Set of Additive Value Functions Representing a Reference Preorder and Intensities of Preference: GRIP Method*, European Journal of Operational Research, 195(2), 460-486.

Greco S., Mousseau V., Słowiński R. (2008), *Ordinal Regression Revisited: Multiple Criteria Ranking Using a Set of Additive Value Functions*, European Journal of Operational Research, 191, 416-436.

Górecka D., Roszkowska E., Wachowicz T. (2014), *MARS – A Hybrid of ZAPROS and MACBETH for Verbal Evaluation of the Negotiation Template* [in:] Group Decision and Negotiation 2014 (GDN 2014), Proceedings of the Joint International Conference of the INFORMS GDN Section and the EURO Working Group on DSS, eds. P. Zaraté, G. Camilleri, D. Kamissoko, F. Amblard, 24-31.

Górecka D., Roszkowska E., Wachowicz T. (2016), *The MARS Approach in the Verbal and Holistic Evaluation of the Negotiation Template*, Group Decision and Negotiation, DOI: 10.1007/s 10726-016-9475-92016.

Herrera F., Alonso S., Chiclana F., Herrera-Viedma E. (2009), *Computing with Words in Decision Making: Foundations, Trends and Prospects*, Fuzzy Optim. Decis. Making, 8, 337-364.

Herrera F., Herrera-Viedma E. (2000), *Linguistic Decision Analysis: Steps for Solving Decision Problems under Linguistic Information*, Fuzzy Sets and Systems, 115, 67-82.

Jacquet-Lagrèze E., Siskos Y. (1982), *Assessing a Set of Additive Utility Functions for Multicriteria Decision Making. The UTA Method*, European Journal of Operational Research, 10 (2), 151-164.

Jacquet-Lagrèze E., Siskos Y. (2001), *Preference Disaggregation: 20 Years of MCDA Experience*, European Journal of Operational Research, 130 (2), 233-245.

Jagielska I., Matthews C., Whitfort T. (1999), *An Investigation into the Application of Neural Networks, Fuzzy Logic, Genetic Algorithms, and Rough Sets to Automated Knowledge Acquisition for Classification Problems*, Neurocomputing, Vol. 24, 37-54.

Konopka P. (2013), *Zastosowanie wnioskowania rozmytego do oceny ryzyka kredytowego przedsiębiorstw*, Studia Ekonomiczne Uniwersytetu Ekonomicznego w Katowicach nr 163, Modelowanie preferencji a ryzyko '13, 285-299.

Larichev O.I., Moshkovich H.M. (1997), *Verbal Decision Analysis for Unstructured Problems*, Kluwer Academic Publishers, Boston.

Larichev O.I., Moshkovich H.M. (1995), *ZAPROS-LM – A Method and System for Ordering Multiattribute Alternatives*, European Journal of Operational Research, 82(3), 503-521.

Medina R.S., Cueto M.J.V. (2013), *Modeling Credit Risk: An Application of the Rough Set Methodology*, International Journal od Banking and Finance, Vol. 10, 34-56.

Nemery P., Ishizaka A., Camargo M., Morel L. (2012), *Enriching Descriptive Information in Ranking and Sorting Problems with Visualizations Techniques*, Journal of Modelling in Management, 7(2), 130-147.

Pawlak Z. (1982), *Rough Sets*, Int. J. Computer and Information Sci., 11, 341-356.

Peters J. (1990), *A Cognitive Computational Model of Risk Hypothesis Generation*, Journal of Accounting Research, 28, 83-109.

Raport o stanie sektora małych i średnich przedsiębiorstw w Polsce w latach 2012-2013 (2014), PARP, Warszawa.

Roy B. (1996), *Multicriteria Methodology for Decision Aiding*, Kluwer Academic Publishers, Netherlands.

Roszkowska E., Wachowicz T. (2015), *Holistic Evaluation of the Negotiation Template – Comparing MARS and GRIP Approaches* [in:] B. Kamiński, G.E. Kersten, P. Szufel, M. Jakubczyk, T. Wachowicz (eds.), The 15th International Conference on Group Decision and Negotiation Letters, Warsaw School of Economics Press, 139-148.

De Servigny A., Renault O. (2004), *Measuring and Managing Credit Risk*, McGraw-Hill, New York.

Siskos Y., Grigoroudis E., Matsatsinis N.F. (2005), *UTA Methods* [in:] J. Figueira, S. Greco, M. Ehrgott (eds.), *Multiple Criteria Decision Analysis: State of the Art Surveys*, Springer, New York, 297-334.

Thomas L.C., Edelman D.B., Crook J.N. (2002), *Credit Scoring and Its Applications Monographs on Mathematical Modeling and Computation*, SIAM (Society for Industrial and Applied Mathematics), Philadelphia.

Trzaskalik T. (red.) (2014), *Wielokryterialne wspomaganie decyzji. Metody i zastosowania*, Polskie Wydawnictwo Ekonomiczne, 126-152.

(www 1) http://www.m-macbeth.com/en/downloads.html (access: 1.02.2016).

(www 2) Annual Report on European SMEs 2014/2015, http://ec.europa.eu/growth/smes/business-friendly-environment/performance-review/index_en.htm (access: 1.02.2016).

(www 3) Closing the Credit Gap for Formal and Informal Micro, Small, and Medium Enterprises, World Bank, http://www.worldbank.org/en/topic/financialsector/brief/smes-finance (access: 1.02.2016).