sciendo

TATRA MOUNTAINS
Mathematical Publications

DOI: 10.2478/tmmp-2018-0018
Tatra Mt. Math. Publ. **72** (2018), 17–29

FROM MULTICRITERIAL DATA ANALYSIS UP TO THE EXCLUSIVE CONTRACT

Erika Fecková Škrabuľáková

Inst. of Control and Informatization of Production Processes, Faculty BERG, Technical University of Košice, SLOVAKIA

ABSTRACT. In the present paper, we propose a heuristic for identifying the key supplier of a company. In order to develop the supplier's evaluation tool, we use the multicriterial data analysis. The main statistical instrument here is the principal component analysis. Using the data from all realized orders of a chosen company in Slovakia from the year 2017, we identify its key supplier. Hence, this study helps to close the gap between theoretical work on principal component analysis and actual practice. The importance of the present work underlines the fact that the company is planning to sign an exclusive contract with the recommended supplier.

1. Introduction

Businesses of today are depending on strategic relations between customers and their suppliers. According to [2], one of the most critical activities a firm should focus on is suppliers' selection, evaluation, and involvement. The effective selection of business partners is one of the most important issues in business, as the selection of the right suppliers that fit companies strategy may reflect in drastic cost savings.

The enterprises are forced to make improvements in their supply chain management [4] due to competition in a global environment [12], in order to produce low cost, but high-quality products that earn both customers and suppliers satisfaction [2] and fulfill the market requirements efficiently and dynamic [1] with all the respect to increased environmental asserts [7], [23].

2010 Mathematics Subject Classification: Primary: 62P30; Secondary: 62H25.
Keywords: exclusive supplier, multicriterial data processing, principal component analysis.
This work was supported by the Slovak Research and Development Agency under the contract No. APVV-14–0892 and by the Grant VEGA 1/0908/15.

Mainly the suppliers are selected by companies based on three basic factors, in particular: their ability to meet some quality standards, their delivery schedule and the price they offer. However, in modern management, there are several other factors that have to be taken into account in order to establish a long-term relationship between suppliers and customers [21].

A lot of papers about supplier evaluation and selection process based on different multiple criteria have been published since 1960s [30]. In the past years, this process has undergone a significant change due to increased technological capabilities and newly developed methodologies. The focus is concentrated on the identification of selection criteria for suppliers' evaluation by various businesses in the marketplace. [15]

Hence, in the spotlight of many researchers (see, e.g., [6], [9], [13], [15], [18], [20], [22], [30]) is the analysis of key performance indicators such as geographical location of supplier; net price after discounts and charges; production facilities and capacities; continuous improvement; ability to be flexible in changes of ordered volumes; delivery time; reasonable tenure; performance history of each supplier or personal relationships that can result in mutual cost reductions. Whereas the price seems to be the main and stable key factor from cost-saving point of view [6], [13], another factors such as the geographical location have decreased in significance in the last years [18]. On the other hand, the good interaction between the purchasers and the technical staff of the company grown in its importance [27]. It was observed that there is a correlation between the supplier evaluation process and the supplier relationships [31]. Evaluation of the existing suppliers brings benefits mainly in the form of better all-round service, improved overall quality, delivery performance and relationships, not rarely savings in monetary and other measurable terms [8], [19], [29]. Therefore, it is imperative for a company to clarify what type of relationship is desired with its suppliers [16], clearly define the objectives of the company [24], [32], and deduce the preferred key evaluation criteria for the particular company because the results of various studies are different.

The most important factors according to [10] are the quality, delivery, and performance history. According to [30], these factors are the net price, delivery time and quality. Results of another study [15] showed that the most important factors are the attitude of the vendor towards the customer, supplier delivery time, product quality and price. The first one is most surprising.

W e b e r in [29] demonstrates the use of data envelopment analysis as a tool for measuring the performance of vendors on multiple criteria. He identifies three main approaches for evaluation, namely: categorical, weighted point and cost ratio.

The first one influences the company to initially decide the evaluation parameters of their suppliers. Some form of the rating system such as neutral, satisfactory or preferred should be assigned to these parameters. After the sum of all parameters is calculated, the supplier with the highest score is chosen. Each parameter is equally weighted. Although this could be considered as disadvantage of this method [15], this method is preferred by companies with limited resources. The implementation of this method is easy. The second approach is known as the linear average of the weighted-point method. By C h e n et al. [5] it can be used by most firms. This method is more objective than the categorical one. Here the factors are weighted according to their importance and each weighting is multiplied by the assigned performance score. A sum consisting of each criterion's result defines the final rating of suppliers. The third approach is the cost-ratio method in which the cost of each factor is calculated and it is given as a percentage of total purchases. The supplier with the lowest net adjusted cost is chosen as the key supplier of the company. This method is very complex and requires a well-designed cost-accounting system. Therefore, it is not the first choice approach of small firms. Since financial sources of companies are limited, not all existing suppliers are evaluated.

The objective of this study is to identify the key supplier of a chosen company based on the data of all company's orders during the year 2017. The multicriterial data analysis is used here in order to develop a suppliers' evaluation tool. The main software used is Statistica 12 and the main statistical instrument here is the principal component analysis. According to our knowledge, this method for identification of exclusive supplier was not used in the same context before. Moreover, this study helps to close the gap between theoretical work on principal component analysis and actual practice. Its importance underlines the fact that an exclusive contract will be subscribed with the identified key supplier in the near future.

The remainder of this paper is divided into five main sections. The following (second) section provides a brief explanation of the need of this study. The third section outlines the methodology employed in this research. The way of data processing is described in the fourth section. The fifth one shows the results and provides the discussion about the key findings. Conclusions and recommendations can be found in the last section.

2. Case studies specification

In contrast to several studies dealing with the identification of the key criteria for best supplier determination we are going more into individual business. We introduce a strategy for identification of an exclusive supplier for a small company in east of Slovakia dealing with the renovation of historical vehicles.

The renovation of historical vehicles is a very specific field of business and there are only few suppliers satisfying the requirements of the company. Therefore, the list of suppliers is relatively small and their objectives are often very different and incomparable. The more specific is the renovation business (with conditions for the used parts for their originality, identity, adequacy...) the greater is the challenge to identify the key partner of the company.

In a small firm, such as the chosen one, the selection of the supplier is subject to 1–2 persons who have cumulative function of the purchaser, the decision-maker, the authorizing officer, the guardian and, not rarely the user as well. Since inventory management for the company is not their primary job, the time perspective does not allow them to concentrate on time-consuming broad-spectrum market research for each order. The prior experience with the supplier plays a significant role in the purchase. Therefore, the company is interested in identifying which supplier or suppliers out of the already existing partners is/are exclusive for the entity in order to subscribe exclusive contract(s) with it/them. The benefits of such contracts can be seen in the economic sphere––promising more favorable supply and pricing conditions as well as simplifying the work process.

3. Methodology

In order to solve a practical problem like this, mathematical tools of multi-criterial data analysis are of use and the principal component analysis (PCA), see, e.g., [14], [25] and [26], is worth for application. Based on the data collected from all the orders from all the suppliers of the company in the year 2017, a basic database was created. The obtained data were compared and analyzed on monthly basis and for each month of the year 2017 individually the PCA was used and the key factors were determined. Based on this, point scales were determined for each criterion and the intervals of values reached by the individual criterion in a given month were proportionally divided. According to the value of the criterion in each month and its facility into the respective interval, the points were assigned to each supplier on monthly basis. The cumulative score of obtained points in the year 2017 determined the key suppliers of the company. With the first one in the list, the company is planning to sign an exclusive contract in the near future.

Out of the four basic research techniques: study of documents, observations, interviews and questionnaires [3] we have used the first three here. The study of the available literature about known evaluation methods and criteria determined the framework of this paper. The observations were made after analysis, selection and evaluation of collected internal company's documents.

Hence, the primary sources of information were obtained through research in the chosen enterprise, secondary data through literature research. Both qualitative and quantitative data were gathered.

4. Data processing

In order to identify the individual suppliers of the company, 12 basic tables were prepared—each one for one month of the year 2017, see [28]. These tables show processed records about all executed orders for the company in 2017. For each order the records include: supplier's name, its scope of the assortment, the type of ordered item, date of order and delivery, the total delivery time, the price for one item, the number of ordered pieces, the total price for all ordered pieces, package information, the price for delivery of one item and all the ordered items, the total price for all the ordered items inclusive delivery and the identification of the envisaged usage of each item.

Afterwards, the data from these tables were arranged into another 12 tables processed on a monthly basis, where only the data relevant for PCA were outlined, namely:

Supp. No.: identification of the supplier by its preassigned number;

ADT: average delivery time in days;

TP: total price for all ordered items in EUR;

API: average price for an item in the order in EUR;

TD: total price for delivery in EUR;

AD: average price for delivery of one item of the order in EUR;

NP: the number of ordered pieces;

ANPI: the average number of ordered pieces per item;

NOR: the number of orders realized.

These key performance indicators for evaluating the suppliers were chosen after the interview with forwarding agents of the enterprise. Table 1 shows a part of the processed data related to January 2017.

Since it is difficult to determine which of the key performance indicators has a greater influence on the supplier's exclusivity, before assigning some weights in the form of point's intervals to each indicator, we used the principal component analysis. PCA became the main statistical instrument used in this study. It has been chosen in order to transform the original variables into a smaller set of linear combinations. Here the principal components are arranged according to their relevance, by the decreasing variance. The first one accounts as much

Table 1. Processed data related to January 2017.

Supp. No.	ADT	TP	API	TD	AD	NP	ANPI	NOR
1	3.22	196.79	7.57	29.40	1.13	2148	82.60	10
2	3.00	214.71	10.74	20.25	1.01	42	2.10	8
3	6.42	102.95	14.71	11.81	1.69	39	5.57	3
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
20	27.00	21.93	21.93	3.00	3.00	3	3.00	1

of the variability in the data as possible, the second one has the orthogonal position to the preceding component and has the highest variance among all rest orthogonal components and so on. Clearly, it is possible that there are several principal components reciprocally not correlated [17].

There are several ways how to determine the number of components that best describe the relationship among the variables. One of them is Kaiser's criterion according to which it is enough to investigate only factors with an eigenvalue greater or equal to 1 [26]. The other approach uses the fractional residual variance plots for PCA, where the theoretical values are the contribution from the residual eigenvalues. Here we search for the greatest V-cut of the curve after which it reaches a flat plateau. The number of factors before this V-cut defines the required number of principal components. [11]

We have used the second approach thanks to which it was possible to decrease the original space of variables into 2–3 dimensional one, see Figure 1. As the number of determined key performance indicators of suppliers was relatively small, we come to a decision for the 2-dimensional space. From the projection of the key performance indicators into the factor space, see Figure 2, we could order them according to the importance in every month of the year 2017. Factors located closer to the center of the circle had smaller importance that those with greater distance from the center. The numeric values of the coordinates of the key performance indicators in the 2-dimensional factor space for each month of the year 2017 can be found in [28].

The smaller was the angle between the key performance indicator, the center of the circle and another key performance indicator, the greater was their correlation. In the case that this angle was close to 90°, there was no correlation between the variables, and in the case it was close to 180°, the correlation was negative. By using the software Statistica one can easily get a table of correlation of the key performance indicators with remarkable correlations highlighted. In [28], it can be find for each month of the year 2017.

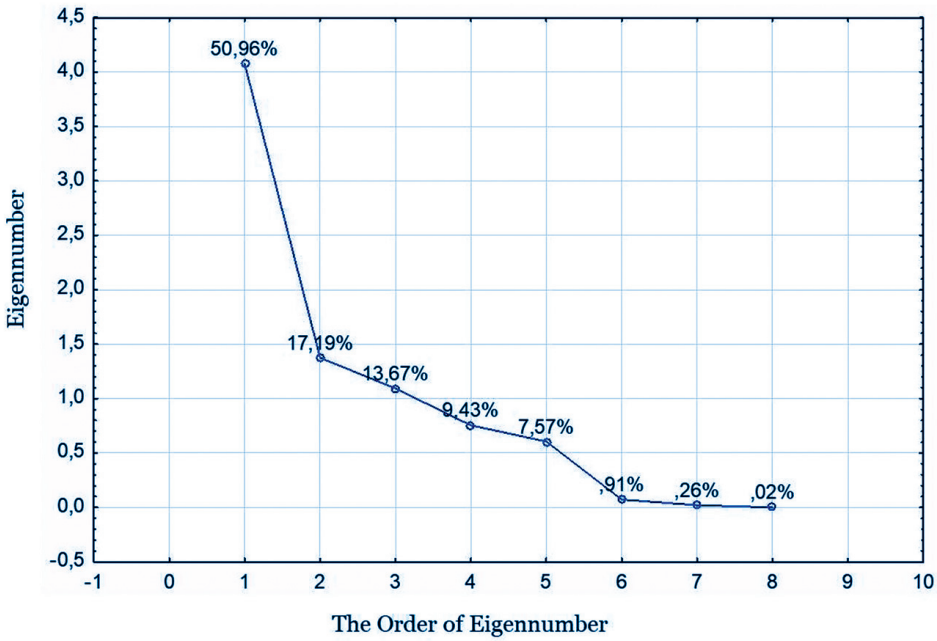

FIGURE 1. The fractional residual variance plots for PCA related to data from January 2017.

Based on the observed importance of the key performance indicators, point scales were assigned to each of them as follows: For each month of the year 2017 the key indicators were ordered according to their importance that is directly proportional to their distance from the centre of the circle in Figure 2. Those indicators, that attained first place in this ordering for the year 2017 most often, were considered as most important ones, and therefore, the widest scale of points was assigned to them. The lesser importance of the indicator was determined, the tighter was the scale of points assigned to the respective indicator. Therefore, a scale of 1–10 points was assigned to the indicators with the greatest importance, namely, the number of realized orders (NOR) and the total price for the items (TP). From 8 down to 1 points were assigned according to indicator total delivery price (TD). Within the indicator number of ordered pieces (NP) and average number of ordered pieces per item (ANPI) it was possible to earn 1–6 points and for average price for item in order (API) 1–4 points. The average delivery price (AD) and the average delivery time (ADT) were of the least importance, therefore the assigned (indirect proportional) scales in these cases were 1–2 points.

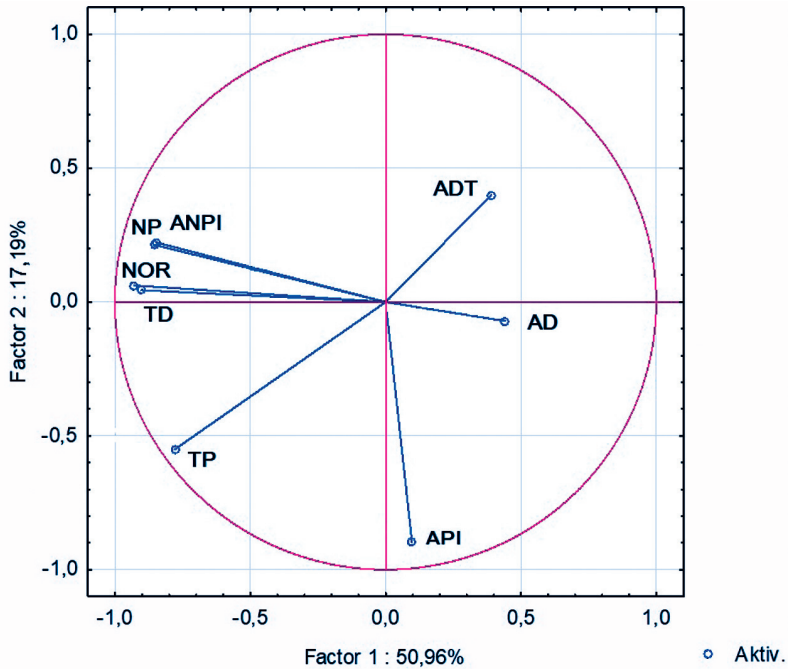

FIGURE 2. The projection of the key performance indicators into the factor space related to data from January 2017. (The graph corresponds to all suppliers.)

The point values related to the key performance indicators were assigned to suppliers on monthly basis using interval sorting. These points were summarized for each month of the year 2017, see the last column of Table 2. The total amount of the earned points in the year 2017 determined the required order of suppliers.

TABLE 2. Counting the total points achieved by the suppliers of January 2017.

Supp. No.	**ADT**	**TP**	**API**	**TD**	**AD**	**NP**	**ANPI**	**NOR**	**Σ**
1	2	10	1	1	2	6	6	10	38
2	2	10	1	3	2	1	1	8	28
3	2	5	1	5	2	1	1	3	20
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
20	1	1	1	8	2	1	1	1	16

5. Results and discussion

We found out that during the year 2017 the company was cooperating with in total 40 different suppliers. These have earned in total from 12 up to 412 points in our evaluation model. Table 3 shows the form of the obtained results. Clearly, it is reduced.

The highest score 412 points was earned by the Supplier No. 1. The second highest score was assigned to the Supplier No. 2: 286 points. Supplier No. 11 earned 190 points, what was the third highest value. The gap between the fourth and the fifth place was very tight. Supplier No. 7 achieved 141 points and Supplier No. 8 got 140 points. The average earned score was 65,95 points.

TABLE 3. Reduced table of counting the total points achieved by the suppliers in each month of the year 2017.

S. No.	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XII**	**XII**	**Σ**
1	38	37	32	29	27	38	31	40	29	33	38	40	412
2	28	19	24	30	23	0	27	24	30	28	24	29	286
3	20	0	28	0	0	0	17	0	19	0	19	0	103
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
7	18	14	17	23	0	0	15	0	0	22	18	14	141
8	17	14	16	0	24	15	0	16	0	23	15	0	140
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
11	23	17	0	20	16	32	23	0	0	17	20	22	190
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
20	16	0	0	0	0	0	0	0	0	0	0	0	16
21	0	21	0	0	0	0	0	0	0	0	0	0	21
22	0	18	16	0	0	0	0	0	20	0	0	0	54
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
34	0	0	0	0	0	0	0	0	12	0	0	0	12
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
40	0	0	0	0	0	0	0	0	0	0	0	21	21

According to our supplier's evaluation, we suggest the firm to subscribe an exclusive contract with the Supplier No. 1. Although the highest earned point score determined very clearly this key supplier of the company, all the 5 suppliers mentioned above can be considered as strategic partners for the firm.

The presented way of supplier's evaluation does not fit in detail to any of the three main approaches for supplier's evaluation identified by W e b e r [29] and mentioned in the introduction of this paper. It has the most in common with the second mentioned approach—the linear average of the weighted-point method.

The basis for the difference between the method mentioned by W e b e r [29] and the method presented in this paper can be find in the fact that we are going more into individual business and react on the needs of one concrete firm. The key performance indicators for evaluating the suppliers were also not chosen according to results of some general research study, but after the interview with forwarding agents of the entity.

The processed data were original data from all the orders of the firm during the year 2017, the real data. Hence, the results of this study are both valuable and sensitive for this company. Therefore, naturally, its name, as well as the names of its suppliers is not highlighted in this paper.

6. Conclusions

In this paper, we proposed a model framework for supplier's evaluation and a heuristic for company's key supplier identification based on point's assignation. In order to decide about the range of point's scales assigned to every spotted factor of exclusivity, we have used one of the multicriterial data processing methods—the principal component analysis.

The PCA together with the appropriate heuristic gives an evaluation tool. We agree with [15] that the tool itself does not lead to improvements per se. It is the practical use of the tool that closes the gap between theoretical work and practice and lies one step towards a better cooperation with the suppliers.

Therefore, the suggested way of an exclusive supplier's identification was applied on the internal data of a chosen company in east of Slovakia dealing with a specific kind of business—the renovation of historical vehicles. An exclusive supplier of this company as well as its key partners was identified.

The company is planning to subscribe an exclusive contract with the identified exclusive supplier in the near future. This fact underlines the importance of the presented work.

REFERENCES

[1] AKSOY, A.—ÖZTÜRK, N.: *Supplier selection and performance evaluation in just-in-time production environments*, Expert Systems with Applications **38** (2011), no. 5, 351–6359;
https://www.sciencedirect.com/science/article/pii/S0957417410013424

[2] ARAZ, C.—OZKARAHAN, I.: *Supplier evaluation and management system for strategic sourcing based on a new multicriteria sorting procedure*, International Journal of Production Economics **106** (2007), no. 2, 585–606;
https://www.sciencedirect.com/science/article/pii/S0925527306002131

[3] BRYMAN, A.: *Social Research Methods*, Oxford University Press, New York, 2012.

[4] CEBI, F.—BAYRAKTAR, D.: *An integrated approach for supplier selection*, Logistics Information Management **16** (2003), no. 6, 395–400;
https://www.emeraldinsight.com/doi/abs/10.1108/09576050310503376

[5] CHEN, I. J.—PAULRAJ, A.—LADO, A. A.: *Strategic purchasing, supply management, and firm performance*, Journal of Operations Management **22** (2004), no. 5, 505–523;
https://www.sciencedirect.com/science/article/pii/S0272696304000798

[6] CHO, D. W.—LEE, Y. H.—AHN, S. H.—HWANG, M. K.: *A framework for measuring the performance of service supply chain management*, Computers & Industrial Engineering **62** (2012), no. 3, 801–818;
https://www.sciencedirect.com/science/article/pii/S0360835211003378

[7] DOU, Y.—ZHU, Q.—SARKIS, J.: *Evaluating green supplier development programs with a grey-analytical network process-based methodology*, European Journal of Operational Research **233** (2013), no. 2, 420–431;
https://www.sciencedirect.com/science/article/pii/S0377221713002129

[8] DRABIKOVÁ, E.: *Examination of the Company Valuation Pertaining to Manufacturing Sector Using the Selected Method*, In: MMK 2017, Magnanimitas, Hradec Králové, 2017, pp. 17–24.

[9] DROGE, C.—VICKERY, S. K.—JACOBS, M. A.: *Does supply chain integration mediate the relationships between product/process strategy and service performance? An empirical study*, International Journal of Production Economics **137** (2012), no. 2, 250–262;
https://www.sciencedirect.com/science/article/pii/S0925527312000631

[10] DICKSON, G. W.: *An analysis of vendor selection systems and decisions*, Journal of Purchasing **2** (1996), no. 1, 5–17;
https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1745-493X.1966.tb00818.x

[11] ESBENSEN, K. H.—GUYOT, D.—WESTAD, F.—HOUMOLLER, L. P.: *Multivariate Data Analysis in Practice: An Introduction to Multivariate Data Analysis and Experimental Design*, CAMO ASA, Oslo, 2002.

[12] FAHY, J.: *A resource-based analysis of sustainable competitive advantage in a global environment*, International Business Review **11** (2002), no. 1, 57–77;
https://www.sciencedirect.com/science/article/pii/S0969593101000476

[13] GROVES, W.—COLLINS, J.—GINI, M.—KETTER, W.: *Agentassisted supply chain management: Analysis and lessons learned*, Decision Support Systems **57** (2014), no. 1, 274–284;
https://www.sciencedirect.com/science/article/pii/S0167923613002340

[14] HAIR, J.—ANDERSON, R.—TATHAM, R.—BLACK, W.: *Multivariate Data Analysis*. Saddle River, Prentice Hall, New Jersey, 1995.

[15] IMERI, S.—SHAHZAD, K.—TAKALA, J.—LIU, Y.—SILLANPÄÄ, I.—ALI, T.: *Evaluation and selection process of suppliers through analytical framework: An empirical evidence of evaluation tool*, Management and Production Engineering Review **6** (2015), no. 3, 10–20;
https://content.sciendo.com/view/journals/mper/6/3/article-p10.xml

[16] INEMEK, A.—MATTHYSSENS, P.: *The impact of buyer-supplier relationships on supplier innovativeness: An empirical study in cross-border supply networks*, Industrial Marketing Management **42** (2013), no. 4, 580–594;
https://www.sciencedirect.com/science/article/pii/S0019850112001824

[17] IVANOVÁ, M.—HOFIERKA, J.: *Základy štatistických metód v geografii*. Fakulta humanitných a prírodných vied Prešovskej univerzity, Prešov, 2009.

[18] JABER, M. Y.—BONNEY, M.—GUIFFRIDA, A. L.: *Coordinating a three-level supply chain with learning-based continuous improvement*, International Journal of Production Economics **127** (2010), no. 1, 27–38;
https://www.sciencedirect.com/science/article/pii/S0925527310001313

[19] LAMMING, R. C.—COUSINS, P. D.—NOTMAN, D. M.: *Beyond vendor assessment: Relationship assessment programmes*, European Journal of Purchasing & Supply Management **2** (1996), no. 4, 173–181;
https://www.sciencedirect.com/science/article/pii/S0969701296000135

[20] LOPPACHER, J. S.—CAGLIANO, R.—SPINA, G.: *Key drivers of buyer-supplier relationships in global sourcing strategies*, International Journal of Procurement Management **4** (2011), no. 2, 156–180;
https://www.inderscienceonline.com/doi/abs/10.1504/IJPM.2011.038897

[21] MANDAL, A.—DESHMUKH, S.: *Vendor selection using interpretive structural modelling (ISM)*, International Journal of Operations & Production Management **14** (1994), no. 6, 52–59;
https://www.emeraldinsight.com/doi/abs/10.1108/01443579410062086

[22] PRESUTTI, JR. W. D.—MAWHINNEY, J. R.: *The supply chain-finance link*, Supply Chain Management Review **11** (2007), no. 6, 32–38.

[23] ŠÁNDOROVÁ, K.—ŠOLTÉSZ MATULOVÁ, J.: *Potential of used mobile phones and their material assessment*, Research Journal of Mining **1** (2017), no. 4, 187–193.

[24] SAUNDERS, A. G.: *Supplier audits as part of a supplier partnership*, The TQM Magazine **6** (1994), no. 2, 41–42;
https://www.emeraldinsight.com/doi/abs/10.1108/09544789410054028

[25] SNOOK, S. C.—GORSUCH, R. L.: *Component analysis versus common factor analysis: A Monte Carlo study*, Psychological Bulletin **106** (1989), no. 1, 148–154;
http://psycnet.apa.org/buy/1989-35232-001

[26] TABACHNICK, B. G.—FIDELL, L. S.: *Using Multivariate Statistics*, Allyn & Bacon, Boston, 2007.

[27] TAKEISHI, A.: *Bridging inter-and intra-firm boundaries: Management of supplier involvement in automobile product development*, Strategic Management Journal **22** (2001), no. 5, 403–433;
https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.164

[28] VONDRA, J: *Analýza dodávateľov vybranej spoločnosti (The Analysis of Suppliers of the Selected Company)*. Diploma Thesis, Faculty BERG, Technical University of Košice, Košice, 2018.

[29] WEBER, C. A.: *A data envelopment analysis approach to measuring vendor performance*, Supply Chain Management **1** (1996), no. 1, 28–39;
https://www.emeraldinsight.com/doi/abs/10.1108/13598549610155242

[30] WEBER, C. A.—CURRENT, J. R.—BENTON, W.: *Vendor selection criteria and methods*, European Journal of Operational Research **50** (1991), no. 1, 2–18;
https://www.sciencedirect.com/science/article/abs/pii/037722179190033R

[31] WYNSTRA, F.—PIERICK, E. T.: *Managing supplier involvement in new product development: A portfolio approach*, European Journal of Purchasing & Supply Management **6** (2000), no. 1, 49–57;
https://www.sciencedirect.com/science/article/pii/S0969701299000350

[32] ZAVRŠNIK, B.: *The importance of selection and evaluation of the supplier in purchasing management*, Management (Split) **3** (1998), no. 2, 59–74.

Received September 12, 2018

Institute of Control and
Informatization of Production Processes
Faculty BERG
Technical University of Košice
Boženy Němcovej 3
042 00 Košice
SLOVAKIA
E-mail: erika.feckova.skrabulakova@tuke.sk