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# CALCULATION OF SUPPLIER RATINGS IN SUPPLY CHAIN MANAGEMENT

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**Introduction.** One of the most important elements of effective supply chain management is the selection of the best suppliers. An important aspect of this is the selection of suppliers. By making informed decisions about suppliers, a company can obtain high-quality goods, reduce transportation and storage costs, prevent production stoppage due to material shortages, and gain access to new goods and services. The selection process involves comparing multiple suppliers based on criteria such as price, quality, delivery terms, reputation, compliance with standards, and ability to fulfill contract terms. It is also essential to conduct a detailed analysis of possible risks associated with selected suppliers and choose those with the least exposure to risks.

One tool for comparing suppliers and assigning them to categories is rating assessment. By evaluating each supplier according to various criteria, a total score is determined, reflecting the supplier's position in the rating. This allows for sorting suppliers by performance and selecting those that best meet the company's needs.

**Analysis of recent research and publications.** Currently, the methodology for calculating supplier ratings is receiving significant attention in the scientific literature. For instance, a recent study [1] proposed an algorithm for rating calculation based on several factors, such as deviations from planned delivery dates, deviations from planned material stock quantities, deviations from planned prices, and comments on stock quality. However, the rating algorithm places undue weight on deviations from planned delivery dates, and the importance of other key indicators is understated. Additionally, the authors suggest classifying suppliers into three categories based on their rating: green, yellow, and red. However, the yellow category includes suppliers whose delivery deviations are within 120 days, which is unacceptable given the critical importance of timely and quality material stock delivery in the required quantities.

In [2], an evaluation of the supplier's rating is proposed based on the criteria of price, quality, and product preservation level.

The authors in [3] propose a method for calculating the comprehensive supplier rating assessment by considering various criteria, such as reliability, tariff (price), order fulfillment time, financial stability, service quality, packaging quality, product range, negotiation readiness, vehicle fleet condition, cargo safety, and personnel qualification. The authors note that these criteria have both positive and negative optimal values, meaning that some criteria should be maximized while others should be minimized. However, the authors did not take this factor into account when forming the rating assessment, which may lead to inaccurate ratings.

In [4], it is proposed to calculate the supplier's rating taking into account the probability of acquiring a certain value for each of the rating assessment criteria: the average price level of the supplier's goods, the price level of the main product, the average quality level of the supplier's goods, the quality level of the main product, the average delivery delay time, the maximum delivery delay time, the overall range of the supplier's goods, and the quantity of the supplier's goods needed by the company.

In [5], it is proposed to determine the supplier's dishonesty index based on data on violations of delivery times, delivery of products of inadequate quality, and the amount of under-delivered products. For each crite-

rion, an ABC analysis is proposed, based on which the supplier's overall ABC group is determined. However, a methodology for generalizing the overall ABC group is not proposed in the paper.

As can be seen from the overview, there is currently no single view on how to form a rating assessment of suppliers.

**Objectives of the article.** The aim of the work is to develop the most optimal algorithm for calculating the supplier rating, which is an important element of supply chain management. The scientific article uses the following research methods: observation, analysis, generalization, synthesis, comparison, and explanation.

**The main material of the study.** The rating evaluation can be based on both expert data and statistical data. A rating based on expert data is typically formed subjectively by highly qualified experts with experience in the relevant field. Experts evaluate suppliers based on various criteria and assign them a rating. This approach is useful when it is impossible to gather statistical data on working with suppliers, such as for potential suppliers. A rating based on statistical data is formed based on data collected from various sources. Special programs and analytical tools can be used to collect and analyze such data. This rating allows for a more objective characterization of suppliers.

After choosing the method of rating calculation (through expert evaluation or based on statistical data), it is necessary to determine the list of criteria that allow for comparison of suppliers. The criteria used to evaluate suppliers may vary depending on the needs of the company and the industry in which it operates [1–7]. This paper proposes identifying the following key criteria:

1. A group of criteria related to the overall condition and capabilities of the supplier: financial condition of the supplier; production capabilities; production flexibility; technological capabilities; level of innovation of the enterprise; efforts to manage quality; quality of packaging; quality of transportation, and so on.

2. Group of criteria related to supplier's business reliability: ease of communication with the supplier; problem-solving effectiveness; warranty policy and after-sales service; ability to change order fulfillment time; subcontracting share; emergency recovery plans; payment terms; risk distribution conditions, and so on.

3. A group of criteria related to operational risks: price level; presence of defects; delivery delay time; deviation of actual delivery volume from the one stated in the contract, etc.

To ensure a more objective rating, each evaluation criterion is assigned a weight that reflects its importance to the customer, where $\sum_{i=1}^{N} k_i = 1$, with $k_i$ – representing the significance of the *i*-th criterion (weighting coefficient), and $N$ – being the total number of evaluation criteria for the supplier rating. The weight of each criterion is determined based on its importance to the company. Articles [8–10] provide a detailed analysis of the method of generating criterion significance using the Analytic Hierarchy Process (AHP). Article [11] proposes conducting a sensitivity analysis to determine how the priorities for supplier selection change by altering the weight coefficients assigned to each criterion.

In the case of calculating the rating based on expert evaluations for all criteria, it is necessary to choose a single evaluation scale, for example, from 0 to 10, and not allow for different optimal values of the criteria. To do this, assign a rating of 0 to the worst criterion value and 10 to the best. Another option for a rating system is to use the Likert scale, which uses a range of values from 1 to 5, where 1 means "do not prefer" and 5 means "strongly prefer" [12]. It is advisable to give preference to suppliers with the highest rating. In this case, the supplier's rating is calculated using the following algorithm:

$$R_p = \sum_{i=1}^{n} C_{ip} \times k_i, \tag{1}$$

where $C_{ip}$ is the value of the *i*-th criterion for the p-th supplier.

It is advisable to calculate the rating based on statistical data for criteria related to operational risks. In this case, we propose evaluating the value of each criterion from two perspectives, namely in comparison with the market average and taking into account the dynamics of changes in this criterion. In works [10; 13–14], the TOPSIS method has been proposed for supplier selection. The method involves identifying stimulating factors, the maximization of which leads to a move towards an "ideal" expected state, and demotivating factors, the maximization of which leads to a move towards an "ideally negative" expected state. Based on the results of the TOPSIS method, suppliers will be ranked according to their relative proximity to the "ideal" state. However, the TOPSIS method does not allow for the analysis of the dynamics of changes in such proximity. The algorithm for evaluating criteria proposed in our work involves collecting statistical data in the form of demotivating factors. The decrease in the ratio of the value of the demotivating factor, which describes the state

of a particular supplier, to the market average value of such a demotivating factor, describes a move towards the "ideal" expected state. In addition, our proposed algorithm allows for the consideration of the dynamics of such movement.

1. Let us describe in detail the algorithm for evaluating criteria proposed by us:

$$CORPMP_{gp} = PRS1_{gp} / \frac{\sum_{p=1}^{P} PRS1_{gp}}{P}, \quad (2)$$

where $CORPMP_{gp}$ is the ratio of the price of the *g*-th product supplied by the *p*-th supplier to the average market price; $PRS1_{gp}$ is the price in the current period of the *g*-th product supplied by the *p*-th supplier; and *P* is the number of suppliers.

$$GRPRS_{gp} = PRS1_{gp} / PRS1_{gp}, \quad (3)$$

where $GRPRS_{gp}$ is the growth rate of the price of the *g*-th product supplied by the *p*-th supplier, and $PRS0_{gp}$ is the price of the *g*-th product supplied by the *p*-th supplier in the previous period.

$$FRC_{gp} = \left(VS1_{gp} \times PRS1_{gp}\right) / \sum_{g}\left(VS1_{gp} \times PRS1_{gp}\right), \quad (4)$$

where $FRC_{gp}$ is the share of the *g*-th product supplied by the *p*-th supplier in the current period, and $VS1_{gp}$ is the volume of supplies of the *g*-th product in the current period by the *p*-th supplier.

$$C_{1p} = \sum_{g}\left(CORPMP_{gp} \times GRPRS_{gp} \times FRC_{gp}\right), \quad (5)$$

where $C_{1p}$ is the evaluation of the "price level" criterion for the *p*-th supplier.

2. "Defect presence" criterion.

$$FRCLQG1_{p} = \sum_{g}\left(AMLQG1_{gp} \times PRS1_{gp}\right) / \sum_{g}\left(VS1_{gp} \times PRS1_{gp}\right), \quad (6)$$

where $FRCLQG1_{p}$ is the share of defective goods supplied by the *p*-th supplier in the current period; $AMLQG1_{gp}$ is the volume of defective *g*-th goods supplied by the *p*-th supplier in the current period.

$$FRCLQG0_{p} = \sum_{g}\left(AMLQG0_{gp} \times PRS0_{gp}\right) / \sum_{g}\left(VS0_{gp} \times PRS0_{gp}\right), \quad (7)$$

where $FRCLQG0_{p}$ is the share of defective goods supplied by the *p*-th supplier in the previous period; $AMLQG0_{gp}$ is the volume of defective *g*-th goods supplied by the *p*-th supplier in the previous period.

$$CORFRCLQG_{p} = FRCLQG1_{p} / \frac{\sum_{p=1}^{P} FRCLQG1_{p}}{P}, \quad (8)$$

where $CORFRCLQG_{p}$ is the ratio of the proportion of defective products supplied by the *p*-th supplier in the current period to the average market proportion.

$$GRLQG_{p} = FRCLQG1_{p} / FRCLQG0_{p}, \quad (9)$$

where $GRLQG_{p}$ is the growth rate of the supply of defective goods by the *p*-th supplier.

$$C_{2p} = CORFRCLQG_{p} \times GRLQG_{p}, \quad (10)$$

where $C_{2p}$ is the assessment of the "presence of defects" criterion for the *p*-th supplier.

3. The criterion of "delivery delay time".

$$AVGDEL1_{p} = TOTDAYDEL1_{p} / NUMDEL1_{p}, \quad (11)$$

where $AVGDEL1_{p}$ is the average delivery delay of goods by the *p*-th supplier in the current period; $TOTDAYDEL1_{p}$ is the total number of days of delivery delays by the *p*-th supplier in the current period; $NUMDEL1_{p}$ is the number of deliveries of goods by the *p*-th supplier in the current period.

$$AVGDEL0_{p} = TOTDAYDEL0_{p} / NUMDEL0_{p}, \quad (12)$$

where $AVGDEL0_{p}$ is the average delay in delivery of goods supplied by the *p*-th supplier in the previous period; $TOTDAYDEL0_{p}$ is the total number of days of delivery delays for goods supplied by the *p*-th supplier in the previous period; $NUMDEL0_{p}$ isthe number of deliveries of goods supplied by the *p*-th supplier in the previous period.

$$CORAVGDEL_p = AVGDEL1_p / \frac{\sum_{p=1}^{P} AVGDEL1_p}{P}, \quad (13)$$

where $CORAVGDEL_p$ is the ratio of the average delivery delay of products supplied by the *p*-th supplier in the current period to the market average delivery delay.

$$GRAVGDEL_p = AVGDEL1_p / AVGDEL0_p, \quad (14)$$

where $GRAVGDEL_p$ is the growth rate of the average delivery delay of goods supplied by the *p*-th supplier.

$$C_{3p} = CORAVGDEL_p \times GRAVGDEL_p, \quad (15)$$

where $C_{3p}$ is the evaluation of the "delivery time" criterion for the *p*-th supplier.

1. Criterion "deviation of actual delivery volume from the one specified in the contract".

$$FRCUNG1_p = \sum_g \left( \left| VS1_{gp} - VCON1_{gp} \right| \times PRS1_{gp} \right) / \sum_g \left( VCON1_{gp} \times PRS1_{gp} \right), \quad (16)$$

where $FRCUNG1_p$ is the fraction of underdeliveries of goods supplied by the *p*-th supplier in the current period, and $VCON1_{gp}$ is the volume of supplies of the *g*-th product according to the contract concluded with the *p*-th supplier in the current period.

$$FRCUNG0_p = \sum_g \left( \left| VS0_{gp} - VCON0_{gp} \right| \times PRS0_{gp} \right) / \sum_g \left( VCON0_{gp} \times PRS0_{gp} \right), \quad (17)$$

where $FRCUNG0_p$ is the fraction of underdeliveries of goods supplied by the *p*-th supplier in the previous period, and $VCON0_{gp}$ is the volume of supplies of the *g*-th product according to the contract concluded with the *p*-th supplier in the previous period.

$$CORFRCUNG_p = FRCUNG1_p / \frac{\sum_{p=1}^{P} FRCUNG1_p}{P}, \quad (18)$$

where $CORFRCUNG_p$ represents the ratio of the proportion of goods under-delivered by the *p*-th supplier in the current period to the market average proportion of under-delivered goods.

$$GRUNG_p = FRCUNG1_p / FRCUNG0_p, \quad (19)$$

where $GRUNG_p$ is the growth rate of underdeliveries by the *p*-th supplier.

$$C_{4p} = CORFRCUNG_p \times GRUNG_p, \quad (20)$$

where $C_{4p}$ is an estimate of the criterion "deviation of actual delivery volume from the volume specified in the contract" for the *p*-th supplier.

In the case of rating suppliers based on statistical data, algorithm (1) is also used to calculate the overall supplier rating. Preference should be given to suppliers with the minimum rating score.

Calculating supplier ratings allows companies to compare and select the most efficient suppliers for cooperation. Supplier ratings can be used to make decisions on expanding or reducing the supplier list, planning procurement, and determining the advantages of one supplier over another. To achieve this, it is advisable to compare the results of supplier rating with the classification of suppliers using the ABC analysis method. If a supplier is rated as promising based on the rating results but does not fall into group A according to the ABC analysis results, then a plan of action should be developed to improve cooperation with that supplier. Conversely, if a supplier is rated as unpromising based on the rating results but falls into group A according to the ABC analysis results, immediate action must be taken to remove such a supplier from the company's list of partners. In addition, with regard to suppliers who belong to group A based on the ABC analysis results and are promising based on the rating, it is necessary to develop a negotiation strategy for negotiating loyalty their pricing policy in relation to our company. Such measures in the future may improve the supplier's rating score.

**Conclusions.** Calculating a supplier rating allows a company to identify the most effective suppliers that meet its needs and develop a strategy for collaborating with each of them. Supplier selection is essential in making supply chain management decisions as it impacts the quality and price of goods, the stability and timeliness of deliveries, risk reduction, and ensuring production stability. The algorithm proposed in the study for evaluating rating criteria involves comparing the values of each criterion with the average market values of corresponding criteria and considering changes in criterion values over time. This enables the selection of the right suppliers, helping the company improve its results and gain a competitive advantage in the market.

In further research, it is advisable to compare the correlation of the results of ranking some companies using the proposed algorithm in the article with international ratings of such companies [15].

***REFERENCES:***

1. Vovk Ya. H. (2020). Decision-making methodology during competitive supplier selection. *Bulletin of the Khmelnytskyi National University*, no. 6, pp. 305–309. Available at: http://journals.khnu.km.ua/vestnik/wp-content/uploads/2022/01/vknu-es-2020-n-6-288.pdf#page=305 (accessed 27 March 2023).

2. Boichuk I. V., Dmytriv A. Ya. (2014). Marketing of an industrial enterprise: education manual. Kyiv: "Center for Educational Literature", 620 p.

3. Kisera T. O., Polishchuk A. V., Kostiuchenko L. V. (2022). Rating of online suppliers of books on the Ukrainian market. *Problems of training professional personnel in logistics in the conditions of a global competitive environment*: a collection of reports of the 19th International Scientific and Practical Conference. National Aviation University. Kyiv, pp. 85–88. Available at: https://er.nau.edu.ua/handle/NAU/54812 (accessed 27 March 2023).

4. Moskovchenko D. V. (2021). Peculiarities of choosing suppliers for an enterprise in conditions of uncertainty. *Materials of the KIT-2021 conference*. Kharkiv: HNADU, pp. 227–231.

5. Karpenko Yu. (2017). The process of operational management of relations with suppliers. *Scientific Bulletin of Odessa National Economic University,* no. 5, pp. 70–85. Available at: http://n-visnik.oneu.edu.ua/collections/2017/247/pdf/70-85.pdf (accessed 27 March 2023).

6. Kara M. E., Fırat Ü. O. (2018). Supplier Risk Assessment Based on Best-Worst Method and K-Means Clustering: A Case Study. *Sustainability*, no. 10(4), 1066. DOI: https://doi.org/10.3390/su10041066 (accessed 27 March 2023).

7. Puška1 A., Stojanović I. (2022). Fuzzy multi-criteria analyses on green supplier selection in an agri-food company. *Journal of Intelligent Management Decision,* vol. 1, no. 1, pp. 2–16. DOI: https://doi.org/10.56578/jimd010102 (accessed 27 March 2023).

8. Hruška R., Průša P., Babić D. (2014). The use of AHP method for selection of supplier. *Transport*, 29:2, pp. 195–203. DOI: https://doi.org/10.3846/16484142.2014.930928 (accessed 27 March 2023).

9. Dweiri F., Kumar S., Khan S. A., Jain V. (15 November 2016). Designing an integrated AHP based decision support system for supplier selection in automotive industry. *Expert Systems with Applications*, vol. 62, pp. 273–283. DOI: https://doi.org/10.1016/j.eswa.2016.06.030 (accessed 27 March 2023).

10. Tusnial A., Sharma S. K., Dhingra P., Routroy S. (2021). Supplier selection using hybrid multicriteria decision-making methods. *The international journal of productivity and performance management*, vol. 70, no. 6, pp. 1393–1418. Available at: https://www.emerald.com/insight/content/doi/10.1108/IJPPM-04-2019-0180/full/html (accessed 27 March 2023).

11. Rajesh R., Ravi V. (2015). Supplier selection in resilient supply chains: a grey relational analysis approach. *Journal of Cleaner Production,* vol. 86, pp. 343–359. DOI: https://doi.org/10.1016/j.jclepro.2014.08.054 (accessed 27 March 2023).

12. Akanmu, A., Asfari, B., Olatunji, O. (2015). BIM-Based Decision Support System for Material Selection Based on Supplier Rating. *Buildings,* vol. 5, pp. 1321–1345. DOI: https://doi.org/10.3390/buildings5041321 (accessed 27 March 2023).

13. Pudycheva H.O. (2021). Using TOPSIS methods for choosing an electricity supplier. *Pryazovsky Economic Bulletin*, vol. 4 (27), pp. 98–102. Available at: http://pev.kpu.zp.ua/journals/2021/4_27_ukr/19.pdf (accessed 27 March 2023).

14. Singh A. (2014). Supplier evaluation and demand allocation among suppliers in a supply chain. *Journal of Purchasing and Supply Management*, vol. 20, issue 3, pp. 167–176. DOI: https://doi.org/10.1016/j.pursup.2014.02.001 (accessed 27 March 2023).

15. Tyvonchuk O. (2020). Esg ratings of companies – the essence and peculiarities of formation. *Galician Economic Herald*, vol. 6, no. 67, pp. 104–113. Available at: http://elartu.tntu.edu.ua/handle/lib/34203 (accessed 27 March 2023).

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**Oleksandra Belz,** PhD in Economics, Associate Professor, Associate Professor of the Department of Information Systems in Management, of Ivan Franko Lviv National University. **Calculation of supplier ratings in supply chain management.**

The aim of this work is to develop the most optimal algorithm for calculating supplier ratings, which is an important element of supply chain management. The article analyzed existing methods for calculating a supplier's rating and identified their shortcomings. An algorithm for calculating supplier ratings based on both expert data and statistical data has been described. The study highlights the key criteria that are relevant for evaluating suppliers, grouping them into those related to the general condition and capabilities of the supplier, those related to the reliability of the supplier's business, and those related to operational risks. The proposed algorithm for evaluating supplier rating criteria involves collecting statistical data in the form of disincentive factors. The algorithm calculates the supplier rating by considering the ratio of the value of the disincentive factor that describes a particular supplier's condition to the average market value of such a disincentive factor. The algorithm also takes into account changes in the values of supplier evaluation criteria over time. The study suggests comparing the results of the supplier rating with the classification of suppliers according to the ABC analysis method. Based on this comparison, the study proposes a

business logic approach: if the supplier is promising based on the rating but does not fall into group A according to the ABC analysis, an action plan should be developed to improve cooperation with the supplier. If the supplier is unpromising based on the rating and falls into group A according to the ABC analysis, urgent measures should be taken to remove the supplier from the company's partner list. Finally, if the supplier belongs to group A according to the ABC analysis and is promising according to the rating, a strategy should be developed for negotiating their price policy in relation to the company. The conclusion has been formulated that the algorithm proposed in the study for rating criteria evaluation will enable companies to make an effective choice of suppliers.

**Key words:** supplier rating, evaluation criteria, supply chain management, ABC analysis, supplier selection.

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**Белз Олександра Григорівна,** кандидат економічних наук, доцент, доцент кафедри інформаційних систем у менеджменті, Львівський національний університет імені Івана Франка. **Розрахунок рейтингу постачальників у задачі управління постачаннями.**

Метою роботи є розробка найбільш оптимального алгоритму розрахунку рейтингу постачальників, що є важливим елементом управління постачаннями. У статті проаналізовано існуючі методики розрахунку рейтингу постачальника та виявлено їхні недоліки. Описано алгоритм розрахунку рейтингових оцінок постачальників на підставі як експертних даних, так і статистичних даних. Виокремлено основні критерії, за якими доцільно оцінювати постачальників. Критерії оцінення запропоновано групувати: ті, що пов'язані із загальним станом і можливостями постачальника; ті, що пов'язані з надійністю бізнесу постачальника; ті, що пов'язані з операційними ризиками. Запропоновано алгоритм оцінки критеріїв рейтингування постачальників, який передбачає збір статистичних даних у форматі факторів-дестимуляторів. Алгоритм передбачає розрахунок рейтингу з урахуванням співвідношення значення фактора-дестимулятора, який описує стан конкретного постачальника, до середньоринкового значення такого фактора-дестимулятора. Також алгоритм враховує динаміку зміни значень критеріїв оцінення постачальника. Запропоновано порівнювати результати рейтингування постачальників з класифікацією постачальників за методом ABC-аналізу. За результатами порівняння запропоновано застосовувати таку бізнес-логіку: якщо за результатами рейтингування постачальника оцінено як перспективного, а за результатами ABC-аналізу він не попадає в групу А, тоді необхідно розробити план дій для покращення співпраці з таким постачальником; якщо за результатами рейтингування постачальника оцінено як неперспективного, а за результатами ABC-аналізу він попадає в групу А, тоді необхідно терміново вжити заходів щодо виведення такого постачальника з переліку партнерів компанії; якщо постачальник належать до групи А за результатами ABC-аналізу та є перспективними за результатами рейтенгування, тоді необхідно розробляти стратегію ведення переговорів щодо лояльності їхньої цінової політики по відношенню до компанії. Сформульовано висновок, що запропонований у дослідженні алгоритм оцінки критеріїв рейтингу дасть змогу компаніям зробити ефективний вибір постачальників.

**Ключові слова:** рейтинг постачальника, критерії оцінення, управління постачаннями, ABC-аналіз, вибір постачальників.