Od teorii do praktyki zarządzania – wybrane zagadnienia nauki o zarządzaniu i jakości oraz nauki o bezpieczeństwie

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THE USE OF MULTI-CRITERIA DECISION ANALYSIS IN THE SELECTION OF SUPPLIERS USING THE EXAMPLE OF A MANUFACTURING COMPANY

ABSTRACT: The aim of the article is to identify the criteria for selecting suppliers and applying multi-criteria decision analysis when selecting suppliers on the example of a manufacturing company. The article is of a theoretical and empirical nature. The theoretical part presents the role of suppliers in the supply chain based on literature studies and indicates various criteria for selecting suppliers. As part of the empirical research, analyzes were carried out on the example of a small manufacturing enterprise. The analytical hierarchical process (AHP) method was used to select and evaluate suppliers. The study revealed the effects of supplier selection and evaluation. Ten criteria were selected for analysis, three of which turned out to be the most important, i.e. price and quality of the supplied products and completeness of supplies. These criteria are crucial when making decisions by managers and employees regarding the selection of suppliers. The research results expand knowledge about the impact of various factors on the selection of suppliers that affect the company's competitiveness. They constitute practical recommendations and are a source of knowledge for managers and employees responsible for making decisions related to the selection of suppliers.

KEYWORDS: supply chain, multi-criteria decision analysis, manufacturing company

Zastosowanie wielokryterialnej analizy decyzyjnej przy wyborze dostawców na przykładzie przedsiębiorstwa produkcyjnego

STRESZCZENIE: Celem artykułu jest zidentyfikowanie kryteriów wyboru dostawców oraz zastosowanie wielokryterialnej analizy decyzyjnej przy wyborze dostawców na przykładzie przedsiębiorstwa produkcyjnego. Artykuł ma charakter teoretyczno-empiryczny. W części teoretycznej zaprezentowano na postawie studiów literatury rolę dostawców w łańcuchu dostaw oraz wskazano na różne kryteria wyboru dostawców. W ramach badań empirycznych przeprowadzono analizy na przykładzie małego przedsiębiorstwa produkcyjnego. Do wyboru i oceny dostawców zastosowano metodę analitycznego procesu hierarchicznego (AHP). Badanie ujawniło skutki wyboru i oceny dostawców. Do analizy wybrano dziesięć kryteriów, z których trzy okazały się najistotniejsze, tj.: cena i jakość dostarczanych produktów oraz kompletność dostaw. Kryteria te są kluczowe przy podejmowaniu decyzji przez menedżerów i pracowników dotyczących wyboru dostawców. Wyniki badań poszerzają wiedzę na temat wpływu różnych czynników na wybór dostawców, mających wpływ na konkurencyjność firmy. Stanowią praktyczne rekomendacje i są źródłem wiedzy dla menedżerów i pracowników odpowiedzialnych za podejmowanie decyzji związanych z wyborem dostawców.

SŁOWA KLUCZOWE: łańcuch dostaw, wielokryterialna analiza decyzyjna, przedsiębiorstwo produkcyjne

Entry

The issue of supplier selection plays an important role in supply chain management. It started to be of common interest to both scientists and practitioners as a result of the changes taking place on the competitive market. Business managers, especially in view of changing conditions caused by the pandemic crisis, have become increasingly

aware that in order to succeed in a competitive market, they must establish specific criteria for selecting suppliers.

The most important variable in supply chain management is supplier selection (Heikkinen 2012). Supplier selection is a decision-making process whose aim is to evaluate potential suppliers against a set of evaluation standards (Sharma and Tripathy 2023). The purpose of a supplier selection decision is to identify entities that can meet company's requirements and deliver products as required (Prakash *et al.* 2023). The choice of suppliers is a very important decision for a company, since the quality and price of products as well as the timeliness of deliveries depend on them. This is also related to achieving appropriate sales proceeds. Moreover, the quality and cost of the final product are also a direct consequence of the supplier selection decision (Prakash *et al.* 2018). The choice of suppliers has a direct impact on reducing costs, minimizing risk and uncertainty, and improving customer service (Tusnial *et al.* 2021). It is the purchasing department that is responsible for the proper selection of suppliers. The related decisions should consider the benefits and costs as well as the goals of the company's operations.

Choosing a good and reliable supplier has become a crucial and decisive factor leading to the success of most enterprises (Modibbo *et al.* 2022, p. 807). It is suppliers who shape the efficiency of the supply chain. They also affect the ability of companies to manage supply chain resources (Lii and Kuo 2016). Supplier management is thus essential as the product life cycle is getting shorter, and high volatility in product demand and evaluation has a direct impact on supply chain performance (Singh and Modgil 2020, p. 253-254). In a situation where there are many suppliers on the market who offer a product with the same characteristics, a procedure should be developed and the rules and criteria that will be used in the selection of suppliers should be listed. Properly conducted supplier selection affects the results of companies and their supply chain (Alkahtani *et al.* 2019). Therefore, making multi-criteria decisions is required, including both quantitative and qualitative criteria (Modibbo *et al.* 2022, p. 807).

The purpose of the article is to identify the supplier selection criteria and application of multi-criteria decision analysis when selecting suppliers using the example of a manufacturing company.

The paper is both theoretical and empirical in nature. The theoretical part presents the role of suppliers in the supply chain based on the literature studies and indicates various criteria for selecting suppliers. As part of the empirical research, analyses were carried out within a small manufacturing enterprise. In order to select and evaluate suppliers the analytical hierarchical process method (AHP) was applied. The study revealed the effects of selecting and evaluating suppliers. Ten criteria were selected for the analysis, three of which turned out to be the most important, i.e. the price and quality of the products supplied, and the completeness of deliveries. These criteria are crucial and

accompany managers and employees in making decisions as to the selection of suppliers. Other criteria with less impact but high dependence require secondary actions.

The research results broaden the knowledge of the impact of various factors on the choice of suppliers that affect the company's competitiveness. They serve as practical recommendations and a source of knowledge for managers and employees responsible for making decisions related to the selection of suppliers. They enable the diagnosis of the current situation and facilitate changes aimed at improving operational capabilities in the supply chain. The practical application of the supplier selection procedure leads to making the right decisions regarding the selection of the best suppliers.

Criteria and models of supplier selection – review of the literature

There are studies in the literature whose authors suggest the use of various criteria for selecting suppliers. Most attention is paid to the importance of various criteria and sources of information in order to evaluate potential suppliers (de Boer 2017). For the purposes of the study, the criteria used by various authors were listed below (Table 1).

Table 1. Supplier selection criteria

Author	Criteria
Modibbo U.M., Hassan M., Ahmed A. and Ali I. (2022)	product cost, product quality, product delivery, services provided, supplier details (profile) and the capabilities of all staff.
Salam M.A. and Khan S.A. (2018)	price, quality, delivery, technical support and financial documentation (timeliness of settlements).
Luthra S., Govindan K., Kannan D., Mangla S.K. and Garg C.P. (2017)	environmental cost, quality, product cost, environmental competence and occupational health and safety.
Ulutas A., Shukla N., Kiridena S. and Gibson P. (2016)	supplier's financial position and volume flexibility.
Hwang B.N., Chen T.T. and Lin J.T. (2016)	quality, supplier certification, facilities, continuous improvement, physical distribution and channel relationships.
Ageron B., Gunasekaran A. and Spalanzani A. (2013)	information technology/information system.
Bruno G., Esposito E., Genovese A. and Passaro R. (2012)	process and product quality, service level, management and innovation, and financial standing.
Chang B., Chang C.W. and Wu C.H. (2011)	technological capacity, delivery, lead time, production capacity.
Kuo R.J., Wang Y.C. and Tien F.C. (2010)	cost, quality, service, delivery, local community and corporate social responsibility.
Simpson P.M., Siguaw J.A. and White S.C. (2002)	quality, certifications, equipment, continuous improvement, distribution, relationship factors.

Source: own study.

The list of criteria applied may include a few of the most important factors or else there may be many of them. In practice, companies define different criteria when selecting suppliers. There is no single commonly adopted list. Enterprises develop their own criteria depending on the needs and internal and external conditions. Supplier selection criteria help the company to identify suppliers and decide on the best one. The development of transparent criteria ensures better organization and the ability to select the right suppliers. This, in turn, contributes to an effective supplier management system.

The supplier selection process consists of several successive stages. At the respective stages, suppliers are evaluated using various criteria. The supplier selection process begins with the awareness of the demand for materials or products. Selection criteria are then defined on the basis of which further decisions are made.

Various types of models are helpful when selecting suppliers. Developing a general supplier selection model is not an easy task for the following reasons (Davidrajuh 2003, p. 28):

– it is a multi-person activity – supplier selection involves people at several management levels,
– type of order – supplier selection procedures vary depending on what is ordered,
– duration of cooperation – criteria for selecting suppliers depend on the duration of the expected cooperation between the supplier and the buyer.
– type of cooperation – selection criteria also depend on the degree of advancement of cooperation between the supplier and the buyer. If a potential supplier is to become a strategic partner, a lot of selection criteria are devised.

The three-stage supplier selection model is particularly noteworthy here (Davidrajuh 2003, p. 33-34) and it involves (Figure 1).

1) pre-selection – the management sets strategic purchasing goals.
2) selection – the main selection procedure, starting with many potential suppliers and ending with the preferred one.
3) post-selection – establishing cooperation with the selected supplier.

Once the decision criteria have been established, the initial selection and the final selection of suppliers are carried out. Based on the evaluation of the offers, two or three are selected. The final selection is then made following negotiations with the respective two or three candidates.

The selection of the final supplier is preceded by a series of evaluations, with the number of suppliers gradually decreasing as various criteria are applied. For example, the supplier is verified to be ISO 9001 certified as a means of assessing its ability to manage quality, or in terms of ISO 14040 for the environmental impact of their products and technologies. The enterprise may also expect suppliers to present the social impact of their companies – i.e. their Corporate Social Responsibility (CSR).
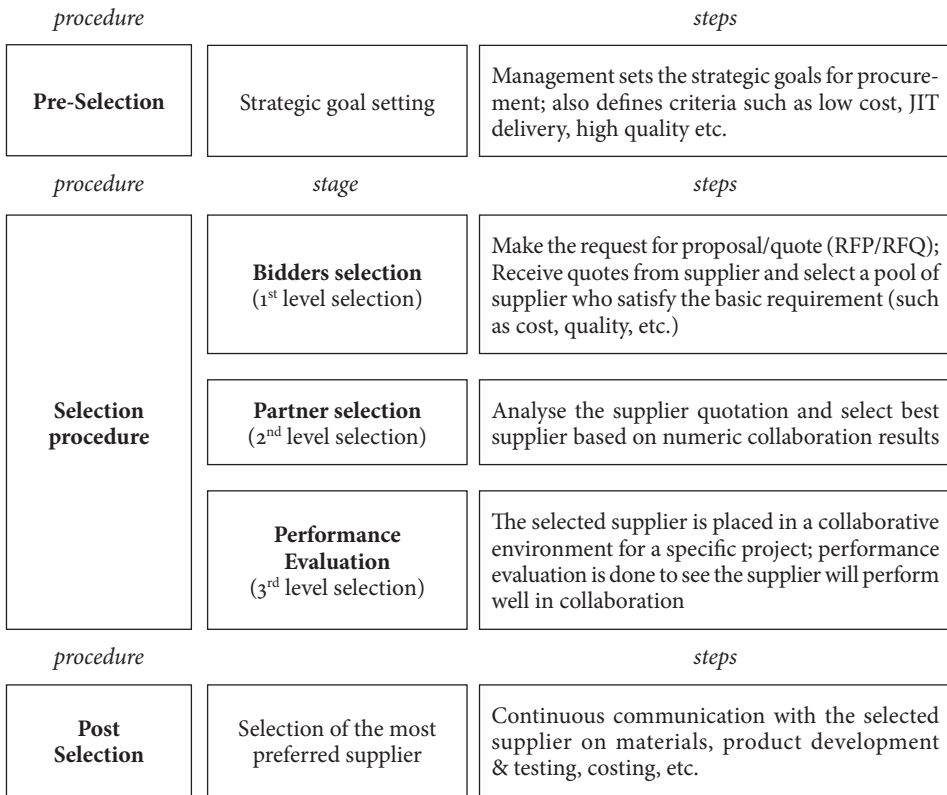
procedure		steps
Pre-Selection	Strategic goal setting	Management sets the strategic goals for procurement; also defines criteria such as low cost, JIT delivery, high quality etc.

procedure	stage	steps
Selection procedure	**Bidders selection** (1st level selection)	Make the request for proposal/quote (RFP/RFQ); Receive quotes from supplier and select a pool of supplier who satisfy the basic requirement (such as cost, quality, etc.)
	Partner selection (2nd level selection)	Analyse the supplier quotation and select best supplier based on numeric collaboration results
	Performance Evaluation (3rd level selection)	The selected supplier is placed in a collaborative environment for a specific project; performance evaluation is done to see the supplier will perform well in collaboration

procedure		steps
Post Selection	Selection of the most preferred supplier	Continuous communication with the selected supplier on materials, product development & testing, costing, etc.

Figure 1. General model of the supplier selection procedure
Source: Davidrajuh 2003, p. 33.

Supplier selection and evaluation procedure using the example of a production company

Description of the company's activities

The supplier selection procedure was presented using the example of a chimney system production company. The company has been operating on the domestic market since 2010. It is involved in the production of chimney systems that exhaust fumes resulting from the combustion of all types of fuels, including: gas, fuel oil, coal and wood. The company employs 49 people. Its offer includes chimney systems that are commonly used in construction. They are used in the construction of houses, blocks of flats, institutions and companies.

The main raw material for the production of chimney systems is stainless steel. Its use prevents the occurrence of external corrosion, ensures tightness and offers resistance to temperature as well as to mechanical and thermal phenomena. The company's

products are sold to other enterprises, wholesalers, DIY stores and installers. They are also available online.

The supplier selection method applied and research problems

The choice of a supplier is a very important decision for a company, since the quality and price of products as well as timeliness of deliveries depend on the supplier of components. It also affects the sales of products to customers and achieving the corresponding proceeds from the sale. In a situation where there are many suppliers on the market offering a product with the same characteristics, a procedure should be developed and the rules and criteria stipulated that will be used when selecting suppliers.

As the selection and evaluation of suppliers is a multifaceted issue, it requires the use of an appropriate method. The researched company does not have a uniform supplier evaluation and selection system. Therefore, solutions were arrived at that allow the selection of the most appropriate supplier. The Analytic Hierarchy Process (AHP) method was used to this purpose. The method that facilitates decision making (Prusak and Stefanów 2014).

The AHP method was developed in the 1970s by the American professor Thomas L. Saaty. It is a multi-criteria method of hierarchical analysis of decision problems.

The AHP method involves the presentation of the decision-making problem in the form of a hierarchical structure, with the decision-making goal at the top, the criteria affecting it below, and the decision-making variants at the bottom (Prusak and Stefanów 2014). As a method of searching for the best decisions, it indicates not only which alternative may be chosen among the available variants, but also justifies its suitability (Górski 2019).

The following basic steps can be distinguished in the method (Prusak and Stefanów 2014):

– creating a model of the problem structure in the form of a hierarchy tree of factors,
– evaluating the hierarchical model and determining the "importance" of the respective criteria and sub-criteria by comparing them in pairs, when applying the appropriate rank scale,
– estimating the value of weights for individual criteria and sub-criteria (priorities),
– verifying the decision maker's ratings used in pairwise comparisons with the help of the CR coefficient,
– applying sensitivity analysis.

For the purposes of the research, three research problems were formulated in the form of questions:

Q1: What will key supplier evaluation criteria be considered?
Q2: Which three supplier evaluation criteria are the most important in the opinion of the researched enterprise?

Q3: Which of the surveyed suppliers meet the assessment criteria to the greatest extent?

Answers to these questions will be attempted in the supplier selection and evaluation procedure.

The procurement process in the company begins when there is a need for specific raw materials. Then, potential suppliers who are able to supply the company with the right materials are selected. Existing customer databases are used, but information is also posted on the Internet to attract new suppliers.

Supplier selection and evaluation procedure

The supplier selection and evaluation procedure involves five stages:
Stage 1: Establishing supplier evaluation and selection criteria.
Stage 2: Calculating weights for the specified criteria.
Stage 3: Determining the point scale for individual criteria.
Stage 4: Awarding points to suppliers for individual criteria.
Stage 5: Final assessment of suppliers.

Stage 1: Determining supplier evaluation and selection criteria

The first stage in the study is to identify and select supplier selection criteria in line with the company's goals. Then, the weights of individual criteria should be determined, based on the multi-criteria AHP (Analytic Hierarchy Process) method. An MS Excel spreadsheet was used to calculate the weights. The 9-point Saaty scale was applied to determine the significance and the degree of dominance. For the purposes of supplier evaluation and selection, 10 criteria were adopted in the surveyed company, which were given rank and priority (Table 2).

Table 2. The resulting weights for the criteria

No.	Criterion	Priority	Rank	(+)	(-)
K1	Price of products	27.4%	1	14.5%	14.5%
K2	Quality of delivered products	20.5%	2	8.6%	8.6%
K3	Completeness of deliveries	20.2%	3	10.8%	10.8%
K4	Timeliness of deliveries	9.6%	4	5.0%	5.0%
K5	Delivery time	5.7%	5	2.8%	2.8%
K6	Security of deliveries	5.1%	6	2.0%	2.0%
K7	Quality of packaging	4.9%	7	1.9%	1.9%
K8	Transportation costs	3.6%	8	2.2%	2.2%
K9	Terms of payment	1.7%	9	0.9%	0.9%
K10	Level of customer satisfaction	1.2%	10	0.8%	0.8%

Rating according to AHP scale: 1 – Equal, 3 – Moderately important, 5 – Strong, 7 – Very high, 9 – Extremely important (2, 4, 6, 8 intermediate values). CR cohesion factor = 9.5% < 10.
Source: own study.

The criteria selected in the supplier selection process were analysed in terms of their dependence and importance for the company's operations. The analyses show that the three most important criteria for evaluating suppliers are the price and the quality of the products supplied as well as the completeness of deliveries. These three factors combined accounted for 68.1%. The next factors are: timely deliveries, which account for around 10% of importance, followed by delivery time (5.7%) and security of deliveries (5.1%). The smallest importance was attributed to the quality of packaging (4.9%) and transportation costs (3.6%). The criteria that have little impact on the assessment and selection of the supplier due to the weak dependence are payment terms (1.7%) and customer satisfaction (1.2%).

Stage 2: Calculating weights for the criteria selected

The next stage of the analysis is to determine the importance of individual parameters of the criteria, so that they meet the requirements of the company. To achieve it, the criterion priority matrix method is used (Table 3). The calculated weights are largely dependent on the circumstances and are entirely based on the specificity of the examined company. In order to compare the selected criteria with each other, they are assigned scores that reflect the relationship between them. We compare the criteria in the first column with the same criteria in the first row. The value in a cell that equates to itself with the same criterion equals 1 (Table 3). The table below presents the scale of the assigned results.

Table 3. Criteria precedence matrix

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10
K1	1	2	2	7	5	6	4	8	8	9
K2	0.50	1	1	3	7	7	5	7	7	9
K3	0.50	1.00	1	3	8	8	4	5	6	8
K4	0.14	0.33	0.33	1	2	2	4	6	6	7
K5	0.20	0.14	0.12	0.50	1	1	1	2	5	8
K6	0.17	0.14	0.12	0.50	1.00	1	2	2	7	8
K7	0.25	0.20	0.25	0.25	1.00	0.50	1	2	5	7
K8	0.12	0.14	0.20	0.17	0.50	0.50	0.50	1	5	7
K9	0.12	0.14	0.17	0.17	0.20	0.14	0.20	0.20	1	2
K10	0.11	0.11	0.12	0.14	0.12	0.12	0.14	0.14	0.50	1
Sum	3.11	5.20	5.00	15.70	25.80	26.30	21.80	33.40	50.50	66

Source: own study.

The matrix shows the importance of the respective criteria and allows to draw conclusions as to which criteria are most important for the company at the stage of supplier selection.

In the next table, each cell is divided by the sum of values in its column, then the data obtained in the row are averaged and – in this way – weights are assigned to specific criteria (Table 4).

Table 4. Criteria precedence matrix and assigned weights

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	Mean
K1	0.32	0.38	0.40	0.44	0.19	0.23	0.18	0.24	0.16	0.14	0.22
K2	0.16	0.19	0.20	0.19	0.27	0.26	0.23	0.21	0.14	0.14	0.21
K3	0.16	0.19	0.20	0.19	0.31	0.30	0.30	0.15	0.12	0.12	0.20
K4	0.04	0.06	0.06	0.06	0.08	0.07	0.18	0.18	0.12	0.11	0.08
K5	0.06	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.09	0.12	0.06
K6	0.05	0.02	0.02	0.03	0.03	0.04	0.04	0.06	0.14	0.12	0.07
K7	0.08	0.03	0.05	0.01	0.04	0.02	0.09	0.06	0.09	0.11	0.06
K8	0.03	0.02	0.04	0.01	0.02	0.02	0.02	0.03	0.09	0.11	0.05
K9	0.03	0.02	0.03	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.03
K10	0.03	0.02	0.02	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.01
Sum											1

Source: own study.

Due to the application of the criteria priority matrix method, the weights for the indicated criteria were obtained. The calculations show that the top priority issue for the company is the quality of the products supplied (0.22). It is followed by the price offered by the supplier (0.21) and the completeness of deliveries (0.20). The consecutive places were occupied by the timeliness of deliveries (0.08) and the security of supply (0.07). Equal importance was attributed to two factors, i.e. delivery time and quality of packaging (0.06 each). The least important ones are transportation costs (0.07), terms of payment (0.03) and assessment of satisfaction with relations with suppliers (0.01).

Stage 3: Determining the point scale for individual criteria

After determining the weights of individual criteria, points are assigned to them according to the guidelines adopted by the company (Table 5).

Table 5. Criteria matrix

No.	Criterion	Description	Point scale
1	Products price	Very low prices	100
		Low prices	75
		Average prices	50
		High prices	25
		Very high prices	0
2	Quality of delivered products	High quality of products	100
		Quality of products is unquestionable	75
		Slight quality discrepancies	50
		Low quality	0

3	Completeness of deliveries	Deviation under 5%	100
		Deviation 5-10%	85
		Deviation 11-40%	50
		Deviation 41-100%	0
4	Timeliness of deliveries	Timely deliveries	100 pts
		Late deliveries (100 pts – 10 pts) for each day of delay in delivery	(100 pts – 10 pts)
		Deliveries ahead of schedule (100 pts – 5 pts) for each day ahead of schedule	(100 pts – 5 pts)
5	Delivery time	Short delivery times up to 3 days	100
		Average delivery times 4-8 days	50
		Long delivery times 9-14 days	25
		Delivery times too long, longer than 14 days	0
6	Security of deliveries	Very high security	100
		High	75
		Medium	50
		Low	25
		Very low	0
7	Quality of packaging	Very good quality packaging	100
		Slight losses in the quality of packaging	80
		Visible losses	50
		Defective or severely damaged packaging	0
8	Transportation costs	Very high	100
		High	70
		Medium	50
		Low	25
		Very low	0
9	Terms of payment	Payment on delivery	100
		Payment within 7 or 14 days after delivery	80
		Payment within 21 or 30 days after delivery	60
		Payment 30 days after delivery	50
		Payment within 45 days after delivery	30
		Payment after more than 45 days	0
10	Level of customer satisfaction	Feelings associated with: transparency of the offer, credibility of information, relations with the supplier and handling complaints	from 30 to 100

Source: own study.

Stage 4: Awarding points to suppliers for individual criteria

In the table below, points were awarded to suppliers for individual criteria based on the points specified in the criteria matrix.

Table 6. Points awarded to suppliers for individual criteria

No.	Criteria weights	A measure of points	The number of points obtained by the supplier for a given criterion			
			D1	D2	D3	D4
K1	22	0-100	75	100	50	0
K2	21	0-100	100	50	75	100
K3	20	0-100	85	85	85	85
K4	8	0-100	100	70	100	100
K5	6	0-100	100	50	50	0
K6	7	0-100	50	25	100	25
K7	6	0-100	100	50	50	50
K8	5	0-100	100	70	50	50
K9	3	0-100	80	60	50	80
K10	1	30-100	100	75	25	100

Source: own study.

Stage 5: Final assessment of suppliers

The final breakdown of the points obtained includes the individual categories and the corresponding measures of points, as well as the number of points obtained by the supplier for a given criterion (Table 7).

Table 7. Final supplier evaluation results

Criterion	The number of points obtained by the supplier for a given criterion			
	D1	D2	D3	D4
K1	16.50	22.00	11.00	0.00
K2	21.00	10.50	15.70	21.00
K3	17.00	17.00	17.00	17.00
K4	8.00	5.60	8.00	8.00
K5	6.00	3.00	3.00	0.00
K6	3.50	1.70	7.00	1.70
K7	6.00	3.00	3.00	3.00
K8	5.00	3.50	2.50	2.50
K9	2.40	1.80	1.50	2.40
K10	1.00	0.70	0.20	1.00
Sum	86.40	69.80	68.90	56.60
Categories				
I	from 75 to 100 points			
II	from 60 to 74 points			
III	from 59 to 45 points			
IV	below 45 points			

Source: own study.

On this basis, the supplier's final rating is calculated using the following formula:

$$Z = X \, Y : \Sigma \, X \qquad (1)$$

where:

Z – the number of points obtained for a given criterion,

X – the weight of the criterion,

Y – the number of points awarded within the criteria 0-100

The points awarded to the supplier are multiplied by the previously determined weights, and then divided by the sum of all weights, i.e. by 100. The table below shows the final results obtained resulting from the supplier evaluation method applied.

Due to the number of points obtained, the suppliers were classified within the four categories devised for the purposes of the analysis. The first category included suppliers with the highest scores i.e. between 75 and 100. The second category concerned suppliers who received between 60 and 74 points. The third category included suppliers who scored between 45 and 59 points. The last fourth category included suppliers who were not qualified due to low scores below 45 points.

Final scoring for the respective suppliers
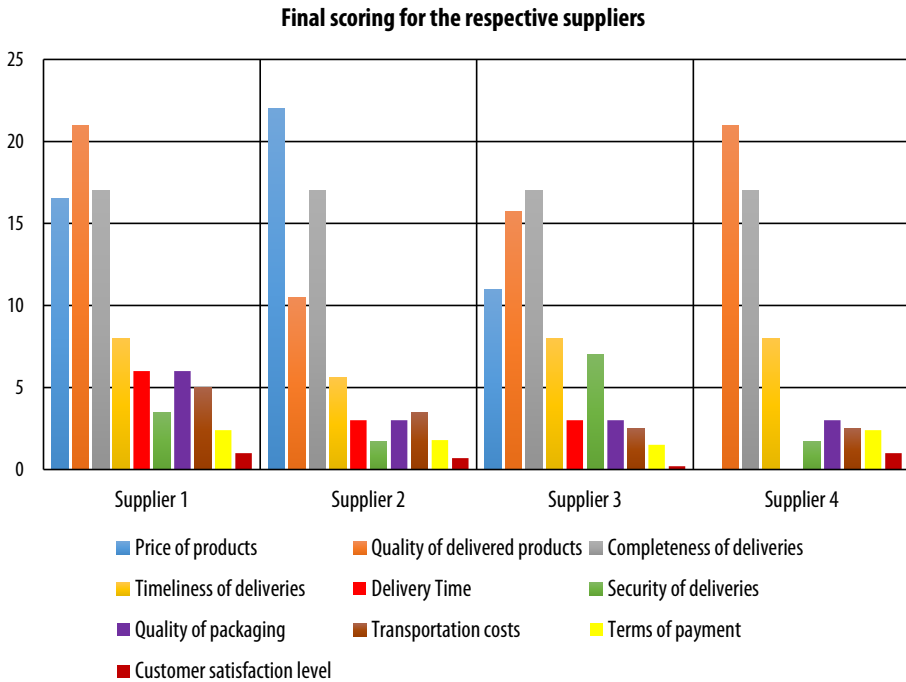
Chart 1. Suppliers final score based on 10 criteria
Source: own study.

Based on the multi-criteria analysis of suppliers, the most advantageous offer was selected. The supplier with the highest score of 86.4 points turned out to be supplier number 1 and he was assigned to category I, i.e. suppliers qualified in the first place. The first four criteria had the greatest impact on their choice, i.e.: the quality and completeness of deliveries as well as the price and timeliness of deliveries. Therefore, it can be assumed that an entity that is able to deliver the complete order at the right time, at the right price and quality will constitute the best supplier. These criteria are treated as key criteria. If there are changes to these criteria, they affect a number of other criteria that depend on them. The strong dependence indicates that they require all other criteria to be met.

Two suppliers were included in the second category. Supplier 2 received 69.8 points and 68.9 points were awarded to supplier 3, respectively. Supplier No. 4 was included in the third category as they received 56.6 points. None of the offers was included in the fourth category. Graph 2 shows the ratings for the four suppliers within 10 criteria.

Research conclusions

The supplier selection criteria adopted for the analysis made it possible to distinguish between the best and the worst suppliers. The suppliers obtained feedback on the scores they had obtained and the category to which they had been assigned. They are now aware what the company expects from them, what their strengths and weaknesses are, what they need to improve and work on. The assessments received by the suppliers should motivate them to undertake further efforts to meet the company's expectations.

As a result of the conducted research, answers to the three research problems were obtained.

Q1: What key supplier evaluation criteria will be considered?

For the purposes of supplier evaluation and selection, 10 criteria were adopted, which were given rank and priority (Table 2). The detailed description along with the scale of assigned points is included in the criteria priority matrix (Table 4), (Research problem 1).

Q2: Which three supplier evaluation criteria are the most important according to the researched company?

The analyses show that the three most important supplier evaluation criteria are the price and the quality of the products supplied, and the completeness of the supplies (Research problem 2). These three factors combined accounted for 68.1%.

Q3: Which of the surveyed suppliers meets the assessment criteria to the greatest extent?

The supplier with the highest score of 86.4 points turned out to be the first supplier and they were assigned to category I, i.e. suppliers qualified in the first place (Research problem 3). Information obtained on the performance of the suppliers constitutes the basis for making most informed decisions regarding supply chain management.

Conclusion

The article presents the problem of selecting suppliers for a company producing chimney systems. The analyses were based on a multi-criteria decision-making process.

The evaluation and selection of suppliers in view of the changing market conditions is an important issue for managers in charge of the supply chain. Securing reliable and competent suppliers thus becomes one of the key factors (Yadav and Sharma 2015).

In practice, choosing the right suppliers has a huge impact on the company's operations. This impact can be positive or negative. Potential benefits include cost reduction, increased customer satisfaction, and the company's profitability and competitiveness. With a transparent supplier evaluation process, companies may build trust and long-term relationships with their suppliers for the purposes of product development and innovation (Salam and Khan 2018). In the case of the wrong choice of a supplier, however, the company may incur huge losses. These losses may be attributed to costs, problems with sales or losing customers.

In practice, companies use different criteria when selecting suppliers. There is no single commonly adopted procedure. Enterprises develop their own procedures depending on the objectives as well as internal and external conditions. Transparent procedures ensure better organization and the ability to select the right suppliers. This, in turn, results in an effective supplier management system.

The AHP method applied facilitated the selection of the most suitable supplier. The conducted analyses are a source of useful information on the selection of appropriate suppliers in dynamic situations in order to strengthen long-term relationships with them.

For the surveyed company, the choice of suppliers and relations with suppliers are extremely important in terms of the price and quality of the products supplied and the completeness of deliveries. These criteria are crucial for managers and employees when making decisions concerned with the selection of suppliers. Therefore, the company's activities should be aimed at maintaining and strengthening the existing standards of service and supplier satisfaction. They should also aim at acquiring new and retaining existing customers.

Implementing the transparent rating system helped the suppliers identify their strengths and weaknesses. Those who scored the most points considered it the proof of their success. They are certainly good candidates for building long-term relationships through making a positive contribution to the company's value chain. The ultimate goal of the supplier selection procedure was to reduce the purchasing risk and increase the value for the company as well as for the supplier and the customer.

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