

ORIGINAL

Fuzzy Decision-Making Model for evaluating supplier performance: A case study of a mining company

Modelo de toma de decisiones difusa para evaluar el desempeño de los proveedores: un estudio de caso de una empresa minera

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ABSTRACT

A company's performance depends on the efficiency of its supply chain. In an environment where supply chains become more complex, it is important to evaluate supplier performance. This process is challenging due to the multiplicity of criteria to be considered and the involvement of several experts with different interpretations and judgments, which classifies it as a multi-criteria decision-making (MCDM) problem. In order to address this complexity, the objective of this article is to develop a model based on fuzzy logic that will facilitate this evaluation by supporting managers in their decision-making processes related to the qualification or disqualification of suppliers. To illustrate the application of fuzzy logic, a case study was conducted within a company operating in the mining sector with the aim of evaluating several suppliers on the basis of five evaluation criteria: delivery time, quality, staff behavior, and commitments to quality, hygiene, safety, the environment, and corporate social responsibility. The fuzzy logic model was used to process the evaluations from experts and to calculate the performance level of each supplier. In order to validate this model, the results of the fuzzy evaluation were compared with those from the company's original method. The comparison showed that the fuzzy model gives consistent and relevant results that reflect the company's real practices. The study shows that fuzzy logic can improve supplier evaluation by handling complex situations and supporting fair and balanced managerial decisions.

Keywords: Fuzzy Logic; Decision-Making; Supply Chain; Supplier; Overall Performance.

RESUMEN

El rendimiento de una empresa depende de la eficiencia de su cadena de suministro. En un entorno en el que las cadenas de suministro se vuelven más complejas, es importante evaluar el rendimiento de los proveedores. Este proceso es complicado debido a la multiplicidad de criterios que hay que tener en cuenta y a la participación de varios expertos con diferentes interpretaciones y juicios, lo que lo clasifica como un problema de toma de decisiones multicriterio (MCDM). Para abordar esta complejidad, el objetivo de este artículo es desarrollar un modelo basado en la lógica difusa que facilite esta evaluación, apoyando a los gerentes en sus procesos de toma de decisiones relacionadas con la calificación o descalificación de proveedores. Para ilustrar la aplicación de la lógica difusa, se llevó a cabo un estudio de caso en una empresa del sector minero con el objetivo de evaluar a varios proveedores en función de cinco criterios de evaluación: plazo de entrega, calidad, comportamiento del personal y compromisos con la calidad, la higiene, la seguridad, el medio ambiente y la responsabilidad social corporativa. El modelo de lógica difusa

se utilizó para procesar las evaluaciones de los expertos y calcular el nivel de rendimiento de cada proveedor. Para validar este modelo, se compararon los resultados de la evaluación difusa con los del método original de la empresa. La comparación mostró que el modelo difuso ofrece resultados coherentes y relevantes que reflejan las prácticas reales de la empresa. El estudio demuestra que la lógica difusa puede mejorar la evaluación de los proveedores al manejar situaciones complejas y respaldar decisiones gerenciales justas y equilibradas.

Palabras clave: Lógica Difusa; Toma de Decisiones; Cadena de Suministro; Proveedor; Rendimiento General.

INTRODUCTION

The supply chain is a fundamental pillar of any company's operational activities, encompassing all stages related to the production and marketing of a product.⁽¹⁾ Suppliers play an important role in the supply chain. Any failure on their part can affect the entire functioning of the chain.⁽²⁾ Therefore, companies conduct periodic evaluations of their suppliers using tools such as quality audits, performance reports, or internal assessments. These practices make it possible to calculate a performance score for each supplier based on criteria predefined by the company, such as quality, cost, and delivery reliability. This is an ongoing process that takes place throughout the duration of the relationship with the supplier and aims to improve the relationships established with them. In this context, maintaining lasting, high-quality relationships with suppliers is therefore essential in supply chain management.⁽²⁾

Through the evaluation process, companies define their expectations, ensure that they are met, and provide constructive feedback to suppliers.⁽²⁾ They can implement responsible sourcing practices, make ethical decisions, and establish sustainable partnerships with suppliers who share their values and business objectives.⁽³⁾

However, with growing awareness of the environmental and social impacts of industrial activities, companies can no longer limit themselves to purely economic criteria when evaluating their suppliers.⁽³⁾ In this context, the integration of indicators of commitment to quality, health, safety, the environment, and corporate social responsibility represents an innovative step forward in supply chain management⁽³⁾ because it enables collaboration with more responsible and committed suppliers, thereby strengthening the company's reputation, increasing its brand value, and generating a positive impact on society.⁽³⁾

Nevertheless, evaluating a supplier's performance remains a complex task, as it requires taking into account a wide range of criteria and standards.⁽⁴⁾

In fact, much of the information used to evaluate supplier performance cannot be quantified with fixed or well-defined boundaries, due to its qualitative and subjective nature.⁽⁴⁾ Instead, it tends to take the form of expressions or terms in natural language, which are often imprecise.⁽⁴⁾ This is the case when evaluating suppliers, where several criteria are difficult to quantify or define. Expressions that are very often used in evaluation, such as "good quality" or "reasonable price," remain vague and lack precision.

However, traditional evaluation methods do not always take into account the subjectivity and uncertainty in expert judgments, hence the use of fuzzy logic, which can be addressed using fuzzy logic to model this uncertainty. It is a problem-solving approach that allows precise conclusions to be drawn from imprecise or incomplete data.⁽⁵⁾ Thanks to its flexibility, the model allows decision-makers to take into account imprecision, uncertainty, and subjectivity in the evaluation of supplier performance.⁽⁴⁾ In this context, the application of artificial intelligence to evaluation is a dynamic field of research, offering powerful tools for improving decision-making.

The objective of this study is to develop a fuzzy logic model for evaluating supplier performance in industrial contexts. This approach aims to overcome the limitations of traditional methods by offering a more comprehensive and objective view of supplier performance. The application of the methodology is illustrated through a real-life case study conducted in a mining company, demonstrating the relevance and added value of the proposed model.

Literature Review

Although various methods have been developed for supplier evaluation, it is important to note that a distinction must be made between the latter, which aims to monitor and improve supplier performance, and supplier selection, which aims to choose one or more suppliers from a list of candidates.

This evaluation is based on a variety of approaches, ranging from traditional methods to more recent techniques capable of integrating uncertainty. Many researchers have therefore relied on multi-criteria decision-making (MCDM) methods to address complex issues, particularly in the field of supplier evaluation. These methods make it possible to analyze several criteria simultaneously, whether qualitative or quantitative, and thus provide a rigorous and objective basis for decision-making.

In this section, we present the methods most commonly used in the literature:

The AHP (Analytic Hierarchy Process) method, introduced by Saaty in 1980, is an effective tool for solving complex problems involving multiple criteria.⁽⁶⁾ However, a major difficulty lies in ranking the criteria according to their specific importance to each company. In the industrial context, each criterion has its own value, making their ranking in order of priority delicate and sometimes subjective.⁽¹⁾

In his study, Rezaei proposed a multi-criteria decision-making (MCDM) method based on the Best-Worst Method (BWM) approach. It is based on pairwise comparisons between the best and worst criteria relative to the others.⁽⁷⁾ Recently, due to its simplicity of implementation, the BWM method has become more popular because it requires fewer comparisons than the AHP method and gives more consistent results.

Hwang and Yoon proposed the TOPSIS method, which is characterized by its simplicity of implementation. It is based on the fundamental idea that the best alternative must be closest to the positive ideal solution and furthest from the negative ideal solution.⁽⁸⁾

Roy developed the ELECTRE method, which is based on the principle of outranking, allowing the relationships between different alternatives to be analyzed in order to choose the most appropriate one.⁽⁹⁾

Bran and Vincke introduced the PROMETHEE method, which offers a more flexible framework for ranking alternatives. It is based on the use of preference functions specific to each criterion, thus offering the possibility of establishing both partial and complete rankings of alternatives.⁽¹⁰⁾

However, these approaches have limitations when it comes to integrating imprecise and subjective judgments, which are common in supplier evaluation. Hence the need to introduce fuzzy logic, which is an effective means of overcoming this limitation and managing imprecise and complex situations.⁽⁵⁾

It is important to note that the majority of work devoted to supplier evaluation places a strong emphasis on economic criteria, often neglecting other strategic dimensions such as QHSE and CSR commitments. This limitation justifies the need for more comprehensive and tailored approaches, such as the one we propose in this paper.

Furthermore, although several studies use fuzzy logic in the context of supplier evaluation, few focus specifically on its application according to criteria that also cover environmental and societal dimensions. Studies incorporating real-world applications also remain limited, and even rarer when it comes to the mining sector.

To the author's knowledge, this study is one of the first to apply a fuzzy approach, modeled in Matlab based on a real case study. The originality of this research therefore lies mainly in the use of real data for the evaluation, as well as in the consideration of criteria that simultaneously integrate economic, environmental, and social aspects.

METHOD

Presentation of Fuzzy Logic

Developed by mathematician Lotfi Zadeh in the 1960s, fuzzy logic is an artificial intelligence method based on continuous values between 0 and 1 that can be used to model uncertainty and imprecision. This contrasts with classical Boolean logic, which is limited to binary values of "True" or "False" (1 or 0).

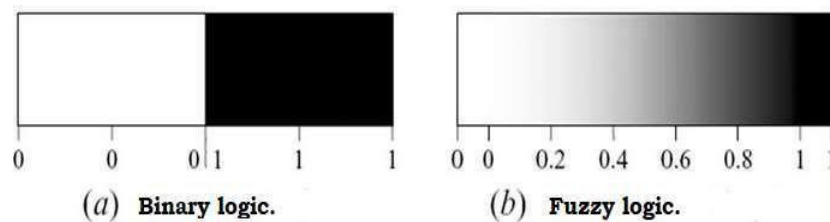


Figure 1. Range of logical values in Binary and Fuzzy logic⁽¹¹⁾

Fuzzy logic is distinguished by a more intuitive reasoning than that of classical logic. It allows the representation and modeling of imprecise or complex phenomena through the use of rules and membership functions associated with fuzzy sets.⁽¹¹⁾ Fuzzy set theory focuses on quantification and reasoning using natural language, where many terms have ambiguous meanings.⁽⁵⁾

Fuzzy logic is one of the key techniques of artificial intelligence, the purpose of which is to develop models capable of simulating intelligent behavior. It is distinguished by its fundamental objective: to formalize human reasoning in order to represent it in a form that can be exploited by computer systems.⁽¹²⁾

Membership functions and fuzzy rules are the fundamental elements of fuzzy logic. They enable linguistic formulations derived from professional expertise to be transformed into mathematical expressions, thus ensuring the transition from qualitative representation to quantitative modeling.⁽¹²⁾

The most used fuzzy logic system is the one proposed by Mamdani.

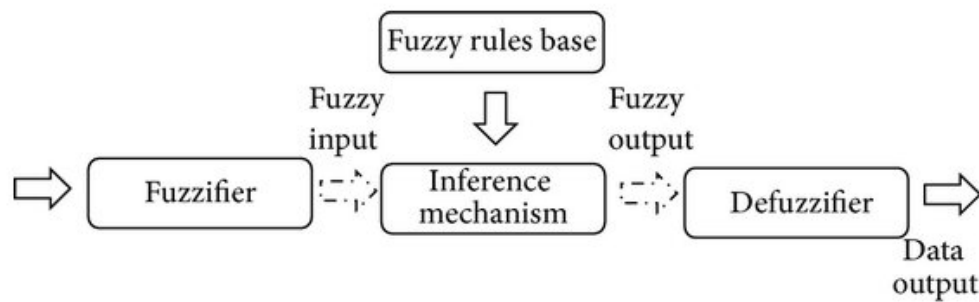


Figure 2. Mamdani general fuzzy logic system⁽¹²⁾

In a fuzzy logic-based approach, modeling a process involves dividing the model's variables into fuzzy classes representing different linguistic states.⁽¹³⁾

IF...THEN conditional rules are used to define the output associated with each combination of these classes. Conditions can be combined using logical connectors such as AND, OR, or XOR (Either...or) to model complex relationships between variables.⁽¹³⁾

Fuzzification

Fuzzification is the transition from the real world to the fuzzy world, associating numerical data with qualifiers expressed in natural language.⁽¹¹⁾

It allows precise data to be transformed into fuzzy data or membership functions.⁽¹⁴⁾ A membership function links the value of an input variable to a given degree of membership for each of the fuzzy sets.⁽⁵⁾

The most commonly used function shapes are triangular and trapezoidal:

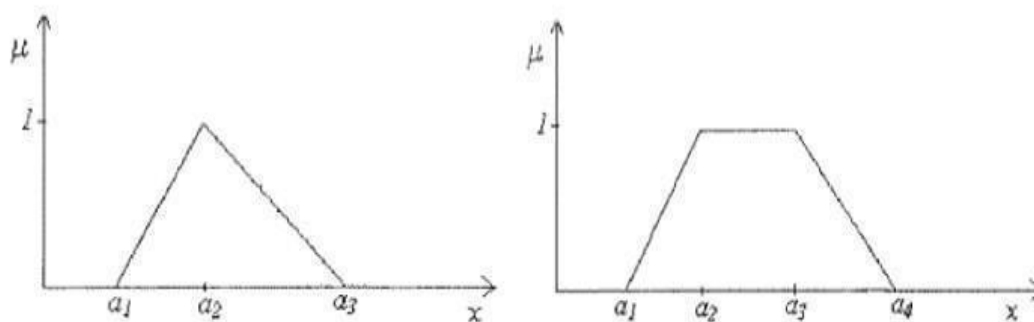


Figure 3. Membership function of a triangular and trapezoidal fuzzy number⁽¹³⁾

Fuzzy Inference System

Inference is the brain of fuzzy reasoning. It establishes the link between the membership functions of the input variables and those of the outputs.⁽¹¹⁾

The purpose of this process is to associate membership functions with control rules in order to generate the fuzzy output. These rules can be interpreted as representing the knowledge of an expert in a specific field of application.⁽¹⁴⁾ They allow the decision maker to express variables in linguistic terms (low, medium, or high) before converting them into numerical values through the defuzzification process.⁽¹¹⁾

Defuzzification

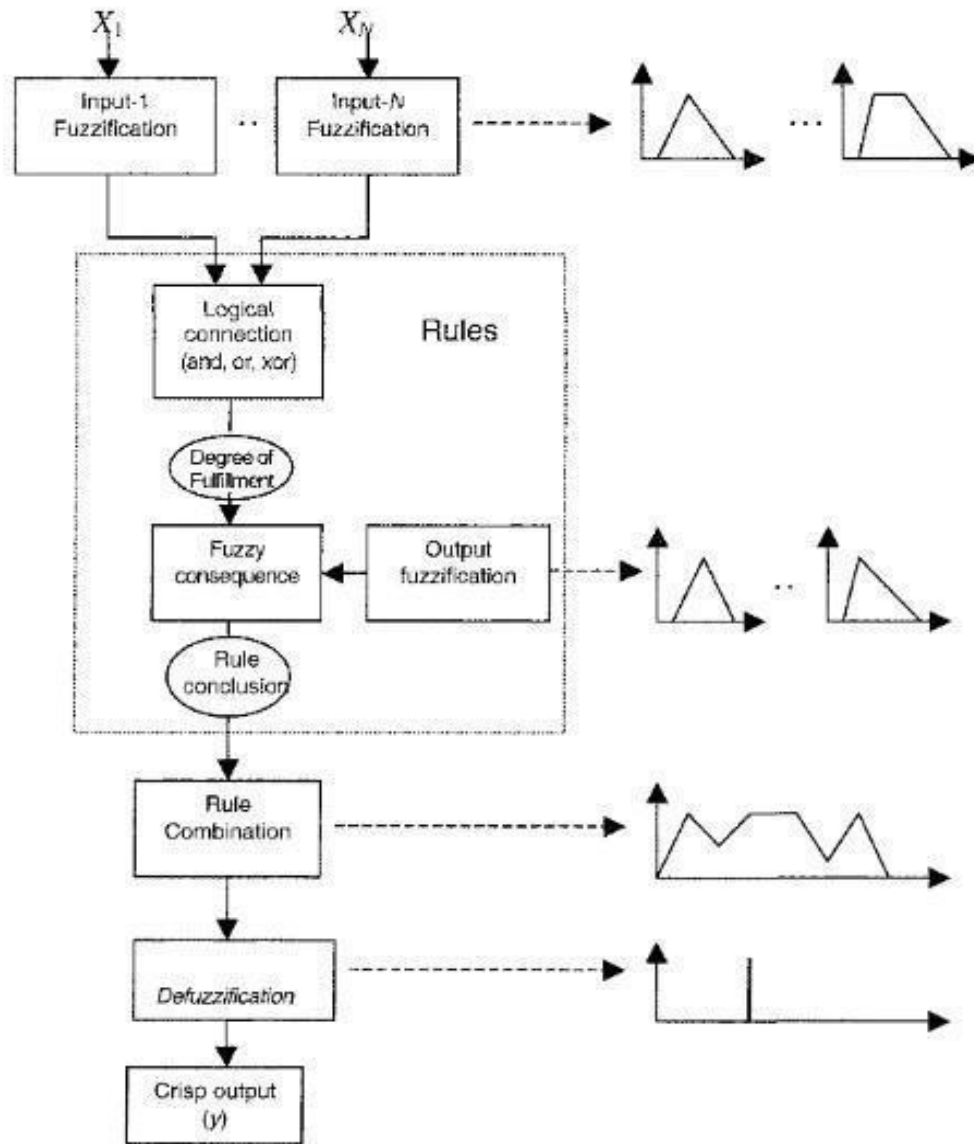
Simply converting to linguistic variables following the fuzzification phase is not enough. It is necessary to perform the reverse operation to retrieve the precise value of the variable. This step of returning from the linguistic to the real is called "defuzzification."

The defuzzification process is necessary in order to obtain an accurate output that can be used in real applications.⁽¹⁴⁾

Three main defuzzification methods are frequently used: the maximum value average, the center of gravity, and the altitude method.⁽¹⁴⁾

Structure of the Fuzzy Logic Model

The steps involved in fuzzy logic modeling, described above, can be summarized in the following diagram, which illustrates the overall structure and key interactions:

Figure 4. Schematic of a fuzzy logic-based model⁽¹³⁾

Case study

Proposed Method for Supplier Performance Evaluation

To illustrate the applicability of the proposed method, a case study was conducted within an industrial company. This company, based in southern Morocco and active in the mining sector, works with a large portfolio of suppliers, allowing better management of its purchases. Each year, it evaluates its suppliers through a participatory process led by a committee of experts involving representatives from different activities, using an Excel file in which each supplier is rated according to several predefined criteria to ultimately assign them a performance score.

In addition to delivery times and product and service quality, other indicators are also very important to include in the performance evaluation of suppliers in the mining sector, such as commitments to quality, health, safety, and corporate social responsibility, thereby providing a comprehensive and sustainable overview of the business.

The interaction between all these parameters makes the decision to evaluate suppliers more complex, which justifies the use of fuzzy logic.

Indicators definition

Once the list of suppliers to be evaluated has been drawn up, the next step is to define the criteria for this evaluation, bearing in mind that these criteria may vary from one company to another.

Supplier performance as an output indicator will be evaluated on the basis of the following five input indicators:

- Quality: assesses the suitability of products to the required technical standards and specifications.⁽²⁾
- Delay: assesses the supplier's ability to process orders quickly and meet agreed delivery schedules.⁽³⁾
- Attitude: assesses, in particular, the supplier's ability to respond quickly and provide effective assistance.⁽²⁾
- QHSE Commitment (Quality, Health, Safety, and Environment Commitment): assesses the supplier's ability to meet quality, health, safety, and environmental requirements through concrete and measurable actions such as risk prevention, improvement of product or service quality, customer satisfaction, compliance with standards and certifications, compliance with hygiene standards, employee health and safety, incident management, and environmental protection.
- CSR Commitment (Corporate Social Responsibility Commitment): assesses, in particular, working practices, respect for human rights, diversity and inclusion initiatives, and relations with local communities, with an emphasis on ethical behavior and the societal impact of suppliers.⁽³⁾

In this study, we use the term RSE (French acronym), which is equivalent to CSR in English. For consistency with the figures, the acronym RSE is retained in the graphs.

The proposed fuzzy model can therefore be summarized as follows:

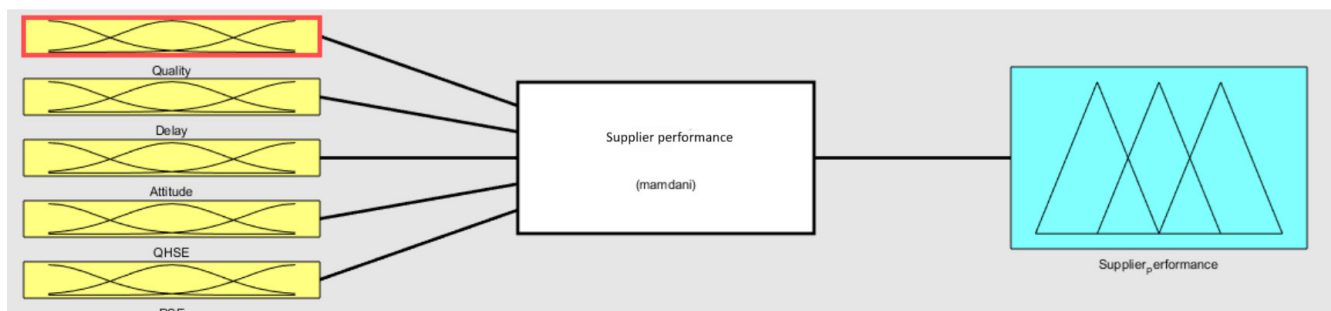


Figure 5. The Fuzzy Model

Modeling of indicators

After defining the proposed method and the input and output indicators, the next step is to model them by determining the membership functions of each variable, as illustrated in the figures below:

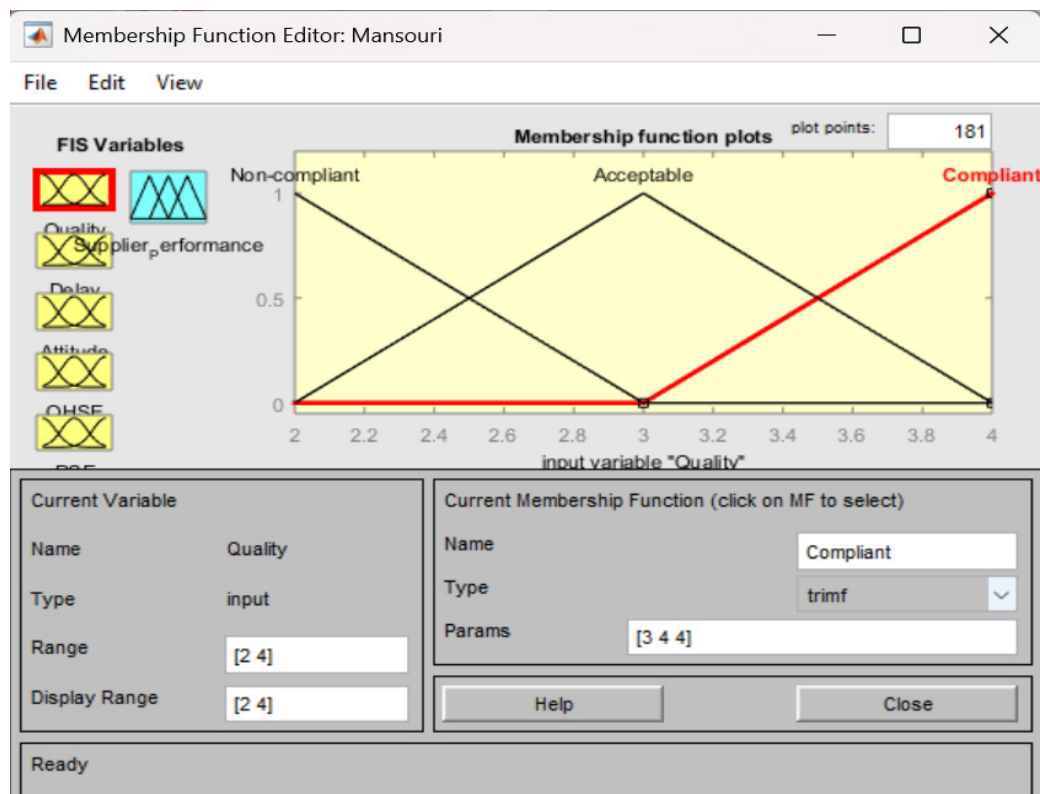


Figure 6. Membership Function for Quality

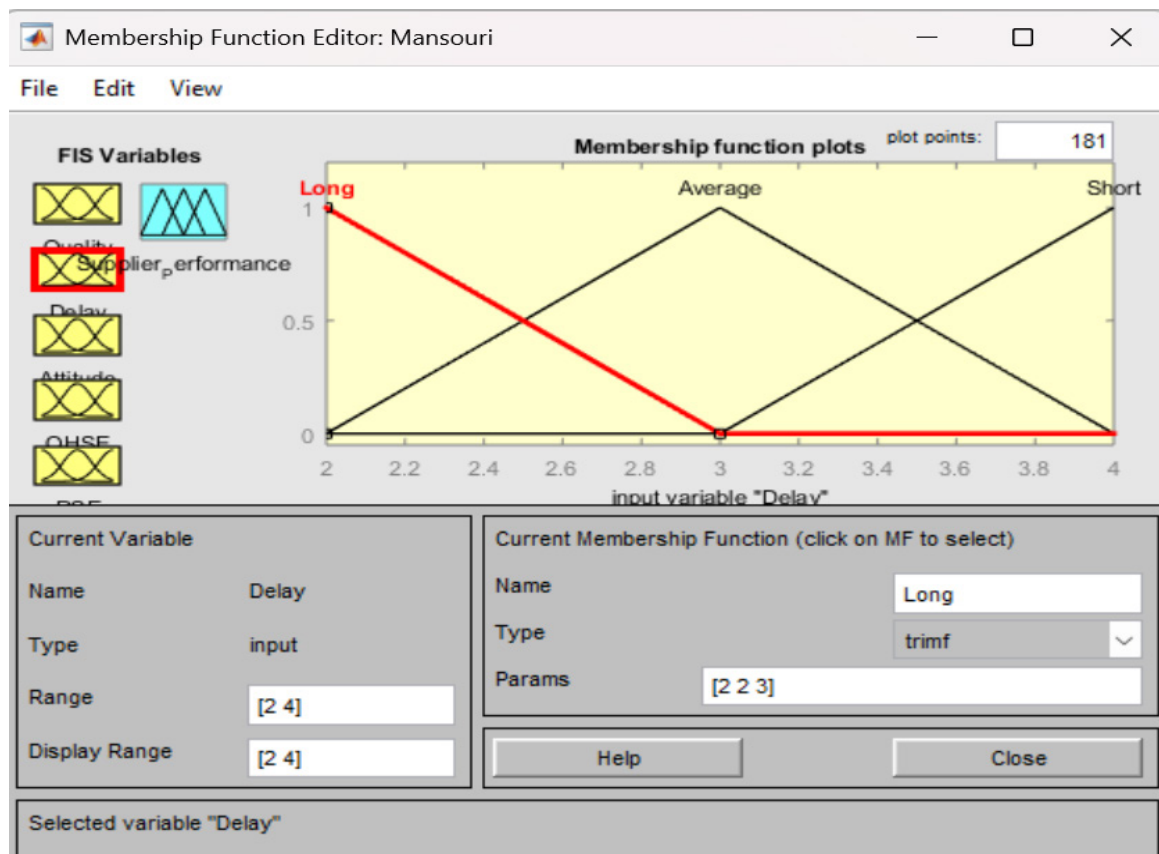


Figure 7. Membership Function for Delay

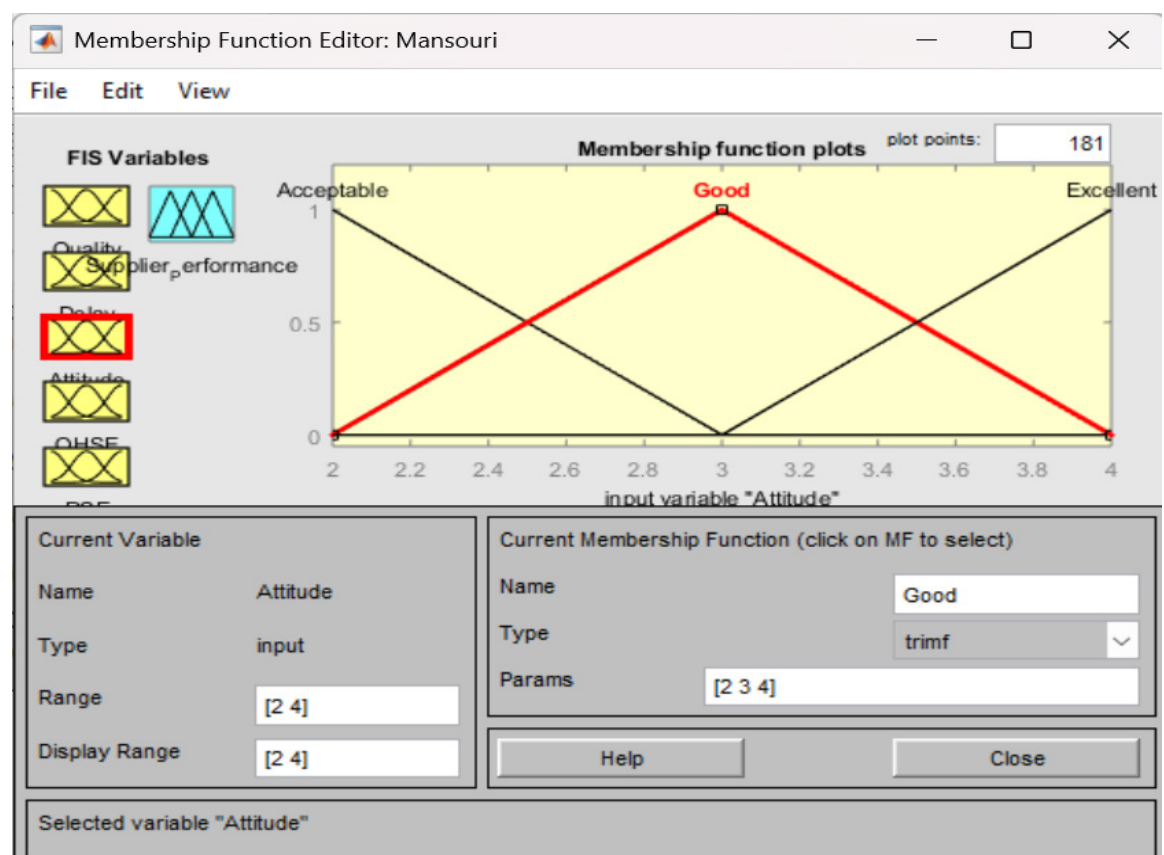


Figure 8. Membership Function for Attitude

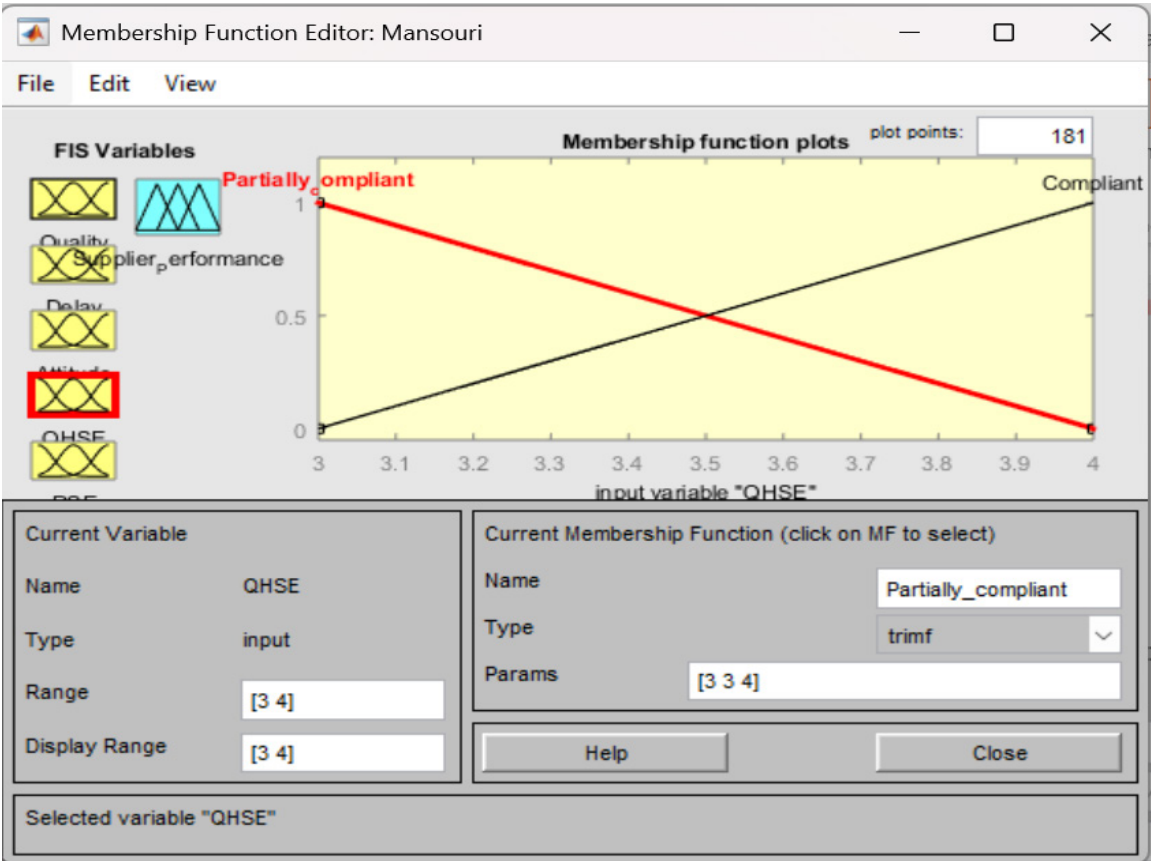


Figure 9. Membership Function for QHSE Commitment

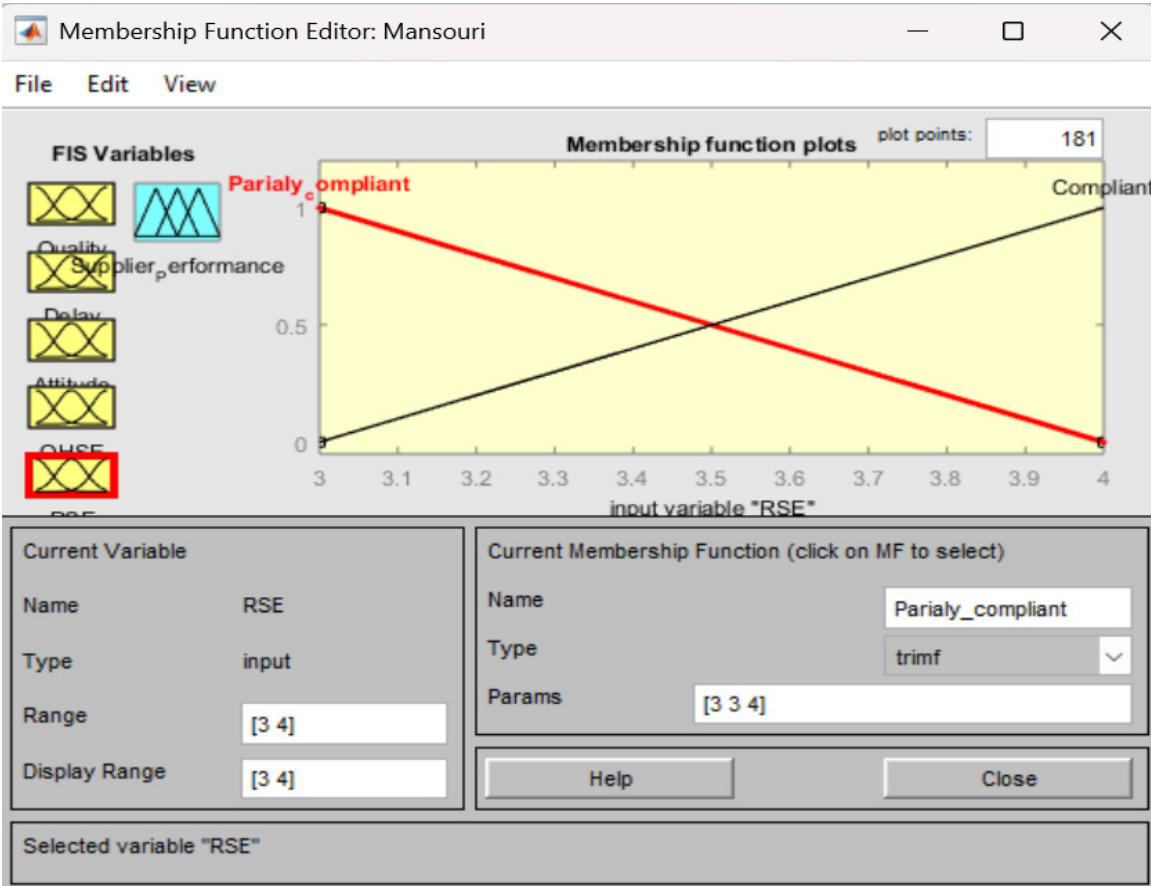


Figure 10. Membership Function for CSR Commitment

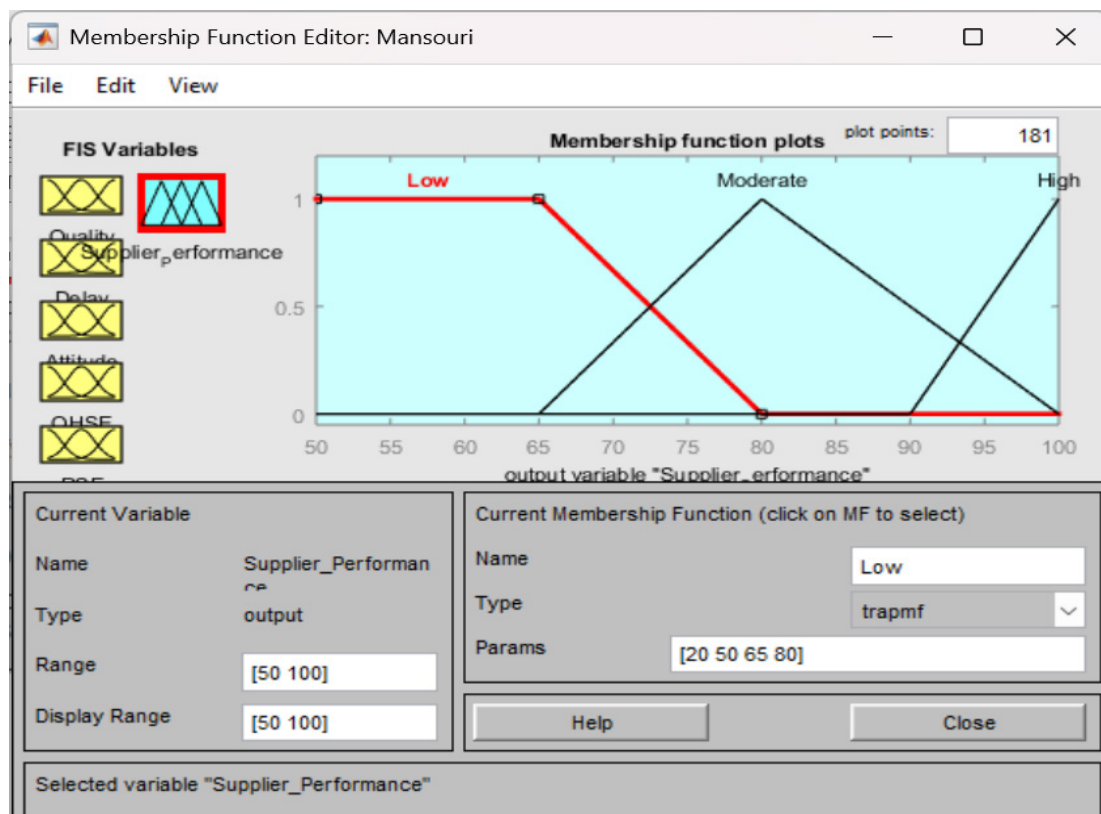


Figure 11. Membership Function for Supplier Performance

Fuzzy inference

This step consists of developing fuzzy rules, defined by experts, in order to express the relationships between the various input indicators.

In our case study, we implemented 108 fuzzy rules ($3 \times 3 \times 3 \times 2 \times 2$) using the AND operator.

By way of illustration, below are two fuzzy rules that were used in the context of our case study:

97. If (Quality is Non-compliant) and (Delay is Long) and (Attitude is Excellent) and (QHSE is Compliant) and (RSE is Compliant) then (Supplier_Performance is Moderate) (1)
 98. If (Quality is Non-compliant) and (Delay is Long) and (Attitude is Excellent) and (QHSE is Compliant) and (RSE is Partially compliant) then (Supplier_Performance is Low) (1)

Figure 12. Fuzzy Rules Presentation

Defuzzification

As illustrated in the following figure, the defuzzification step, based on the center of gravity method, converts the fuzzy set which includes quality, delay, attitude, QHSE commitment, and CSR commitment into a precise numerical value representing supplier performance:

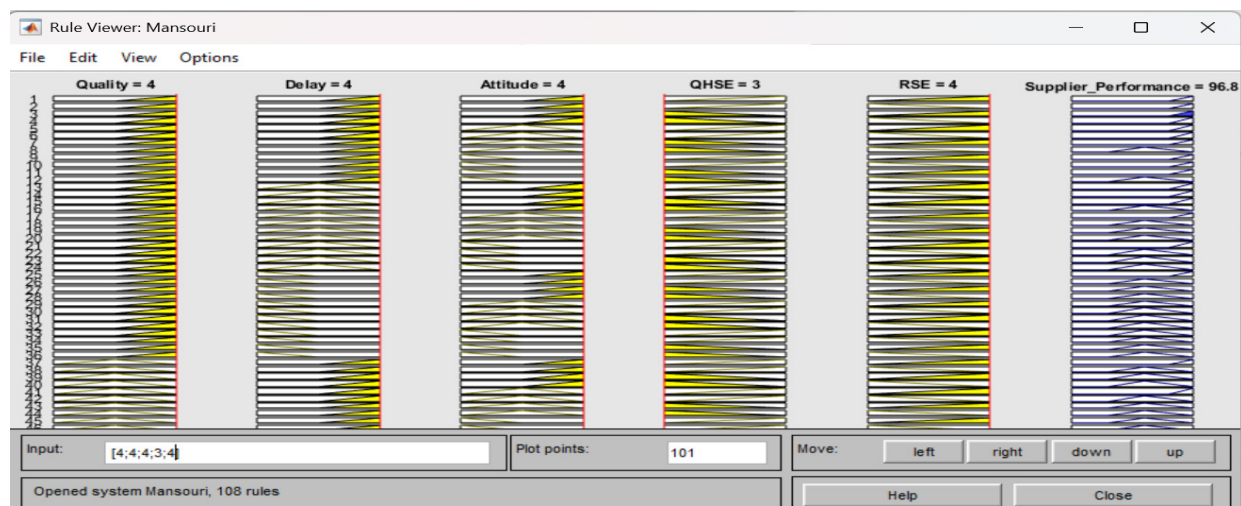


Figure 13. Defuzzification process

RESULTS AND DISCUSSION

After implementing the inference system, the defuzzification results must be analyzed. Analyzing the graphs helps to understand the relationship between the input indicators and the output indicator. To do this, the surfaces are analyzed by varying two inputs, while the remaining three inputs are kept constant. The output is then represented on the y-axis to visualize the corresponding response.

Important note: in the graphs, the “Delay” axis corresponds to the score given to the supplier by the company. A high score means a short delay (i.e., good performance), while a low score corresponds to a long delay (i.e., poor performance).

Therefore, when we refer to a “high lead time” in the interpretation of the results, we are referring to a good (short) lead time and not a long lead time.

Use case 1

In this case, the indicators Attitude, QHSE commitment, and CSR commitment are set as medium.

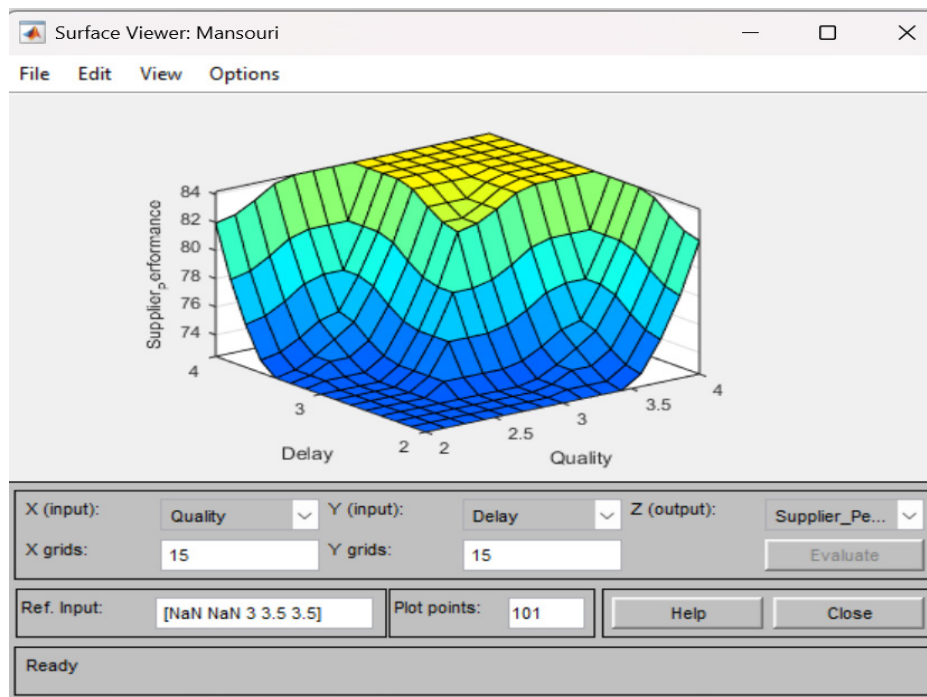


Figure 14. Surface View for Use Case No. 1

Figure 14 shows how supplier performance varies according to quality and lead time when the other criteria are set to an average value. Performance is very low when quality and lead time are low, and it reaches its highest level when both are high. On the other hand, a high lead time and low quality give us average performance, and the same outcome is observed when lead time is low and quality is high. It can be concluded that performance depends on the combination of the two criteria: a single good criterion already improves performance, but the best situation is when both are high.

However, slope analysis indicates that improving quality leads to a faster increase in performance than improving lead time. We can therefore deduce that quality has a more decisive effect on supplier performance than lead time, although both criteria contribute to the model, which is justified by the fact that our company assigns a higher weighting to quality than to lead time.

This result highlights the strategic importance of quality in supplier relationship management. An improvement in quality has an immediate effect on product conformity and customer satisfaction, leading to better overall performance. Thus, the proposed model confirms that prioritizing quality as a key criterion allows for a more realistic and sustainable assessment of suppliers.

Use case 2

In this case, the indicators Attitude, Delay, and CSR commitment are set as medium.

Figure 15 shows that performance drops when quality and QHSE commitment are low and peaks when both criteria are high. Low quality with high QHSE commitment gives us average performance, but improving quality increases performance even if QHSE commitment is low, which shows the importance of the quality criterion given its weighting, which exceeds that of QHSE commitment.

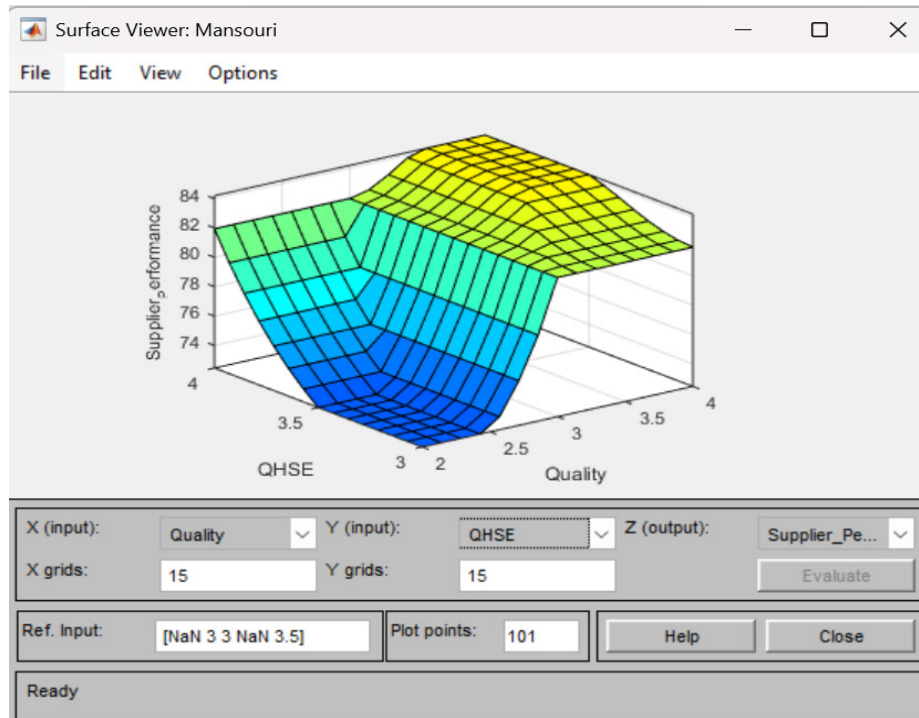


Figure 15. Surface View for Use Case No. 2

The graph also shows the complementarity of the two criteria. Indeed, supplier performance does not depend on a single criterion, but on the combination of quality and QHSE commitment. If one is low, the other can compensate to some extent, but to achieve optimal performance, both must be high.

These results highlight the interdependence between quality and QHSE commitment. Although quality remains the most determining factor, a high level of QHSE engagement enhances overall performance. This confirms that supplier performance does not rely solely on the quality of products or services but also on the ability to integrate responsible practices into operations.

Use case 3

In this case, the indicators Attitude, Quality, and CSR commitment are set as medium.

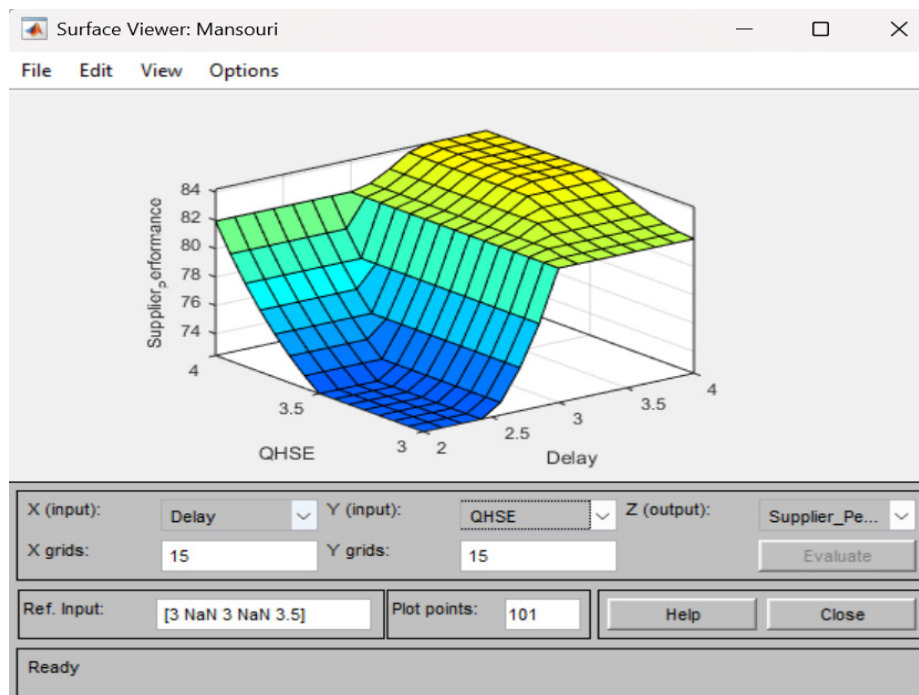


Figure 16. Surface View for Use Case No. 3

Figure 16 shows that performance is only maximized when both lead time and QHSE commitment are high. Conversely, when both criteria are low, performance drops significantly. If one criterion is high but the other is low, performance remains limited: delivery time severely penalizes a supplier, even one committed to QHSE, while good delivery time does not compensate for low QHSE commitment.

It is also noticeable that average values for QHSE commitment and lead time also result in relatively low performance. This shows that the model considers that an average level on both criteria simultaneously degrades performance more than a single isolated weakness.

This graph highlights the simultaneous importance of QHSE commitment and lead time in achieving good performance.

Use case 4

In this case, the indicators Delay, QHSE commitment, and CSR commitment are set as medium.

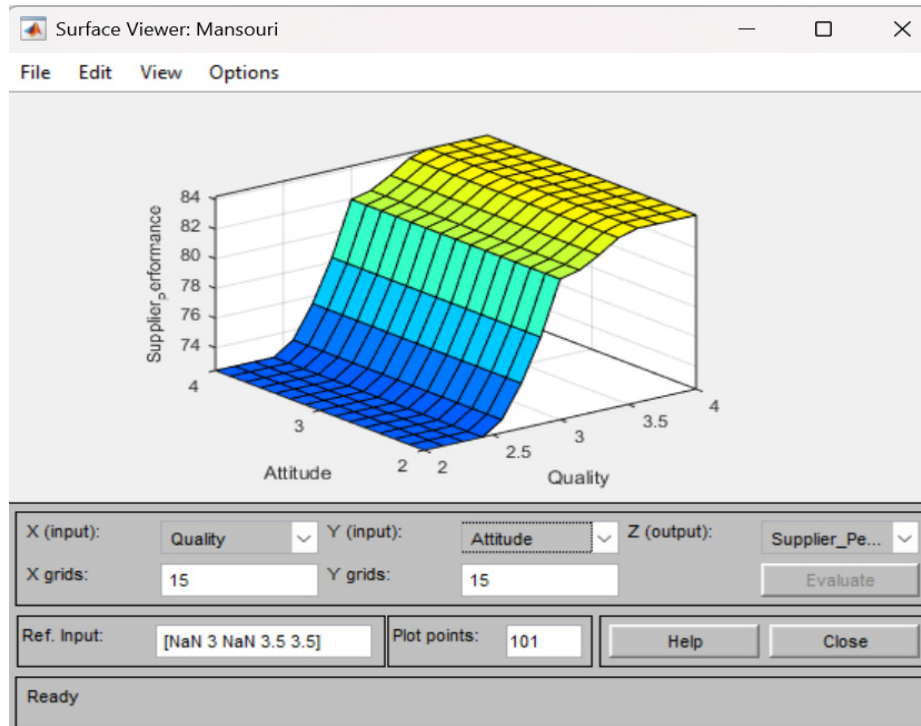


Figure 17. Surface View for Use Case No. 4

Figure 17 shows that the surface area increases when quality rises from low to high. Performance is very low when quality is low, even if attitude is good, and remains acceptable when quality is high, even if attitude is low.

Attitude influences performance, but to a lesser extent than quality, which plays a structuring role: A supplier with a poor quality rating cannot compensate with a good attitude, which shows that quality has a stronger impact than attitude on supplier performance. This is justified by the fact that there is a large gap between the weightings of the two criteria (the weighting for quality is much higher than that for attitude).

These results show that quality is the most determining factor in supplier performance, while attitude plays a secondary but complementary role. These observations confirm that the weighting of criteria directly affects supplier evaluation and that quality should be prioritized in decision-making. Behavioral aspects contribute to reinforcing and stabilizing the overall performance.

The results obtained do not follow a binary logic whereby a supplier's performance would be high if all input indicators were simultaneously good, hence the interest of fuzzy logic, which makes it possible to highlight intermediate cases. For example, it shows that average criteria do not necessarily result in average performance, but sometimes in poor performance, or that a very strong criterion can compensate for a weaker criterion to some extent.

Evaluation of the presented model

To validate our model, a sample of 20 suppliers was selected from the company's database. For each of them, the actual values of the five input indicators and the overall performance were collected.

These data are summarized in the table below, which also presents the performance values generated by the fuzzy logic model we propose, as well as the percentage error between the actual and estimated values.

Table 1. Comparison between real supplier performance and fuzzy logic model results

Supplier No.	Quality	Delay	Attitude	QHSE Commitment	CSR Commitment	Real Performance	Fuzzy Logic Performance	Error %
1	4	2	4	4	4	90	92	2,22
2	4	4	4	3	3	90	93	3,33
3	4	4	4	4	4	100	96,8	3,20
4	4	4	3	3	3	88	85	3,41
5	4	1	3	3	3	73	75	2,74
6	3	1	3	3	3	65	63	3,08
7	4	4	3	3	4	93	96,8	4,09
8	3	2	2	3	4	73	75	2,74
9	3	2	4	3	4	77	80	3,90
10	4	4	4	3	4	95	96,8	1,89
11	4	3	3	3	3	83	81,7	1,57
12	3	3	3	3	3	75	76	1,33
13	3	3	4	4	3	82	81,7	0,37
14	4	4	2	3	3	86	85	1,16
15	2	3	3	3	4	72	74	2,78
16	2	1	2	4	4	65	66	1,54
17	3	4	4	3	3	82	81,7	0,37
18	3	2	2	3	4	73	75	2,74
19	3	4	4	4	4	92	93	1,09
20	4	3	4	3	3	85	84	1,18

The accuracy of the model is validated by calculating the relative error, a key indicator used to quantify the divergence between predictions and actual values. Its formula is as follows:

$$\text{Relative error \%} = x \times 100$$

The results obtained show that the error rate is very low for all suppliers, which means that the model outputs and actual performance values are very close, thus confirming the relevance, consistency, and reliability of the model as a decision-making tool.

CONCLUSIONS

Supplier evaluation is a key concept in supply chain management, enabling the analysis of supplier performance based on various criteria with the aim of improving supplier relationships and strengthening long-term partnerships. Today, this evaluation is no longer limited to economic criteria alone. It now incorporates qualitative, organizational, environmental, and social dimensions. The simultaneous integration of these multiple dimensions makes supplier evaluation a multi-criteria strategic decision-making issue that influences the competitiveness of the company.

To address this issue, we have developed a decision-making model based on fuzzy logic to model the imprecise and subjective judgments involved in supplier evaluation. This model facilitates evaluation by simultaneously integrating several qualitative and quantitative criteria, thus offering a more comprehensive and nuanced view of supplier performance. Using inference rules, it replicates reasoning similar to that of humans and takes into account dimensions related to quality, safety, the environment, and social responsibility, thereby enriching the traditional approach focused solely on economic criteria.

Applying the model to a real-life case study conducted within a mining company has demonstrated its relevance and consistency and shown that it provides useful insights in this specific context, although the results depend on the predefined criteria and weightings specific to this mining company and could vary for other companies or sectors. The weightings reflect the strategic priorities of the studied company. This shows that the model can serve as a decision-making tool for evaluating suppliers and establishing sustainable and responsible relationships with them, while helping to strengthen the competitiveness and overall performance of the supply chain, with future applications possible in other industries and with additional criteria.

This article, therefore, provides supply chain decision-makers with key benchmarks to guide the supplier

evaluation process, offering elements of analysis that can strengthen managerial decisions regarding the validation or elimination of partners.

BIBLIOGRAPHIC REFERENCES

1. S. Tabit and A. Soulhi, "A MODEL FOR SUPPLIER SELECTION IN MANUFACTURING INDUSTRIES," Vol., No. 20, 2022.
2. Politechnika Bydgoska, W. Żarski, M. Lasocka, and Politechnika Bydgoska, "THE ROLE OF SUPPLIER EVALUATION IN ENHANCING SUPPLY CHAIN EFFICIENCY AND COLLABORATION," Sci. Pap. Silesian Univ. Technol. Organ. Manag. Ser., vol. 2025, no. 220, pp. 547-557, 2025, doi: 10.29119/1641-3466.2025.220.35.
3. T. Althaqafi, "Environmental and Social Factors in Supplier Assessment: Fuzzy-Based Green Supplier Selection," Sustainability, vol. 15, no. 21, p. 15643, Nov. 2023, doi: 10.3390/su152115643.
4. M. Madhoushi and A. N. Aliabadi, "Supplier Performance Evaluation Based On Fuzzy Logic," vol. 1, no. 5, 2011.
5. A. S. Omar, M. Waweru, and D. R. Rimiru, "A Literature Survey: Fuzzy Logic and Qualitative Performance Evaluation of Supply Chain Management."
6. M. B. Jeddou, "Application of the AHP Method for Multi-Criteria Supplier Selection."
7. J. Rezaei, "Best-worst multi-criteria decision-making method," Omega, vol. 53, pp. 49-57, June 2015, doi: 10.1016/j.omega.2014.11.009.
8. "Hwang, CL., Yoon, K. Methods for Multiple Attribute Decision Making. In: Multiple Attribute Decision Making. Lecture Notes in Economics and Mathematical Systems. vol. 186. Springer, Berlin, Heidelberg. 1981. https://doi.org/10.1007/978-3-642-48318-9_3."
9. B. Roy, "Ranking and choice in the presence of multiple viewpoints."
10. J. P. Brans and Ph. Vincke, "Note—A Preference Ranking Organization Method: (The PROMETHEE Method for Multiple Criteria Decision-Making)," Manag. Sci., vol. 31, no. 6, pp. 647-656, June 1985, doi: 10.1287/mnsc.31.6.647.
11. A. S. Hatim Lakhoul, "Fuzzy Decision-Making Model for Inventory Leveling under Uncertainty Conditions."
12. A. A. Aguilar Lasserre, M. V. Lafarja Solabac, R. Hernandez-Torres, R. Posada-Gomez, U. Juárez-Martínez, and G. Fernández Lambert, "Expert System for Competences Evaluation 360° Feedback Using Fuzzy Logic," Math. Probl. Eng., vol. 2014, no. 1, p. 789234, 2014, doi: 10.1155/2014/789234.
13. Y. HUNDECHA, BARDOSSY, ANDRAS, and H.-W. and WERNER, "Development of a fuzzy logic-based rainfall-runoff model," Hydrol. Sci. J., vol. 46, no. 3, pp. 363-376, June 2001, doi: 10.1080/02626660109492832.
14. Y. Bai and D. Wang, "Fundamentals of Fuzzy Logic Control – Fuzzy Sets, Fuzzy Rules and Defuzzifications," in Advanced Fuzzy Logic Technologies in Industrial Applications, Y. Bai, H. Zhuang, and D. Wang, eds., in Advances in Industrial Control., London: Springer London, 2006, pp. 17-36. doi: 10.1007/978-1-84628-469-4_2.

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