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Suppliers re-evaluation for tomorrow's smart supply chain: AHP approach and performance criteria in automotive industry

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Keywords: automotive industry, intelligent supply chain, supplier re-evaluation, quality, case study.
Abstract: The automotive sector has seen significant growth in recent years, with supply chain management becoming a key pillar for meeting evolving industry demands. Effective supply chain management relies heavily on material handling, impacting both inbound and outbound logistics. The study addresses the issue faced by automotive clients experiencing a decline in their quality KPIs due to non-compliant products delivered by suppliers. The focus is on identifying these suppliers, reclassifying them based on performance, and establishing key criteria for supplier re-evaluation, to address quality issues. We identify eight critical supplier selection criteria in the automotive sector. Supplier failures can lead to non-compliant raw materials, causing customer complaints and warranty returns due to undetected defects. The second part of the study involves reclassifying the suppliers of an automotive company with deteriorating quality KPIs. Using the Pareto principle and Lorenz curve, we identified the suppliers responsible for the majority of raw material deliveries. The Analytic Hierarchy Process (AHP) was used to reclassify suppliers based on quality criteria. The reassessment allowed us to identify underperforming suppliers who needed corrective action plans, or in some cases, exclusion in favor of suppliers meeting industry standards. This process involved meetings with the company's management team to define effective action plans aimed at improving quality performance. This approach will help automotive companies better align their supply chains with market demands, delivering value to customers while maintaining competitiveness. By optimizing supplier selection and reclassification, companies can reduce complaints, improve satisfaction, and enhance both the customer experience and production efficiency.

1 Introduction

Supply chain management is an essential part of the business strategy of many automotive companies [1], directly influencing their ability to meet customer demand, minimize costs and maximize customer satisfaction by reducing or eliminating complaints through the delivery of compliant products.

Nowadays, automotive organizations aim to introduce the smart supply chain of tomorrow as a crucial lever of development for this sector, but the constraint is to produce products with high quality in order to satisfy the customer and having an objective of zero claims. This is why automotive companies try to improve their chain weather inbound, intern and outbound logistics for the production management flow.

Inbound logistics plays a crucial role for the automotive industries. Therefore, any disruption at suppliers' companies can cause different types of anomalies at the customer such as: delivery of non-compliant products, delivery in delay, non-compliance with the quantity requested to be delivered or delivery of erroneous items, confusion of either references or products for another customer, etc. All this has a direct impact on the performance of the customer's supply chain, and consequently the disruption of the production lines of end customers or even the shutdown of the customer's supply chain, as a result the dissatisfaction of the consumer for the product.

In this context, the automotive industries in Morocco and even around the world have recently experienced major disruptions in their supply chains, since the Covid-19 pandemic in 2019/2020. Emphasizing the problem of industries that produce electronic cards. This issue has disrupted any industry in the world that has as a component in the nomenclature of the product to manufacture an electronic card, more mainly the automobile markets that have experienced several successive shutdowns and technical unemployment of their collaborators and employees.

At the heart of this effective management is supplier selection and re-evaluation, a strategic decision that can have a significant impact on the overall performance of tomorrow's intelligent supply chain. The aim of our study is to identify the key criteria for the selection and re-evaluation of supplier performance, addressing the issue faced by automotive clients who suffer from a degradation of their quality KPI due to the non-compliance of products delivered by suppliers. This paper underscores the need to

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regularly re-evaluate the supplier panel in these situations to implement corrective actions or even replace suppliers if necessary, focusing on essential performance criteria needed to choose suppliers for an efficient and intelligent supply chain. In this article, we take a detailed look at supplier selection criteria, highlighting the key factors to consider as fact ensures supply chain success. This is followed by a case study of an automotive multinational industry well placed to reclassify its textile suppliers assumed the deteriorating quality situation caused by non-compliant raw materials received from suppliers. The study will begin with an illustration of the purchasing panel of suppliers working with this multinational and then based on the number of items to be delivered by each supplier; it will be easy to target the niche of suppliers to be included in the study applying the Pareto principle validated by the Lorenz curve.

Moreover, by applying the AHP method in multi-criteria decision making with its four steps (identification of evaluation criteria, comparison matrix, calculation, and the last step evaluation.), we will be able to determine the most appropriate supplier for the project[2]. Also deciding which suppliers to carry on working with and which ones to turn around so as not to lose customers and keep their loyalty.

2 Literature review: supplier selection criteria and re-evaluation

When we talk about supply chain management, in literature many articles treat the topic in high level considering the issue of evaluation and selection supplier as the first essential step for companies in order to improve their visibility in the market regarding customer's satisfaction. Moreover, industries aim to attract new projects for more gain. While reviewing multiple papers, no article handles the subject in retroactive face by re-evaluating the purchasing panel of an industry emphasizing a problematic experienced in that company, also making an update by criteria for smart supply chain of tomorrow to optimise Keys performance indicators, so this let our study newer and unique.

Many authors and studies take the subject of supplier selection like a priority in research. For textile industries [3] the process present 3 phases: phase 1 supplier selection with 7 criteria that have an impact to identify qualified suppliers, then phase 2 proposes 8 criterions to explore if the supplier selected meet what is required in the products and which level. the third and final phase. Supplier re-evaluation with 9 criteria, it examine the performance of system for suppliers included in the selection process [4].

Nowadays, the automotive industry worldwide is booming, with many variations. So that, in the automotive industries purchasing team should integrate a crucial element, while selecting and evaluating suppliers by different multicriteria [2], considering the procurement strategy one supplier for many products , so called the product life cycle of each product (PLC) [5], and for the case of automotive industries tier 1 it's necessary to highlight that the reputation of suppliers is vital element to be considered [6].

In terms of supplier selection, there is a wide range of criteria and methods that has been studied to assist organizations in identifying the best suppliers and in improving their supply chain performance [1,7]. According to recent literature reviews on the state-of-the-art in supplier selection frameworks, both traditional criteria (cost, quality and delivery time) as well as green or sustainable criteria are considered in most of these frameworks, particularly those from industries that stress environmental considerations [2].

Four basics criteria founding from Fuzzy-AHP method in decision making : "Environment management system', 'Pollution control', 'Quality', and 'Green image in order to select green suppliers in the automotive industry [8].

Multi-Criteria Decision-Making (MCDM) Methods: MCDM methods such as Analytic Hierarchy Process (AHP), Data Envelopment Analysis (DEA), fuzzy logic models are regularly used for providing a weight to the supplier aspects and supporting the selection decision under some circumstances. Such approaches manage a trade-off between quantitative and qualitative aspects, allowing for performance metrics efficiency (e.g., CO2 emissions), while still considering environmental criteria [9].

Green Supplier Selection: An expanding domain of supplier selection research addresses green or sustainable criteria, where suppliers are selected based on the environmental impact and efficient utilization of resources. This includes aspects such as carbon footprint, waste disposal, and sustainable practices. This integration of these criteria is viewed as fundamental for industries including manufacturing and construction, which face rising demands to limit their impacts on the contentment with the environment [10].

Ontology-Based Knowledge Management to overcome fragmentation in this domain, certain research works propose ontology-based frameworks to specify knowledge and support decision-making. This method systematizes criteria and selection methods, facilitating easier comparisons as well as the diffusion of information between firms [11].

New Trends and Research Directions: The review also provides insights into addressing challenges like reconciling economic and green criteria, compensating for uncertainties in the supply chain level, as well as integrating real-time data that underlies continuous re-evaluation of suppliers. Future research, we suggest, may integrate AI and ML more deeply to enhance adaptability and predictive capabilities in selecting suppliers and re-evaluating ones [10].

These findings highlight the importance of continuing to evaluate and reassess suppliers as organisations work to meet efficiency, regulatory and sustainability pressures.

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3 Methodology

The present article analyzes the impact of re-evaluating purchasing panel in the automotive industry to improve and rectify the quality KPI for each automotive company suffer from non-conformity of products delivered by suppliers [12]. For this purpose, a case study in the sector will affect positively our analysis; the preselected suppliers were analyzed in correlation with the AHP method [13]. Adding that the performance indicators of each industry are affected by the supplier selection flow to define a purchasing panel, in particular the selection criteria phase, which must be precise and concise to achieve an intelligent supply chain. Considered criteria evaluation for suppliers were determined according to a survey of experts in this automotive sector. The criteria defined requires organizations to assess their suppliers preselected after knowing any deviations in the targeted KPI, keeping in mind driven customer satisfaction as a pillar ensuring quality approach.

Faced with industry demands, automotive experts have developed a comprehensive set of criteria for supplier selection, to be followed by each organization according to its problematic issue seeking to resolve.

This paper takes the AHP method and key criteria selection for supplier evaluation and selection in automotive industry based on characteristics of product quality/conformity to provide a systematic reassessment of suppliers and identify the steps to be taken for an intelligent supply chain, the methodology is designed in multiple phases. The objective of this study is to provide the key criteria selecting automotive suppliers, in the other hand realize the suppliers who need improvement or corrective action towards quality and compliance requirements for automotive industry. Based at first, on a survey aimed to identify the key criteria for supplier selection in the automotive sector to build a smart supply chain. The target audience included various automotive suppliers, members of the management committee within the studied industry ;(comprising 2,300 employees operating 24 hours a day, 6 days a week in three rotating shifts), as well as the industry's clients and automotive experts. The survey followed a qualitative design and utilized a mix of question types, including open-ended questions, Likert scales, and multiple-choice formats. The survey medium varied: face-to-face interviews, paper surveys, and verbal surveys conducted via calls were employed. In total, we collected 500 samples over a six-month period. To ensure participant trust, we guaranteed data confidentiality by anonymizing all responses. For paper surveys and email-based distribution, regular reminders were sent to participants to maximize response rates. During the data analysis phase, the collected responses were systematically organized in an Excel document. The analysis focused on identifying satisfaction scores and common feedback themes. This process allowed us to extract the required criteria in relation to the automotive industry that are: Product or service quality, cost prices and costs, Terms of delivery, Production capacity and stock availability, Customer service and technical support, Innovation and R&D, Financial stability and reputation and finally Sustainability and social responsibility.

Secondly, in difficult suppliers we wanted to prioritize selection actions and provide a proper recovery plan using AHP approach. In this part of research, we use quantitative methods using the Pareto principle to choose the suppliers from the purchasing panel requiring the focus. In addition, to confirm our Pareto analysis, we used the Lorenz curve, to see the distribution of items among the different suppliers, which enabled us to analyze their concentration and visualize them, while quantifying inequality by calculating the Gini coefficient. The AHP method which allows structuring complex decision problem and the systematic comparison of many criteria; this method was used to re-evaluate the supplier performance, based on 4 criteria according to the survey which data that was collected through a questionnaire given to a sample of suppliers and experts in the automotive industry as explained in the first part. The analysis was complemented by data from supplier audit reports, sources of previous evaluations and historical data in databases. The data was then collected and incorporated into an AHP model, on which the weight of each criterion in terms of importance for supplier selection has been determined. The AHP method was used to rank suppliers according to their overall performance, taking into account the strategic priorities of automotive companies. Suppliers with low scores were identified as requiring a recovery plan or, in the most serious cases, replacement.

Apart from that, although the AHP method is well known for its authenticity, it uses subjective judgments in defining weights, which sometimes can create bias into the results as a limitation of this study. Supplier re-evaluation is a multi-criteria decision-making problem where many factors have to be considered at the same time; therefore, the AHP method should be used. It also facilitates the systematic and streamlined decision- making; the Figure 1 represent the Methodological Framework for the Study: Re-evaluating Suppliers in the Automotive industry.

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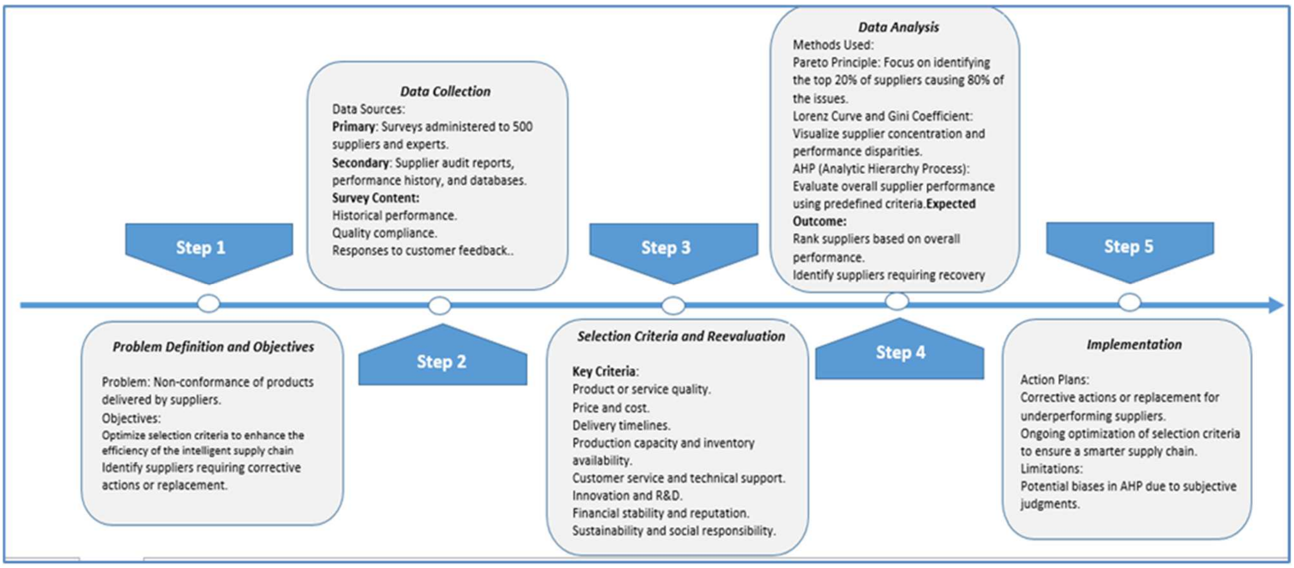

Figure 1 Methodological framework for the study: re-evaluating suppliers in the automotive industry

4 Results and discussion

4.1 Result analysis: Supplier criteria selection and reclassification for the automotive industries

According to a survey includes a population of 500 suppliers, customers and experts in the automotive sector, the following criteria in Table 1 are the keys for the issue of supplier selection, re-evaluation and reclassification leading to a smart supply chain of tomorrow for automotive industries.

Table 1 Supplier selection criteria

Criteria	*Points to highlight*
Product or service quality	Industries seeking to have a good relationship with their customers by offering to them compliance of products that meet established quality standards [8]. Therefore, the quality of products delivered by a supplier remain a crucial point to ensure, through looking for suppliers who may provide products that meet customer's expectations.
Prices and costs	The price of the products or services delivered by a supplier is a fundamental criterion in the selection process. Considering if the cost of products is jusfied by the quality provided at supplier's company.
Terms of delivery	Providing products on time is one of the most important criteria for automotive industries, any delay conducts many disruptions in customer's lines arrived to consumers.
Production capacity and stock availability	The agreed delivery supplier relies on his capacity production, adding the importance of stock availability at supplier for any issue facing whether it is at the customer or the supplier.
Customer service and technical support	Customer satisfaction ensured by the creation of good interface supplier-customer team, in order to respond to customer's complaints and problematic. In addition, supplier should offer support to technical customer's issue.
Innovation and R&D	Having a center of research and development for a supplier will increase the opportunity to be selected, because the supplier has the ability to invest and innovate in the products.
Financial stability and reputation	This criterion related to the reputation and the image of that supplier industry in the market and if he is financially stable. So that the customer's avoid non-conformity of products either the stoppage of supplier production lines.
Sustainability and social responsibility	In recent times, industries have taken the direction of taking into account different ethics standards and social responsibility in their world of employment and hoping to have them in their customers: such as the environmental aspect [7], the human aspect, working conditions [14,15], automotive certifications...

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4.2 Result analysis: Case study of supplier reclassification for textile raw materials in the automotive industry

4.2.1 Background

In the context of the reclassification of suppliers included on the company's purchasing panel, a specific study had to be carried out. In this study, we seek to pinpoint the suppliers with the greatest impact and the most effective ones in order to remedy the quality situation, which had deteriorated due to customer complaints linked to the non-conformity of textile raw materials [4], which appeared only after delivery and integration of the products delivered into the customer's production chain.

Table 2 displays the purchasing panel of this multinational automotive company, which exceeds 520 items spread over several suppliers, keeping the names of supplier's manufactories confidential for reliable results.

Table 2 Supplier panel

Supplier	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19
Number of items	96	61	52	36	33	26	23	20	18	17	14	13	12	12	12	8	7	7	6
Supplier	F20	F21	F22	F23	F24	F25	F26	F27	F28	F29	F30	F31	F32	F33	F34	F35	F36	F37	F38
Number of items	5	4	4	3	3	3	3	3	2	2	2	1	1	1	1	1	1	1	1
Supplier	F39	F40	F41	F42	F43	F44	F45	F46	F47	F48	F49								
Number of items	1	1	1	1	1	1	1	1	1	1	1								

4.2.2 Choice of suppliers to include in the study

Pareto's law , Lorennz curve

The Pareto principle (or law) is an analytical tool born of the empirical observations of the economist Vilfredo Pareto and the qualitician Joseph Moses Juran, who disseminated the concept in 1954 [16,17].

The Pareto principle is a general method for separating any aggregate into two parts: vital problems and more secondary problems - in all cases, the application of the Pareto principle makes it possible to identify the properties of strategic problems and to separate them [16].

For Juran, this principle has "universal" value: The fact that managerial problems generally have the same properties makes the Pareto principle a universal tool for analysis [16]. In short, the Pareto principle, also known as the 80/20 principle or the 80/20 law [18,19], describes a rule according to which 80% of the effects are the product of 20% of the causes [17].

In fact, applying the Pareto law 20% of suppliers deliver 80 % items the study will be based on suppliers, who deliver 12 and more items to this multinational automotive industry as depicted in Figure 2. As a next step, to validate our Pareto analysis result, we'll approach the analysis of item concentration by supplier, with Lorenz curve plotting [20], in order to rank suppliers first in ascending order by number of items delivered. A subsequent calculation of the cumulative percentage is carried out for suppliers and items, as abscissa and ordinate axes. The origin (0,0) is shown as the first point, and the last point (1,1) represents the total distribution. In order to quantify the distribution inequality, we calculate the Gini coefficient using the following formula (1):

$$Gini\ coefficient\ = 1 - (2 * area\ under\ the\ Lorenz\ curve) \quad (1)$$

While the area under the Lorenz curve is calculated using the trapezoidal method, the area of the trapezoid between two successive points $(X_{i-1}, Y_{i-1})$and (X_i, Y_i) , X_i for the cumulative percentages of suppliers and Y_i for the cumulative percentages of items. Finally, by summing the areas of the trapezoids between all successive points we get the total area under Lorenz curve [20]. Given by the following formulas (2) and (3):

$$trapezzoid\ area = \frac{(Y_{i-1}+Y_i)}{2} . (X_i - X_{i-1}) \quad (2)$$

$$area\ under\ the\ Lorenz\ curve\ = \sum_{i=1}^{n} \frac{(Y_{i-1}+Y_i)}{2} . (X_i - X_{i-1}) \quad (3)$$

- X_i the cumulative percentages of suppliers attending the point i,
- Y_i the cumulative percentages of items attending the point i,
- n total number of suppliers.

When we apply the previous steps, we get as a result of the calculation (4):

$$Gini\ coefficient\ = 1 - (2 * area\ under\ the\ Lorenz\ curve) = 1 - (2 * 0.16) = 0.68 \quad (4)$$

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The Lorenz curve represented in Figure 3, and our calculations give a Gini coefficient of 0.68, which indicates a very unequal distribution of items among the suppliers. Since the Gini coefficient ranges from 0 to 1, a result close to 0 suggests a more equal distribution, while a result close to 1 indicates a high concentration [20]. For our study, a minority of suppliers holds a significant share of the items (15 suppliers out of a total of 49 suppliers).

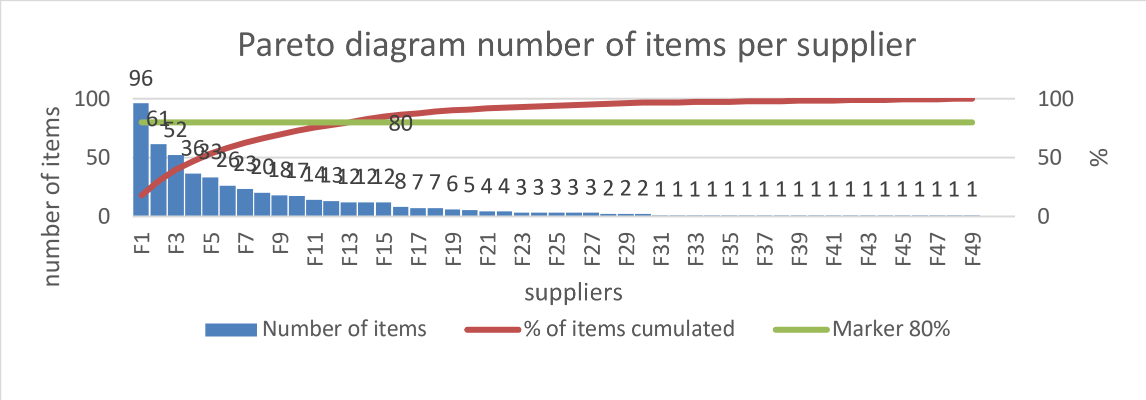

Figure 2 Pareto diagram

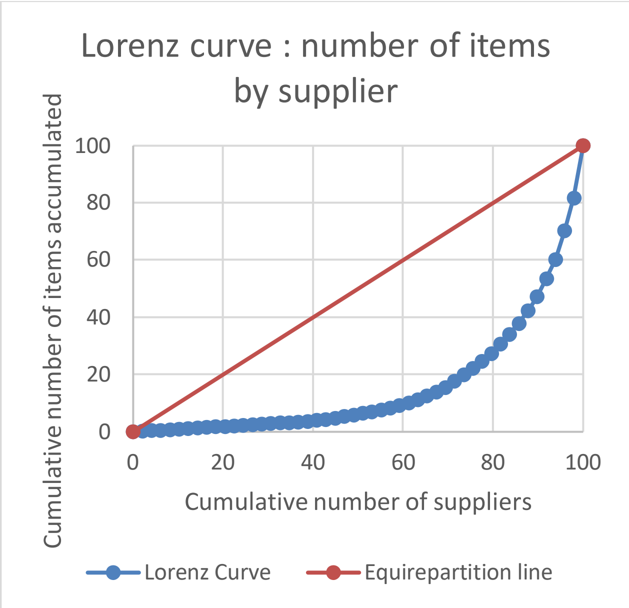

Figure 3 Lorenz curve

4.2.3 Application of AHP method

Whhy using the AHP method

One of the most widely used decision support methods; the AHP method was designed by Thomas Saaty (1977, 1980) in the 1970 [21]. Since its introduction 40 years ago, it has been used in a wide range of applications all over the world [22-23].

Using the AHP approach, a model composed of a hierarchy of criteria is developed with the aim of evaluating the alternatives considered for achieving a specific objective [24]. Implementing AHP involves the representation of a decision problem by a hierarchical structure reflecting the interactions between the various factors (objective, criteria and alternatives) of the problem [13].

Identification of assessment criteria

In order to remedy the quality situation, the study will focus on the following evaluation criteria [25] in Figure 4. In this paper, we mean by each criterion seeking improvement of quality for this automotive industry:

Product or service quality: number of complaints related to each supplier over 6 months.

Customer service and technical support: On-time response to complaints (D3 24 hours, D6 15 days, D8 60 days).

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Production capacity and stock availability: quantity produced per week and availability of stock items in the event of non-conformities.

Innovation and R&D: Availability of a development centre or engineering team

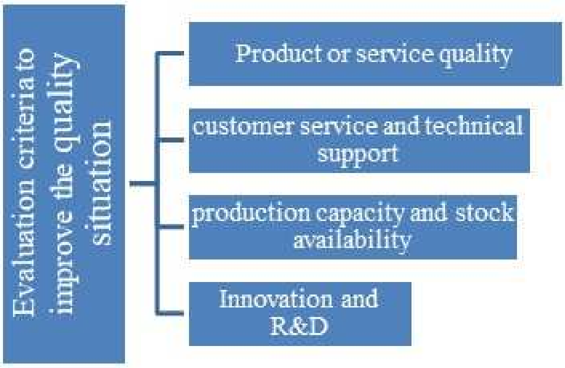

Figure 4 Supplier evaluation criteria

Comparison matrix

In the AHP process, the relative importance or weight of the criteria is established through expert consultations, interviews, or group discussions [26,27]. Each criterion is compared with the others in pairs, using either qualitative or quantitative evaluation methods [27], nine-point numerical scale, known as the Saaty scale, is commonly used for these pairwise comparisons. The details of this scale are presented [28], in Table 3 below:

Table 3 Saaty scale

Importance intensity	Definition	Explanation
1	Equal Importance	Judgmental or need
3	Moderate importance of one over another	Judgmental or need
5	Strong importance	Judgmental or need
7	Very strong importance	Judgmental or need
9	Extreme importance	Judgmental or need
2, 4, 6, 8	Intermediate value between the two adjacent	Judgmental or need

For the AHP comparison matrix, the relativity importance of the criteria is defined using Saaty's scale. Each important criterion i in relation to a criterion j, and this is done by pairing each position (i,j), and for each value of (j,i)th position of the matrix will be the inverse of the value attributed to (i,j)th position according to the equation (5) [27]. Therefore, to ensure this first step, consultation with the Purchasing Manager, the Director and the Quality team within the company was essential in order to set the comparison coefficients for each pair of criteria according to the Saaty scale [29]. It is vital that the purchasing and quality managers, and possibly their colleagues, are involved at this stage, as they are in the best position to assess the relative importance of each pair of criteria [30].

$$a_{ij} > 0, \quad a_{ji} = \frac{1}{a_{ij}}, \quad a_{ii} = 1 \; \forall i \tag{5}$$

Where each element a_{ij} is the priority ratio between the criterion i and criterion j according to a preference scale. The matrix of all the coefficients is presented in the form of Table 4.

Table 4 Comparison matrix

	customer service and technical support	Quality of product or service	production capacity and stock availability	Innovation and R&D
customer service and technical support	1	(1/5)	(1/3)	(1/5)
Quality of product or service	5	1	2	2
production capacity and stock availability	3	(1/2)	1	3
Innovation and R&D	5	(1/2)	(1/3)	1

Weight of evaluation criteria

Once the comparison matrix step accomplished, we should now obtain the weight of each criterion. Therefore, we will use the geometric approximation method [31] to calculate the eigenvectors making up the estimation vector. This is done by applying the nth root equation (where n is the size of our comparison matrix, which is 4) of the product of the elements in each row of our comparison matrix following the equation (7). At the end, each element of the estimation vector obtained is divided by the sum of all the elements of this vector: this is the normalization step, to obtain the relative weight of each criterion.

Step 1: Apply the power $\frac{1}{4}$ to each element of the matrix A by the equation (6):

$$A^{\left(\frac{1}{4}\right)} = \begin{pmatrix} 1^{\left(\frac{1}{4}\right)} & \frac{1}{5}^{\left(\frac{1}{4}\right)} & \frac{1}{3}^{\left(\frac{1}{4}\right)} & \frac{1}{5}^{\left(\frac{1}{4}\right)} \\ 5^{\left(\frac{1}{4}\right)} & 1^{\left(\frac{1}{4}\right)} & 2^{(1/4)} & 2^{\left(\frac{1}{4}\right)} \\ 3^{\left(\frac{1}{4}\right)} & \frac{1}{2}^{\left(\frac{1}{4}\right)} & 1^{\left(\frac{1}{4}\right)} & 3^{\left(\frac{1}{4}\right)} \\ 5^{\left(\frac{1}{4}\right)} & \frac{1}{2}^{\left(\frac{1}{4}\right)} & \frac{1}{3}^{\left(\frac{1}{4}\right)} & 1^{\left(\frac{1}{4}\right)} \end{pmatrix} \tag{6}$$

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Step 2: Multiplying the elements in each row of our matrix $A^{(\frac{1}{4})}$: The product of the elements in line i equation (7):

$$A1_i = P_i = \prod_{j=1}^{n} a_{ij}^{(\frac{1}{4})} \quad (7)$$

Step 3: Sum of line products application of the equation (8):

$$A2 = S = \sum_{i=1}^{n} A1_i \quad (8)$$

Step 4: Calcul the relative weight of each criterion following the equation (9):

$$w_i = \frac{A1_i}{A2} \quad (9)$$

Table 5 Weight of evaluation criteria

	A1	A2	w=Weight=A1/A2
customer service and technical support	0.3398	4.8665	0.0698
Quality of product or service	2.1147	4.8665	0.4346
production capacity and stock availability	1.4565	4.8665	0.2993
Innovation and R&D	0.9554	4.8665	0.1963
Total	4.86647		

Before moving on to the evaluation stage by calculating the score for each supplier, it is essential to calculate the CR Consistency Ration, to check the consistency of our judgments on our comparison matrix, calculated as the followed equation (10) :

$$CR = \frac{CI}{RI} \quad (10)$$

With CI the consistency index to calculated we should use the equation (11) below :

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (11)$$

Where n is the size of the matrix and λ_{max} maximum eigenvalue of each criteria in the matrix.

For RI, is .Saaty's randomized index 1977depends on the size of the developed matrix, as shown in the Table 6:

Table 6 randomized index

Size of matrix	3	4	5	6	7	8	9	10
RI	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

After performing the calculations we found (12):

$$CR = \frac{\frac{\lambda_{max}-n}{n-1}}{RI} = \frac{\frac{4,276-4}{3}}{0,9} = 0.0924 \quad (12)$$

By this result in *CR* we can conclude the consistency of the judgements in our comparison matrix with a consistency ratio below 0.1.

Evaluation

Here comes the final step in our approach to reclassify the suppliers by getting the finding of the suppliers score calculation, table 7 presents the data for each supplier criteria contributing to this study explained previsiouly

The calculation of the scores for the different suppliers and their multi-criteria classification summarized in Table 8 after normalization. So, the results analysis lead us to prioritize and reclassify suppliers table 9, the best supplier keeping working with is F4 with a score of 0.70 in dark green, followed by F3 with a score of 0.67 and in third place F7 with a performance of 0.65 according to all evaluation criteria above. Furthermore, we can conclude to the range of supplier performance affecting quality of products delivered which is very significant, with a maximum score of 0.70 and a minimum score of 0.37.

Using this AHP approach, which calculates a score for each supplier, the company can select and know, in order of priority, the automotive textile suppliers who must remedy their situation requesting an improvement action, starting with those classified in yellow and then those classified in blue, as shown in Table 8 above.

Table 7 Supplier data table

Supplier	customer service and technical support	Quality of product or service	production capacity and stock availability	Innovation and R&D
F 1	5	10	5000	1
F 2	6	6	7500	3
F 3	3	3	10000	4
F 4	2	5	5500	2
F 5	7	7	10500	2
F 6	4	5	12000	5
F 7	4	4	6500	3
F 8	7	8	8800	2
F 9	9	9	9500	3
F 10	5	12	7000	2
F 11	3	6	20000	6
F 12	4	4	16000	5
F 13	9	11	6000	3
F 14	8	8	10500	4
F 15	3	4	12500	5

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Table 8 Supplier evaluation table

	customer service and technical support	Quality of product or service	production capacity and stock availability	Innovation and R&D	
Weight	0.06982659	0.43455379	0.29928778	0.19633184	Final calcul
F 1	0.4	0.3	1	1	0.65391639
F 2	0.33333333	0.5	0.66666667	0.33333333	0.50552156
F 3	0.66666667	1	0.5	0.25	0.6798317
F 4	1	0.6	0.90909091	0.5	0.70080458
F 5	0.28571429	0.42857143	0.47619048	0.5	0.4468717
F 6	0.5	0.6	0.41666667	0.2	0.45961518
F 7	0.5	0.75	0.76923077	0.33333333	0.65649395
F 8	0.28571429	0.375	0.56818182	0.5	0.45112392
F 9	0.22222222	0.33333333	0.52631579	0.33333333	0.38333211
F 10	0.4	0.25	0.71428571	0.5	0.44851199
F 11	0.66666667	0.5	0.25	0.16666667	0.37137187
F 12	0.5	0.75	0.3125	0.2	0.49362244
F 13	0.22222222	0.27272727	0.83333333	0.33333333	0.44888212
F 14	0.25	0.375	0.47619048	0.25	0.37201527
F 15	0.66666667	0.75	0.4	0.2	0.53144788

Table 9 Supplier reclassification

Ranking	1	2	3	4	5	6	7	8	9	10
Suppliers	F 4	F 3	F 7	F 1	F 15	F 2	F 12	F 6	F 8	F 13
Score	0.70081	0.67983	0.65649	0.65392	0.53145	0.50552	0.49362	0.45962	0.45112	0.44888
Ranking	11	12	13	14	15					
Suppliers	F 10	F 5	F 9	F 14	F 11					
Score	0.44851	0.44687	0.38333	0.37202	0.37137					

4.2.4 Discussion

Recovery plan

It was crucial to consult with the purchasing manager, the director, and the quality team before determining the appropriate corrective actions for the suppliers identified in yellow in Table 9. This collaborative decision-making process ensures that any actions taken are in line with the company's strategic objectives and operational requirements.

To address the situation effectively, second-level escalation letters were issued to each supplier under the jurisdiction of this multinational automotive division. These letters served as formal requests for corrective action plans from suppliers who were not meeting the expected standards. The company required these suppliers to submit their plans and to commit to a 100% delivery compliance check over a period of three months, in accordance with the group's quality standards. This proactive monitoring aimed to ensure that the suppliers could meet the high-performance thresholds necessary to support the company's operations.

Should the suppliers fail to meet the agreed standards or fail to take appropriate corrective action within the specified timeframe, they would be subject to first-level escalation within the group of the multinational. This higher level of escalation would involve more direct intervention from senior management and could potentially result in the severing of the supplier relationship if performance did not improve.

Additionally, the situation required immediate attention to ensure that suppliers who deviate from agreed terms are addressed promptly. Replacing non-compliant suppliers is crucial, as continued failure to meet the company's requirements not only impacts operational efficiency but also tarnishes the company's reputation and diminishes its competitive position in the marketplace. Non-compliance could ultimately affect the brand image and the company's customer loyalty.

It is essential that the company forms partnerships with suppliers who are aligned with the strategic objectives and vision of this multinational automotive leader. By ensuring that suppliers meet the company's standards, the company can maintain a strong competitive edge, retain customer loyalty, and enhance its market position in the long term.

ABC classification

As a benefit from this study, to implement an ABC classification of suppliers based on the Pareto principle:

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Class A: Suppliers representing 80% of value, though only 20% of the total number. These are high-priority suppliers that require significant strategic focus to maximize benefits.

Class B: Suppliers with moderate impact, where continuous improvement programs can be implemented.

Class C: Low-impact suppliers who can be replaced more easily or used for non-critical supplies.

This classification would allow the company to concentrate its efforts on the most strategic partners, optimizing both costs and risks, while enhancing the resilience of the supply chain in facing future challenges.

In conclusion, effective supplier relationship management is vital for ensuring that suppliers who do not meet performance standards are given the opportunity to improve. However, it is equally important to take decisive action when necessary, replacing those suppliers who cannot meet the required expectations, to safeguard the company's operational integrity and market competitiveness.

5 Conclusion

In the automotive industry, building the smart supply chain of the future requires continuous analysis and rigorous follow-up with suppliers, even well beyond the initial selection stage. Given the ever-stricter quality requirements, it has become essential to regularly assess the supplier panel against key performance indicators (KPIs), with a particular emphasis on quality metrics.Selecting suppliers in the automotive industry is a complex and highly strategic process. Multiple criteria must be considered to ensure that the chosen suppliers effectively contribute to the overall performance of the supply chain. The study identifies eight critical criteria, which include: Product or service quality, cost prices and costs, Terms of delivery, Production capacity and stock availability, Customer service and technical support, Innovation and R&D, Financial stability and reputation and finally Sustainability and social responsibility. By incorporating these criteria into the supplier selection process, automotive companies can significantly enhance their operational efficiency, reduce supply chain risks, and strengthen their competitive position as they transition toward a smart, responsive supply chain.

The use of the Analytic Hierarchy Process (AHP) method has proven particularly beneficial for this multinational automotive company. AHP allows the company to prioritize and reclassify its supplier portfolio based on their impact on quality KPIs. Here's how it translates into actionable outcomes:

Prioritizing critical suppliers: Through AHP, the company can identify suppliers with the weakest quality performance, enabling targeted corrective actions or exploring alternative partnerships.

Optimizing resource allocation: By focusing on high-performing suppliers, the company can allocate resources more efficiently and strengthen relationships with strategic partners.

Continuous improvement of customer-supplier relationships is crucial for maintaining an agile and effective supply chain. Leveraging the insights gained from AHP-based evaluations, the company can implement differentiated pricing strategies tailored to the performance of each supplier: incentives for high-performing suppliers: Offering more favorable payment terms or long-term contracts to suppliers who excel in quality metrics,
adjusting pricing negotiations for suppliers needing improvement, based on their impact on the company's strategy vision.

By optimizing these relationships, the automotive industry can adapt more quickly to market fluctuations, ensuring that its suppliers align with evolving strategic priorities. This approach enables the company to deliver added value to customers in terms of quality, reliability, and innovation. The findings from this research pave the way for continuous improvements to develop a more intelligent and responsive supply chain.

Our research has certain limitation, such as limitations of the AHP Method, this approach relies on subjective judgment, which may introduce bias into the decision-making process. Moreover, in this article we take the case of automotive industries that can make the difference, if we choose another sector, it must be a necessity to change the selection criteria to meet the requirements and characteristics of each sector. Building on the findings and limitations of this study, several potential avenues for future research could help deepen our understanding of supplier selection and performance evaluation in the automotive industry and beyond; Industry 4.0 technologies like IoT, AI, and big data analytics are being adopted by the automotive industry for effective supply chain management. The role of these tools in improving the evaluation phase where suppliers are evaluated based on their performance and risk forecasting could also be identified by future research. this research examines of machine learning methods would reduce subjectivity and provide a more data-driven approach to supplier selection., Further research could also have a specific issue such us a subject to treat impact of collaborative risk-sharing mechanisms on supplier performance and how these can contribute to a smart supply chain of tomorrow.

By leveraging methodologies such as AHP and ABC analysis, this integrated approach enables automotive companies to successfully navigate towards a smart, future-proof supply chain. Ensuring that every supplier aligns with objectives related to quality, cost, flexibility, and sustainability allows companies to not only meet current market demands, but also to anticipate future industry trends.

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