Revista de Ciencias Tecnológicas (RECIT). Universidad Autónoma de Baja California ISSN 2594-1925
Volumen 9 (3): e492. Julio-Septiembre, 2026. https://doi.org/10.37636/recit.v9n3e492

Estudio de casos

An analytical framework for country-of-origin determination in Mexican-assembled products within a nearshoring context

Un marco analítico para la determinación del país de origen en productos ensamblados en México: implicaciones para el nearshoring

Francisco Iván Franco-Ortiz, Diana Sánchez-Partida, Patricia Cano-Olivos, Santiago Omar Caballero-Morales

Faculty of Engineering, Logistics, Manufacturing and Automotive (FILMA), UPAEP – SECIHTI Puebla, 21 South 1103 Barrio Santiago C.P 72410, Puebla, México.

Corresponding author: Francisco-Ivan Franco-Ortiz, Faculty of Engineering, Logistics, Manufacturing and Automotive (FILMA), UPAEP – SECIHTI Puebla, 21 South 1103 Barrio Santiago C.P 72410, Puebla, México. E-mail: franciscoivan.franco@upaep.edu.mx. ORCID: 0009-0000-5083-6437.

Received: April 29, 2026 **Accepted:** August 25, 2026 **Published:** September 11, 2026

Abstract. - *This paper analyzes the elements that US Customs and Border Protection (CBP) considers when determining a product's country of origin. It also provides an in-depth assessment of the manufacturing capabilities of potential suppliers for a weighing product, followed by a comparison of the results obtained through the Analytic Hierarchical Process (AHP) method. The findings show that a product assembled in Mexico that contains components from other countries can still be declared as "Mexican" if suppliers can demonstrate that the materials used to manufacture the product undergo a substantial transformation within Mexico. Therefore, transferring operations from China to Tijuana is feasible, and once the components from Mexican suppliers are approved by the company, there will be a 25% reduction in product cost due to the elimination of tariffs on exporting Chinese-made products to the US.*

Keywords: Manufacturing; Substantial transformation; Tariffs; Country of origin; Procurement.

Resumen. - *Este trabajo analiza los aspectos que conforman el país de origen de un producto ante el Departamento de Protección de Aduanas y Fronteras de los Estados Unidos, además de realizar un análisis exhaustivo de las capacidades de manufactura de los proveedores potenciales de un producto de pesaje, para luego comparar los resultados obtenidos mediante el método de Análisis Hierárquico de Procesos (AHP). Los resultados muestran que es posible declarar un producto ensamblado en México como mexicano ante las aduanas estadounidenses, siempre y cuando los proveedores puedan comprobar que el material que fabrican sufre transformación substancial dentro de México, por lo que se concluye que la transferencia de operaciones planteada desde China a Tijuana es factible, y, que una vez que los componentes de los proveedores mexicanos sean aceptados por la compañía, habrá un 25% de ahorro en el costo del producto, resultante por la eliminación del pago de los aranceles de exportar producto chino hacia Estados Unidos.*

Palabras clave: Manufactura; Transformación sustancial; Aranceles; País de origen; Proveeduría.

1. Introduction

The commercial war between China and the United States has been escalating in recent years. Since 2018, the 25% tariffs imposed by the US to Chinese products [1] have generated significant impacts in the global supply chains across the world affecting the manufacturing costs and the profit margins of companies who rely on Chinese components, which has pushed the manufacturing industry to redesign their supply network, favoring the creation of new localization strategies that are more resilient and less dependent on Asian markets, this phenomena is now known as "*nearshoring*".

The war on tariffs represents an outstanding opportunity for Latin American countries [2], especially for Mexico, which is attractive to nearshoring given its proximity to the US and its commercial agreements.

Studies conducted between 2020 and 2023 [3] show that the nearshoring strategies adopted by companies resulted in a 5.2% improvement in Mexico's manufacturing sector, and, simultaneously, increased the foreign investment by 11.4%.

In terms of money, specifically regarding China, its investment in Mexico totaled 1,041.1 million dollars between 2018 and 2022 [4], most of which was directed to the manufacturing sector.

A comparison of exports to the US from Mexico and China after the COVID-19 pandemic. While both countries recovered promptly, Mexico saw improvements in its supply chains, indicating that both countries suffered disruptions. While both countries found ways to recover promptly, Mexico saw improvements in its exports after the pandemic, while China did not [5]. This could suggest that some companies have deviated part of their supply networks from China to Mexico.

When a component's source of supply is subbed, one must declare its country of origin, as it is the component's "passport" that determines whether it can enter a given country, its tariffs, and its labeling instructions [6]. When an assembly contains different components originating from different countries, a detailed analysis must be conducted to determine which country of origin should be declared to customs.

An incorrect declaration of an assembly's country of origin may result in severe audits by the CBP, slower cross-border operations, and even the loss of the exporting fee [7].

In this context, determining the country of origin for products with components sourced from multiple countries becomes a critical challenge for companies seeking to optimize costs while ensuring regulatory compliance. This study examines the criteria used by the U.S. Customs and Border Protection and evaluates supplier capabilities for key components of a weighing product.

1.1. Problem Context

This work focuses on Mettler-Toledo, a leading manufacturer of weighing and analytical instruments, whose operations in China are experiencing margin erosion due to tariffs on products exported to the United States. Based on the criteria established by U.S. Customs and Border Protection for determining a product's country of origin, the study analyzes the feasibility of transferring production processes to Mexico, assessing local supplier capacity and the potential for substantial transformation to mitigate tariff

ISSN 2594-1925

impacts. The article contributes to the literature on nearshoring and the reconfiguration of supply chains amid increasing trade protectionism.

The goal of transferring operations from China to Mexico is to classify scales manufactured in Mexico as "Made in Mexico" when exporting them to the United States and the rest of the world, even when these scales contain components from China. Simply manufacturing in Mexico is not sufficient to claim the "Made in Mexico" label; there is more to it.

A finished good's country of origin is determined by its design, the manufacture of its components, and its final assembly. The key is identifying which components are critical to the products' functionality, and, in complex products, such as electronic scales, this assessment requires a detailed analysis of the products' bill of materials, just like the one Mettler Toledo performed on their scales, where the company has determined the critical components of a scale are the printed circuit board assembly (PCBA), the platter, the spider and the load cell.

The purchasing and compliance department of Mettler-Toledo examined all sourcing options for the scales' critical components under case number #N311705. It recognized that there is no determining factor in evaluating a product's country of origin. The findings show that the best scenario for declaring the scales as "Made in Mexico" is alternative #1 in table #1, where 3 of 4 critical components are sourced from Mexican suppliers, and 1 is sourced from a Chinese supplier.

Table 1. Alternatives to declaring Mettler-Toledo's scale as "Made in Mexico" based on the country of origin of its critical components.

	COO PCBA	COO Platter	COO Spider	COO Cell	% COO MEX
Alt. 1	**MX**	**MX**	**MX**	**CN**	**65% - 70%**
Alt. 2	**MX**	**MX**	**CN**	**CN**	**35% - 50%**
Alt. 3	**MX**	**CN**	**CN**	**CN**	**15% - 35%**
Alt. 4	**CN**	**CN**	**CN**	**CN**	**0% - 15%**

Based on this, developing local suppliers is a key strategy to strengthen competitiveness in the industrial sector, as building relationships with suppliers enables organizations to reduce costs, improve product quality, and ensure the supply of components [9]. These practices have strengthened Mexico's value chain. Relocating suppliers, government incentives, and the creation of strategic industrial clusters prove the country's ability to develop technical, competent, and specialized supply bases.

1.2. Evaluation criteria on developing Mexican suppliers for the critical components of a scale

1.2.1 Printed Circuit Board Assembly (PCBA)

A printed circuit board assembly is integrated in mostly all the modern electronic products. It is made from integrated chips, capacitors, resistors, and switches, which are positioned and soldered on a board specifically designed for a given product, as shown in Figure 1.

ISSN 2594-1925

Figure 1. Printed Circuit Board Assembly (PCBA).

In Mettler-Toledo's scales, the PCBA interprets the information given by the load cell and transfers the weight of a product into the scale's display.

Due to the designs' specifications, Mettler-Toledo's PCBAs must undergo an In-Circuit Test (ICT) to guarantee the assembly sequence has been thoroughly followed and to discard any possible defects on the electronic components, and a Functional Circuit Test (FCT) after being turned on, so the voltage, frequency, and current can be evaluated.

Both tests carry additional costs, which are factored into the non-recurring engineering (NRE) charges suppliers estimate. It is evaluated as a decision variable in the PCBA bidding process, along with PCBA costs, suppliers' locations, components' markups, assembly costs, sales, general, and administrative costs (SG&A), and lead time.

The quote request (RFQ) was issued for a volume of 10,000 units per year. More than fifteen suppliers were identified, and after carefully reviewing each site's location and capacity and discarding those that did not meet Mettler-Toledo's quality standards, just 5 suppliers were invited to participate.

Figure 2 shows the location of the suppliers invited to the PCBA RFQ.

Figure 2. Map of Mexican suppliers for PCBAs

ISSN 2594-1925

To protect the company's intellectual property, the 5 suppliers were asked to sign a Non-Disclosure Agreement (NDA) before proceeding with the RFQ, but only 4 agreed.

An NDA clearly defines what information should be treated as "confidential" and establishes how it should and should not be accessed [11].

All files needed to produce a quote for the PCBA design were shared with the 4 suppliers who signed the NDA, but only 2 submitted proposals on time.

Table 2 compares the suppliers' bids. Note that this study does not show actual costs; the price displayed is a "should-cost" model developed by Mettler-Toledo's strategic sourcing team. The percentages shown in each vendor section indicate how close or far they fell from the baseline price used [12].

Table 2. PCBA Quote Comparison: Displaying the Evaluation Criteria and Contrasting Against the Company's "Should Cost" Model.

	LOCATION	COST	MARK-UP	ASSEMBLY	SG&A	PROFIT	NRE	LEAD TIME
SHOULD COST MODEL	**TJ**	**$20.35**	**$0.85**	**$4.15**	**$1.45**	**$1.50**	**$15k**	**20 WEEKS**
PCBA SUPPLIER 1	**TJ**	**+12%**	**-71%**	**-20%**	**-35%**	**+5%**	**+37%**	**0%**
PCBA SUPPLIER 2	**CJS**	**-11%**	**+93%**	**+20%**	**+36%**	**-6%**	**-12%**	**-10%**

1.2.2 Platter

It is plate-shaped, as shown in Figure 3, and made of "304" stainless steel. This is the component where the products being weighted rest while the weighting function is being executed.

It consists of an exterior radius and an interior radius, with a height difference between them large enough for another component called "Spider" to fit. The Spider's function is to transfer the weight of a product to the load cell.

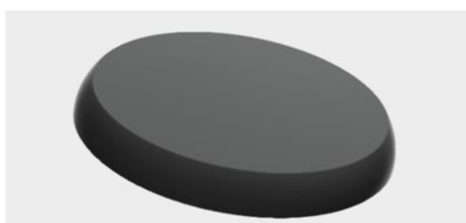

Figure 3. Platter.

After reviewing 14 sheet metal stamping suppliers in the Baja California region and evaluating their size and location, 4 suppliers were shortlisted for the execution of the NDA portion of the bid.

Figure #4 shows the location of the suppliers invited to the platter RFQ.

ISSN 2594-1925

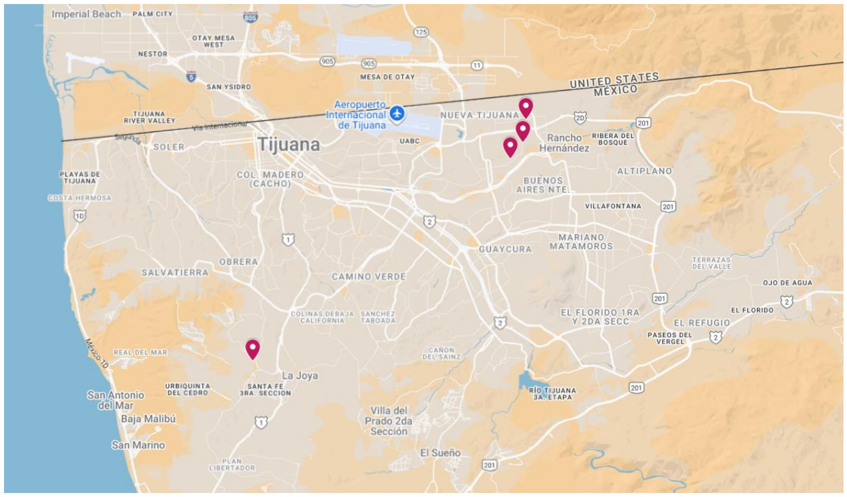

Figure 4. Map of Mexican suppliers for stainless steel platter.

The 4 suppliers agreed to the NDA's terms and conditions, and the 2D & 3D files needed to produce a quote were shared with them, along with all cosmetic specifications and the material safety data sheet (MSDS) for the protective rubber installed after stamping. The comparison of the quotes is shown in Table 3.

Table 3. Platter quote comparison: displaying the evaluation criteria and contrasting against the company's "should cost" model.

	LOCATION	MATERIAL	RUBBER	ASSEMBLY	TOOLING	LEAD TIME
SHOULD COST MODEL	**TJ**	**304**	**ROHS**	**$15.70**	**$6,500**	**20**
PLATTER SUPPLIER 1	**TJ**	**304**	**ROHS**	**+43%**	**-32%**	**-10%**
PLATTER SUPPLIER 2	**TJ**	**304**	**ROHS**	**-43%**	**+22%**	**0%**

1.2.3 Spider

Casted from ADC12 Aluminum, this component sits within the Platter and helps balance the product's weight and prevent reading errors in the load cell during the weighting process.

Figure 5. Spider.

ISSN 2594-1925

A handful of suppliers with aluminum die-casting capabilities expressed interest in bidding on 10,000 units, most of them based in the country. Figure 6 maps the location of the vendors invited to sign an NDA for this opportunity.

Figure 6. Map of Mexican suppliers for aluminum spider.

The 5 interested suppliers received a physical sample of the Spider, along with the 2D and 3D files needed to quote.

Table 4 shows a contrast between the should-cost model generated by Mettler-Toledo's strategic sourcing team and the results from two different suppliers.

Table 4. Spider quote comparison: displaying the evaluation criteria and contrasting against the company's "should cost" model.

	LOCATION	MATERIAL	DIE CAST	MACHINING	PAINTING	PACKAGING	NRE	LEAD TIME
SHOULD COST MODEL	MEX	\$0.65	\$1.45	\$3.50	\$2.50	\$0.07	\$32,500	20
ADC12 DC SUPPLIER 1	MEX	+28%	+34%	NQ	NQ	-38%	+11%	+20%
ADC12 DC SUPPLIER 2	MEX	-34%	-43%	NQ	NQ	+8%	-12%	-20%

Since none of the identified suppliers has machining or painting capabilities, the company will need to assess whether these jobs will be performed in its own machining center or sent to a third party.

1.2.4 Load cell

Its function is to convert the weight into an electrical signal, which the PCBA then interprets and displays on the scale's screen.

ISSN 2594-1925

The weighting occurs when an object rests on a platform-platter, which transmits the object's weight to the load cell, where a slight nuclear deformation results from the applied force. This creates a voltage signal that the PCBA processes, then displays a visible message to the user on the scale's screen.

Figure 7. Load cell.

Per Mettler-Toledo's decision, the load cell will not be procured in Mexico. Figure #8 shows the location of the load cell supplier in China.

Figure 8. Map of a Chinese supplier of the load cell.

2. Literature Review

This study applies the Analytical Hierarchy Process (AHP) to identify the best combination of Mexican suppliers for 3 out of 4 critical components on the assembly of a Mettler-Toledo scale.

The AHP method is a decision-making tool often used to address multiple variables in a problem. Thomas L. Saaty developed this methodology in the 1970's. It was published in the 1980s, and, according to Saaty himself, the AHP method consists of creating a comparative framework for evaluating variables, in which the user compares alternatives and combines the results to identify the best decision [13].

Like studies that use the AHP method to select suppliers [14], this study follows the AHP method to identify Mexican suppliers for 3 critical-to-function components.

The AHP method consists of 6 stages [15] where: 1) The problem is defined, 2) The evaluation criteria are defined, 3) The alternatives are defined, 4) Hierarchy is defined, 5) Comparisons are made, 6) Results are calculated, and decisions are made.

Similar studies [16] use the AHP method to evaluate suppliers, with the decisive factors often including material costs, quality procedures, discounts offered, delivery time, and compliance, among others.

ISSN 2594-1925

Slight variations in the decisive factors have been reported in other studies [17], but, due to the nature of this work and the key differences between each critical-to-function component in Mettler-Toledo's scale, each component needs its own selection criteria; therefore, 3 AHP processes will be needed.

Although the AHP methodology has been used in works focused on the country of origin, little has been done to explore the correct classification of a product for export purposes, much less when a complex assembly carries a wide array of components in its bill of materials from different countries.

Researchers have used the AHP method focusing on the country of origin [18]. Still, the main goal was to minimize supply risks. Other works [19] utilize the AHP method to evaluate which aspects influence Indian consumers' selection of a given product from specific countries. Another study [20] challenges the effectiveness of declaring a product's correct country of origin in the Moroccan market. In contrast, another study [21] compares decision-making factors in domestic or imported vehicles on the Iranian market. Still, no other article focuses on the correct categorization of a product's country of origin as this work does.

3. Methodology

To improve the understanding of the methodology, Figure 9 presents a process flow diagram that summarizes the evaluation framework, from the identification of critical components and supplier selection to the application of the AHP model and the final country-of-origin determination.

For the AHP model, this work uses the Saaty scale [22] for each critical-to-function component of Mettler-Toledo's scale, as each supplier must be evaluated according to different needs and capacities.

The weighing of all variables in the AHP matrices used in this study was verified using equation (1), in which a CR value < 1 is considered successful.

$$CR = \frac{\mathrm{CI} = \dfrac{(\mathrm{Nmax} - \mathrm{N})}{(N-1)}}{\mathrm{RI} = \dfrac{(1.98) * (N-2)}{N}} \qquad (1)$$

Where:

- ✓ *CR = Consistency Ratio*
- ✓ *CI = Consistency Index*
- ✓ *RI = Random Index*
- ✓ *Nmax = Sum of the multiplication of the variable matrix by the obtained weights*
- ✓ *N = Number of criteria*

ISSN 2594-1925

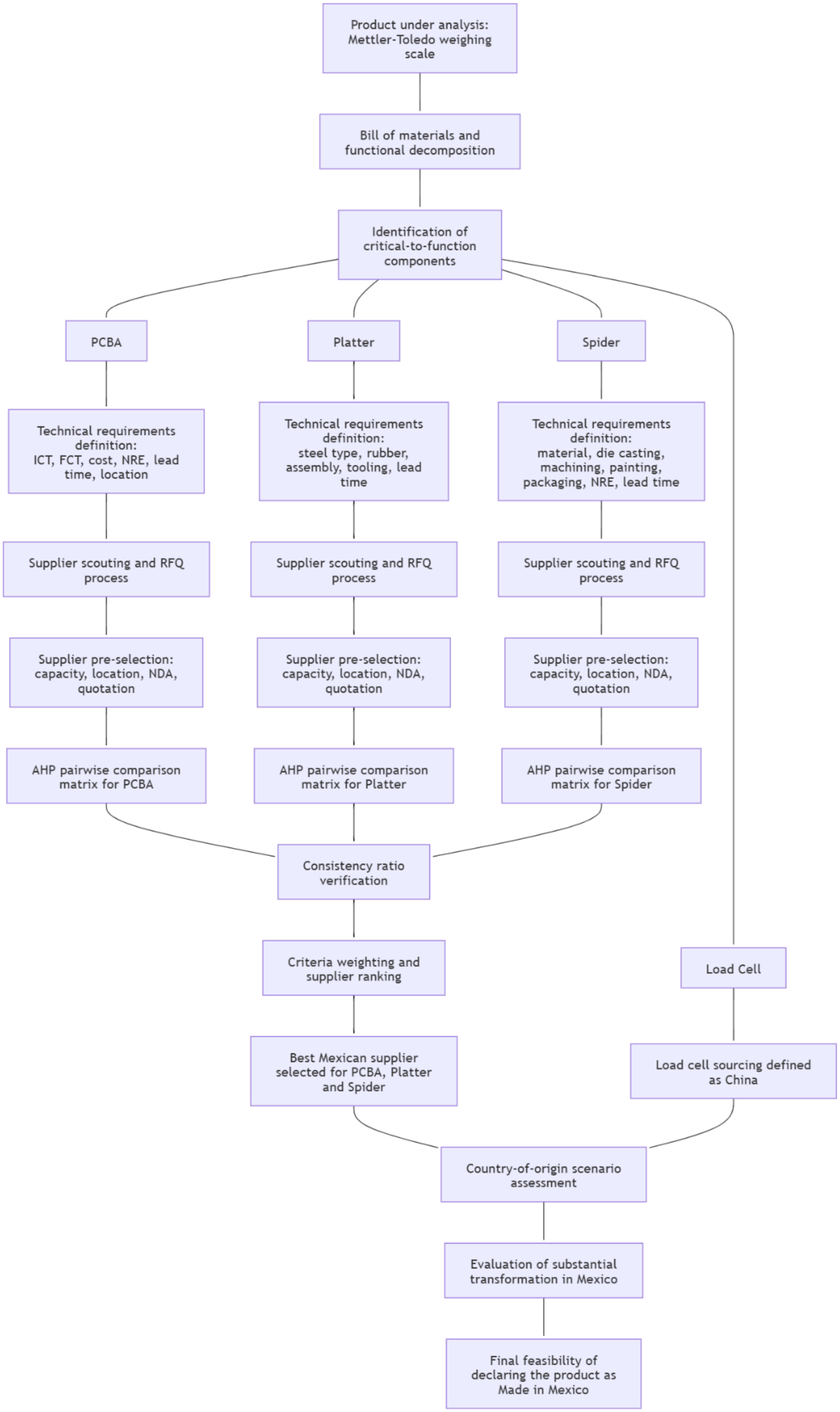

Figure 9. Diagram process flow: component identification, AHP-based selection, and country-of-origin determination.

ISSN 2594-1925

4. **Results**

4.2. AHP Method applied to PCBA bids

The weighting of the AHP matrices helped identify the priority of each of the PCBA's variables. Equation (2) confirmed that the weighting was successful, yielding a consistency ratio of 0.0981. The AHP method indicates that a CR value <1 is considered acceptable.

$$CR = \frac{0.1285}{1.4850} \qquad (2)$$

The evaluation criteria for the PCBA evaluation are:

1. Location
2. Cost
3. Mark-Up
4. Assembly
5. Sales, General & Administration
6. Profit
7. NRE Charges
8. Lead Time

In summary:

- ✓ Location is 7 times more important than the material cost, and 3 times more important than the NRE and lead time.
- ✓ Mark-Up is 3 times more important than location and other factors.
- ✓ The assembly cost is 3 times more important than location and other factors.
- ✓ SG&A is 3 times more important than location and other factors.
- ✓ Profit is 2 times more important than mark-up and SG&A, and 3 times more important than location and assembly. Cost.
- ✓ NRE is 3 times more important than material cost and lead time.
- ✓ Lead time is 3 times more important than material cost.

Table #5 provides a detailed overview of the judgment relationships, Table #6 presents the criteria weighting, and Table #7 shows the application of these variable weightings for each PCBA supplier based on the results of their quotations.

ISSN 2594-1925

Table 5. Comparative prioritization of PCBA cost drivers and key decision factors.

	Location	Material	Mark-UP	Assembly	SG&A	Profit	NRE	Lead Time
Location	1	1/7	3	3	3	3	1/3	1/3
Material	7	1	7	7	7	9	3	3
Mark-Up	1/3	1/7	1	1/3	1/3	2	1/3	1/3
Assembly	1/3	1/7	3	1	3	3	1/3	1/3
SG&A	1/3	1/7	3	1/3	1	2	1/7	1/5
Profit	1/3	1/9	1/2	1/3	1/2	1	1/7	1/5
NRE	3	1/3	3	3	7	7	1	1/3
Lead Time	3	1/3	3	3	5	5	3	1
TOTAL	**15.33**	**2.35**	**23.50**	**18.00**	**26.83**	**32.00**	**8.29**	**5.73**

Table 6. AHP weighting for PCBAs.

	AHP Normalized Comparison Matrix								Weighting
Location	0.07	0.06	0.13	0.17	0.11	0.09	0.04	0.06	**0.09**
Material	0.46	0.43	0.30	0.39	0.26	0.28	0.36	0.52	**0.37**
Mark-Up	0.02	0.06	0.04	0.02	0.01	0.06	0.04	0.06	**0.04**
Assembly	0.02	0.06	0.13	0.06	0.11	0.09	0.04	0.06	**0.07**
SG&A	0.02	0.06	0.13	0.02	0.04	0.06	0.02	0.03	**0.05**
Proft	0.02	0.05	0.02	0.02	0.02	0.03	0.02	0.03	**0.03**
NRE	0.20	0.14	0.13	0.17	0.26	0.22	0.12	0.06	**0.16**
Lead Time	0.20	0.14	0.13	0.17	0.19	0.16	0.36	0.17	**0.19**

Table 7. AHP weighting Applied to PCBA quotes.

	Location	Material	Mark-Up	Assembly	SG&A	Profit	NRE	Lead Time	Priority
PCBA Supplier 1	0.75	0.42	1.00	0.75	0.83	0.44	0.44	0.44	6.6
PCBA Supplier 2	**0.25**	**1.25**	**0.20**	**0.25**	**0.17**	**1.33**	**1.33**	**1.33**	**10.1**
TOTAL	1.00	1.67	1.20	1.00	1.00	1.78	1.78	1.78	

The application of the AHP method enabled a structured evaluation of the decision criteria and supplier alternatives for each critical component. For the PCBA, the comparison matrix on Table 5 and its normalized results (Table 6) reveal that material cost, lead time, and NRE are the most influential factors, indicating a strong emphasis on cost efficiency and supply responsiveness.

When these weights are applied to the supplier quotations in Table 7, Supplier 2 achieves a higher overall priority (10.1 vs. 6.6) due to its superior performance on high-impact variables such as material cost, NRE, and lead time. This outcome demonstrates how the AHP framework integrates multiple criteria beyond unit price, providing a more robust and balanced supplier selection.

ISSN 2594-1925

4.3. AHP Method applied to Platter bids

The weighting in the AHP matrices helped identify the priority of each variable to be evaluated for the Platter. It was verified that the weighting was carried out successfully using (3), yielding a result of 0.0865. The AHP method indicates that a CR value < 1 is considered acceptable.

$$CR = \frac{0.1285}{1.4850} \qquad (3)$$

The criteria used for the Platter were:

1. Location
2. Type of Steel
3. Type of Rubber
4. Assembly Cost
5. NRE Charges
6. Lead Time

In summary:

- ✓ Location is 5 times more important than material type and other factors.
- ✓ Material type is 3 times more important than material cost.
- ✓ Rubber type is 5 times more important than location.
- ✓ NRE is 7 times more important than location.
- ✓ Lead time is 5 times more important than material type.

Table #8 provides a detailed comparison of the criteria, Table #9 presents the criteria weighting, and Table #10 shows the application of these variable weightings for each Platter supplier based on the results of their quotations.

Table 8. Comparative prioritization the platter’s cost drivers and key decision factors.

	Location	Steel	Rubber	Assembly	NRE	Lead Time
Location	1	1/5	5	1/3	7	5
Steel	5	1	5	1/3	3	5
Rubber	1/5	1/5	1	1/3	3	3
Assembly	3	3	3	1	5	1/3
NRE	5	1/3	1/3	1/5	1	1/3
Lead Time	5	1/5	1/3	3	5	1
TOTAL	**19.20**	**4.93**	**14.67**	**5.20**	**24.00**	**14.53**

ISSN 2594-1925

Table 9. AHP weighting for platters.

	AHP Normalized Comparison Matrix						Weighting
Location	0.05	0.01	0.26	0.02	0.36	0.26	**0.16**
Steel	0.26	0.05	0.26	0.02	0.16	0.26	**0.17**
Rubber	0.01	0.01	0.05	0.02	0.16	0.16	**0.07**
Assembly	0.16	0.16	0.16	0.05	0.26	0.02	**0.13**
NRE	0.26	0.02	0.02	0.01	0.05	0.01	**0.06**
Lead Time	0.26	0.01	0.02	0.16	0.26	0.05	**0.13**

Table 10. AHP weighting applied to platter quotes.

	Location	Steel	Rubber	Assembly	NRE	Lead Time	Priority
Platter Supplier 1	0.50	0.28	0.50	0.10	2.30	0.50	8.7
Platter Supplier 2	**0.50**	**2.50**	**0.50**	**0.90**	**0.46**	**0.50**	**10.6**
TOTAL	1.00	2.78	1.00	1.00	2.76	1.00	

The comparison matrix in Table 8 and the resulting weights in Table 9 show a more balanced distribution across criteria, with steel type, location, assembly, and lead time emerging as key drivers.

The weighted evaluation on Table 10 identifies Supplier 2 as the preferred option due to its stronger performance in critical technical and cost-related variables.

4.4. AHP method applied to Spider bids

The weighting in the AHP matrices helped identify the priority of each variable to be evaluated for the Spider. It was verified that the weighting was carried out successfully using (4), yielding a result of 0.0918. The AHP method indicates that a CR value < 1 is considered acceptable.

$$CR = \frac{0.1364}{1.4850} \qquad (4)$$

The criteria used to evaluate Spider were:

1. Location
2. Material Cost
3. Casting Cost
4. Machining Cost
5. Painting Cost
6. NRE Charges
7. Lead Time

In summary:

ISSN 2594-1925

- ✓ Location is 5 times more important than material cost and other factors.
- ✓ Machining & Painting costs are 7 times more important than material costs.
- ✓ Packaging cost is 9 times more important than material cost.
- ✓ NRE charges are 3 times more important than lead time.

Table 11 provides a detailed comparison of the criteria, Table 12 presents the criteria weighting, and Table 13 shows the application of these variable weightings for each Spider supplier based on the results of their quotations.

Table 11. Comparative prioritization the spider's cost drivers and key decision factors.

	Location	Material	Casting	Machining	Painting	Packaging	NRE	Lead Time
Location	1	1/5	2	2	2	2	1/5	1/7
Material	5	1	7	7	7	9	3	3
Casting	1/2	1/7	1	1/3	3	2	1/3	1/5
Machining	1/2	1/7	3	1	3	3	1/3	1/5
Painting	1/2	1/7	1/3	1/3	1	2	1/7	1/5
Packaging	1/2	1/9	1/2	1/3	1/2	1	1/7	1/5
$ NRE	5	1/3	3	3	7	7	1	1/3
Lead Time	7	1/3	5	5	5	5	3	1
TOTAL	**20.00**	**2.41**	**21.83**	**19.00**	**28.50**	**31.00**	**8.15**	**5.28**

Table 12. AHP weighting of the spider.

	AHP Normalized Comparison Matrix								Weighting
Location	0.05	0.08	0.09	0.11	0.07	0.06	0.02	0.03	**0.06**
Material	0.25	0.42	0.32	0.37	0.25	0.29	0.37	0.57	**0.35**
Casting	0.03	0.06	0.05	0.02	0.11	0.06	0.04	0.04	**0.05**
Machining	0.03	0.06	0.14	0.05	0.11	0.10	0.04	0.04	**0.07**
Painting	0.03	0.06	0.02	0.02	0.04	0.06	0.02	0.04	**0.03**
Packaging	0.03	0.05	0.02	0.02	0.02	0.03	0.02	0.04	**0.03**
NRE	0.25	0.14	0.14	0.16	0.25	0.23	0.12	0.06	**0.17**
Lead Time	0.35	0.14	0.23	0.26	0.18	0.16	0.37	0.19	**0.23**

Table 13. AHP weighting applied to spider quotes.

	Location	Material	Casting	Machining	Painting	Packaging	NRE	Lead Time	Priority
Spider Supplier 1	0.50	2.00	1.50	0.50	0.50	0.30	1.00	1.50	6.4
Spider Supplier 2	**0.50**	**0.29**	**0.30**	**0.50**	**0.50**	**1.50**	**0.33**	**0.30**	**13.3**
TOTAL	1.00	2.29	1.80	1.00	1.00	1.80	1.33	1.80	

ISSN 2594-1925

The comparison matrix for the Spider, shown in Table 11, highlights the dominance of material cost, lead time, and NRE, reflecting the importance of manufacturing complexity and raw material impact. The final evaluation from Table 12 shows a significant advantage for Supplier 2, confirming its competitiveness across the most relevant criteria. Overall, the results consistently demonstrate that Supplier 2 provides the best alternative for each component, supporting the feasibility of sourcing critical parts locally under a nearshoring strategy.

5. Discussions

Due to the adaptiveness nature of the AHP method, it can be used as a multi-criteria decision-making tool during the supplier selection process. Evidence suggests that this methodology can support different industries; a study for the automotive industry considered delivery, price, quality, and service as the main weighting items [14].

And while the AHP method has been used on “hybrid ensemble” scenarios [23], there is no evidence of its application to define a product’s country of origin based on its subcomponents -until today.

5.1. Future research

This study focuses specifically on assessing the country of origin of critical-to-function components on weighing scales; however, the determination of a product’s country of origin can be carried out in the same fashion for any assembly whose components originate from different countries. Future research may reference this work to examine which components are critical to the functionality of an assembled product, enabling more effective strategies for developing local suppliers.

Studies such as the one conducted by this company’s customs compliance team help establish precedents regarding the importance of product-specific expertise. They may also lead to the creation of new jobs within companies that require technical knowledge to be conveyed to customs authorities. This would require a framework for identifying or developing subject-matter experts [24], with a specific focus on the product’s assembly being submitted to the United States Customs and Border Protection (CBP).

6. Conclusions

Understanding that in the case of complex products such as scales—which contain components originating from different countries—assembling in Mexico is not sufficient to declare its exporting documents as ‘made in Mexico,’ this study provides a detailed evaluation of the functionality of the product in question and, in collaboration with the customs compliance department and the United States Customs and Border Protection agency, develops a case study that identifies which critical components must be manufactured in Mexico for the scale to be declared as Mexican. This helps avoid additional charges when importing or exporting the product, resulting from the tariff increases imposed since 2018.

Considering all scenarios evaluated by customs compliance subject matter experts, and contemplating that 3 of 4 critical-to-function components will be sourced in Mexico, Table 14 projects a probability of 65% to 70% that the whole assembly can be declared as “Made in Mexico”, which is sufficient for Mettler-Toledo to allow the progress of the project, even if the load cell will remain being sourced from China.

ISSN 2594-1925

Table 14. Probability of Declaring Mettler-Toledo's Scale as "Made in Mexico" with the selected suppliers.

	PCBA	Platter	Spider	Load Cell	% COO MEX
Mettler-Toledo's Scale	MX PCBA Supplier #2	MX Platter Supplier #2	MX Spider Supplier #2	CN Load Cell Supplier	65% - 70%

The results show that a reduction of 25% in the product's cost resulting from eliminating tariffs is feasible, and can be reached once the 3 critical-to-function components being sourced in Mexico have been tested and validated by Mettler-Toledo's engineering and quality department, and once the logistics team notifies the port authority about these changes. The product's country of origin is classified properly as Mexico.

In conclusion, the determination of a finished product's country of origin is driven by the functional relevance of its critical-to-function components rather than by the total number of parts manufactured domestically. It is further recommended that firms systematically document and preserve all evidence related to the country-of-origin analysis of each component, as a preventive measure in anticipation of potential audits or requests from customs authorities.

7. Authorship acknowledgement

Francisco-Ivan Franco-Ortiz: Ideation; Data analysis; Writing; Original draft. *Diana Sánchez-Partida:* Methodology; Writing; Review and editing. *Santiago-Omar Caballero-Morales:* Methodology; Methodological guidance. *Patricia Cano-Olivos;* Project Administration.

References

[1] A. Lopez-Peña y R. Mora-Vega, "La Guerra Comercial Entre Estados Unidos y China: Un Enfrentamiento Más Allá De Los Aranceles", *InterSedes*, vol. XX, no. 42, pp. 236-245, 2019, doi: 10.15517/isucr.v20i42.41853.

[2] A. Fernández Hernández y E. Bravo Benítez, "Potencialidad del nearshoring para el desarrollo económico de México", *Región Científica*, vol. 2, no. 2, p. 2023105, 2023, doi: 10.58763/rc2023105.

[3] G. D. Ramírez Sierra, A. A. González Martínez, F. F. Villegas Rojas y M. A. Monroy Cruz, "Impacto del nearshoring en la actividad económica de México (2020-2023)", *Problemas del Desarrollo. Revista Latinoamericana de Economía*, vol. 56, no. 220, pp. 125-152, 2025, doi: 10.22201/iiec.20078951e.2025.220.70230.

[4] J. Romero-Aguilar, "El nearshoring en México y su relación con China, Corea del Sur y Japón", *Revista Mexicana de Estudios sobre la Cuenca del Pacífico*, vol. 1, no. 1, pp. 31-54, 2023, doi: 10.53897/RevPortes.2024.02.02.

[5] T. Stringer y M. Ramírez-Melgarejo, "Nearshoring to Mexico and US Supply Chain Resilience as a Response to the COVID-19 Pandemic", *Findings*, vol. 1, pp. 1-8, dic. 2023, doi: 10.32866/001c.91272.

[6] J. M. Peterson, "Substantial Transformation: The Worst Rule for Determining Origin of Goods - Except for All the Rest", *Vanderbilt Journal of Transnational Law*, vol. 56, no. 4, pp. 1065-1097, 2023. [En línea]. Disponible en: https://scholarship.law.vanderbilt.edu/vjtl/vol56/iss4/3

[7] V. C. Jones y M. R. Rosenblum, "U.S. Customs and Border Protection: Trade Facilitation, Enforcement, and Security", Congressional Research Service, Informe R43014, mar. 2013. [En línea]. Disponible en: https://ecommons.cornell.edu/server/api/core/bitstreams/818204ef-3bf4-41d0-9fbf-4904dac87b3b/content

ISSN 2594-1925

[8] S. A. Mack, “The country of origin, marking and application of Section 301 remedies of the FreshBase retail scale”, U.S. Customs & Border Protection, 2020. [En línea]. Disponible en: https://rulings.cbp.gov/search?term=8423.81.0030

[9] M. Ahmed y L. Hendry, “Supplier development literature review and key future research areas”, *International Journal of Engineering and Technology Innovation*, vol. 2, no. 4, pp. 293-303, 2012.

[10] Y. Crama, J. Van De Klundert y F. C. R. Spieksma, “Production planning problems in printed circuit board assembly”, *Discrete Applied Mathematics*, vol. 123, nos. 1–3, pp. 339–361, 2002, doi: 10.1016/S0166-218X(01)00345-6.

[11] P. Witman, “The art and science of non-disclosure agreements”, *Communications of the Association for Information Systems*, vol. 16, pp. 259-270, 2005, doi: 10.17705/1CAIS.01611.

[12] E. M. Shehab y H. S. Abdalla, “Manufacturing cost modelling for concurrent product development”, *Robotics and Computer-Integrated Manufacturing*, vol. 17, no. 4, pp. 341–353, 2001, doi: 10.1016/S0736-5845(01)00009-6.

[13] T. Saaty, “Fundamentals the Analytic Hierarchy Process”, en *The Analytic Hierarchy Process in Natural Resource and Environmental Decision Making*, (Managing Forest Ecosystems, vol. 3), 2001, doi: 10.1007/978-94-015-9799-9_2.

[14] F. Dweiri, S. Kumar y V. Jain, “Designing an integrated AHP based decision support system for supplier selection in automotive industry”, *Expert Systems with Applications*, vol. 62, pp. 273-283, 2016, doi: 10.1016/j.eswa.2016.06.030.

[15] P. Bhutia y R. Phipon, “Application of AHP and TOPSIS method for supplier selection problem”, *IOSR Journal of Engineering (IOSRJEN)*, vol. 2, no. 10, pp. 43-50, oct. 2012, doi: 10.9790/3021-021034350.

[16] P. Hruska, P. Prusa y D. Babic, “The use of AHP method for selection of supplier”, *Transport*, vol. 29, no. 2, pp. 195-203, 2014, doi: 10.3846/16484142.2014.930928.

[17] G. Rajesh y P. Malliga, “Supplier Selection Based on AHP QFD Methodology”, *Procedia Engineering*, vol. 64, pp. 1283-1292, 2013, doi: 10.1016/j.proeng.2013.09.209.

[18] B. Mirza Murtanza, “Fuzzy-AHP application to country risk management”, *American Business Review*, vol. 21, no. 2, pp. 109-116, 2003.

[19] A. Lohan, A. Ganguly y C. Kumar, “What’s foreign is better? A fuzzy AHP analysis to evaluate factors that influence foreign product choice among Indian consumers”, *International Journal of the Analytic Hierarchy Process*, vol. 12, no. 3, pp. 460-487, 2020, doi: 10.13033/ijahp.v12i3.743.

[20] F. Lambarraa-Lehnhardt, R. Ihle y H. Elyoubi, “How successful is origin labeling in a developing country context? Moroccan consumers’ preferences toward local products”, *Sustainability*, vol. 13, no. 15, Art. no. 8433, 2021, doi: 10.3390/su13158433.

[21] S. Amiri y E. Yousefi, “The comparative analysis of affecting factors on purchasing domestic and imported cars in the Iran Market – Using AHP Technique”, *International Journal of Marketing Studies*, vol. 3, no. 2, pp. 142-150, 2011, doi: 10.5539/ijms.v3n2p142.

[22] T. L. Saaty, “How to make a decision: The analytic hierarchy process”, *European Journal of Operational Research*, vol. 48, no. 1, pp. 9–26, 1990, doi: 10.1016/0377-2217(90)90057-I.

[23] S. Hosseni y A. Khaled, “A Hybrid ensemble and AHP approach for resilient supplier selection”, *Journal of Intelligent Manufacturing*, vol. 30, no. 1, pp. 207-228, 2019, doi: 10.1007/s10845-016-1241-y.

[24] J. Mattoon, “Designing and developing technical curriculum: Finding the right subject matter expert”, *Journal of STEM Teacher Education*, vol. 42, no. 2, Art. no. 5, pp. 61-76, 2005. [En línea]. Disponible en: https://ir.library.illinoisstate.edu/jste/vol42/iss2/5

ISSN 2594-1925

Copyright (c) 2026 Francisco Iván Franco-Ortiz, Diana Sánchez-Partida, Patricia Cano-Olivos, Santiago-Omar Caballero-Morales

This text is protected by a Creative Commons 4.0.

You are free to share—copy and redistribute the material in any medium or format—and adapt the document—remix, transform, and build upon the material—for any purpose, even commercially, provided you comply with the following condition:

Attribution: You must give appropriate credit to the original work, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use of the work.

License summary - Full license text

ISSN 2594-1925