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RESEARCH

# Opportunity Areas and Best Practices in Procurement Management in Metallurgical Companies in Gomez Palacio, Durango, Mexico

## Áreas de oportunidad y mejores prácticas en la gestión de compras en empresas metalmecánicas de Gómez Palacio, Durango, México

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## Abstract

The objective of this work was to identify areas of opportunity in the management of purchases, its operations, and functions in small and medium-sized enterprises in the metalworking sector of Gómez Palacio, Durango, Mexico. The hypothesis proposed was that there are practices in the purchasing area that are managed inefficiently and represent areas of opportunity for improvement, thereby contributing to enhancing the effectiveness and efficiency of the supply chain. To gather the necessary information, a questionnaire designed on Google Forms was applied to a non-probabilistic sample of 13 metalworking companies in the city of Gómez Palacio, Durango, Mexico. Statistical analysis was carried out using the non-parametric Kruskal-Wallis test for small samples and the Chi-square statistic. The maturity test of the practices was performed using the SCOR model (Supply Chain Operations Reference Model). The results, obtained through the identification of weaknesses in the process, allowed for the identification of areas of opportunity in some purchasing practices, as well as specific areas of opportunity for the 13 companies studied.

**Keywords:** Degree of Maturity, Supply Chain, Purchasing, Supplier Selection

**JEL Codes:** M21

## Resumen

El objetivo de este trabajo fue identificar áreas de oportunidad en la gestión de compras, sus operaciones y funciones en pequeñas y medianas empresas del sector metalmecánico de la ciudad de Gómez Palacio, Durango, México. Se planteó la hipótesis de que existen prácticas en el área de compras que se gestionan de manera deficiente y que representan áreas de oportunidad para su mejora contribuyendo con ello a mejorar la eficacia y la eficiencia de la cadena de suministro. Para obtener la información necesaria se aplicó un cuestionario diseñado en Google forms a una muestra no probabilística de 13 empresas del ramo metalmecánico de la ciudad de Gómez Palacio, Durango., México. El análisis estadístico se realizó con la prueba no paramétrica para muestras

pequeñas Kruskal-Wallis y el estadístico Chi cuadrado. La prueba de maduréz de las prácticas se realizó con el uso del modelo SCOR (Supply Chain Operations Reference Model. Los resultados, obtenidos a través de la identificación de debilidades en el proceso, permitieron encontrar áreas de oportunidad en algunas prácticas de compras, asi como también áreas de oportunidad específicas para las 13 empresas estudiadas.

**Palabras Clave:** Grado de Madurez, Cadena de Suministro, Compras, Selección de Proveedores

**Códigos JEL:** M21

## Introduction

The metalworking industry is a fundamental link in the national production framework, providing key machinery and supplies to economic activities such as construction, automotive, mining, and aerospace, among others. In this sense, the metalworking industry has a decisive impact on job creation, requiring a variety of specialists, including operators, mechanics, technicians, welders, electricians, turners, and post-graduate experts, among others (CONACYT, 2020a).

The metalworking industry in Gómez Palacio, Durango, is strategically positioned in terms of connectivity, which allows it to serve as a logistical distribution hub that encourages capital investment in companies within the sector. It is important to highlight the significance of the metalworking experience in the region of study, where important manufacturing groups are dedicated to the production of steel pipes with oilfield specifications, bodywork, metal forms, and export metal furniture (CONACYT, 2020b).

The increasing complexity of supply chains (SC) creates the need to measure and monitor their functioning to assess performance (Vinajera, Marrero, & Crespón, 2020). Purchasing is an essential part of a company as it impacts the organization's ability to achieve its strategic projects (Porter, 1982). Manene (2014) refers to "purchasing" as a key activity for organizations, where inputs are transformed into finished goods, contributing to profitability since purchased materials represent 40-60% of the value of the final product sales. Among the objectives of purchasing management are cost reduction, obtaining quality inputs and services, and thereby achieving profitability and process efficiency (Álzate, 2017).

It is necessary to seek the optimization of supply chain functions, including purchasing, which trigger the effective use of time to contribute to the elimination of unnecessary activities and enhance the profitability of resources. Several factors can lead to deficiencies in the process, such as poor information management, lack of process control, insufficient staff training, poor planning, inadequate communication, and others. These issues can result in customer and process non-compliance, low product quality, inadequate inventories, high costs, and delays in activities, among others.

In recent years, the use of the SCOR model has increased for supply chain management. SCOR® (Supply Chain Operations Reference Model) is a product of the APICS Supply Chain Council (APICS SCC) (APICS, 2021), whose tools for methodology, diagnostics, and benchmarking help organizations diagnose and, if necessary, make changes in their supply chain processes. Among other functions, it allows for diagnosing the maturity level of purchasing practices and supports communication among supply chain partners to improve efficiency and related activities.

The aim of this study was to identify areas of opportunity in the management of purchases, operations, and functions in small and medium-sized metalworking enterprises in the city of Gómez Palacio, Durango, Mexico. The identification of these areas of opportunity was based on an analysis of how purchases and material sourcing are managed, as well as the measurement of the maturity level at which they are carried out. The hypothesis suggests that there are inefficient purchasing practices that represent areas of opportunity for improvement, contributing to enhancing the efficiency of the supply chain.

## Literature Review

In the area of purchasing, Chai & Ngai (2020) state that supplier selection is a sophisticated problem, oriented toward application and decision-making, which is why it has received significant attention. The complexity of supply chains increased due to the global pandemic, which, regardless of the

strategy, resulted in losses beyond the anticipated effects (Kano, Tsang, & Yeung, 2020). Kusrini, Rifai & Miranda (2019) assert that measuring supply chain performance using the SCOR model can lead to process improvements, including purchasing, to enhance market competitiveness. Rizkya et al. (2019) highlight that SCOR is a method proposed by the Supply Ikatrinasari et al. (2020) recommend improving the supply chain with performance measurement results using four criteria: 1) Reliability criterion: order fulfillment compliance, 2) Responsiveness criterion: order fulfillment cycle time, 3) Cost criterion: cost of goods sold, and 4) Asset criterion: effective cycle time.

According to APICS (2021), best practices to evaluate are the maturity level based on the Supply Chain Operations Reference (SCOR) model to determine performance metrics such as planning, sourcing, manufacturing, delivering, returning, and enabling, as well as their performance attributes, namely reliability, responsiveness, agility, cost, and asset management efficiency.

To measure performance, it is necessary to define the objectives pursued in the supply chain processes (Masi, Day & Godsell, 2017). Moreover, Perdana, Usman & Arifiya (2020) define that mapping the supply chain practices of the company is based on SCOR, which serves, among other things, to identify risks, their severity, occurrence, and correlation.

Arone and Ganoza (2020) used the SCOR model for supply chain management in a transportation company. Based on the model's results, they made improvement recommendations to enhance the company's competitiveness. Buitrago et al. (2021) reported deficiencies in the processes of a company, from the logistics of sourcing raw materials to the delivery of the product to the final customer. With the results obtained, a strategy was launched to adjust processes with the aim of organizing, optimizing, and ensuring the management of acquisition and distribution of goods. Cruz (2019) analyzed the supply chain of a pharmaceutical franchise to reduce stockout rates through a proposal based on the SCOR methodology.

Ancajima et al. (2020) argue that proper supply chain management leads to greater efficiencies in an organization's production chain. They used the SCOR model, which enabled them to assess the diagnosis of the five supply chain processes at Nobex Foods S.A. Moreno and Fuentes (2017) applied the planning function of the SCOR model in the manufacturing sector of Bogotá, Colombia. This study also applied the SCOR model to the manufacturing sector in the city of Gómez Palacio, Durango, Mexico.

Bonifacio (2020) mentions that poor coordination and deficiencies in purchasing functions are reflected in poor process management between the sales and distribution areas. This miscoordination causes incorrect, duplicated, and crossed orders. This can be corrected by applying the SCOR methodology, which, through diagnostics, analyzes the strengths and weaknesses of the supply chain process or processes.

## Methodology

The research design used in this study was non-experimental, with a mixed approach, meaning both qualitative and quantitative. The qualitative approach was utilized with a set of 11 open-ended questions employed to evaluate the maturity of purchasing practices, comparing what was evidenced through interviews and the ideal, as established by experts, according to the SCOR methodology (APICS, 2021).

The SCOR model consists of a set of standardized processes and activities with common terminology, best practice information, and references to software tools and their suppliers. The SCOR model allows for describing the business activities necessary to meet customer demand and is organized around five main management processes: Planning (Plan), Sourcing (Source), Manufacturing/Service (Make), Delivery (Deliver), and Return (Return).

The model provides a unique framework that combines Business Processes, Management Indicators, Best Practices, and Technologies into a unified structure to support communication between Supply Chain Partners and improve Supply Chain Management efficiency.

On the other hand, the quantitative approach was used to measure purchasing management through the use of items evaluated on a Likert scale and analyzed with inferential statistics using the non-parametric Kruskal-Wallis test and the Chi-square statistic (Levin and Rubin, 2010). The Kruskal-

Wallis test is the non-parametric equivalent of one-way analysis of variance (ANOVA) and detects differences in the distribution location. Non-parametric tests analyze data that do not require a normal distribution or homogeneity of variances (Lind, Marchal, and Mason, 2004).

In both approaches, a questionnaire was applied to a non-probabilistic sample of 13 small and medium-sized companies in the metalworking sector of Gómez Palacio, Durango, Mexico. The 13 companies are registered in the National Directory of Economic Units (DENUE) of INEGI. The instrument was developed using the Google Forms tool and was sent to the purchasing managers electronically due to the COVID-19 health contingency.

The questionnaire was divided into three sections: 1) general company data, 2) direction (strategic planning, guidelines, and organization), and 3) purchasing practices and supply chain measurement. In this study, the results of section 3 focused on purchasing management were analyzed. The validity and reliability of the instrument were evaluated using Cronbach's alpha (α) statistic.

The minimum acceptable value for Cronbach's alpha coefficient is 0.70; below this value, the internal consistency of the scale used is low. The maximum expected value is 0.90; above this value, redundancy or duplication is considered (Lind, Marchal, and Mason, 2004). In evaluating the instrument used in this study, a value of 0.88 was obtained, indicating that the instrument is reliable. An instrument is reliable when it is consistent in its application, meaning that the results of the test are the same when applied a second time to the same subjects (test-retest or equivalent test).

Table 1 shows the variables analyzed in the study and their measurement scale. The purchasing management variables and the operations and functions variables were evaluated using the Likert scale to capture the perceptions of the interviewees. With the values obtained, their means were calculated and compared using the Kruskal-Wallis test and the Chi-square statistic with a significance level of $\alpha = 0.05$ to analyze potential statistical differences. The practices were valued differently, highlighting those with low values, which, for this study, represented areas of opportunity for improvement. In the case of the better-evaluated practices, they should be maintained to ensure efficient purchasing processes.

As mentioned above, the maturity evaluation of purchasing practices was carried out using the SCOR methodology (APICS, 2021). A set of 25 practices related to the purchasing area were selected from the SCOR catalog. Practices in the supply chain that do not relate to the purchasing area were not considered for this study. Based on the responses obtained, purchasing practices were classified into five categories according to their development or maturity level (Table 2): (a) Primitive practices, (b) Ascending practices, (c) Standard practices, (d) Improved practices, and (e) Emerging practices. The development level of each practice (last column) was based on the classification proposed by SCOR, and the rating (1 to 5) was according to Lockamy and McCormack (2004) to quantify the maturity level of each purchasing practice, as well as of the 13 companies studied.

**Table 1.** Study Variables and Measurement Scale

| Subsection | Scale | Variables |
|---|---|---|
| Purchasing Management | LIKERT SCALE (Level of agreement, from Strongly Agree to Strongly Disagree) | Material requirements, response time to users, budget, supplier evaluation, quotation methods, supplier delivery time, product recipt according to specifications, use of software, years of buyer experience. |
| Operations and Functions in Purchasing | LIKERT SCALE (Always to Never) | Applications in the company related to demand planning and forecasting, projects, information and communication technologies, training of purchasing staff, supplier classification, key performance indicators, risk assessment, and predictive analysis. |
| Best Practices (SCOR) | Open-ended questions, qualitative approach, perception. | Indicators of how raw materials are planned and sourced for demand, alignment of production plans with mechanisms and strategies, evaluation for supplier selection, optimization of inventory, costs, and processes for the flow of raw material sourcing. |

**Table 2.** Evaluation and maturity levels of different purchasing practices in the studied companies.

| Definition | Rating | Level |
|---|---|---|
| (a) Primitive Practices: The processes are not structured and are poorly defined. There are no process measurements, and organizational functions and structures are based on traditional roles, not horizontal processes. | 1 | Ad Hoc |
| (b) Ascending Practices: These represent business methods that can be generalized and have shown poor supply chain performance as a result. Basic processes are defined and documented. | 2 | Defined |
| (c) Standard Practices: These have been historically practiced by a wide range of companies either by default or by accident. Managers employ intentional management and strategic outcomes. They are implemented in broad job roles and structures outside traditional functions. | 3 | Linked |
| (d) Improved Practices: These are current, structured, and repeatable practices that have had a proven positive impact on supply chain performance. | 4 | Integrated |
| (e) Emerging Practices: These are practices where companies introduce new technology, knowledge, or radically different ways of organizing processes, with a culture of horizontal collaboration and competition based on multi-enterprise networks. | 5 | Extended |

## Results and Discussion

### Measurement of the Application of Purchasing Management

Figure 1 shows the results of measuring the implementation of 14 supply chain purchasing management practices. These practices were taken from the "best practices" in the purchasing section of the SCOR methodology (APICS, 2021). The three lowest-rated practices were: "our company has actively collaborated in group purchasing organizations" (2.77) (Practice 1), "the purchasing department has developed supplier classification according to their level of importance (ABC)" (3.23) (Practice 2), and "predictive analysis practices have been implemented in the purchasing area of our company" (3.46) (Practice 3).

On the other hand, the three highest-rated practices were (Figure 1): "our purchasing function has used information and communication technologies for supply management" (4.38) (Practice 12), "our company's purchasing function has worked on specific joint projects with other company functions/departments/processes that require high collaboration and communication" (4.38) (Practice 13), and "our company's purchasing function has participated in strategic management processes" (4.46) (Practice 14).

However, to test whether the differences between the means were statistically significant, the Kruskal-Wallis test was applied. According to the significance level ($p<0.05$), the null hypothesis of equality of means was rejected, and the research hypothesis that at least one mean was different was accepted.

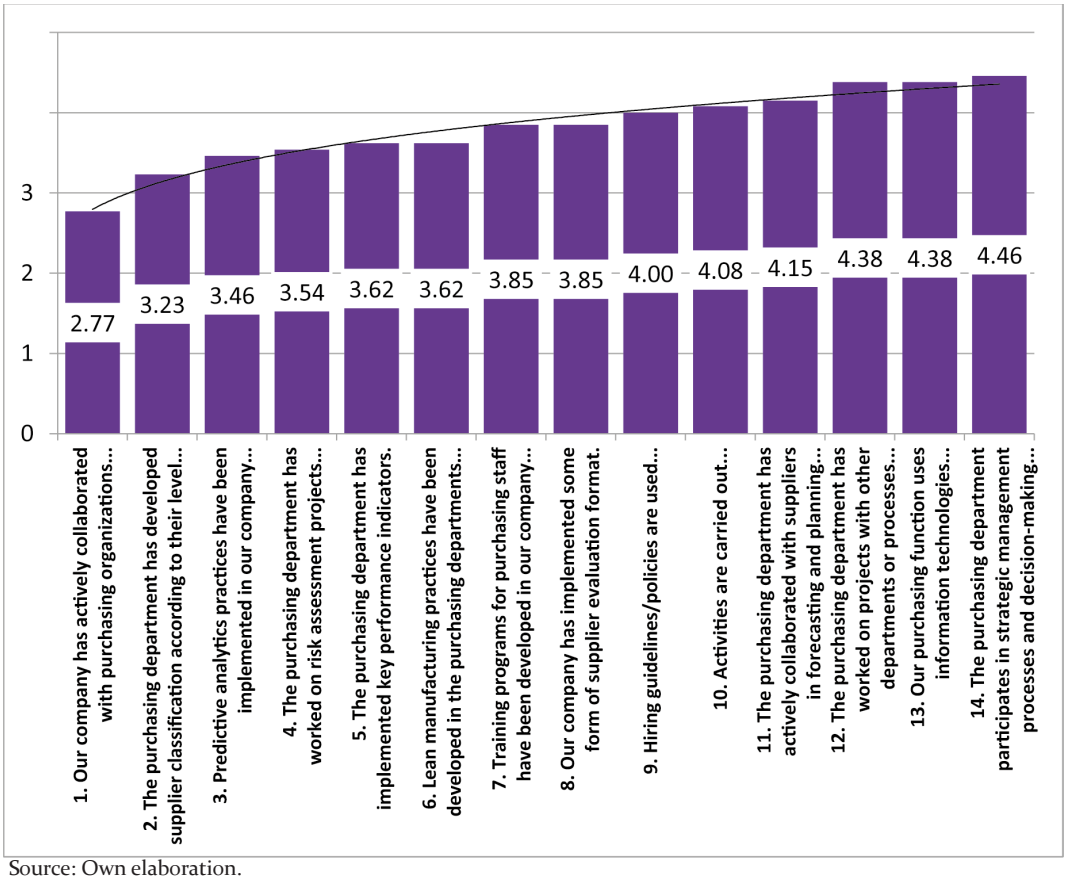
Subsequently, a post hoc test was conducted to compare all means against each other, obtaining the following results: Practice 1 was statistically equal ($p>0.05$) to Practices 2, 3, and 4, but different ($p<0.05$) from Practices 5 to 14 (Figure 1). Practice 2 was statistically equal ($p>0.05$) to Practices 1 to 11 but different ($p<0.05$) from Practices 12, 13, and 14.

Practices with low evaluations present areas of opportunity to improve processes. Improvement opportunities are mainly perceived in actively collaborating in organizations for group purchasing (Practice 1) and conducting supplier classification activities (Practice 2); to a lesser extent, in predictive analysis in the purchasing area (Practice 3) and in risk assessment projects (Practice 4). Practices from 5 onwards, which were highly rated, only need to be maintained.

### Evaluation of Purchasing Management

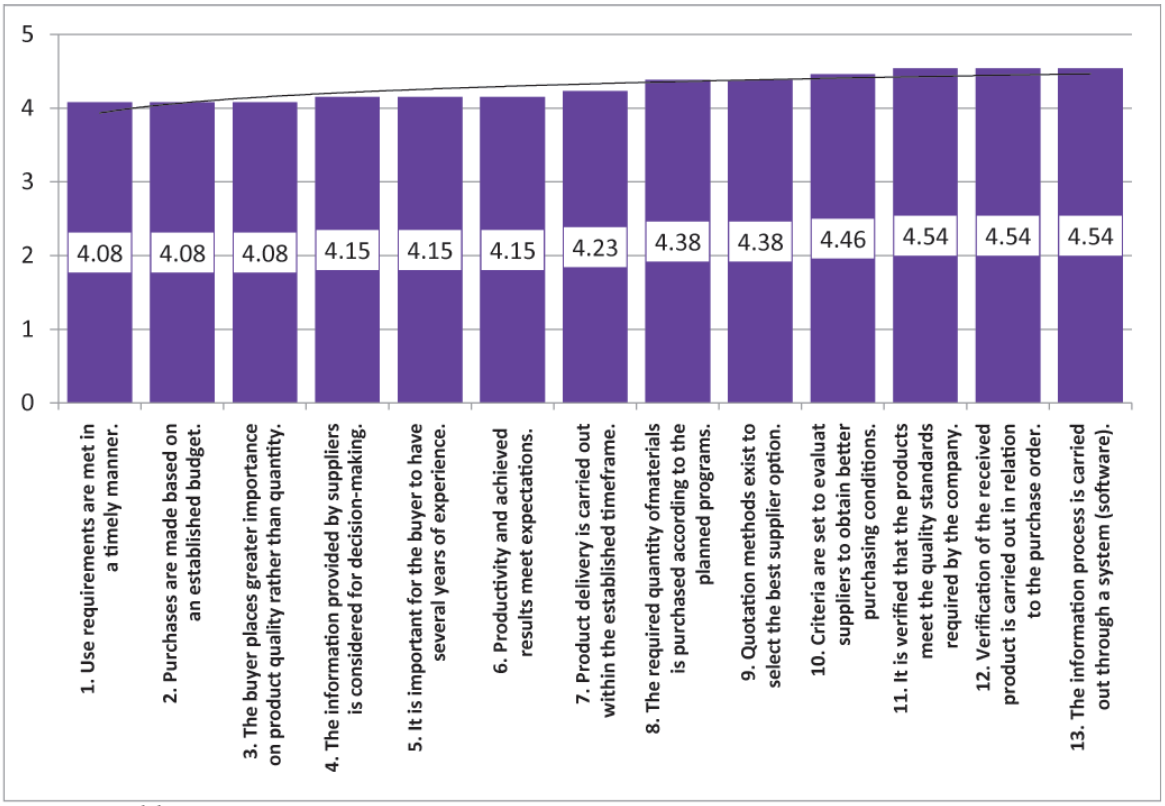
Figure 2 presents the results of the evaluation of 13 supply chain purchasing management practices. The results of applying the Kruskal-Wallis test indicate that the null hypothesis of equality of means is not rejected ($p>0.05$). This means that the interviewees

**Figure 1.** Evaluation of Purchasing Management in Metal-Mechanical Companies in Gomez Palacio, Durango.




Source: Own elaboration.

**Figure 2.** Evaluation of Purchasing Management in the Supply Chain.




Source: Own elaboration.

— purchasing managers — stated that they perform the different practices in their companies with the same frequency.

However, as a "trend", three purchasing practices were identified that require greater attention, as they obtained the lowest evaluation scores (4.08 each). These practices are: "user requirements are met in a timely manner (Practice 1)", "purchases are made based on an established budget (Practice 2)", and "the buyer gives more importance to product quality than to quantity (Practice 3)". This result suggests that there is a need to improve responsiveness to user requirements, to carry out purchasing planning based on a budget, and to consider that customers value not only the quality but also the quantity of supplies.

Conversely, the three highest-rated practices (4.54 each) were: "products are verified to meet the quality standards required by the company (Practice 11)", "verification of the received product is carried out in relation to the purchase order (Practice 12)", and "the information process is carried out through a system (Practice 13)". These practices should be maintained, as they are essential for the purchasing department's contribution to the competitiveness of the supply chain.

**Evaluation of the Maturity of Best Practices in Purchasing Management**

Based on the application of the research instrument in the 13 participating companies, the purchasing practices used and their level of maturity were identified. As mentioned above, the maturity assessment was based on SCOR, which is a supply chain operations reference model. In this study, the performance of best practices was evaluated for the processes related to suppliers and manufacturers, selecting 25 best practices (BP) linked to purchasing, procurement, and supply management.

The practices considered for analysis were the following: BP.097 Supplier Research; BP.100 Strategic Sourcing; BP.147 Goods Reception Inspection; BP.068 Supplier Delivery Performance Analysis; BP.128 Supplier Recovery; BP.060 Corrective Action on Order Delivery Time; BP.056 Improvement of Supplier Raw Material Quality; BP.134 Supplier Evaluation; BP.162 Long-term Supplier Partnership Agreement; BP.021 Global Production/Sales Planning (Demand); BP.042 Periodic Review of Procurement Conditions; BP.015 Safety Stock Planning; BP.069 Raw Material Receiving Process; BP.129 Return Policy Included with Shipping Document; BP.144 Purchase Order Management; BP.161 Enterprise-wide Spend Analysis; BP.016 Supply Network Planning; BP.034 Inventory Planning with Supplier Collaboration; BP.030 Inventory Record Accuracy; BP.087 ABC Inventory/Supplier Classification; BP.033 Improvement of Traditional Demand Forecasting; BP.140 Return Authorization Required; BP.145 Supplier Collaboration; BP.059 Employee Incentives for Effective Inventory Management; and BP.091 Job Load Evaluation.

The practices were classified and evaluated according to their level of development or maturity as follows: Primitive Practices (1), Emerging Practices (2), Standard Practices (3), Improved Practices (4), and Leading Practices (5). Practices with a score closer to 5 represent a higher level of maturity (Table 2). "Low maturity" processes are characterized by obsolete practices and/or a lack of discipline and consistency. "High maturity" processes frequently employ best practices and are implemented with a high degree of discipline and compliance. Table 3 shows the results found in this study. The maturity levels of both practices and companies were evaluated. In the case of companies, they were identified with letters from A to M to protect their privacy in accordance with the confidentiality agreement. Companies with higher scores show a higher level of development in the application of purchasing best practices.

The worst evaluated practices were BP.162 "Long-term Supplier Partnership Agreement" with a score of 2.08 (scale 1-5); BP.087 "ABC Inventory/Supplier Classification" with 2.62; and BP.059 "Employee Incentives for Effective Inventory Management" with 2.77. These practices are classified between "Improved Practices" and "Standard Practices" (Table 2) and present areas of opportunity for improvement in establishing long-term agreements with suppliers, performing inventory/supplier classification, and creating employee incentives for better inventory management.

On the other hand, the best evaluated practices were BP.140 "Return Authorization Required" with an average score of 4.0, BP.147 "Goods Reception Inspection" and BP.069 "Raw Material Receiving Process," both with an average score of 3.92. These three evaluations are related to the processes of receiving and returning goods, and in general, companies are performing them well, so they should simply be maintained. These practices are classified as "Improved Practices" (Table 2), which are current, structured, and repeatable practices that have had a proven and positive impact on supply chain performance.

**Table 3.** Evaluation of the Maturity of Best Practices in Purchasing Management in Metal-Mechanical Companies of Gomez Palacio, Durango.

| Companies: | H | I | L | G | E | M | K | B | C | A | F | J | D | Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BP.140 Return authorization required | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4.00 |
| BP.147 Goods inspection reception | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3.92 |
| BP.069 Raw material reception process | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3.92 |
| BP.056 Improvement of suppliers' raw material quality | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 3.85 |
| BP.129 Return policy included with the shipping document | 4 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 3.85 |
| BP.144 Purchase order management | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 4 | 3.85 |
| BP.030 Inventory record accuracy | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3.85 |
| BP.097 Supplier research | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 3.77 |
| BP.068 Supplier delivery performance analysis | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 3.77 |
| BP.042 Periodic review of procurement conditions | 4 | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 1 | 3 | 4 | 3 | 3.46 |
| BP.161 Company-wide expense analysis | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 3 | 2 | 3.54 |
| BP.016 Supply network planning | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 3 | 2 | 3.54 |
| BP.060 Corrective action on order lead time | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3.46 |
| BP.015 Safety stock planning | 4 | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 1 | 4 | 4 | 3 | 3.46 |
| BP.034 Extend inventory planning using supplier collaboration | 4 | 4 | 3 | 3 | 4 | 3 | 4 | 4 | 1 | 1 | 4 | 4 | 3 | 3.23 |
| BP.100 Strategic sourcing | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 2 | 3 | 4 | 1 | 3 | 1 | 3.08 |
| BP.021 Global production/sales (Demand) planning | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 2 | 3 | 4 | 1 | 3 | 1 | 3.08 |
| BP.033 Improve traditional demand forecasting | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 2 | 3 | 4 | 1 | 3 | 1 | 3.08 |
| BP.145 Supplier collaboration | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 2 | 3 | 4 | 1 | 3 | 1 | 3.08 |
| BP.128 Supplier recovery | 4 | 4 | 4 | 3 | 4 | 2 | 3 | 4 | 3 | 1 | 3 | 3 | 1 | 3.00 |
| BP.134 Supplier evaluation using robust assessment tools | 4 | 4 | 4 | 3 | 4 | 2 | 3 | 4 | 3 | 1 | 3 | 2 | 1 | 2.92 |
| BP.091 Job workload evaluation | 4 | 4 | 4 | 4 | 3 | 4 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 2.85 |
| BP.059 Employee incentives for effective inventory management | 4 | 3 | 4 | 4 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 1 | 1 | 2.77 |
| BP.087 ABC inventory/supplier classification | 3 | 1 | 4 | 4 | 3 | 2 | 2 | 3 | 3 | 3 | 4 | 1 | 1 | 2.62 |
| BP.162 Long-term supplier partnership agreement | 2 | 3 | 1 | 4 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 1 | 1 | 2.08 |
| Average Maturity | 3.9 | 3.8 | 3.7 | 3.7 | 3.7 | 3.4 | 3.3 | 3.3 | 3.3 | 3.2 | 3.1 | 3.0 | 2.2 | 3.36 |

Source: Own elaboration.

Regarding the companies evaluated, the best-rated were companies H and I, with average scores of 3.9 and 3.8, respectively (Table 3). However, these companies presented some low scores in the practices BP.087 "Inventory/Supplier Classification" and BP.162 "Long-term Partnership Agreement with Suppliers", which represent specific areas of opportunity for improvement.

On the other hand, the worst-rated companies were J and D, particularly in the practices BP.091 "Workload Evaluation", BP.059 "Employee Incentives for Effective Inventory Management", BP.087 "Inventory/Supplier Classification", and BP.162 "Long-term Partnership Agreement with Suppliers". These practices were rated at level 1, corresponding to "Primitive Practices", which are described as processes that are unstructured and poorly defined, with no performance measurements, and where functions and organizational structures are based on traditional roles rather than horizontal processes. Therefore, these four practices represent critical areas of improvement for companies J and D.

In general, most of the companies are at level 4, called "Improved Practices", which are current, structured, and repeatable practices that have shown a proven positive impact on supply chain performance. However, there is potential for them to advance to level 5, "Emerging Practices", where companies introduce new technology, knowledge, or radically different ways of organizing processes, fostering a culture of horizontal collaboration, and where competition is based on multi-company networks. Moving towards this level would allow companies to develop greater efficiency to survive in an increasingly competitive environment.

In a previous study, Cruz (2019) found deficiencies in the following practices within the companies analyzed — in research similar to the present work: 1) The management of consignment inventory, where the supplier manages within the company's warehouses the raw materials owned by them to be consumed according to needs; and at the same time, the practice of bidding processes to obtain raw materials at lower costs; 2) Processes still follow a manual and mechanical course, showing an area of opportunity to improve automation levels through the use of technology in inventory management and the systematization of procedures; and 3) The level of coordination and planning of the supply chain is incipient, without reaching an optimal level. Although the type of companies analyzed in that study belonged to the pharmaceutical sector, in the metal-mechanical sector —the object of this study— similar problems were also found in inventory management, identifying areas of opportunity in process automation through the use of information technologies.

Similarly, García (2018) found that companies that use ICT in their production processes or in their relationship with the final customer can improve their competitive position and obtain better operational and financial results. The improvement resulting from the introduction of ICT can generate better outcomes for companies, especially when applied specifically to the supply chain. Many authors have analyzed the influence of ICT through the theory of transaction costs or the resource-based view; however, few have empirically tested their impact on results, as García (2018) did.

By applying the SCOR methodology in this research, and considering the complexity of the metal-mechanical industry —which has a high level of foreign suppliers— it was possible to identify areas of opportunity, as presented in the following conclusions.

## Conclusions

1. Purchasing management within the supply chain is a highly important process because it improves its effectiveness and efficiency by reducing and controlling costs, ensuring the supply of the required quantities in terms of time, quality, and price. Therefore, it is essential to identify areas of opportunity for its improvement.

2. In the measurement of purchasing management, among the 14 activities evaluated, the two that represent the greatest areas of opportunity are the need to carry out group purchasing to generate economies of scale, and the classification of suppliers to select those most reliable in terms of quality, timeliness, and compliance with orders or contracts. To a lesser extent, it is also worth mentioning the need to conduct predictive analyses (forecasts) in the purchasing area and to develop projects focused on risk assessment and mitigation within the purchasing process.

3. In the evaluation of 13 purchasing management practices within the supply chain, the results indicate that there were no statistically significant differences among them. However, there is a perceived "tendency" towards lower evaluation scores in some practices that generate areas of opportunity, such as: the need to improve responsiveness to user requirements, to carry out purchasing planning based on a budget, and to consider that customers value not only the quantity but also the quality of the supplies.

4. The maturity level of 25 best practices related to purchasing, procurement, and supply management was also evaluated. The "low maturity" processes are characterized by obsolete practices and/or a lack of discipline and consistency. In contrast, "high maturity" processes frequently employ best practices and are implemented with a high degree of discipline and compliance. The practices with the lowest maturity level reveal areas of opportunity for improvement in the purchasing process, among which the following stand out: establishing long-term partnership agreements with suppliers, carrying out inventory/supplier classification, and applying employee incentives for effective inventory management.

5. The individual performance of the 13 companies participating in this study was also evaluated. Most of the companies are at level 4, known as "improved practices", which are practices that have had a proven and positive impact on supply chain performance. However, some companies received low evaluations because they implement "primitive practices", described as processes that are not structured and are based on traditional functions, which indicates that there is still much room for improvement.

## References

Ancajima, A., Flavia, A., Rosas, L. S. A. L. Y., Zayuri, M., Quiroz, S., & Selene, E. (2020). FACULTAD DE GESTIÓN Y ALTA DIRECCIÓN Análisis y propuesta de mejora de la gestión de la cadena de suministro de una empresa del sector olivícola . Caso de estudio : Nobex Foods S . A. Recuperado de: https://tesis.pucp.edu.pe/repositorio/handle/20.500.12404/18271?show=full

Álzate, J. (2017). Propuesta de mejoramiento en el area de compras de la empresa construccion, reingenieria, producción. (c.r.p). S.A.S.. Universidad Autonoma de Occidente, en la Cuidad de Santiago de Cali (1Aa), 1–106. Recuperado de: https://red.uao.edu.co/handle/10614/9520

APICS. SCOR Supply Chain Operations Reference Model. 2021. Available online: http://www.apics.org/docs/default-source/scor-training/scor-v12-0-framework-introduction.pdf?sfvrsn=2 (accessed on 21 May 2023).

Arone, C. E., y Ganoza, J. C. (2020). Análisis del Modelo SCOR en la Gestión de la Cadena de Suministros de una empresa de transporte en Arequipa 2018-2019, Escuela de post grado y estudios continuos. Universidad Privada del Norte, Arequipa, Lima, Peru. Recuperado de: https://alicia.concytec.gob.pe/vufind/Record/UUPN_1da33eae25120819636211 62dcebd6ce/Details

Bonifacio, L., (2020). Evaluación del desempeño del aprovisionamiento de una concesionaria de vehículos en lambayeque empleando el modelo Scor, Facultad de Ciencias Empresariales de la Universidad Católica Santo Toribio de Mogrovejo. Recuperado de: https://tesis.usat.edu.pe/handle/20.500.12423/2661

Buitrago, D., Castrillon, G., Hernández. Y., Robayo, D. y Piñeros, C., (2021). Propuesta en Supply Chain Management y Logística en la empresa ZARA U Universidad Nacional Abierta y a Distancia – UNAD

Chai, J., & Ngai, E. (2020). Decision-making techniques in supplier selection: Recent accomplishments and what lies ahead. Expert Systems with Applications, 140, 112903. https://doi.org/10.1016/j.eswa.2019.112903

CONACYT. (2020a). Fondos-y-apoyos/programa-de-estimulos-a-la-innovacion. Información obtenida de: http://www.conacyt.mx/index. php/

CONACYT. (2020b). Agenda de Innovación de Durango. CONACYT. www.agendasinnovacion.org. Recuperado de https://www.agendasinnovacion.org/wp-content/uploads/2015/03/Agenda-de-Innovaci%c3%b3n-Durango.pdf

Cruz, A. (2019). Análisis de la cadena de suministro utilizando el modelo SCOR para la reducción de los índices de quiebre de inventarios de una empresa farmacéutica. Tesis Doctoral. Universidad de Guayaquil. Facultad de Ingeniería Industrial. Recuperado de: http://repositorio.ug.edu.ec/handle/redug/51947

García, A. J. (2018). Gestión de la cadena de suministro: análisis del uso de las TIC y su impacto en la eficiencia. Tesis Doctoral. Universidad Complutense

de Madrid. Recuperada de: https://eprints.ucm.es/id/eprint/46224/1/T39544.pdf

Ikatrinasari, Z. F., Harianto, N., & Yuslistyari, E. I. (2020). Improvement of supply chain pelkatrinasari, Z. F., Harianto, N., & Yuslistyari, E. I. (2020). Improvement of supply chain performance of printing services company based on supply chain operation references (Scor) model. Uncertain Supply Chain Management, . Uncertain Supply Chain Management, 8(4), 845–856. https://doi.org/10.5267/j.uscm.2020.6.001

Kano, L., Tsang, E. W. K., & Yeung, H. W. (2020). Global value chains: A review of the multi-disciplinary literature. Journal of International Business Studies, 51(4), 577–622. https://doi.org/10.1057/s41267-020-00304-2

Kusrini, E., Rifai, M. A. B., & Miranda, S. (2019). Performance measurement using supply chain operation reference (SCOR) model: A case study in a small-medium enterprise (SME) in Indonesia. IOP Conference Series: Materials Science and Engineering, 697(1). https://doi.org/10.1088/1757-899X/697/1/012014

Levin, R. y Rubin, D. 2010. Estadística para Administración y Economía. Ed. Pearson. 7ª edición revisada. México, D.F. 799 p.

Lind, D., Marchal, W., y Mason, R. 2004. Estadística para Administración y Economía. Ed. Alfaomega. 11a edición. México, D.F. 830 p.

Lockamy, A., y McCormack, K. (2004). The development of a supply chain management process maturity model using the concepts of business process orientation. Supply Chain Management: An International Journal, 9(4), 272-278. doi: 10.1108/1359854041055001

Manene Cerrageria, L.M. (2014) Dirección de compras: su importancia, desempeño e interrelaciones. Actualidad empresa 2019. Recuperado de http://actualidadempresa.com/direccion-de-compras-su-importancia-desempeno-e-interrelaciones/

Masi, D., Day, S., & Godsell, J. (2017). Supply chain configurations in the circular economy: A systematic literature review. Sustainability (Switzerland), 9(9). https://doi.org/10.3390/su9091602

Moreno Ramírez, M. A., & Fuentes, M. N. (2017). Función De La Planeación En El Modelo Scor, Caso: Empresas De Familia Del Sector De Alimentos. Universidad De La Salle, 1–23. Recuperado de: https://ciencia.lasalle.edu.co/administracion_de_empresas/1399/

Perdana, S., Usman, R., & Arifiya, N. (2020). Analysis of Perdana, S., Usman, R., & Arifiya, N. (2020). Analysis of supply chain risk mitigation strategies in the Bogor compressor company with the house of risk method. IOP Conference Series: Materials Science and Engineering, 852(1). https://doi.org/. IOP Conference Series: Materials Science and Engineering, 852(1). https://doi.org/10.1088/1757-899X/852/1/012094

Porter, M. E., (1982) Competitive Advantage of Nations, Prentice-Hall, New York, NY

Rizkya, I., Syahputri, K., Sari, R. M., Siregar, I., & Utaminingrum, J. (2019). SCOR: Business Process Analysis and Supply Chain Performance in Building Materials Industry. IOP Conference Series: Materials Science and Engineering, 598(1). https://doi.org/10.1088/1757-899X/598/1/012070

Vinajera, A., Marrero, F., & Cespón, R. (2020). Evaluación del desempeño de la cadena de suministro sostenible enfocada en procesos. Estudios Gerenciales, 36(156), 325–336. https://doi.org/10.18046/j.estger.2020.156.3699. Recuperado de: https://www.icesi.edu.co/revistas/index.php/estudios_gerenciales/article/view/3699