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METHOD FOR EVALUATING THE MATURITY LEVEL OF PURCHASING PROCESS IN THE CONSTRUCTION INDUSTRY

MÉTODO PARA AVALIAÇÃO DO GRAU DE MATURIDADE DO PROCESSO DE COMPRAS NA INDÚSTRIA DE CONSTRUÇÃO CIVIL

MÉTODO PARA EVALUAR EL GRADO DE MADUREZ DEL PROCESO DE COMPRAS EN LA INDUSTRIA DE LA CONSTRUCCIÓN CIVIL

ABSTRACT

Objective: This technical-technological product aimed to develop a framework for measuring the maturity level of the purchasing process in companies operating in the construction industry.

Context and methodology: The procedure was developed through a multiple case study conducted in four medium-sized construction companies operating in the vertical residential construction sector in Balneário Camboriú, SC. Data was collected using a structured questionnaire administered to the purchasing managers of four companies.

Diagnosis: The results indicate that all surveyed companies have a purchasing process maturity level of 4, meaning that the practices are formally implemented and effectively used.

Practical implications: From a practical perspective, the system is intended to assist construction companies in analyzing and defining priorities to improve the maturity of their purchasing departments.

Applicability: The proposed system can be applied to medium-sized construction companies. Replicability: The proposed system can also be applied to construction companies of different sizes, as well as in different sectors, such as horizontal construction, roadworks, and infrastructure. In such cases, some practices may need to be adapted to the specific sector.

Innovativeness: This work is pioneering in developing a system for measuring the maturity level specifically for the procurement process in construction, a highly important area in companies that involves significant financial flow.

Keywords: Maturity Level; Procurement; Construction Industry.

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RESUMO

Objetivo: O presente produto técnico-tecnológico procurou desenvolver uma sistemática para mensuração do grau de maturidade do processo de compras das empresas que atuam na indústria de construção civil.

Contexto e metodologia: Quanto ao procedimento, foi desenvolvida por meio de estudo de casos múltiplos em quatro construtoras de porte médio, que atuam no ramo de obras habitacionais verticais na cidade de Balneário Camboriú, SC, através de questionário estruturado, junto aos gestores de compras das empresas.

Diagnóstico: Os resultados indicaram que todas as empresas pesquisadas possuem um grau de maturidade do processo de compras nível 4, ou seja, as práticas estão implantadas formalmente e são utilizadas de forma efetiva.

Implicações práticas: Do ponto de visto prático, a sistemática se propõe em auxiliar as empresas da construção civil na análise e definição de prioridades para melhorar a maturidade do setor de compras.

Aplicabilidade: a sistemática proposta pode ser aplicada em empresas da construção civil de porte médio.

Replicabilidade: a sistemática proposta poderá ser aplicada em construtoras de outros portes, como também de diferentes ramos de atuação, como construtoras de obras horizontais, rodoviárias, infraestrutura. Neste caso, algumas práticas deverão ser adequadas para o ramo desejado.

Inovatividade: este trabalho torna-se inédito por desenvolver uma sistemática de mensuração do grau de maturidade específico para o processo de compras na construção, uma área de grande importância nas empresas e que demanda grande fluxo financeiro.

Palavras-Chave: Grau de Maturidade; Compras; Construção Civil.

RESUMEN

Objetivo: Este producto técnico-tecnológico tuvo como objetivo desarrollar una sistemática para la medición del grado de madurez del proceso de compras en empresas que operan en la industria de la Construcción civil.

Contexto y metodología: Con respecto al proceso, fue desarrollado por intermedio de estudio de casos múltiples en cuatro constructoras de medio porte, que actúan en el ramo de obras de vivienda verticales en la ciudad de Balneario Camboriú, Brasil, a través de cuestionario estructurado, junto a los gestores de compras de las empresas.

Diagnóstico: Los resultados indicaron que todas las empresas analizadas poseen un grado de madurez en el proceso de compras nivel 4, o sea, las prácticas están implantadas formalmente y son utilizadas de forma efectiva.

Implicaciones prácticas: Desde el punto de vista práctico, el sistema se propone a auxiliar las empresas de construcción civil en el análisis y definición de prioridades para mejorar la madurez del sector de compras.

Aplicabilidad: El sistema propuesto puede ser aplicado en empresas de construcción civil de medio porte.

Replicabilidad: El sistema propuesto podrá ser aplicado en constructoras de otros portes, así como en diferentes ramos de actuación, como constructoras de obras horizontales, obras viales, infraestructura. En este caso, algunas prácticas deberán ser adecuadas al ramo deseado.

Innovación: Este trabajo resulta inédito al desarrollar un sistema de medición del grado de madurez específico para el proceso de compras en la construcción, un área de gran importancia en las empresas y que demanda gran flujo financiero.

Palabras clave: Grado de Madurez; Compras; Construcción Civil.

CONTEXT IN WHICH THE PROBLEM IS PRESENTED

The construction industry holds great relevance in the Brazilian economy by generating millions of jobs and moving high volumes of materials, impacting the GDP and the entire sup-ply chain of the country. This sector is a pillar for socioeconomic growth and for the consoli-dation of national infrastructure. In 2023, the sector

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recorded 2.5 million jobs, and 2024 saw a 4.7% increase in employment, approaching 3 million. The execution of construction projects demands a vast supply chain, connecting the construction industry to more than 60 economic activities in the national industry (CIBIC, 2025). Thus, to ensure efficiency, the purchasing process must adopt good practices, seeking quality raw materials at competitive prices.

In this regard, supply logistics aims to make products and services available at the right time and place, with the lowest possible cost. The modern approach involves integration with management and marketing, adding value through circular economy and sustainability practic-es (Charef & Emmitt, 2021; Li et al., 2022). Logistics operations are divided into physical dis-tribution, manufacturing support, and supplies, with the latter being responsible for the acqui-sition and movement of materials (Kazancoglu et al., 2021; Tam & Weisheng, 2013). Supply logistics has become an essential strategic factor, enabling continuity of material flow, cost re-duction, and greater competitiveness (Kazancoglu et al., 2021; Moschen-Schimek et al., 2023).

The purchasing process is essential for business competitiveness, representing between 40% and 60% of total expenses. With technological advances and growing environmental concerns, purchasing has come to require greater planning and sustainability (Duan et al., 2019; Low et al., 2020). This function involves multiple organizational areas, being responsible for identifying suppliers, negotiating prices, and aligning acquisitions with business strategies, including waste reduction and environmental management (Charef & Emmitt, 2021; Ferronato & Torretta, 2019).

The process encompasses planning, evaluation, and contracting, with a focus on quali-ty, time, quantity, price, and appropriate supplier (Devaki & Shanmugapriya, 2022; Li et al., 2022). Purchasing is both an organizational structure and a strategic activity, encompassing market analysis, negotiation, and supplier development, with emphasis on digital technologies such as BIM and blockchain (Charef & Emmitt, 2021; Li et al., 2022). Companies with a more mature purchasing department tend to present better results, following more advanced and strategic practices (Kabirifar et al., 2021; Mahpour, 2018).

Maturity models evaluate and compare the level of business development, making it possible to identify improvements and optimize processes. Greater maturity means better inte-gration with strategic decisions (Devaki & Shanmugapriya, 2022; Li et al., 2022). Maturity represents the pursuit of excellence and continuous improvement, incorporating sustainability and digital transformation (Jin et al., 2019; Purohit et al., 2021). Emerging in the 1970s with Crosby, the idea evolved into various areas, expanding to circular economy and waste man-agement (Charef & Emmitt, 2021; Kazancoglu et al., 2021). The models evaluate the defini-tion, management, measurement, and control of processes, allowing comparisons between companies (Devaki & Shanmugapriya, 2022; Li et al., 2022).

In the purchasing area, maturity reflects professionalism and sophistication, involving people management, strategies, and suppliers, with a focus on strategic and sustainable value (Ferronato & Torretta, 2019; Low et al., 2020). At advanced levels, purchasing transforms from an operational function into a strategic role, impacting competitiveness and sustainability (Duan et al., 2019; Tam & Weisheng, 2013). Higher levels reflect the adoption of global best practices, including circular economy and integrated waste management (Kabirifar et al., 2021; Mahpour, 2018).

Mature organizations use integrated systems, digital technologies, and trained profes-sionals to act strategically, unlike companies with low maturity, where purchasing is merely operational (Charef & Emmitt, 2021; Li et al., 2022). High levels of maturity promote effec-tive management, generating innovation, cost reduction, increased productivity, and minimiza-tion of environmental impacts (Devaki & Shanmugapriya, 2022; Kazancoglu et al., 2021).

In the construction industry, efficiency in purchasing requires continuous evaluation of its impact on business and environmental performance. By applying maturity models, compa-nies obtain accurate diagnoses and guidelines for improvement (Jin et al., 2019; Moschen-Schimek et al., 2023). Many activities in construction do not

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add value, only costs (Ghailani et al., 2023; Kabirifar et al., 2021), improperly absorbing resources through problems such as: lack of control, rework, excess or shortage of inputs, conflicts between construction site and purchasing, emergency purchases, and unnecessary movement of materials. These failures re-sult in goods and services that do not meet customer needs (Ferronato & Torretta, 2019; Jin et al., 2019; Purohit et al., 2021). A high degree of maturity in purchasing promotes savings through acquisitions at the right time, quantity, deadline, quality, and location, contributing to waste reduction and environmental impacts (Charef & Emmitt, 2021; Low et al., 2020).

This article proposes assisting companies in analyzing and defining priorities to im-prove the maturity of the purchasing sector through the development of a Technical-Technological Product (TTP) for measuring the Maturity Level of the Purchasing Process in Civil Construction (MLPPCC). The tool was applied to four medium-sized companies that operate in the construction of vertical housing developments in Balneário Camboriú, Santa Ca-tarina. The application showed balance among the surveyed companies, which presented level 4 maturity in the purchasing process.

CHARACTERIZATIONS OF THE INVESTIGATED REALITY

Company "A" operates in the segment of commercial and high-standard vertical residential building construction and is classified as medium-sized. It was founded in 2017, has three employees, and its headquarters is located in the city of Itajaí/ SC. Most of the activities at construction sites are performed by outsourced companies. The person responsible for the responses was the civil engineer who is responsible for managing the construction company's purchasing.

Company "B" operates in the segment of vertical residential building construction and is classified as medium-sized. It was founded in 2006 and has 15 employees, who mainly perform finishing activities for the projects. The remaining activities are carried out by outsourced companies. The person responsible for the responses was the civil engineer who is the purchasing manager of the construction company.

Company "C" operates in the segment of vertical residential building construction and is classified as medium-sized. It was founded in 2016 and has 10 employees. It classifies its products as mid-standard. The person responsible for the responses was the partner-director of the construction company, who also acts as the purchasing manager.

Lastly, company "D" operates in the segment of vertical residential building construction and is classified as medium-sized. It was founded in 2014 and has 28 employees. It classifies its products as having an excellent finishing standard. The person responsible for the responses was the technical manager of the construction company, an architect and urban planner who also acts as the purchasing manager.

DIAGNOSIS AND DEVELOPMENT OF THE TECHNICAL-TECHNOLOGICAL PRODUCT (TTP)

The objective of this multiple case study was to discover the maturity level of the purchasing process in construction companies operating in the city of Balneário Camboriú/SC. At this stage of the research, the maturity level of the purchasing process was generally defined as a measure of the degree to which a purchasing department is advanced, sophisticated, and professional. Furthermore, purchasing maturity is a measure of how people, strategies, practices, suppliers, and communication are managed in a purchasing department to capture the strengths of suppliers (Úbeda, Alsua, & Carrasco, 2015). The purpose of a case study is to gather detailed and systematic information about a phenomenon (Patton, 2002).

As the object of analysis, the attributes and practices of the purchasing process of construction companies are being considered. Four medium-sized companies from the vertical housing construction sector operating in the city of Balneário Camboriú, Santa Catarina were surveyed. The criterion for classifying company size is that of BNDES, which considers a medium-sized company to be one with annual gross operating revenue or annual income greater than R$ 4.8 million and less than or equal to R$ 300 million (BNDES, 2025).

In this research, the System for Measuring

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the Maturity Level of the Purchasing Process in Civil Construction (MLPPCC) is composed of seven attributes: (1) Purchasing Strategy; (2) Outsourcing Strategy; (3) Purchasing Process; (4) Sustainability; (5) Information Management; (6) Purchasing Organization; (7) Performance Evaluation. With the exception of the "Sustainability" attribute, all others are based on Batra (2017), representative of ISM – India (Institute for Supply Management – India). Listed below are each of the practices that comprise the attributes, as well as their weight within the system.

Practices of Attribute 1 – Purchasing Strategy

The practices of the "Purchasing Strategy" attribute are listed in Figure 1, with their respective designations and weights considered in the MLPPCC measurement system.

Figure 1

Practices related to Attribute 1 – Purchasing Strategy.

ATTRIBUTE 1 – PURCHASING STRATEGY		
DESIGNATION	**PRACTICES**	**WEIGHT**
A1P1	The purchasing sector/department process is involved in the planning of product design (buildings).	1,0
A1P2	The role of the purchasing sector/department in the product planning process (buildings) is formally defined, documented, and followed.	0,8
A1P3	The purchasing sector/department conducts an analysis of the materials and services supply market.	0,6
A1P4	The process of analyzing the materials and services supply market is formally defined, documented, and followed.	0,6
A1P5	There is a formally defined procedure for the development of materials and services suppliers.	1,0
A1P6	The supplier development procedure is described and communicated within the company.	0,6
A1P7	The purchasing sector/department conducts training and workshops for the development of its suppliers.	0,2
A1P8	Suppliers are involved from the development phases of product design (buildings).	0,8
A1P9	The purchasing sector/department uses management by categories of materials and services.	1,0
A1P10	The criteria for purchasing categorization are formally defined, documented, and followed.	1,0
A1P11	Purchasing systematically analyzes the expenses of each category in relation to suppliers, materials, and services to identify improvement opportunities.	0,2

Source: Authors (2025).

Practices of Attribute 2 – Outsourcing Strategy

The practices of the "Outsourcing Strategy" attribute are listed in Figure 2, with their respective designations and weights considered in the MLPPCC measurement system.

Figure 2

Practices related to Attribute 2 – Outsourcing Strategy.

ATTRIBUTE 2 – OUTSOURCING STRATEGY		
DESIGNATION	**PRACTICES**	**WEIGHT**
A2P1	There is a formally defined, documented outsourcing strategy for services that is followed.	1,0
A2P2	The services outsourcing strategy is known by other sectors/departments of the company.	1,0
A2P3	The purchasing sector/department makes decisions about producing products and executing services internally or buying products and outsourcing services from external suppliers.	0,6
A2P4	There is a methodology used by the purchasing sector/department to make decisions about producing products and executing services internally or buying products and outsourcing services from external suppliers.	0,2
A2P5	The selection of service suppliers is carried out systematically and according to clearly defined requirements and criteria.	0,6
A2P6	The service supplier selection process is formally defined, documented, and followed.	1,0
A2P7	There are service supplier performance criteria and they are included in the supplier selection process.	0,6
A2P8	There is a formally defined procedure for evaluating service suppliers after the execution of services.	1,0
A2P9	The results of the performance evaluation after the execution of services are communicated to the supplier.	1,0
A2P10	The purchasing sector/department has a person responsible for the development of service suppliers (new and current).	1,0

Source: Authors (2025).

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Practices of Attribute 3 – Purchasing Process

The practices of the "Purchasing Process" attribute are listed in Figure 3, with their respective designations and weights considered in the MLPPCC measurement system.

Figure 3

Practices related to Attribute 3 – Purchasing Process.

ATTRIBUTE 3 – PURCHASING PROCESS		
DESIGNATION	**PRACTICES**	**WEIGHT**
A3P1	The purchasing process is formally defined, documented, and followed by the purchasing sector/department.	1,0
A3P2	The demands for materials and services (requisitions) necessary for the execution of the construction project are derived directly from the construction designs (plans).	1,0
A3P3	The demand planning process is formally described, documented, and followed.	1,0
A3P4	The purchasing sector/department is solely responsible for purchasing all inputs, materials, and services acquired for construction projects (plans).	1,0
A3P5	The purchasing sector/department is integrated with other processes (engineering, operations, finance, sales, HR, etc.).	1,0
A3P6	The purchasing sector/department contributes to the development of products (buildings) during the construction design phase (plan).	1,0
A3P7	There is a formally defined procedure for evaluating suppliers of inputs and materials after the delivery of inputs and materials that is described, documented, and followed.	0,2
A3P8	The selection of suppliers of inputs and materials is carried out systematically according to formally defined and documented selection criteria.	0,2
A3P9	There is a procedure for processing and monitoring purchase orders that is formally described, documented, and followed.	0,6
A3P10	The company carries out the development of suppliers of inputs and materials in order to improve their operational performance based on the performance evaluation conducted.	0,2
A3P11	There is a formally defined procedure for receiving inputs and materials with criteria and verification of inputs and materials, including economic aspects (price, quantity, etc.) and qualitative aspects (integrity, quality, etc.).	1,0
A3P12	The receiving and storage of inputs and materials, the fractionation and identification of materials, their distribution and allocation, and inventory control are the responsibility of the purchasing sector/department.	0,2
A3P13	There are criteria for standardization of inputs and materials that include prioritization of the use of products evaluated by a multidisciplinary team (engineering, planning, purchasing, logistics, etc.).	1,0
A3P14	The storage process for inputs and materials is formally defined and follows the criteria established in PBQP-H for good storage practices and ensures good practices for the integrity and adequate conservation of materials.	1,0
A3P15	The inventory of inputs and materials is regularly and comprehensively audited to identify discrepancies, and corrective actions are adopted by the purchasing sector/department.	0,4
A3P16	The inventory control of inputs and materials is formalized and documented and includes an inventory replenishment policy that defines the inventory level and replenishment criteria.	0,2
A3P17	The results of the performance evaluation of suppliers of inputs and materials use quantitative and qualitative indicators that are monitored by the purchasing manager and include corrective actions.	0,6
A3P18	The reputation of the supplier of inputs and materials is considered as a selection criterion.	0,2
A3P19	The ISO 9001:2015 certification of suppliers of inputs and materials is considered as a supplier selection criterion.	0,2
A3P20	After inspection of the delivery of inputs and materials, the invoice is forwarded to the finance department for payment.	0,6

Source: Authors (2025).

Practices of Attribute 4 – Sustainability

AThe practices of the "Sustainability" attribute are listed in Figure 4, with their respective designations and weights considered in the MLPPCC measurement system.

Figure 4

Practices related to Attribute 4 – Sustainability.

ATTRIBUTE 4 – SUSTAINABILITY		
DESIGNATION	**PRACTICES**	**WEIGHT**
A4P1	The purchasing sector/department seeks equal opportunities for employees through training and development opportunities, job and salary plans, etc.	0,2
A4P2	There are procedures to maintain favorable health, safety, and work environment conditions in all company environments (offices and construction sites).	1,0
A4P3	The purchasing sector/department contributes to the local economy by using labor and suppliers from the locations where the construction projects are located.	1,0
A4P4	The purchasing sector/department aims to minimize pollutant emissions at construction sites through the acquisition of inputs and materials from suppliers that do not harm the environment (green purchasing).	0,6
A4P5	The purchasing sector/department seeks the minimization and elimination of waste at construction sites through the acquisition of inputs and materials from suppliers that minimize waste generation.	0,6
A4P6	The purchasing sector/department makes use of inputs and materials from recycled/sustainable sources.	0,6
A4P7	The reverse logistics process for proper disposal and discarding of construction waste is defined, documented, and followed.	0,2
A4P8	The materials and services acquired allow for improved productivity during construction projects.	0,8
A4P9	The purchasing sector/department contributes to the consistent and sustainable growth of the company's profit.	1,0
A4P10	The purchasing sector/department seeks to acquire materials and services that allow for reducing the completion time of construction projects.	1,0

Source: Authors (2025).

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Practices of Attribute 5 – Information Management

The practices of the "Information Management" attribute are listed in Figure 5, with their respective designations and weights considered in the MLPPCC measurement system.

Figure 5

Practices related to Attribute 5 – Information Management.

ATTRIBUTE 5 – INFORMATION MANAGEMENT		
DESIGNATION	**PRACTICES**	**WEIGHT**
A5P1	The purchasing sector/department uses an ERP (Enterprise Resource Planning) software module for purchasing management.	0,2
A5P2	The purchasing sector/department uses EDI (Electronic Data Interchange) tools for communication with suppliers.	0,2
A5P3	The purchasing sector/department uses an information system for materials inventory management with barcode labels on materials.	0,2
A5P4	The purchasing sector/department uses the internet to automate the materials purchasing process.	0,6
A5P5	The purchasing sector/department uses the internet to prospect for new suppliers (e-sourcing).	1,0
A5P6	The purchasing sector/department uses electronic auctions for the purchase of inputs, materials, and services.	0,2

Source: Authors (2025).

Practices of Attribute 6 – Purchasing Organization

The practices of the "Purchasing Organization" attribute are listed in Figure 6, with their respective designations and weights considered in the MLPPCC measurement system.

Figure 6

Practices related to Attribute 6 – Purchasing Organization.

ATTRIBUTE 6 – PURCHASING ORGANIZATION		
DESIGNATION	**PRACTICES**	**WEIGHT**
A6P1	The mission of the purchasing sector/department is aligned with the company's competitive strategy.	1,0
A6P2	The purchasing sector/department is positioned in the company's organizational chart at the management level (strategic).	1,0
A6P3	The purchasing director has direct access to the company president.	1,0
A6P4	The functions of the purchasing sector/department are formally described and documented.	1,0
A6P5	The professionals of the purchasing sector/department are trained to develop their skills in Purchasing.	1,0
A6P6	Training plans are available and documented.	0,2
A6P7	Individual performance influences personal development and compensation.	0,8
A6P8	There are regular conversations regarding the development of purchasing sector/department employees.	0,2
A6P9	There are career plans in Purchasing.	0,6

Source: Authors (2025).

Practices of Attribute 7 – Performance Evaluation

The practices of the "Performance Evaluation" attribute are listed in Figure 7, with their respective designations and weights considered in the MLPPCC measurement system.

Figure 7

Practices related to Attribute 7 – Performance Evaluation.

ATTRIBUTE 7 – PERFORMANCE EVALUATION		
DESIGNATION	**PRACTICES**	**WEIGHT**
A7P1	Performance indicators for the purchasing process are used.	0,8
A7P2	The performance goals of the purchasing sector/department are formally defined and documented.	0,8
A7P3	The actual performance of the goals is monitored and reported visually.	0,2
A7P4	If performance goals are not achieved, corrective actions are taken immediately.	1,0
A7P5	Risk management is an integral part of the purchasing process.	0,2
A7P6	The risks of the purchasing process are identified and there is a contingency plan to minimize these risks.	0,2

Source: Authors (2025).

Application of the MLPPCC method

The system proposed in this article for measuring the Maturity Level of the Purchasing Process in Civil Construction (MLPPCC) was developed in six stages, as illustrated in Figure 8.

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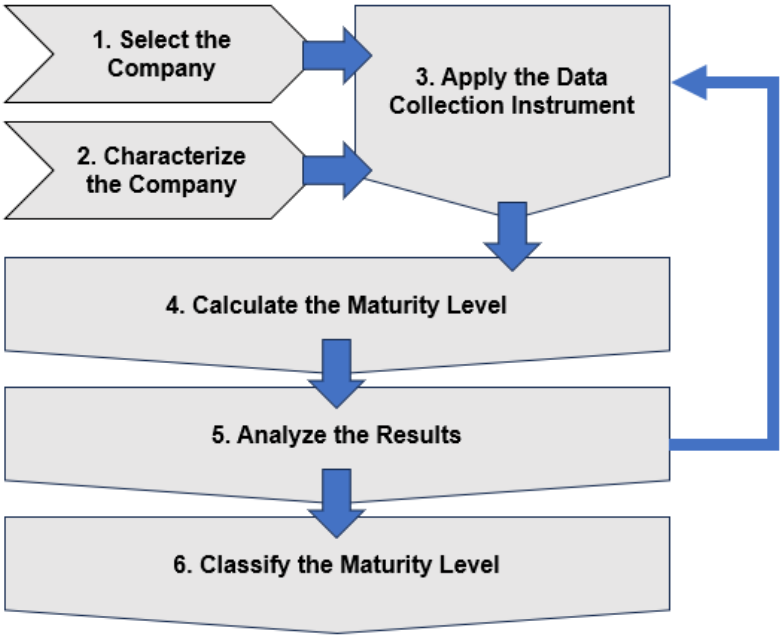
Figure 8
MLPPCC measurement system.



Source: Authors (2025).

After defining the concept of the maturity level of the purchasing process and its attributes and practices, the System for Measuring the Maturity Level of the Purchasing Process in Civil Construction (MLPPCC) was developed, as shown in Figure 8.

Stage 1 consisted of selecting the companies to be evaluated. The data collection instrument was sent to several companies operating in the city of Balneário Camboriú, but only four medium-sized companies responded to the survey. In stage 2, the four surveyed companies were characterized, including company name, year of foundation, number of employees, address, telephone, type of product and target audience, in addition to the size of the surveyed company. At this stage, the purchasing manager responding to the questionnaire was also characterized where data such as name, position in the company, educational background, telephone, and email were requested.

Stage 3 consisted of applying the data collection instrument. The instrument was developed in Excel to facilitate the application and analysis of data. Data collection took place in July 2019. The 72 practices of the seven attributes of the system were evaluated on a Likert scale from 1 to 5, classified between "Strongly Disagree" and "Strongly Agree," as presented in Figure 9.

Figure 9
Methodology for evaluating the system's practices.

PRACTIVE	WEIGHT	Strongly disagree	Disagree	Neither agre nor disagree	Agree	Strongly agree	MLP
SCORE		1	2	3	4	5	
A1P1	**1,0**						
A1P2	**0,8**						
AnPn	**Pn**						

Source: Authors (2025).

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The purchasing manager of the surveyed company answered the questionnaire with the score corresponding to their perception of how the practice is applied in the company. The multiplication of the practice weight defined in the legitimation process by the score given by the purchasing manager forms the Maturity Level of the Practice (MLP), according to equation 1.

$$MLP_n = W_n \times P_n \quad (1)$$

Where:

MLPn = Maturity Level of the Practice n;

W = Score related to the Likert scale;

P = Weight assigned to practice n.

Attribute Maturity Level (AML1, AML2, AML3, AML4, AML5, AML6, and AML7), will be calculated according to equation 2.

$$AML_n = \sum_{n=1}^{n} \frac{MLP_n}{P_n} \quad (2)$$

Where:

AMLn = Attribute Maturity Level n;

$\sum MLP_n$ = Sum of the Maturity Level of the Practice of Attribute n;

P_n = Sum of the practice weights of Attribute n.

The Purchasing Maturity Level (PML) is the result of the MLPPCC measurement system. The PML is composed of the sum of all AML of the seven attributes, as demonstrated in equation 3.

$$\text{PML} = \sum AML_n \quad (3)$$

Where:

PML = Purchasing Maturity Level.

$\sum AML_n$ = Sum of the Attribute Maturity Levels of the seven attributes.

The Purchasing Maturity Level (PML) and the Attribute Maturity Level (AML) can be classified as described in Figure 10.

Figure 10
Classification criteria.

LEVEL	CLASSIFICATION	SCORE	%
LEVEL 1	Does not perform the practices or was started but discontinued.	1 - 7	0% - 20%
LEVEL 2	Practices performed, but in an informal and unstructured manner.	8 - 14	20% - 40%
LEVEL 3	Formalized practices. There are implemented procedures, but they are not fully utilized.	15 - 21	40% - 60%
LEVEL 4	Practices formally implemented and effectively utilized.	22 - 28	60% - 80%
LEVEL 5	Practices implemented, utilized, integrated with other activities and continuously improved	29 - 35	80% - 100%

Source: Authors (2025).

After completing the responses in stage 3, stage 4 was automatically generated by the data collection instrument and the calculation of the Purchasing Maturity Level (PML) was performed, which enabled the analysis of results (stage 5). The maturity classification of each attribute of the system was presented. In this way, it was verified which attributes should be prioritized for corrective measures and improvement of future results.

Stage 6 classified the maturity level of the purchasing process of the surveyed companies and showed in which of the five levels each company is classified, as described in Figure 10.

RESULTS OF THE MLPPCC SYSTEM APPLICATION

In comparing the Purchasing Maturity Level (PML) of companies A, B, C, and D, total balance among the companies is noted, since all were classified as level 4. The company with the highest percentage was Company "B", with 70%, followed by Company "A", with 67%, and lastly Companies "C" and "D", both with 63%, as shown in Figure 11.

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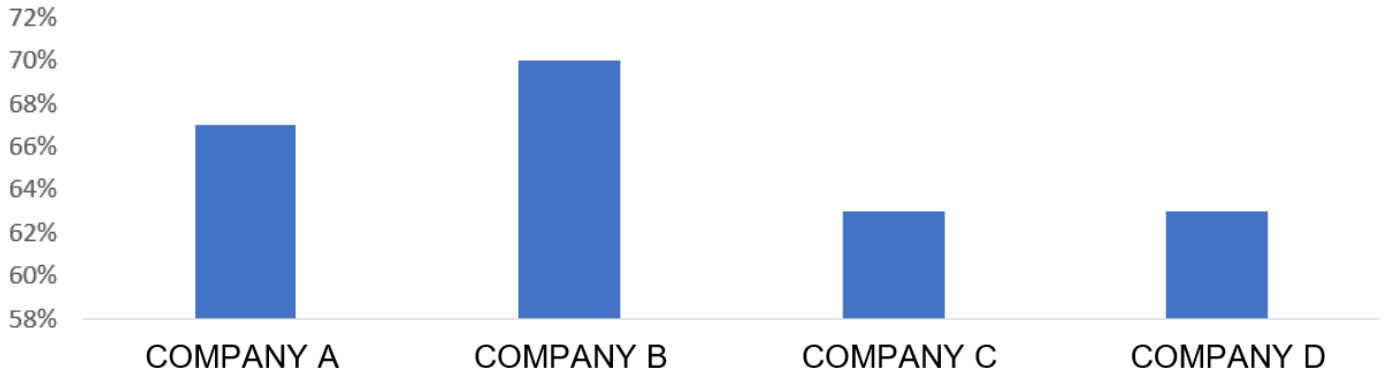
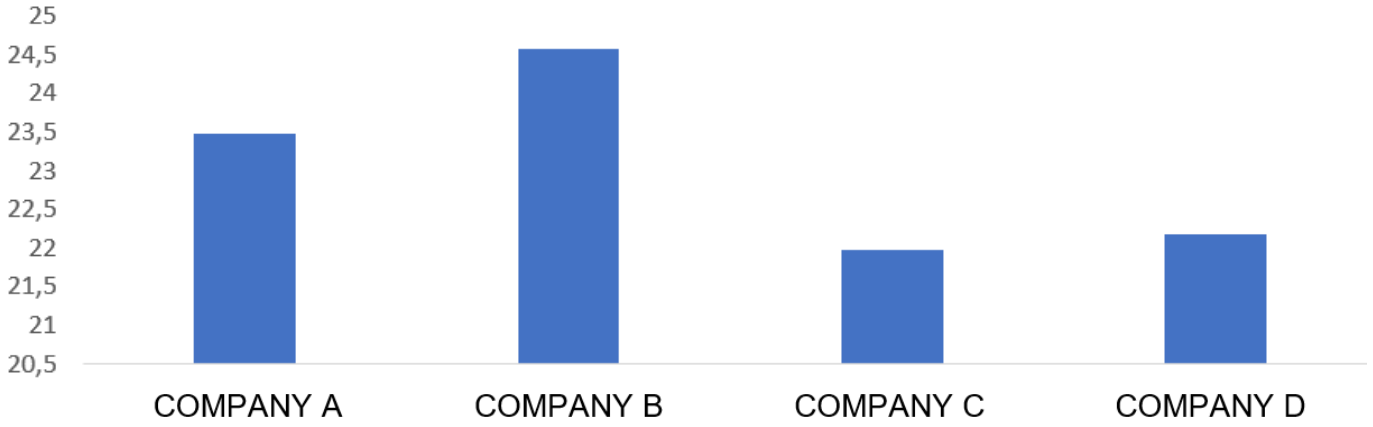
Figure 11
PML percentage of the companies surveyed.



Source: Authors (2025).

Regarding the points, Company "B" presented the highest score, with 24.58 points, followed by Company "A", with 23.47 points. Company "D" reached 22.17 points and lastly, Company "C" with 21.97 points, as shown in Figure 12.

Figure 12
PML points of the companies surveyed.



Source: Authors (2025).

Figure 13 presents the Attribute Maturity Level (AML) of the companies surveyed. In Attribute 1 "Purchasing Strategy", only Company "A" was classified as level 3, the others were classified as level 4. In Attribute 2 "Outsourcing Strategy", only Company "B" was classified as level 5, the others were classified as level 4. In Attribute 3 "Purchasing Process", Company "D" was the only one classified as level 3, the other companies were classified as level 4. In Attribute 4 "Sustainability", only Company "D" was classified as level 3, the others were classified as level 5. In Attribute 5 "Information Management", Company "C" was classified as level 3, while companies "B" and "D" were classified as level 4 and Company "A" was classified as level 5. In Attribute 6 "Purchasing Organization", Company "A" was the only one classified as level 3, the other companies were classified as level 4. In Attribute 7 "Performance Evaluation", Company "C" was the only one classified as level 2, while the other companies were classified as level 3.

Figure 13 also presents the mode of the attribute levels, with the objective of visualizing the highest frequency of levels that occur per attribute in the companies.

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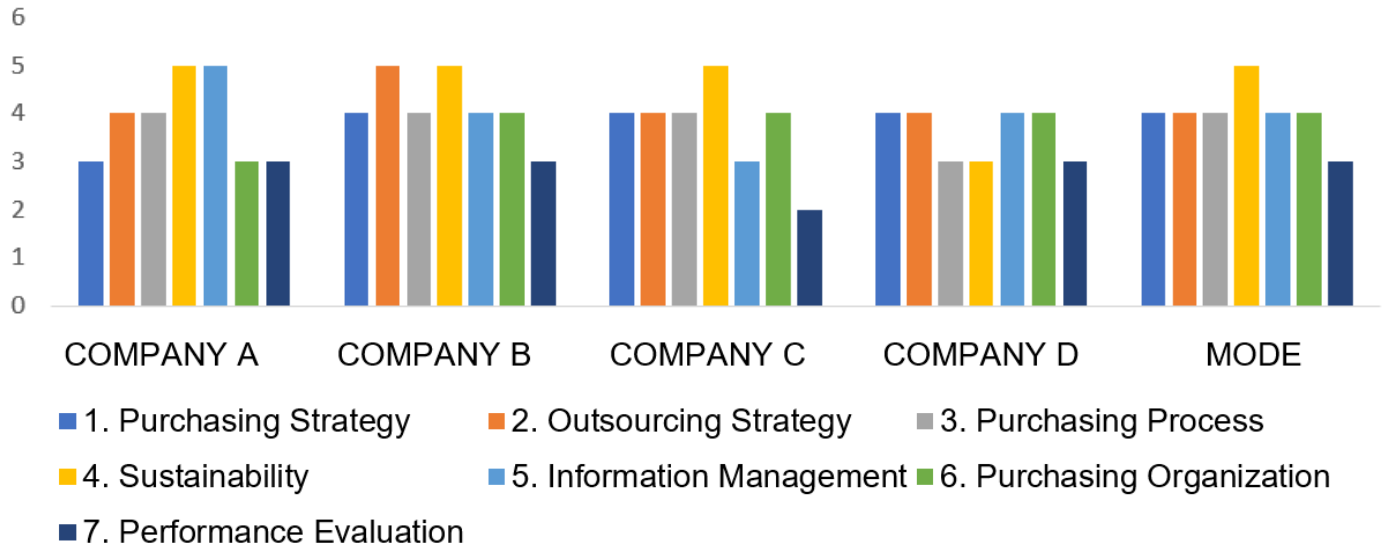
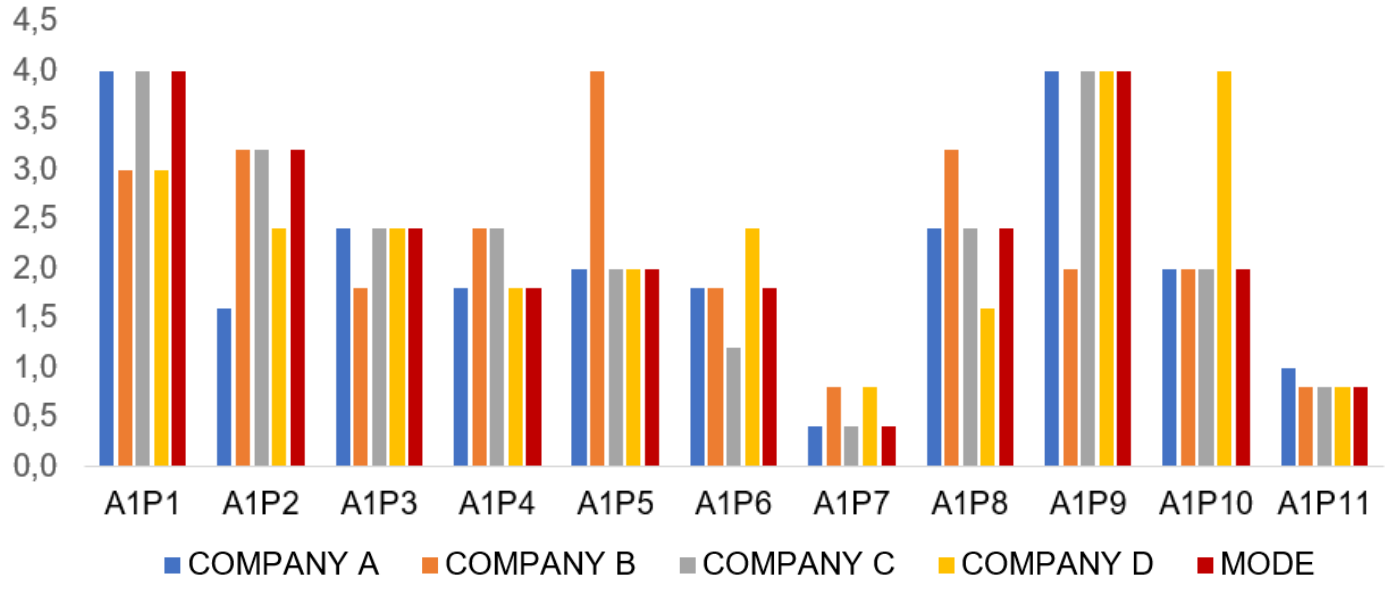
Figure 13
Attribute Maturity Level (AML) of the surveyed companies.



Source: Authors (2025).

Figure 14 presents the Maturity Level of the Practice (MLP) of each of the practices of Attribute 1 "Purchasing Strategy". The figure also presents the mode of the MLP levels, with the objective of visualizing the highest frequency of levels that occur per practice. In practice A1P3 "The purchasing sector/department conducts an analysis of the materials and services supply market", Company "B" recorded the worst performance, while in practice A1P5 "There is a formally defined procedure for the development of materials and services suppliers", the same company presented the best performance. In practice A1P10 "The criteria for purchasing categorization are formally defined, documented, and followed", Company "D" obtained the best result.

Figure 14
Maturity Level of the Practice (MLP) of Attribute 1 "Purchasing Strategy".



Source: Authors (2025).

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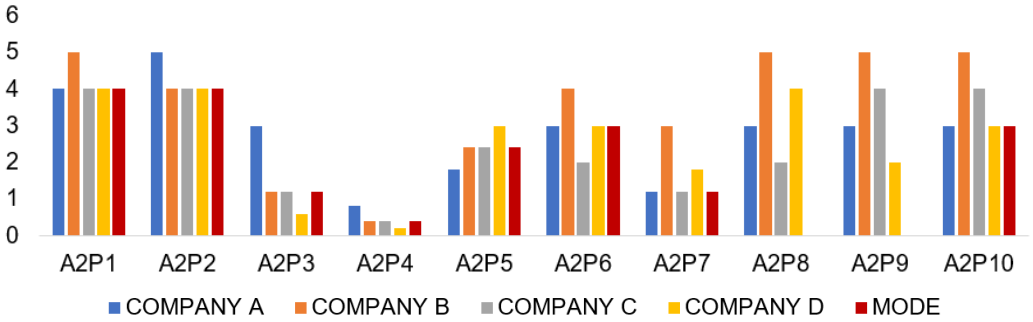
Figure 15 presents the Maturity Level of the Practice (MLP) of each of the practices of Attribute 2 "Outsourcing Strategy". Company "A" stands out in practice A2P2 "The services outsourcing strategy is known by other sectors/departments of the company", having the best result. In practices A2P8 "There is a formally defined procedure for evaluating service suppliers after the execution of services"; A2P9 "The results of the performance evaluation after the execution of services are communicated to the supplier"; and A2P10 "The purchasing sector/department has a person responsible for the development of service suppliers (new and current)", Company "B" obtained the highest classifications.

Figure 15

Maturity Level of the Practice (MLP) of Attribute 2 "Outsourcing Strategy".

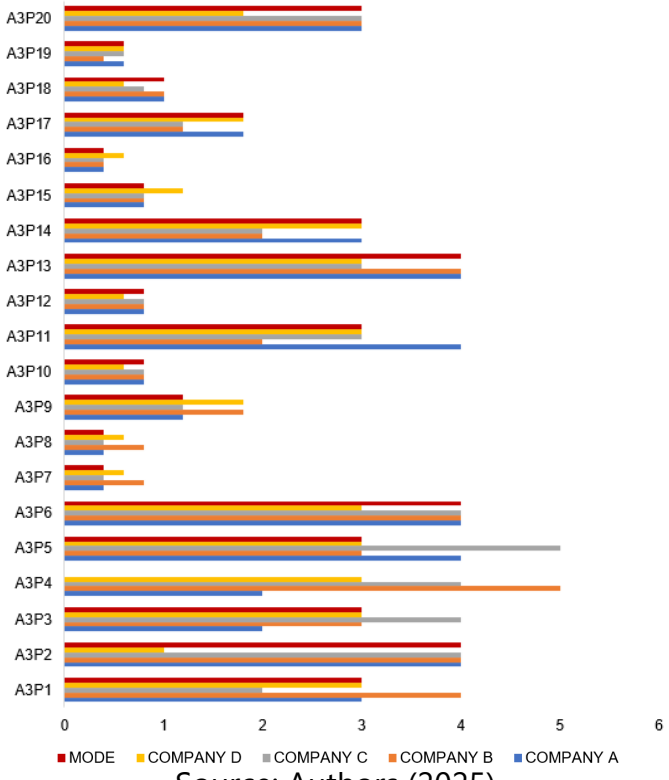


Source: Authors (2025).

Figure 16 presents the Maturity Level of the Practice (MLP) of each of the practices of Attribute 3 "Purchasing Process". In practice A3P2 "The demands for materials and services (requisitions) necessary for the execution of the construction project are derived directly from the construction designs (plans)", Companies "A", "B", and "C" obtained the same classification, while Company "D" presented the lowest result. The same result was found in practices A3P6 "The purchasing sector/department contributes to the development of products (buildings) during the construction design phase (plan)" and A3P20 "After inspection of the delivery of inputs and materials, the invoice is forwarded to the finance department for payment."

Figure 16

Maturity Level of the Practice (MLP) of Attribute 3 "Purchasing Process".



Source: Authors (2025).

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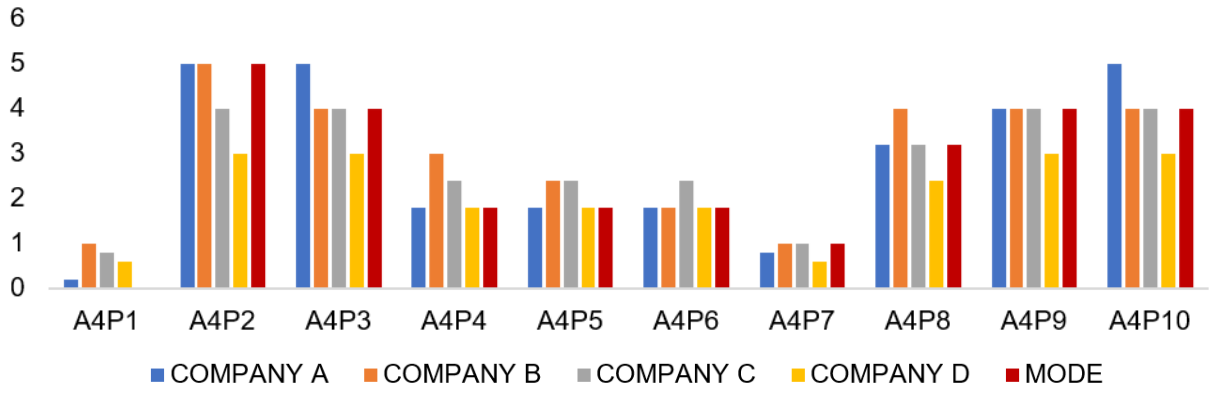
Figure 17 presents the Maturity Level of the Practice (MLP) of each of the practices of Attribute 4 "Sustainability". It is worth noting that in practice A4P2 "There are procedures to maintain favorable health, safety, and work environment conditions in all company environments (offices and construction sites)," Companies "A" and "B" presented the highest score among the companies. In practice A4P6 "The purchasing sector/department makes use of inputs and materials from recycled/sustainable sources", Company "C" presented the highest MLP.

Figure 17

Maturity Level of the Practice (MLP) of Attribute 4 "Sustainability".

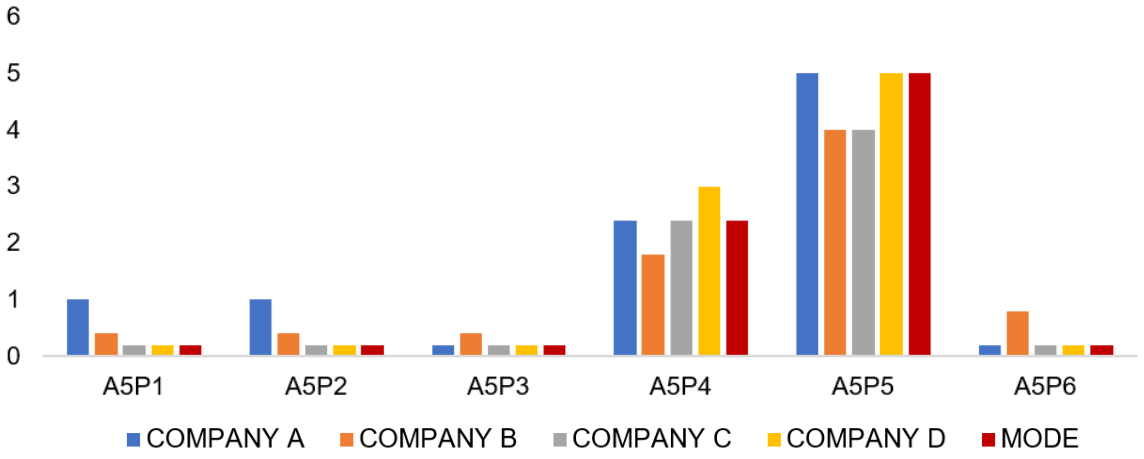


Source: Authors (2025).

Figure 18 presents the Maturity Level of the Practice (MLP) of each of the practices of Attribute 5 "Information Management". Company "A" stands out in practices A5P1 "The purchasing sector/department uses an ERP (Enterprise Resource Planning) software module for purchasing management" and A5P2 "The purchasing sector/department uses EDI (Electronic Data Interchange) tools for communication with suppliers". In practice A5P3 "The purchasing sector/department uses an information system for materials inventory management with barcode labels on materials", all companies presented low performance.

Figure 18

Maturity Level of the Practice (MLP) of Attribute 5 "Information Management".



Source: Authors (2025).

Figure 19 presents the Maturity Level of the Practice (MLP) of each of the practices of Attribute 6 "Purchasing Organization". Company "D" presented the lowest performance in practices A6P1 "The mission of the purchasing sector/department is aligned with the company's competitive strategy" and A6P3 "The purchasing director has direct access to the company president". In practice A6P6 "Training plans are available and documented", Company "A" presented the worst performance.

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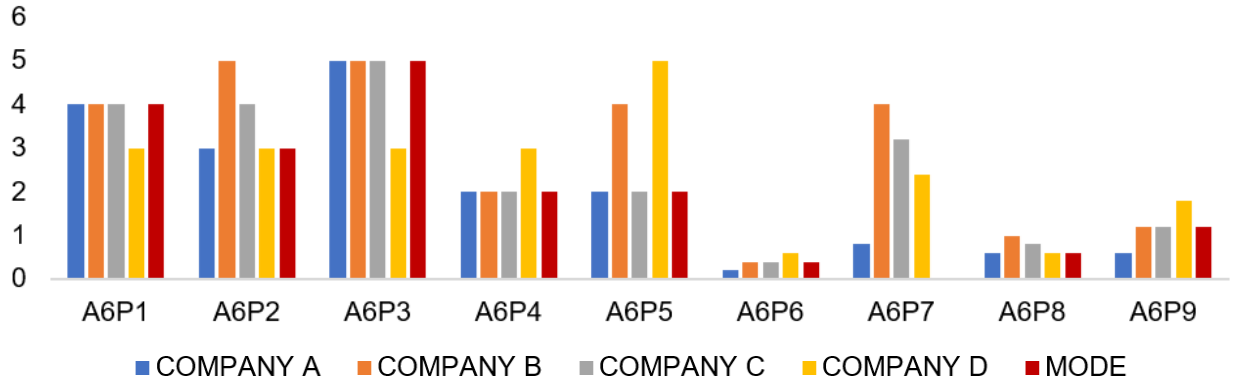
Figure 19

Maturity Level of the Practice (MLP) of Attribute 6 "Purchasing Organization".

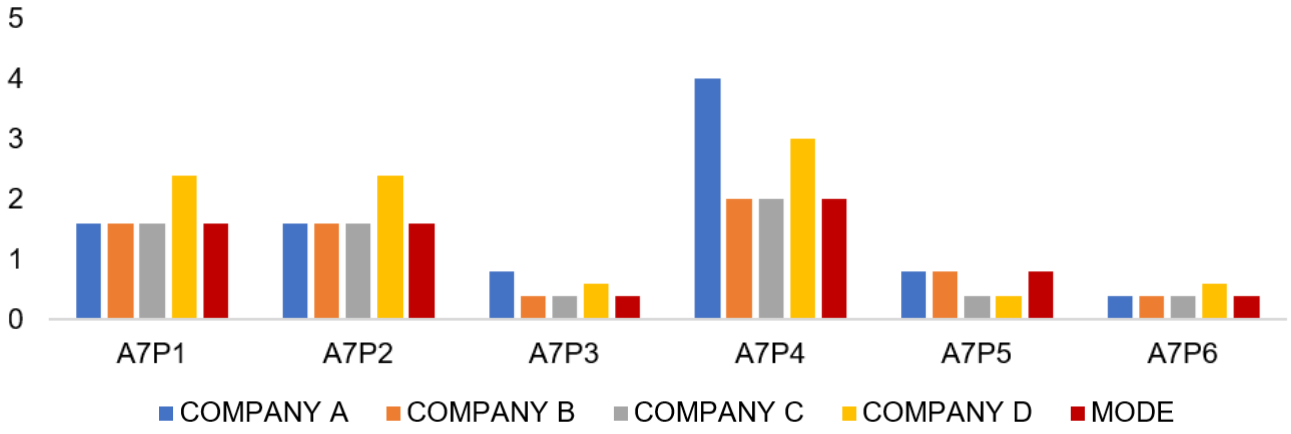


Source: Authors (2025).

Figure 20 presents the Maturity Level of the Practice (MLP) of each of the practices of Attribute 7 "Performance Evaluation".

Figure 20

Maturity Level of the Practice (MLP) of Attribute 7 "Performance Evaluation".



Source: Authors (2025).

Company "D" obtained the best result in practices A7P1 "Performance indicators for the purchasing process are used" and A7P2 "The performance goals of the purchasing sector/department are formally defined and documented". Company "A" stands out in practice A7P4 "If performance goals are not achieved, corrective actions are taken immediately".

Methodological Limitations: Self-Assessment Bias

Data collection through self-assessment questionnaires applied to managers of participating organizations constitutes an important methodological limitation of this study. When respondents evaluate the practices of their own organizations, there is a risk of self-report bias, which can systematically inflate scores due to social desirability or the tendency to present the organization more favorably (Podsakoff et al., 2012). This bias is particularly relevant when managers evaluate practices for which they are directly or indirectly responsible, potentially generating overestimation of organizational maturity (Conway & Lance, 2010). Additionally, the use of a single data source (managers) to evaluate multiple dimensions can produce common method variance, artificially inflating the correlations between the measured variables (Podsakoff et al., 2003).

However, despite these limitations, the self-assessment approach was considered appropriate for this study for three main reasons. First,

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managers occupy a privileged position to evaluate organizational practices holistically, possessing comprehensive knowledge about internal processes and systems that would not be easily accessible through other sources (Cycyota & Harrison, 2006). Second, research in operations management and organizational excellence frequently uses managerial perceptions as valid proxies for organizational practices, especially when objective measures are difficult to obtain or compare across organizations (Flynn et al., 1994). Third, studies demonstrate that, when properly structured with validated scales and objective questions about specific practices (rather than general performance evaluations), self-reported instruments can provide reliable and valid data (Spector, 2006).

Thus, to mitigate potential biases, this study adopted methodological procedures recommended by the literature, including: (a) guarantee of respondent anonymity and confidentiality to reduce social desirability; (b) use of a five-point Likert scale with clearly defined anchors to minimize ambiguity; (c) formulation of items focused on objective and observable practices rather than subjective performance evaluations; and (d) analysis of internal consistency of constructs (Podsakoff et al., 2003; MacKenzie & Podsakoff, 2012).

Comparison with other maturity models

The literature presents several maturity models applied to the purchasing function, each with specific focuses and limitations. The model by Schiele (2007), widely referenced, is based on the evolution of the purchasing function from transactional activities to strategic integration, but was developed for traditional manufacturing industry, not addressing the specificities of civil construction. Similarly, the framework proposed by Paulraj et al. (2006) emphasizes relational capabilities between buyer and supplier but lacks operational and technological dimensions essential for comprehensive diagnosis.

Úbeda, Alsua, & Carrasco (2015) developed a model focused on the transition from operational to strategic purchasing, with five maturity levels. Although conceptually robust, this model presents limitations for application in civil construction as it does not consider sectoral characteristics such as supply chain fragmentation, temporary projects with high demand variability, and multiple stakeholders with divergent interests.

In the specific context of civil construction, Eriksson (2015) proposed a maturity model for supply chain management focused predominantly on collaborative relationships and long-term partnerships. Vrijhoef and Koskela (2000) argue about the need for models that consider the reactive and fragmented nature of purchasing in construction. However, these models lack practical diagnostic tools and objective measurement that allow companies to identify their current level and improvement opportunities in a structured manner.

The MLPPCC model proposed in this study differs from previous ones through three fundamental aspects that make it more suitable for the investigated context:

1. The proposed method incorporates seven specific attributes that address both strategic and operational dimensions relevant to civil construction: (1) Purchasing Strategy; (2) Outsourcing Strategy; (3) Purchasing Process; (4) Sustainability; (5) Information Management; (6) Purchasing Organization; (7) Performance Evaluation. This multidimensional approach overcomes the limitation of models that emphasize only relational aspects (Paulraj et al., 2006) or only strategic dimensions (Schiele, 2007), offering holistic diagnosis of purchasing practices.

2. The method was specifically developed for medium-sized Brazilian civil construction companies, considering resource constraints, lean organizational structure, and regulatory particularities of the sector in the country. Bemelmans, Voordijk & Vos (2013) highlight that generic models frequently fail by disregarding organizational and sectoral context. The MLPPCC operationalizes 72 objective and measurable practices through a Likert scale, enabling practical application and comparability between organizations, which is not easily achievable with more conceptual models (Eriksson, 2015);

3. The system provides an easy-to-apply and interpret self-assessment tool, developed on an accessible platform (Excel), enabling its use by managers without the need for specialized exter-

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nal consulting. This characteristic democratizes access to maturity diagnosis, a critical aspect for medium-sized companies with limited resources for investment in consulting (Xue et al., 2007). Additionally, the model generates quantitative indicators that facilitate longitudinal comparisons within the same organization or benchmarking between companies in the sector.

Furthermore, Lockamy III and McCormack (2004) argue that maturity models should not only diagnose the current state but also offer clear direction for incremental evolution. The MLPPCC meets this requirement by establishing five progressive maturity levels with specific practices associated with each stage, allowing companies to identify gaps and prioritize improvement actions in a structured manner.

CONCLUSIONS AND CONTRIBUTIONS OF THE TECHNICAL-TECHNOLOGICAL PRODUCT

This article proposed a system to measure the maturity of the purchasing process in civil construction, diagnosing the sector and identifying improvement opportunities. High maturity indicates implementation of global best practices, while low maturity reveals their absence (Úbeda, Alsua, & Carrasco, 2015). According to Lockamy III and McCormack (2004, p.273), "achieving each maturity level establishes a higher level of process capability for an organization." By applying the tools present in maturity models, a company not only gains insights into its current purchasing maturity level but also offers possibilities to improve its purchasing maturity (Bemelmans, Voordijk & Vos, 2013).

The MLPPCC system was applied to four medium-sized companies operating in civil construction in the city of Balneário Camboriú/SC and showed that the Purchasing Maturity Level (PML) was balanced among them. The highlight was company "B," which reached 70% in the index, while companies "C" and "D" reached 63%, classifying all companies as level 4 "Practices formally implemented and effectively utilized." Of the seven attributes of the system, attribute 7 "Performance Evaluation" presented the lowest maturity index in the surveyed companies.

5.1 Evaluation of the Technical-Technological Product

The analysis of the Technical-Technological Product (TTP) developed in this research is based on the evaluation criteria established by CAPES for Area 27 - Public and Business Administration, Accounting Sciences and Tourism, according to the evaluation guidance document (CAPES, 2019). These criteria - adherence, impact, applicability, innovation, and complexity - allow for the evaluation of the product's effective contribution to the advancement of knowledge and professional practice in the civil construction sector.

Adherence: The TTP presents high adherence to the demands of the Brazilian civil construction sector, specifically in the context of medium-sized companies. Civil construction is characterized by complex purchasing processes, involving great diversity of inputs, multiple suppliers, and high volume of financial resources (Vrijhoef & Koskela, 2000). The MLPPCC model was developed considering these sectoral specificities, incorporating practices and attributes directly related to the challenges faced by purchasing managers in the sector. The application in four companies empirically validated the adequacy of the instrument to the investigated context, demonstrating that the system responds to the real diagnosis and management needs identified by professionals in the field.

Impact: The impact of the TTP manifests itself in multiple dimensions. From a managerial point of view, the system provides purchasing managers with an objective tool to evaluate the maturity of their processes, identify gaps in relation to best practices, and prioritize investments in improvements. The maturity of the purchasing process is a measure of how people, strategies, practices, suppliers, and communication are managed in a purchasing department to capture the strengths of suppliers, including shared and sustainable cost savings, know-how, innovation, shorter time to market, and productivity improvements (Úbeda, Alsua, & Carrasco, 2015). From an economic point of view, companies with greater maturity in purchasing have the potential to reduce operational costs, improve delivery times, and increase the quality of acquired inputs, directly impacting organizational competitiveness.

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From a social point of view, TTP contributes to promoting a more efficient and productive work environment through the elimination of waste and optimization of organizational processes, enabling purchasing departments to evolve from a merely administrative function to more strategic work that supports business.

Applicability: Applicability constitutes one of the main differentials of the proposed TTP. The model was developed on the Excel platform, widely accessible and familiar to managers, reducing technological barriers to its adoption. The data collection instrument, structured with 72 practices evaluated on a Likert scale from 1 to 5, allows application through self-assessment or audit by external researchers, offering methodological flexibility. Although developed specifically for medium-sized civil construction companies in the vertical residential construction segment, the system presents potential for replicability to construction companies of other sizes and different areas of operation, such as horizontal construction, road construction, and infrastructure, provided that some practices are adapted to the specific context. From a technological point of view, the system can be incorporated into computerized systems and organizational management platforms, promoting automation of data collection and analysis processes, as well as generation of reports and analytical dashboards that support strategic decision-making. This technological insertion contributes significantly to expanding the applicability of the system, in addition to favoring its dissemination among a broader number of organizations.

Innovation: The innovativeness of TTP is evidenced in three main aspects. First, this work becomes unprecedented by developing a system for measuring the maturity level specific to the purchasing process in civil construction, filling a gap identified in the literature, since existing models were developed primarily for traditional manufacturing sectors (Schiele, 2007; Paulraj et al., 2006). Second, the structuring into seven attributes - Purchasing Strategy, Outsourcing Strategy, Purchasing Process, Sustainability, Information Management, Purchasing Organization, and Performance Evaluation - provides a multidimensional approach that surpasses models focused exclusively on relational or strategic aspects, offering holistic diagnosis of purchasing practices. Third, the system allows comparison of results between different companies or within the same company at different periods, enabling sectoral benchmarking and longitudinal monitoring of maturity evolution, functionalities rarely found in similar instruments.

Complexity: The TTP presents complexity appropriate to the investigated problem, balancing methodological rigor with practical application. The structuring into five progressive maturity levels - from nonexistent practices to continuously optimized practices - is based on established models in the process management literature, such as CMMI (Lockamy III & McCormack, 2004). The operationalization of 72 specific practices, distributed across seven attributes, demanded extensive review of specialized literature, consultation with sector specialists, and empirical validation in a real application context. The development of the instrument in Excel, although apparently simple, involved complexity in structuring calculation formulas, attribute weighting, and automated generation of diagnostics and comparative graphs. This technical complexity, however, does not compromise the usability of the product, maintaining an accessible interface for managers without advanced technical training.

Recommendations for Future Work

For future work, it is recommended that, in addition to the application of the questionnaire for self-assessment by purchasing managers of construction companies, the data collection instrument be applied by the researcher at the surveyed company, in the form of an audit. In this way, the results achieved will present a more accurate picture of the purchasing process of the surveyed company and will allow comparison of the purchasing manager's perception with the researcher's diagnosis, mitigating the self-assessment bias discussed earlier.

It is also suggested that future studies could triangulate self-assessed data with objective measures of organizational performance (financial indicators, certifications, external audits) or incorporate multiple sources of respondents (employees from different hierarchical levels) to

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increase methodological robustness and minimize the effects of self-assessment bias (Harrison et al., 1996).

Additionally, it is recommended to apply the system to companies of other sizes and different segments of civil construction, as well as in other cities and regions. The research was applied only to construction companies operating in the city of Balneário Camboriú/SC, which has a civil construction reality different from other locations, limiting the generalization of the findings. Comparative studies between distinct geographical regions could identify regional maturity patterns and contextual factors that influence the adoption of purchasing practices.

The last recommendation concerns the implementation of action plans for the surveyed companies to increase maturity levels in purchasing and, in this way, apply best practices in purchasing processes. Longitudinal studies that follow companies over time after implementing improvements based on the MLPPCC diagnosis could empirically validate the impact of maturity evolution on organizational performance indicators, such as cost reduction, delivery times, and quality of acquired inputs.

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