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Article

Assessing Benefits of ISO/IEC 42001 Artificial Intelligence Management System: Insights from Brazilian Logistics

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Abstract: (1) Background: The study aimed to analyze and rank the benefits of adopting Artificial Intelligence (AI) in the logistics area, considering the opinion of professionals working in the Brazilian logistics sector through the implementation of ISO/IEC 42001; (2) Methods: The procedures adopted included a literature review to identify the benefits of the use and the application of a survey aimed at professionals in the logistics sector. The analysis used the TOPSIS method to identify and rank the most decisive benefits; (3) Results: Of the 15 benefits mapped in the literature, the professionals attributed the greatest importance to customer satisfaction, operational efficiency, incentives for innovation, and improving the company's image and competitive advantage. The results indicate that adopting ISO/IEC 42001 not only promotes process optimization and cost reduction, but also encourages innovation and strengthens competitiveness in the market; (4) Conclusions: the implementation of this standard is vital for companies in the logistics sector, especially in a Brazilian context of major infrastructural and regulatory challenges. The findings highlight the need for a strategic approach to the adoption of AI, emphasizing the importance of efficient logistics management and ethical practices in the application of this technology.

Keywords: ISO/IEC 42001; Artificial Intelligence; Logistics Management; TOPSIS

1. Introduction

Faced with a scenario in which technologies are advancing rapidly, companies are challenged to adapt their operational and management processes to meet new market demands [1]. Recently, with the arrival of Artificial Intelligence (AI), this transformation movement has accelerated even more, requiring organizations to take a proactive stance towards innovation [2].

And when it comes to management processes, logistics is still seen as complex and dynamic, requiring strict control over the various stages involving the flow of products and information along the supply chain [3], [4]. Logistics, by its complex nature, deals with inventory management, transportation, warehousing and distribution, often in global scenarios and under increasing pressures for efficiency and speed [5]. In this context, AI has proved to be an important tool for overcoming these challenges, providing more agility and precision in decision-making in this sector [6].

Thus, in this highly dynamic environment, the integration of advanced technologies is essential to optimizing processes and supporting more assertive decision-making. [7]. According to Sardarabady and Durst [8] the data analysis provided by these technologies, such as AI, helps to predict future needs and plan more effectively, ensuring more proactive resources management.

Recent studies indicate that the application of AI in the logistics sector can lead to a significant improvement in the efficiency and effectiveness of operations, resulting in benefits such as reduced operating costs, optimization of transport routes and better inventory management. [9]. Spilseth et al. [10] point out that AI brings significant benefits to logistics, such as process optimization, demand forecasting and improved inventory and delivery route management, where these advances can increase operational efficiency and reduce costs, as well as enabling more flexible and accurate responses to market demands. [9], [10].

However, with the arrival of AI technologies, concerns are being raised about how they can influence the processes of companies and industries in different sectors, including logistics [11] These concerns lie in ensuring the ethical and efficient implementation of AI, where the creation of standards and regulations, such as ISO/IEC 42001, becomes indispensable [12], [13]. According to Liang et al. [14] inappropriate or irresponsible use of AI can lead to a number of problems, including algorithmic discrimination, invasion of privacy and unfair automated decisions.

According to Valle-Cruz et al. [15] the lack of adequate governance in the implementation of AI can result in adverse consequences for both organizations and society in general, such as concerns about possible negative impacts on economies and markets, including inefficiencies in the allocation of market resources, the potential for an unequal redistribution of income and the tendency for certain AI technologies to be monopolized by large companies from different sectors.

Despite the numerous benefits presented in the literature, it is essential to analyze the impact and, above all, the acceptance of the use of this technology in sectors of society, such as industry and, in particular, logistics. In this context, there are several studies on the benefits of International Organization for Standardization (ISO), but there is a specific lack of data on ISO/IEC 42001 due to its novelty. Therefore, considering that ISO/IEC 42001 for the use of AI is still a standard under discussion, it is necessary to understand how professionals in the logistics sector consider the determining factors, especially in the Brazilian reality. As Brazil is considered to be a country of continental dimensions and with an economy in constant movement, it presents a logistical complexity marked by challenges such as inadequate infrastructure, complex regulations and vast geographical distances [16].

Despite the growing importance of AI in logistics and the development of ISO/IEC 42001, there is a significant gap in the literature on how this standard can be effectively implemented. Previous studies have mainly focused on the general benefits of ISO standards, but there is a scarcity of research specifically addressing the intersection between AI, logistics, and ISO/IEC 42001. This study aims to fill this gap by providing insights into the benefits successful adoption of AI in logistics, aligned with the principles of ISO/IEC 42001. As Brazil presents logistical complexity marked by challenges such as inadequate infrastructure, complex regulations, and vast geographical distances, this study becomes particularly relevant in this context.

This paper is structured in five sections. The first section is dedicated to the introduction, containing a contextualization of the topic, the problem and the objective of the research. The second section is dedicated to the literature review, which presents the theoretical discussions on the subject. The third section presents the methodological procedures adopted, followed by the research stages. The fourth section presents the main results, analysis and discussions. Finally, the last section is made up of the main conclusions of the study, including limitations and directions for future research.

2. Literature Review

The evolution of Artificial Intelligence (AI) began in the 1950s, with John McCarthy conceptualizing it as the ability of machines to replicate human characteristics, such as understanding and problem solving. Today, AI encompasses a vast field of Computer Science, focused on creating intelligent systems capable of performing tasks that previously required human intelligence. In addition, AI is becoming a crucial tool in business decision-making, both as support for human decision-makers and as a decision-maker in its own right, representing new potential for innovative services and products [17].

Risk management is essential for identifying, assessing and mitigating potential threats that could negatively impact the organization. According to Parviainen et al. [18] management standards provide a solid framework for managing risks in a systematic way, including environmental, operational and financial risks. This allows companies to implement effective strategies to minimize losses and seize opportunities, improving resilience and the ability to adapt to market changes. By adopting risk management practices, organizations not only protect their assets and reputation, but also position themselves more solidly in the face of future uncertainties and challenges [19].

Continuous quality improvement is a central objective in management systems [20]. Implementing a quality management system encourages process optimization, waste reduction and increased customer satisfaction. This results in more efficient operations and high-quality products or services, which in turn strengthens the company's competitiveness and sustainability. By prioritizing quality at all stages of the production process, organizations demonstrate a commitment to excellence and customer satisfaction, which are fundamental to long-term success in increasingly demanding and competitive markets [21].

According to Franchina et al. [19] the implementation of an ISO 9001:2015-compliant quality management system at clinical trial sites in Italy has demonstrated significant benefits, such as continuous process improvement and higher quality. In addition, this adoption is essential to ensure the execution of corrective actions and the performance of international audits, as well as to encourage a risk management approach.

Cost reduction is one of the main motivators for adopting effective management systems. Implementing these systems allows inefficiencies, waste and redundancies to be identified and eliminated, resulting in significant savings and a better allocation of resources, increasing the company's profitability and competitiveness. According to Fuchs et al. [22] implementing an energy management system in accordance with ISO 50001 brings benefits to the organization, including cost savings. The standard has helped companies achieve significant energy savings, thereby reducing operating costs related to energy consumption. In addition, many companies report that the additional results of adopting the standard are increased productivity and operational efficiency. Furthermore, the cost savings provided by efficient management practices not only strengthen the organization's financial position, but can also result in more competitive prices for the products or services offered, expanding market opportunities and maximizing return on investment [23].

Certification can improve a company's image by demonstrating a commitment to high quality standards and social and environmental responsibility. This not only attracts customers and investors, but also strengthens the company's reputation in the market. As stated by Heras-Saizarbitoria et al. [24] a positive corporate image is a valuable asset that can differentiate the company from its competitors and build a loyal customer base. In addition, a good reputation can open doors to strategic partnerships, business opportunities and collaborations that drive the organization's long-term growth and success [22].

Adopting sustainable and responsible practices strengthens the organization's values and principles, creating a work environment that is more cohesive and aligned with environmental and social objectives. This not only improves environmental performance, but also engages employees and encourages a sense of collective responsibility, resulting in a more robust and resilient organizational culture. A strong corporate culture is key to attracting and retaining talent, promoting innovation and successfully adapting to market changes, creating a sustainable competitive advantage in the long term [22].

Implementing efficient practices leads to a more efficient operation, reducing downtime and increasing production capacity, resulting in greater productivity and better use of resources. By optimizing processes and eliminating unnecessary or redundant activities, organizations can significantly improve their operational efficiency, allowing them to achieve their production goals more quickly, economically and consistently. Increased productivity not only benefits the company, but can also improve employee satisfaction, reduce stress in the workplace and promote a more positive and motivating environment for everyone involved [22].

Promoting transparency builds trust among stakeholders, reducing uncertainty and promoting accountability, as organizations are held to account for their actions and decisions. By adopting transparent policies and practices, organizations can improve their credibility and reputation by demonstrating a commitment to honesty, integrity and accountability in all areas of operation. In addition, transparency can facilitate effective communication and collaboration between different stakeholders, fostering a more collaborative and productive working environment [18].

By involving a wide range of stakeholders, organizations can gain a more comprehensive understanding of risks and their possible consequences, promoting diversity of perspectives and experiences. Promoting inclusion not only strengthens community and social ties, but can also result in better decisions and solutions, reflecting a more open, democratic and accountable approach to risk management and decision-making. In addition, inclusion can promote innovation and creativity by bringing new ideas and insights into the planning and execution process [18].

Focusing on compliance with requirements can drive innovation in search of more effective and cost-efficient solutions. By challenging organizations to think creatively and explore new approaches to solving problems and meeting customer expectations, the pursuit of compliance with management standards can stimulate innovation at all levels of the organization. In addition, innovation can provide sustainable competitive advantages by differentiating products and services, opening up new markets and strengthening the company's position as a leader in its sector [25].

The standardization of indicators allows organizations to compare their performance in a consistent and meaningful way, making it easier to identify the most effective practices in different areas. This promotes the sharing of best practices between organizations, encouraging collaboration and the exchange of knowledge. By learning from each other, organizations can implement improvements based on these best practices, driving innovation and promoting continuous advancement in their operations and results [23].

Independent data auditing increases the credibility of the information collected by the organization, which is essential for making informed decisions and persuading potential investors and funders. By following recognized standards, organizations improve the reliability of their data, strengthening their position in the market and increasing their attractiveness to potential partners and customers. Reliable data is the basis for accurate analysis and successful strategies, ensuring that decisions are based on accurate and up-to-date information [23].

As pointed out by Poksinska et al. [26] certification confers a significant competitive advantage by enhancing the company's reputation and demonstrating its commitment to high standards of quality and sustainability. This can attract new customers, retain existing ones and open up new markets. The competitive advantage is reinforced by the company's ability to differentiate itself from competitors and offer superior value to customers. By investing in certification, companies can position themselves as leaders in their sector, gaining a strategic advantage over their competitors [24].

The implementation of standards encourages sustainable practices and the optimization of resources, resulting in more economical and environmentally responsible operations [27]. This involves reducing waste, energy consumption and other resources, contributing to cost savings and increased productivity. Improving operational efficiency not only benefits the company, but also has a positive impact on society and the environment by promoting the responsible use of natural resources and minimizing negative impacts [28].

Customer satisfaction is a central objective of quality standards such as ISO 9001. Implementing these standards can not only improve the quality of products and services, but also raise customer satisfaction. Standardized processes and a continuous focus on improvement help ensure that customer needs and expectations are consistently met, fostering customer loyalty and recommendation. Customer satisfaction is fundamental to the long-term success of the organization, as satisfied customers are more likely to return and continue doing business [27].

Increasing the participation of all countries in the digital transformation promotes digital inclusion, which is key to ensuring that everyone can benefit from AI innovations. Reducing digital inequalities means that more people will have access to the tools and resources they need to improve

their living conditions. The equitable spread of technology helps to balance opportunities between nations, promoting fairer and more equal development around the world (UN, 2024).

In the literature on multi-criteria analysis, three widely used methods are the Hierarchical Analysis Method (AHP), the Preference Method by Similarity to the Ideal Solution (PROMETHEE) and the Analysis Method by Similarity to the Ideal Solution (TOPSIS). The AHP, proposed by Saaty in 1990, is a powerful technique for approaching and solving complex and uncertain decision problems. It organizes the criteria into a hierarchy and uses pairwise comparisons to calculate relative weights, allowing the prioritization of alternatives based on subjective judgments. PROMETHEE, on the other hand, is an ordering method based on comparing alternatives in relation to each criterion, using preference functions to assess the dominance of one alternative over another [30]. Both methods are widely recognized for their ability to deal with complex multi-criteria decision problems, offering structured and systematic approaches to decision-making.

The Ideal Solution Similarity Analysis Method (TOPSIS), according to Singer and Özçelik [31] is widely used in multi-criteria analysis because of its intuitive and effective approach. TOPSIS orders the alternatives based on their proximity to the positive ideal solution and their distance from the negative ideal solution, making it possible to identify the most balanced alternative in relation to all the criteria considered. This method is valued for its simplicity and its ability to deal with multiple criteria in an objective and straightforward manner.

3. Methodological Procedures

The aim of this research was to analyze and rank the benefits of adopting ISO/IEC 42001 AI in the logistics sector, considering the Brazilian context. To this end, a literature review and a survey of experts were adopted as the research strategy, organized into four main stages, as shown in Figure 1.

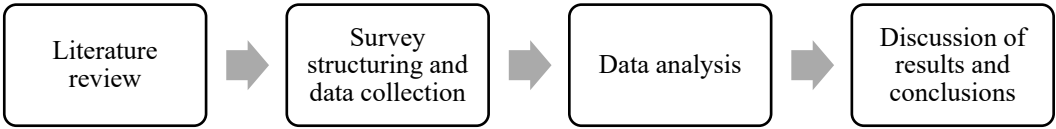


Figure 1. Research stages.

In the first stage, the literature was surveyed. To do this, scientific databases (Science Direct, Scopus, Web of Science and Emerald Insight) were consulted using the search terms "logistics", "artificial intelligence", "benefits" and "ISO/IEC 42001 certification". The result of this search was a general selection of 15 documents, which were downloaded and analyzed. Analysis of the documents resulted in the identification of fifteen benefits of adopting the ISO/IEC 42001 standard in the logistics sector (Table 1), the discussion of which was presented in the previous section.

In the second stage, the survey was structured. At this stage, a structured data collection instrument was developed based on the benefits identified in the literature (Table 1). Then, using an online form using the Google Forms tool, the survey was applied to professionals working in the logistics sector in Brazil. The form was sent to these professionals via digital platforms, such as LinkedIn, and sent individually by e-mail. Data was collected over a period of 6 months, resulting in 44 responses. The sample was made up of professionals working in different sectors of the economy: 47% work in industry, 31% in retail and 22% in distributors. As for the positions held, 49% of the respondents are managers, 20% work as logistics analysts, 9% are directors, 7% are consultants, and the remaining 15% are distributed among the positions of Junior Assistant, CEO, Coordinator, Owner and Supervisor. Geographically, the majority of respondents are located in the state of Pará, around 64%, followed by 16% in Piauí, 7% in Maranhão, 11% in Manaus, Pernambuco and São Paulo, and 2% in the states of Amapá and Sergipe.

In the third stage, after data collection, the data was downloaded into an Excel spreadsheet and analyzed using the TOPSIS method to analyze and rank the benefits perceived by the logistics experts. For each of the benefits listed, the experts indicated on a scale of 0 to 10 how relevant that benefit is considered to be in promoting efficient logistics management in accordance with ISO Standard 42001.

The TOPSIS method (Method of Ordering Preferences by Similarity to the Ideal Solution) is a multi-criteria decision-making technique widely used in various areas of research and practice. Introduced by Hwang and Yoon in 1981, this method is used to determine the best choice between alternatives, considering multiple criteria involving a series of steps [32]. To order the benefits, this study followed the seven steps of the method as recommended by Singh et al. [32] and Martins et al. [33].

Initially, TOPSIS structured a Matrix D (equation 1), in which the elements (x_{ij}) represent the alternatives (i) and the analysis criteria (j).

$$D = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \quad (1)$$

Next, once we had Matrix D, we performed the normalization calculation (equation 2), resulting in Matrix R (equation 3).

$$r_{ij} = x_{ij} / \sqrt{\sum_{i=1}^n x_{ij}^2} \quad (2)$$

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \dots & \dots & \dots & \dots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix} \quad (3)$$

Equation 4 was used to weight the values in the R matrix, resulting in the V matrix (Equation 5). In this study, the weights assigned were 50% for participants with more than 20 years' experience, 30% for those with 11 to 19 years' experience and 20% for those with up to 10 years' experience.

$$v_{ij} = w_j r_{ij} \quad (4)$$

$$V = \begin{bmatrix} v_{11} & v_{12} & \dots & v_{1n} \\ v_{21} & v_{22} & \dots & v_{2n} \\ \dots & \dots & \dots & \dots \\ v_{m1} & v_{m2} & \dots & v_{mn} \end{bmatrix} \quad (5)$$

Equations 6 and 7 were then used to determine the ideal positive (v_j^+) and negative (v_j^-) solutions, where these solutions represent the maximum and minimum values respectively in Matrix V for each of the analysis criteria.

$$s_i^* = \left[\sum_j (v_{ij}^* - v_j^+)^2 \right]^{1/2} \quad (6)$$

$$s_i' = \left[\sum_j (v_{ij}' - v_j^-)^2 \right]^{1/2} \quad (7)$$

Thus, considering the values obtained from the Euclidean distances (v_j^+ and v_j^-), it was possible to calculate, using equation 8, the C_i^* indicator, which made it possible to order the fifteen benefits analyzed in the survey according to the perception of logistics specialists in the Brazilian context. It should be noted that C_i^* values must be between 0 and 1.

$$c_i^* = \frac{s_i'}{(s_i^* + s_i')} \tag{8}$$

Finally, in the fourth stage of this research, through the results analyzed by the TOPSIS method, discussions were established in the light of the literature and the main conclusions of the study were presented.

4. Results and Associated Debates

The result of the literature review was the identification of 15 benefits associated with ISO/IEC 42001 standards. As can be seen in Table 1, the benefits were based on the perspectives of different authors, who discuss the positive impacts of this standard in the context of logistics, understood as one of the most complex sectors in business.

Table 1. - Benefits found in the literature.

Code	Benefits	References
B01	Effective risk management	[18], [19], [24]
B02	Improving process quality	[18], [19], [21]
B03	Reducing costs	[22], [23], [26], [27]
B04	Improving the company's image	[22], [24]
B05	Stronger corporate culture	[22], [24]
B06	Increasing productivity	[22]
B07	Promoting Transparency	[18]
B08	Promoting Inclusion	[18]
B09	Incentives for Innovation	[25]
B10	Sharing good ideas	[23]
B11	Confidence in the data	[23]
B12	Competitive advantage	[24], [26]
B13	Improved operational efficiency	[27], [28]
B14	Customer satisfaction	[19], [27]
B15	Reducing Digital Inequalities	[29]

Source: Prepared by the authors based on the literature.

The benefits listed above reflect what has been discussed in the literature, considering the impacts that AI has had, specifically in the context of companies and their various sectors, such as logistics. However, it can be seen that these benefits, with regard to ISO/IEC 42001, are only concentrated in the theoretical field, and in this study it was verified how decisive they are in the logistics sector in the Brazilian reality. As detailed in the methodological procedures, the data was analyzed using the TOPSIS technique, with the aim of ranking the most decisive benefits for implementing ISO/IEC 42001, according to the perception of these professionals.

As seen in Table 2, the TOPSIS method initially calculated the average scores given by each professional to each of the benefits considered in this study (Table 1). These scores were then normalized, resulting in the R matrix shown in Table 3.

Table 2. - Averages attributed to benefits.

Code	Benefits	G1	G2	G3
B01	Effective risk management	8.67	8.40	8.13
B02	Improving process quality	9.00	8.80	8.08
B03	Reducing costs	9.00	9.07	7.83
B04	Improving the company's image	9.17	9.07	7.71
B05	Stronger corporate culture	8.17	7.67	6.50
B06	Increasing productivity	8.83	9.00	8.58

B07	Promoting Transparency	8.67	8.20	7.54
B08	Promoting Inclusion	8.67	7.47	6.00
B09	Incentives for Innovation	9.33	8.27	8.50
B10	Sharing good ideas	9.33	7.87	7.83
B11	Confidence in the data	9.17	8.47	7.83
B12	Competitive advantage	9.33	8.40	7.88
B13	Improved operational efficiency	9.17	8.67	8.42
B14	Customer satisfaction	9.67	9.07	8.08
B15	Reducing Digital Inequalities	9.17	7.27	6.13

Table 3. - R matrix with normalized values.

Code	Benefits	rij (20 years or older)	rij (Between 20 and 10 years old)	rij (Up to 10 years)
B01	Effective risk management	0.25	0.26	0.27
B02	Improving process quality	0.26	0.27	0.27
B03	Reducing costs	0.26	0.28	0.26
B04	Improving the company's image	0.26	0.28	0.26
B05	Stronger corporate culture	0.23	0.24	0.22
B06	Increasing productivity	0.25	0.28	0.29
B07	Promoting Transparency	0.25	0.25	0.25
B08	Promoting Inclusion	0.25	0.23	0.20
B09	Incentives for Innovation	0.27	0.25	0.28
B10	Sharing good ideas	0.27	0.24	0.26
B11	Confidence in the data	0.26	0.26	0.26
B12	Competitive advantage	0.27	0.26	0.26
B13	Improved operational efficiency	0.26	0.27	0.28
B14	Customer satisfaction	0.28	0.28	0.27
B15	Reducing Digital Inequalities	0.26	0.22	0.21

Weights were then assigned to each group of respondents, with professionals with more than 20 years' experience receiving a weight of 0.50, those with 10 to 20 years' experience receiving a weight of 0.30 and professionals with up to 10 years' experience a weight of 0.20. Thus, with the weighted values, it was possible to obtain the V matrix, as shown in Table 4.

Table 4. - Matrix V weighted values.

Code	Benefits	rij (20 years or older)	rij (Between 20 and 10 years old)	rij (Up to 10 years)
B01	Effective risk management	0.12	0.08	0.05
B02	Improving process quality	0.13	0.08	0.05
B03	Reducing costs	0.13	0.08	0.05
B04	Improving the company's image	0.13	0.08	0.05
B05	Stronger corporate culture	0.12	0.07	0.04
B06	Increasing productivity	0.13	0.08	0.06
B07	Promoting Transparency	0.12	0.08	0.05
B08	Promoting Inclusion	0.12	0.07	0.04
B09	Incentives for Innovation	0.13	0.08	0.06
B10	Sharing good ideas	0.13	0.07	0.05
B11	Confidence in the data	0.13	0.08	0.05
B12	Competitive advantage	0.13	0.08	0.05
B13	Improved operational efficiency	0.13	0.08	0.06
B14	Customer satisfaction	0.14	0.08	0.05
B15	Reducing Digital Inequalities	0.13	0.07	0.04

With the values obtained from Matrix V, the positive (vj+) and negative (vj-) ideal solutions were calculated for each weight (Table 5). Subsequently, using the values in Table 5, the Euclidean distances of the positive and negative ideal solutions were calculated, the results of which can be seen in Table 6. This process resulted in the Ci* coefficient, which served as the basis for ranking the benefits, as shown in Table 7.

Table 5. - Positive ideal solution and negative ideal solution for access to criteria.

Solution criteria	20 years or more	Between 10 and 20 years	Up to 10 years
Positive ideal solution (vj+)	0.14	0.08	0.06
Negative ideal solution (vj-)	0.12	0.07	0.04

Table 6. - Distances from the positive ideal solution, distance from the negative ideal solution and Ci* coefficient.

Code	Benefits	Distance from positive ideal solution (Si+)	Distance from ideal solution Negative (Si-)	Coefficient (Ci*)
B01	Effective risk management	0.016	0.019	0.546
B02	Improving process quality	0.010	0.023	0.690
B03	Reducing costs	0.011	0.024	0.689
B04	Improving the company's image	0.009	0.025	0.728
B05	Stronger corporate culture	0.029	0.005	0.148
B06	Increasing productivity	0.012	0.025	0.681
B07	Promoting Transparency	0.018	0.015	0.461
B08	Promoting Inclusion	0.027	0.007	0.216
B09	Incentives for Innovation	0.009	0.025	0.742
B10	Sharing good ideas	0.013	0.021	0.622
B11	Confidence in the data	0.010	0.022	0.679
B12	Competitive advantage	0.009	0.023	0.719
B13	Improved operational efficiency	0.008	0.025	0.756
B14	Customer satisfaction	0.003	0.031	0.901
B15	Reducing Digital Inequalities	0.024	0.014	0.369

Finally, by ordering the Ci* coefficient values, we obtain a comparative ranking of the benefits of implementing ISO/IEC 42001 in logistics systems, from the perspective of professionals working in the sector. Table 7 shows the results.

Table 7. - Ranking of benefits.

Position	(Ci*)	Code	Benefits
1st	0.90	B14	Customer satisfaction
2nd	0.76	B13	Improved operational efficiency
3rd	0.74	B09	Incentives for Innovation
4th	0.73	B04	Improving the company's image
5th	0.72	B12	Competitive Advantage
6th	0.69	B02	Improving process Quality
7th	0.69	B03	Reducing costs
8th	0.68	B06	Increasing productivity
9th	0.68	B11	Confidence in the data
10th	0.62	B10	Sharing good ideas
11th	0.55	B01	Effective risk management
12th	0.46	B07	Promoting Transparency
13th	0.37	B15	Reducing Digital Inequalities
14th	0.22	B08	Promoting Inclusion

15th	0.15	B05	Stronger corporate culture
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Checking the first ranking of benefits by Brazilian logistics managers, four distinct groups of benefits were observed. Firstly, customer satisfaction was the most relevant benefit, since by ensuring that products are delivered according to specifications and deadlines, the company better meets customer expectations, increasing their trust and loyalty. In addition, compliance with these standards reduces errors and rework, minimizing complaints, providing a more satisfactory experience and ensuring customer loyalty.

The second group of benefits found in the ranking is that improving operational efficiency is crucial, as it allows the company to optimize its processes, reduce costs and increase productivity [34]. Incentives for innovation are equally important, as they stimulate the creation of new solutions and technologies that can improve the services and products offered [35]. Improving the company's image is vital for building a positive reputation in the market, which can attract new customers and strengthen the loyalty of existing ones [36]. Finally, competitive advantage can differentiate the company from its competitors, making it more attractive to customers and business partners, and ensuring its outstanding position in the sector [37].

In the third group of ranking benefits, improving the quality of processes is fundamental, as it ensures that operations are carried out with greater precision and efficiency, raising overall performance standards. [38]. Cost reduction is important as it allows the company to operate more economically, optimizing resources and increasing profitability [39]. Increasing productivity is essential to maximize output and team performance, driving growth and competitiveness [40]. Trust in data is crucial for making informed and strategic decisions, ensuring that the information used is accurate and reliable [41]. In addition, the sharing of good ideas fosters an environment of collaboration and innovation, resulting in continuous improvements and creative solutions to challenges faced by the company [23].

In addition, in fourth place, the benefits related to effective risk management are essential to identify and mitigate possible problems before they negatively impact the organization, ensuring greater stability and security [42]. Promoting transparency strengthens trust between the company and its stakeholders, facilitating open communication and accountability [18]. Reducing digital inequalities is important to ensure that all parts of the organization have equal access to technologies and information, promoting digital inclusion [43]. Promoting inclusion ensures that diverse groups and perspectives are considered, enriching the company's culture and processes. Finally, a stronger company culture is crucial to creating a cohesive and motivated work environment, aligned with the organization's values and goals, which contributes to talent engagement and retention [44]. These benefits together strengthen the company's structure and performance, promoting a more efficient and inclusive work environment.

It is important to note that the benefits at the bottom of the ranking are not necessarily less important than those at the top. The ranking reflects the opinions of the professionals consulted. However, preliminary research into the literature ensured that all the benefits listed were properly validated. Thus, the ranking presented should be understood as a representation of the current perceptions of experts, without detracting from the relevance of the benefits in lower positions.

5. Conclusions

The main objective of this study was to identify and rank the benefits of implementing ISO/IEC 42001 in logistics systems, based on the perceptions of professionals working in the sector in Brazil. The research sought to empirically validate the benefits proposed in the literature, using the TOPSIS technique to rank those considered most relevant by the experts. The analysis was based on a representative sample of professionals from different regions and levels of experience, with the aim of providing a comprehensive and up-to-date overview of the subject.

The results revealed that the most decisive benefits in the professionals' view include customer satisfaction, improved operational efficiency and incentives for innovation. These benefits were highlighted for their ability to optimize processes, reduce costs and strengthen companies' competitiveness. In addition, the analysis indicated that aspects related to improving the quality of

processes, increasing productivity and trust in data are also fundamental to the successful implementation of the standard. The study thus contributes to a more in-depth understanding of the priorities within the Brazilian logistics context.

Despite the significant contributions, the research has some limitations that should be considered. The main limitation is related to the size of the sample and the geographical distribution of the respondents, which, although comprehensive, still may not reflect all the realities of the logistics sector in Brazil. In addition, the study focused exclusively on professionals' perceptions of the benefits of ISO/IEC 42001, without addressing the difficulties or challenges faced in its implementation. These limitations suggest the need for further studies to complement the findings presented here.

Given the limitations identified, future research is recommended to explore new aspects of ISO/IEC 42001 implementation in logistics systems. Firstly, it is suggested that a longitudinal study be carried out that follows the implementation of the standard over time, assessing its practical impacts on an ongoing basis. Secondly, a survey is proposed to investigate the challenges faced by companies during implementation, providing an action plan to overcome them. Finally, a comparative analysis between different industrial sectors, exploring how the particularities of each sector influence the perception and prioritization of benefits, could further enrich the understanding of the subject.

In terms of theoretical and practical implications, this work offers valuable contributions to the literature and to logistics management. Theoretically, it broadens the understanding of the benefits of ISO/IEC 42001, highlighting its relevance to operational efficiency and customer satisfaction. In practice, managers can use the results presented here to direct efforts towards implementing the standard, focusing on the benefits that generate the greatest value for their operations. Thus, this study not only enriches the academic debate, but also offers useful guidelines for decision-making in the field of logistics.

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