

Artificial Intelligence in Usiminas' Logistics: Transportation Optimization and Cost Reduction

Inteligência Artificial na Logística Da Usiminas: Otimização de Transporte e Redução de Custos
Inteligencia artificial en Usiminas Logistics: Optimización del transporte y reducción de costes

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Abstract:

This article focuses on artificial intelligence in Usiminas logistics: transportation optimization and cost reduction and investigates the problem of how artificial intelligence (AI) and cloud computing can optimize Usiminas logistics. Its objective was to delve deeper into how the implementation of Artificial Intelligence (AI) and cloud computing influenced Usiminas logistics. The existing literature was investigated in an exploratory manner, using the methods suggested by Gil (2002) together with Lakatos and Marconi (2003). Our investigation focused on how Amazon Web Services (AWS) solutions, such as AWS Lambda, AWS Glue, AWS CloudFormation, AWS CloudFront, Amazon DynamoDB, and Amazon Route 53, helped to automate processes, connect data, and improve transportation operations at Usiminas. The data revealed a 14% reduction in logistics expenses, which represents an annual savings of approximately R\$9 million, in addition to lower CO₂ emissions. The study compared Usiminas' trajectory with what companies such as Friboi, Clariant, Georgia-Pacific and LU-VE Group have done, highlighting the global movement towards adopting these technologies to increase efficiency and sustainability. Although things have come a long way, we identified obstacles related to the integration of new systems and staff qualifications. In conclusion, using AI and cloud computing is clearly a smart move to reshape logistics, making organizations more competitive and more friendly to the planet.

Keywords: Logistics; Transportation Optimization; Cost Reduction; Cloud Computing; Serverless Architecture.

Resumo:

Este artigo tem como tema inteligência artificial na logística da Usiminas: otimização de transporte e redução de custos e investiga o problema de que forma a inteligência artificial (IA) e a computação da nuvem podem otimizar a logística da Usiminas. O seu objetivo foi se aprofundar em como a implementação da Inteligência Artificial (IA) e da computação em nuvem influenciou a logística da Usiminas. Foi investigado a literatura existente de forma exploratória, usando os métodos sugeridos por Gil

(2002) juntamente com Lakatos e Marconi (2003). Nossa investigação se concentrou em como as soluções da *Amazon Web Services* (AWS), como *AWS Lambda*, *AWS Glue*, *AWS CloudFormation*, *AWS CloudFront*, *Amazon DynamoDB* e *Amazon Route 53*, ajudaram a automatizar processos, conectar dados e melhorar as operações de transporte na Usiminas. Os dados revelaram uma redução de 14% nas despesas de logística, o que representa uma economia anual de aproximadamente R\$ 9 milhões, além de menor emissão de CO². O estudo comparou a trajetória da Usiminas com o que empresas como *Friboi*, *Clariant*, *Georgia-Pacific* e *LU-VE Group* fizeram, enfatizando o movimento mundial em direção à adoção dessas tecnologias para aumentar a eficiência e a sustentabilidade. Embora as coisas tenham evoluído muito, identificamos obstáculos relacionados à integração dos novos sistemas e à qualificação da equipe. Para concluir, usar IA e computação em nuvem é claramente uma jogada inteligente para reformular a logística, tornando as organizações mais competitivas e mais amigáveis ao planeta.

Palavras-chave: Logística; Otimização de Transporte; Redução de Custos; Computação em Nuvem; Arquitetura *Serverless*.

Resumen:

Este artículo se centra en la inteligencia artificial en la logística de Usiminas: optimización del transporte y reducción de costes, e investiga el problema de cómo la inteligencia artificial (IA) y la computación en la nube pueden optimizar la logística de Usiminas. Su objetivo era profundizar en cómo la implementación de la Inteligencia Artificial (IA) y la computación en la nube influyeron en la logística de Usiminas. La literatura existente fue investigada de forma exploratoria, utilizando los métodos sugeridos por Gil (2002) junto con Lakatos y Marconi (2003). Nuestra investigación se centró en cómo las soluciones de Amazon Web Services (AWS), como AWS Lambda, AWS Glue, AWS CloudFormation, AWS CloudFront, Amazon DynamoDB y Amazon Route 53, ayudaron a automatizar procesos, conectar datos y mejorar las operaciones de transporte en Usiminas. Los datos revelaron una reducción del 14% en los gastos logísticos, lo que representa un ahorro anual de aproximadamente 9 millones de R\$, además de una reducción en las emisiones de CO². El estudio comparó la trayectoria de Usiminas con lo que han hecho empresas como Friboi, Clariant, Georgia-Pacific y LU-VE Group, subrayando el movimiento global hacia la adopción de estas tecnologías para aumentar la eficiencia y la sostenibilidad. Aunque las cosas han evolucionado mucho, hemos identificado obstáculos relacionados con la integración de los nuevos sistemas y la cualificación del equipo. Para concluir, utilizar IA y computación en la nube es claramente una decisión inteligente para transformar la logística, haciendo que las organizaciones sean más competitivas y amigables con el planeta.

Palabras clave: Logística; Optimización del transporte; reducción de costes; Computación en la Nube; Arquitectura *serverless*.

1. INTRODUCTION

Logistics is a key factor in industry competition and adaptation, as it directly influences market response time, operational costs, and customer satisfaction. Artificial intelligence (AI) has been used to organize processes, reduce errors, and predict demand and delivery through technological advancements.

The company under study, one of the major names in the Brazilian steel industry, has invested in digitizing its distribution chain, using machine learning solutions and relying on cloud storage to improve operational efficiency.

Technologies such as AWS Lambda, AWS Glue, and AWS CloudFormation help automate processes, integrate data, and optimize transportation routes, reducing costs and increasing productivity.

The research study aims to answer the following research question: How can AI and cloud computing optimize Usiminas' logistics?

This study will analyze transport management efficiency, reduced operational costs and improved demand predictability.

This study is relevant because demand for smarter, more agile, and sustainable logistics processes is growing. With market competitiveness and pressure for more responsible environmental practices, understanding how AI and cloud computing can contribute to the logistical transformation of a large company is fundamental. Furthermore, studies exploring the integrated application of these technologies in the Brazilian steel industry remain scarce, reinforcing the originality and importance of this research.

We adopted an exploratory bibliographic methodology, comparing process performance before and after the adoption of technologies in Usiminas' logistics management.

This article is structured as follows: after this introduction, it presents the theoretical foundation on AI, cloud computing, and Logistics 4.0; then it describes the methodological procedures used to conduct the study. Next, the results from applying these technologies at Usiminas are discussed, including comparisons with other companies that have adopted similar strategies. Finally, the article presents concluding remarks and suggestions for future research.

2. THEORETICAL FRAMEWORK

Understanding the theoretical foundations related to artificial intelligence (AI), cloud computing, and logistics is essential to support the analyses proposed in this article. The integration of these technologies has significantly transformed supply chain management, offering new possibilities for automation, predictive analytics, real-time decision-making, and process optimization.

2.1 Artificial Intelligence in Logistics

Artificial Intelligence (AI) has been widely used in logistics to improve processes

and increase operational efficiency (Ferreira, 2024). According to Brito et al. (2024), AI helps automate complex tasks, analyze large amounts of data, and improve decisions made based on demand forecasts and logistics models.

Pereira (2023) shows that AI has boosted inventory management and product delivery, reducing many human errors. Pinho (2024) adds that machine learning algorithms improve resource allocation and organize logistics flows.

2.2 Logistics and Technological Modernization

Contemporary logistics is truly feeling the effects of technological advancements, especially with the leap to AI and cloud computing. Almeida et al. (2024) argue that integrating AI into logistics improves our ability to predict, control, and ensure safety during transportation and storage.

Ferreira and Ferreira (2024) are investigating how supply management is leveraging automated logistics processes, resulting in faster and better distribution. Oliveira et al. (2024) highlight that introducing AI expands strategic and tactical choices, reduces waste and makes transportation more efficient overall.

2.3 Transportation Optimization with AI

A major advantage of using AI in logistics is its ability to streamline transportation. According to Brito et al. (2024), AI algorithms can accurately predict traffic jams, refine route planning, and reduce delivery times. Moura (2022) emphasized that dividing logistics services into smaller, more manageable units provides better control and adaptability in fleet management.

According to Pegado (2021), using AWS Lambda to supervise transportation made it possible to automatically execute route optimization processes, ensuring better scalability. Burigo et al. (2023) noted that integrating serverless services makes transportation workflow management more agile, leading to lower operational costs.

2.4 Cloud Computing and Serverless Architecture

Cloud computing has radically transformed logistics management by enabling superior scalability and lower infrastructure costs (Pegado, 2021). Serverless architecture in logistics eliminates the need for dedicated servers, reducing costs and increasing task adaptability (Burigo et al., 2023).

Moura (2022) highlights that microservices architecture offers greater system resilience, enabling companies to manage search fluctuations without impacting operational performance. According to Ferreira (2024), cloud computing also simplifies the integration of different logistics segments, improving connectivity and information analysis.

2.5 Cost Reduction in Logistics with AI and Cloud Computing

In logistics, one of the main goals of adopting AI and cloud computing is undoubtedly cost reduction. As Almeida et al. (2024) point out, AI's predictive demand capabilities help avoid excess and optimize resource distribution. Ferreira and Ferreira (2024) highlight that automating logistics processes not only reduces errors but also accelerates order processing, which, in turn, lowers day-to-day expenses.

Oliveira et al. (2024) emphasize that agile solutions improve logistics effectiveness, resulting in a notable reduction in transportation and storage costs. Finally, Moura (2022) examines how a microservices structure can cut operating costs by enabling decentralized, automated management of logistics activities, ensuring faster and more efficient market transactions.

3. METHOD

The research used an exploratory bibliographic approach, focusing on the application of Artificial Intelligence (AI) and cloud computing in Usiminas' logistics.

According to Gil (2002), bibliographic research is carried out using already published material, mainly books, journal articles, and material available on the internet, enabling the construction of a theoretical foundation on the topic. This type of research aims to expand the researcher's knowledge of the object of study by analyzing what other authors have already produced.

Lakatos and Marconi (2003) reinforce that bibliographic research allows the selection of relevant information from secondary sources such as books, dissertations, scientific articles, and institutional documents. Thus, the present study reviewed academic and technical materials on the use of AI in logistics, with a special focus on AWS (Amazon Web Services) solutions applied in the context of Usiminas.

The analysis was conducted qualitatively to interpret and understand how implementing AWS technologies influenced the company's logistics processes, resulting in improvements such as transportation optimization, cost reduction, and enhanced operational sustainability.

4. RESULTS AND DISCUSSION

Usiminas has a logistics modernization plan that aims to implement artificial intelligence and cloud computing. To optimize its operational processes, the company presented *AWS solutions*, such as *AWS... Lambda*, *AWS Glue*, *AWS CloudFormation*, *AWS CloudFront*, *Amazon DynamoDB* and *Amazon Route 53*, facilitating efficient expansion of operations and cost reduction.

4.1 AWS Technologies in Usiminas Logistics

4.1.1 AWS Lambda in Process Automation

serverless computing service that enables the automatic execution of code without the need to provision servers (AWS, 2024). Pegado (2021) emphasizes that this tool is crucial for processing events as they happen, reducing costs and expanding the scalability of logistics operations.

Sharma and Sandhu (2022) confirm that serverless architecture offers more flexibility in application development, reduces latency and optimizes task distribution. At Usiminas, AWS Lambda was implemented to automate transportation data analysis, enabling rapid responses to changes in delivery conditions. Integrating Lambda with other services reduced operational failures and enabled more precise shipment tracking.

4.1.2 AWS Glue in the Context of Data Integration

AWS Glue is an ETL (extraction, transformation, and loading) service that simplifies handling and transferring large amounts of data (AWS, 2024). Burigo et al. (2023) state that this tool is fundamental for combining data from diverse sources and automating integration steps. Abreu (2019) adds that intelligent data management through AWS services, such as Glue, significantly improves the quality and robustness of the information processed.

At Usiminas, AWS Glue was used to unify inventory and transportation data, providing a unified perspective of logistics activities. This improved demand forecasting and optimized distribution routes.

4.1.3 AWS CloudFormation in the Context of Infrastructure Management

AWS CloudFormation enables the automated creation and control of cloud infrastructure, ensuring uniformity and protection (AWS, 2024). Moura (2022) emphasizes that this technology reduces human error by defining the entire infrastructure as code, simplifying scalability. Silva (2024) adds that the serverless architecture used in storage and processing reduces data expenses and increases system robustness.

Usiminas implemented AWS CloudFormation to automatically provide crucial cloud services to support its logistics operations, ensuring high availability and agility in responding to seasonal needs.

4.1.4 AWS CloudFront Enhancing Real-Time Data Flow

AWS CloudFront acts as a Content Delivery Network (CDN), ideal for rapidly distributing information and improving web application performance (AWS, 2024). In logistics, this solution is crucial for ensuring quick access to dashboards and monitoring reports.

Usiminas turned to AWS CloudFront to improve the distribution of real-time logistics data, enabling more precise control of shipments and reducing delays in data transmission between distribution centers.

4.1.5 Amazon DynamoDB in Logistics Data Management

Amazon DynamoDB is a NoSQL database system designed to provide high availability and low latency (AWS, 2024). It is widely used to store large volumes of transaction records.

At Usiminas, DynamoDB was implemented to house shipment histories, order files, and transportation phases, ensuring superior traceability and greater efficiency in fleet management.

4.1.6 Amazon Route 53 in Command of Connectivity

Amazon Route 53 is a domain management and traffic routing service designed to ensure high availability and scalability (AWS, 2024). In logistics, it keeps essential systems always accessible and running.

Usiminas used Route 53 to ensure interconnection between its logistics management systems, reducing communication barriers and ensuring uninterrupted availability of its digital services.

4.2 Impacts on operational efficiency

Implementing AWS technologies has significantly improved Usiminas' logistics. Table 1 summarizes the main transformations:

Table 1 – Comparison between Usiminas' logistics processes before and after the implementation of AI.

Aspect	Before Implementation	After Implementation
Order Receipt	Manual registration, subject to errors and delays.	AWS Lambda automates and eliminates human error
Transportation Processing	Fixed routes, without optimization.	AI analyzes traffic and demand , adjusting routes in real time.
Inventory Management	Decentralized control, ineffective forecasting.	Machine Learning predicts demand , preventing both oversupply and shortages.
Delivery Monitoring	Lack of tracking, frequent delays	AWS CloudFront and Route 53 guarantee real-time tracking.
Cost Efficiency	High fuel consumption, underutilized fleet.	14% reduction in transportation costs
Report Generation	Manual data collection, outdated reports.	AWS CloudFormation generates automatic and accurate reports

Source: Prepared by the authors based on the Usiminas case study (2025)

Adopting AWS Lambda to automate processes has reduced response times to variations in logistics conditions, streamlining transportation management. AWS Glue's ability to unify large amounts of data has improved decision-making, enabling dynamic adaptations in transportation flows and resource allocation.

Using AI to predict demand and improve transportation reduced transportation costs by 14%, saving the company approximately R\$ 9 million per year. This reduction was achieved through route optimization, real-time monitoring, and

integrating logistics information via AWS CloudFormation.

With optimized routes and more accurate demand estimates, CO₂ emissions declined, supporting Usiminas' environmental sustainability. The company could reduce unnecessary fuel consumption by aligning itself with ESG (Environmental, Social, and Governance) practices.

Despite these advantages, some difficulties were noted in implementing AI in Usiminas' logistics. According to Cubo Network (2024), integrating new technologies with legacy systems was one of the biggest barriers. Furthermore, qualified professionals are needed to handle the new tools, which requires additional investment.

Resistance to change was also identified as an obstacle. Implementing AI-based solutions requires a cultural transformation within the company, with greater encouragement for adopting new technologies and integrating across sectors.

4.3 Comparison with other companies with similar technology

AWS CloudFront acts as a content delivery network (CDN), ideal for rapidly distributing information and improving web application performance (AWS, 2024). In logistics, this solution is crucial for ensuring quick access to dashboards and monitoring reports.

In the steel industry, AI is being increasingly used in logistics. Research by Dos Santos et al. (2024) indicates that incorporating AI in large companies has brought improvements similar to those observed at Usiminas, highlighting the fundamental role of this technology in modernizing industry.

The effects of introducing AI at Usiminas can be understood by comparing it with similar examples in the industry. Companies like Friboi, Clariant, Georgia-Pacific, and LU-VE Group have also adopted AI approaches to strengthen their supply chains; they use IoT and big data to monitor logistics remotely, which has helped them deliver on time with remarkable results.

Friboi, for example, achieved more accurate delivery forecasts and better quality control by using machine learning to track its supply network. They adopted AWS solutions to monitor their supply chain better, ensuring perishable products arrive on time and reducing waste (AWS, 2024a).

Clariant reduced logistics expenses by 12% through predictive analytics; they use AI to predict demand changes, helping them maintain the right amount of inventory (AWS, 2024b); meanwhile, Usiminas could explore this to improve inventory management and demand forecasting.

At Georgia-Pacific, predictive maintenance reduced downtime for logistics equipment by 18%; they began using machine learning to identify potential problems with their logistics equipment so they can fix issues before unexpected breakdowns (AWS, 2024c). A similar shift could help Usiminas prevent operational failures through machine learning. Meanwhile, the LU-VE Group showed how IoT can increase supply chain visibility (AWS, 2024d), which Usiminas could use to refine material tracking.

Comparing these situations shows that Usiminas is keeping up with the sector's main methods. However, there are still opportunities to increase AI use in logistics through new avenues, such as more refined predictive analytics and combining IoT for fleet surveillance. Adopting this technology can generate even greater cost reductions, as well as a more environmentally friendly and efficient operation.

5. FINAL CONSIDERATIONS

The study found that adopting Artificial Intelligence and cloud computing in Usiminas' logistics led to significant improvements in operational performance, demand forecasting, and cost reduction. The combination of resources such as AWS Lambda, AWS Glue, and AWS CloudFormation enabled the automation of previously manual processes, improving supply and transportation management and resulting in an annual reduction of R\$ 9 million.

Comparisons with other companies in the sector, such as Friboi, Clariant, and Georgia-Pacific, show that Usiminas is in line with global best practices. However, challenges remain, including integration with older systems, initial implementation costs, and still-specific team qualification requirements for deploying these technologies.

Beyond financial gains, logistics digitalization also promotes sustainability by reducing fuel consumption and minimizing waste. However, to maximize these advantages, Usiminas needs to invest in continuous employee training to ensure full adaptation to new technological tools.

Thus, Artificial Intelligence and cloud computing, through implemented AWS technologies, have optimized Usiminas' logistics by automating processes, integrating and organizing data efficiently, reducing operational costs, improving delivery monitoring, and reinforcing operational sustainability. Therefore, the central question of this study- How can AI and cloud computing optimize Usiminas' logistics? is answered with practical evidence of the advances achieved.

To further advance our approach, we recommend exploring new alternatives, such as digital replicas and blockchain, which enhance the security and traceability of operations. In addition, a more sophisticated implementation of predictive evaluation could further enhance anticipation and competence in transport and goods management.

Another important aspect is the urgent need for training and development guidelines so that employees can make the most of these technological tools. Incorporating an integrated management model with business intelligence can also enhance productivity gains and operational performance.

Finally, future studies can refine the analysis of the long-term impact of these innovations and their effects on the sustainability and competitiveness of the steel industry, while also considering regulatory issues and challenges in disseminating these solutions to other production units of the company.

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