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Use Of APIS For Applying AMRS In Warehouse

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Abstract
This article addresses the integration of Autonomous Mobile Robots (AMRs) with Application Programming Interfaces (APIs) in logistics environments, aiming to improve operational efficiency and accuracy in inventory control. The research explores how the adoption of AMRs connected to management systems such as WMS and ERP directly impacts productivity, reduces downtime and increases the accuracy of inventory data. The integration of APIs allows real-time communication between robots and systems, improving the coordination of operations, optimizing routes, and providing more reliable inventory management. While the benefits are evident, the study also discusses the challenges of implementation, such as the need for effective strategic planning, compatibility with existing systems, and high upfront costs. The analysis of the results, based on performance graphs, shows the improvement in efficiency, reduction of idle time and increased accuracy in inventory control. This work contributes to the understanding of the advantages and challenges of applying AMRs and APIs in logistics, providing a basis for future research and automation practices in the sector.

Keywords: *Autonomous Mobile Robots (AMRs), APIs, System Integration, Logistics Automation, Operational Efficiency, Inventory Control, WMS, ERP, Smart Logistics, Downtime Reduction.*

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I. Introdução

In the search for efficiency in warehouses, the use of Autonomous Mobile Robots (AMRs) has been boosted and the integration of Application Programming Interfaces (APIs) between robots allows robots to communicate with management systems, increasing the efficiency of logistics operations. APIs provide communication between AMRs and logistics systems, allowing the exchange of information in real time. By improving the coordination of robots, making their routes more dynamic and reducing the route travel time within the warehouse, this automation provided by this integration minimizes human errors, improves product traceability, and optimizes the use of space and resources.

The application of AMRs in logistics operations has shown an effective strategy to improve the efficiency and sustainability of processes. According to Körber Supply Chain (2023), the use of AMRs has a direct impact on productivity and also contributes to reducing energy consumption, which is in line with the sustainable practices adopted by many companies. However, putting these robots to work efficiently is not simple, it is necessary to deal with the integration between different systems, make considerable investments and prepare teams well to operate and keep up with the new technology. Log Feed (2023) points out that a well-implemented API is what makes this fluid communication possible, paving the way for faster and smarter operations. Understanding in depth the gains and challenges of integrating APIs into AMRs is essential to update logistics and ensure competitiveness in the market. Although the main focus is to optimize processes and cut costs, it is essential to develop a careful plan that takes into account the infrastructure already installed and the available budget, thus ensuring the success of the implementation.

The adoption of AMRs in storage environments aims, above all, to optimize operational efficiency and minimize the costs involved in logistics activities. However, this implementation requires attention to a series of challenges, among which the need for well-structured strategic planning, compatibility with systems already in operation and the high initial investment required to make the technology feasible stand out.

II. Referencial Bibliográfico

The use of AMRs in logistics environments has been growing thanks to the autonomy and efficiency of these robots. When connected via APIs to management systems such as WMS and ERP, they start to operate in an even more integrated and precise way. This direct link between the platforms optimizes the workflow, improves the control of operations, and contributes to reducing errors and waste. This integration facilitates communication between systems, improves the management of operations, and contributes to reducing failures and waste. On the other hand, it also brings some challenges, such as the need for standardization and concerns

about digital security. Then, the main concepts and applications of AMRs and APIs in the logistics context are explored, as well as the benefits and obstacles involved in this combination.

Autonomous Mobile Robots

AMRs are robotic systems developed to act independently in industrial and logistics environments. Unlike automated guided vehicles (AGVs), which travel along fixed routes demarcated by magnetic rails or ribbons on the ground, AMRs rely on high-precision sensors and intelligent navigation algorithms. These technologies make it possible to map the surroundings, detect and avoid obstacles, and recalculate routes in real time, as conditions change (FRAGAPANE et al., 2021). Thanks to this adaptability, AMRs offer superior operational flexibility, being able to be used in different warehouse scenarios and contributing to optimizing logistics processes, especially in environments with variable demand and workflow.

Application Programming Interface

APIs work as standardized sets of commands and protocols that connect disparate digital systems. In logistics automation, these interfaces allow management tools such as WMS and ERP to dialogue directly with AMRs. Thus, robots receive real-time instructions, send status updates, and exchange operational data, resulting in more agile and accurate coordination (QIN et al., 2022).

Application Of APIS In AMRS In Warehouses

The use of APIs in the integration of AMRs within warehouses is mainly focused on improving the flow of operations, increasing accuracy, and cutting costs according to Hercik et al. (2022), APIs allow AMRs to communicate quickly with central systems, which facilitates the dynamic distribution of tasks and the choice of the best routes within the warehouse. This makes everything more agile and efficient. In addition, this communication via API helps to maintain more accurate inventory control, improves product traceability, and reduces errors in operations, which makes the logistics process much more reliable (Fragapane et al., 2021).

Benefits And Challenges In Using APIS In AMRS

Integrating APIs in AMRs brings a series of advantages and significant gains in productivity, greater efficiency in energy consumption and operational flexibility, studies indicate that, when well implemented, this integration significantly reduces downtime, makes better use of warehouse resources and facilitates adjustment to demand variations. On the other hand, you can't ignore the challenges involved, you need to standardize communication protocols, reinforce cybersecurity practices, and deal with the complexity of connecting disparate systems flawlessly. Having solid planning and well-defined strategies is therefore the way to overcome these obstacles and ensure that APIs play their role in AMRs effectively.

III. Materias E Métodos

The study followed an organized and meticulous process, structured in chained steps to ensure broad coverage and scientific soundness in the analysis of API integration in AMRs in warehouses. In the initial stage, we focused on "Integration of APIs in AMRs in warehouses", this choice sought to contemplate the most recent innovations and publications, reflecting the state of the art of logistics automation and the technological evolutions that have occurred in the last five years.

They then selected the main academic reference databases IEEE, Xplore, ScienceDirect, and SpringerLink, as well as portals specializing in logistics and industrial automation. Central keywords "AMR", "API", "warehouse", "logistics automation", "systems integration" were defined and language filters (English and Portuguese) and Qualis A1 stratum were applied, ensuring a high level of quality and relevance of the publications. For each database, advanced searches were used, combining terms with Boolean operators (AND, OR) and delimiting the publication period.

From these initial searches, approximately 20 references were retrieved. A careful screening of titles and abstracts was then carried out to identify studies that explicitly addressed the integration of APIs in AMRs. Generic or out-of-scope studies were discarded, resulting in the selection of about 10 articles among systematic reviews, case studies, and empirical research for full reading and data extraction. In parallel with the academic literature review, technical reports, white papers, and documentation from suppliers and industry associations were incorporated, recognized for the depth of their practical analyses. These materials include system integration manuals published by AMR manufacturers, communication protocol configuration guides (such as VDA5050), and operational performance benchmark reports. In addition, white papers from major logistics automation solution providers brought detailed case studies, indicating efficiency metrics before and after the implementation of APIs, as well as lessons learned in large-scale scenarios.

The collected materials were organized in spreadsheets, categorized by type of source, year of publication, methodology used, and relevance to the central themes (definitions, benefits, challenges, and

solutions). Then, qualitative content analysis was applied to code and group these data into thematic categories, identifying recurrent patterns, points of convergence and possible divergences between the studies. They highlighted practical success stories, such as the application of APIs for orchestration of AMRs in JD.com (Qin et al., 2022), illustrating the gains in efficiency and operational flexibility.

We perform the triangulation of academic and practical data, confronting different approaches and results. The critical synthesis involved the comparative evaluation of the reported benefits (e.g., reduction of idle times and route optimization) and the challenges faced (standardization of protocols, cybersecurity, and initial investment). Based on this integrated analysis, the discussion section was elaborated, pointing out recommendations for future research and practical implications for the implementation of APIs in AMRs. In this way, the methodological process ensured a comprehensive and balanced view, combining academic rigor, practical relevance and expository clarity, allowing readers of different levels of knowledge to understand the path taken in the research.

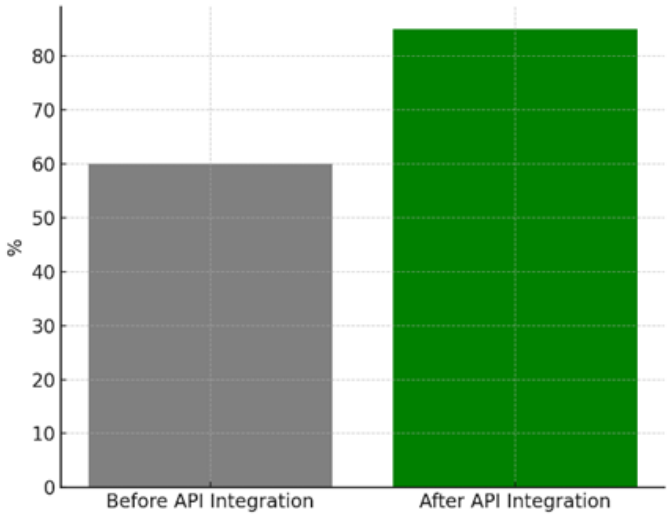
IV. Resultados

The analysis of the data obtained from the literature review, case studies and technical reports allowed to identify concrete impacts of the integration of APIs in Autonomous Mobile Robots (AMRs) within logistics environments. The following are three main axes of results that illustrate the gains in operational efficiency, reduction of idle time and accuracy in inventory control. Each of these aspects is evidenced based on graphs constructed from the most recurrent data in the studies analyzed.

Increased Operational Efficiency

The introduction of APIs allows AMRs to operate in a more intelligent and coordinated way with management systems. This directly reflects the efficiency of logistics operations. The following chart shows the performance comparison before and after integration with APIs. As shown in graph 1.

Figure 1. Operational Efficiency



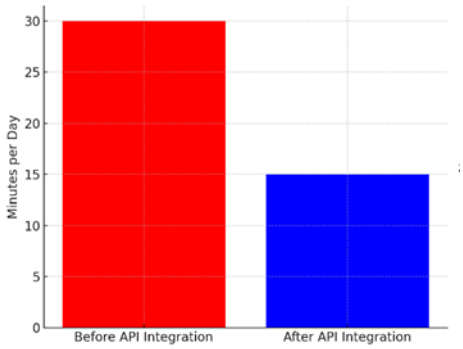
Source: Authors, 2025

The analysis demonstrates a significant increase in operational efficiency, which went from 60% to 85% after integrating with APIs. This gain is directly related to the improvement in communication between systems and robots, optimizing the flow of tasks, reducing bottlenecks, and making better use of warehouse resources.

Reduction Of Downtime

Another crucial aspect identified in the analysis was the significant reduction in downtime of Autonomous Mobile Robots (AMRs). Prior to API integration, robots often faced downtime, waiting for instructions from management systems or human operators. With the implementation of APIs, this communication began to occur in an automated and real-time way, allowing AMRs to be quickly reallocated to new tasks as soon as they complete an activity. This dynamism in the redistribution of tasks avoids unnecessary stoppages, maximizes the use of robots and contributes directly to increased productivity in logistics warehouses. Graph 2 Downtime Reduction after API Integration clearly illustrates this improvement, highlighting the significant drop in downtime after the interfaces were applied.

Figure 2. Downtime Reduction



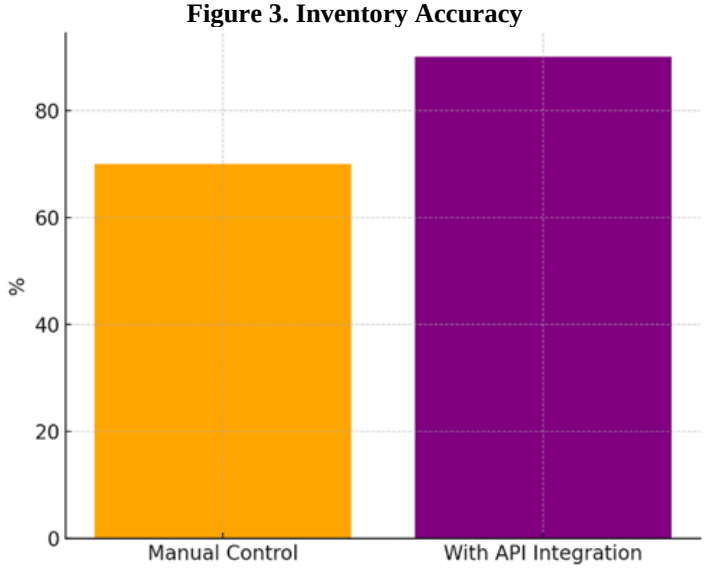
Source: Authors, 2025

As the chart shows, the average downtime dropped from 30 to 15 minutes per day. This reduction directly impacts the warehouse's operating costs and responsiveness, increasing overall productivity. According to Silva (2020), the reduction of idle time can result in a significant optimization of resources, increasing the efficiency of the logistics process. According to Costa and Souza (2018), shorter downtime provides a more agile response and better use of space and tools in the work environment.

Improvement In Inventory Control Accuracy

The integration between Autonomous Mobile Robots (AMRs) and systems such as WMS (Warehouse Management System) and ERP (Enterprise Resource Planning) has been a crucial factor in improving the accuracy of inventory data. This process occurs dynamically and in real time, as robots are able to send constant updates, allowing information about items in the warehouse to be always up-to-date and reliable. Before the implementation of this technology, inventory control processes were more susceptible to human error and outdated information, which generated a series of logistical challenges. According to Almeida (2019), inventory accuracy is one of the pillars for operational efficiency, and its improvement brings direct benefits to resource management.

Figure 3. Inventory Accuracy



Source: Authors, 2025

The inventory accuracy rate rose from 70% to 90% with the adoption of integration via APIs. This change reflects a significant reduction in conference errors and material waste, as well as improved internal and external communication of the company. As Oliveira (2021) points out, the use of integrated technologies in real time allows for more accurate and agile management, reducing errors and increasing the reliability of information. Reliability in inventory information has a direct impact on customer satisfaction, as it allows for greater agility in service and meeting deadlines. According to Rocha (2020), strict inventory control through integrated systems is essential to improve the customer experience, as it enables a clear and accurate view of what is available.

V. Conclusion

The study conducted on the integration of Autonomous Mobile Robots (AMRs) with Application Programming Interfaces (APIs) in logistics environments provided significant insights into the impacts of this technology on operational efficiency, inventory control, and cost reduction. The analysis showed that the integration of AMRs with management systems such as WMS and ERP substantially improves the coordination of operations, making robot routes more dynamic and efficient. This reduces travel time within warehouses, optimizes the use of space and maximises resources, resulting in an overall increase in productivity.

The reduction in downtime, identified as a crucial improvement after the implementation of APIs, illustrates how automation and real-time communication between robots and management systems can eliminate operational bottlenecks and increase the use of available resources. The drop in average downtime from 30 to 15 minutes per day has had a direct impact on operating costs, as well as improved warehouse responsiveness and flexibility. Accuracy in inventory control, another key point of the survey, was improved with the adoption of APIs, reaching a 90% accuracy rate. This improvement not only contributes to the reduction of errors and waste, but also increases the reliability of inventory information, which has a direct impact on customer satisfaction. Integration via APIs, by ensuring up-to-date and accurate data, facilitates decision-making and optimizes the customer experience by enabling more agile and efficient management.

While the benefits of integrating APIs into AMRs are evident, the study also addressed the challenges associated with such implementation. The need for solid strategic planning, compatibility with existing systems, cybersecurity, and high initial investment are all points that require careful attention to ensure a successful implementation. Overcoming these challenges, through well-structured planning and careful integration between systems, is essential for companies to maximize the benefits of this technology.

The study provided a solid foundation for future research in the area of logistics automation and integration of emerging technologies, indicating that while the benefits are significant, attention to detail in the implementation and preparation of operational teams is key to ensuring the success and sustainability of logistics operations.

References

[1]. Almeida, C. Inventory Management And Warehouse Technology: Impacts Of Automation On Inventory Control. Belo Horizonte: Editora Logística, 2019.
[2]. Costa, M; Souza, P. Time Management And Productivity In The Logistics Sector. Rio De Janeiro: Editora De Administração, 2018.
[3]. Fragapane, G. Et Al. A Systematic Literature Review On The Integration Of Robots In Logistics: Current Trends And Future Research Opportunities. Computers & Industrial Engineering, [S. L.], V. 152, P. 107011, 2021. Disponível Em: Https://Doi.Org/10.1016/J.Cie.2020.107011. Acesso Em: 3 Maio 2025.
[4]. Hercík, R. Et Al. The Use Of Autonomous Mobile Robots In Warehouse Logistics: Review And Trends. Procedia Computer Science, [S. L.], V. 200, P. 1047–1056, 2022. Available At: Https://Doi.Org/10.1016/J.Procs.2022.01.292. Accessed On: 3 May 2025.
[5]. Körber Supply Chain. 2023 Trends Report: Robotics And Logistics Automation. 2023. Available At: Https://Www.Koerber-Supplychain.Com. Accessed On: 3 May 2025.
[6]. Log Feed. Intelligent Integration With Amrs: The Role Of Apis. 2023. Available At: Https://Www.Logfeed.Com.Br. Accessed On: 3 May 2025.
[7]. Oliveira, L. Integrated Management Systems: The Transformation Of Logistics Processes. São Paulo: Editora De Tecnologia, 2021.
[8]. Qin, R. Et Al. Intelligent Warehouse System Based On Multi-Robot Scheduling With Api Integration. Journal Of Intelligent Manufacturing, [S. L.], V. 33, P. 273–287 (2022). Available At: Https://Doi.Org/10.1007/S10845-021-01750-7. Accessed On: 3 May 2025.
[9]. Rocha, F. Efficiency In Logistics And The Role Of Real-Time Integration Technologies. Rio De Janeiro: Editora De Administração, 2020.
[10]. Silva, J. Optimization Of Logistics Processes In Warehouse Environments. São Paulo: Editora Logística, 2020.