



Impact of Artificial Intelligence on the Logistics Processes of Port Companies in the District of Buenaventura

Neila Yasmina Millán

Universidad del Pacífico, Buenaventura, Colombia

Email: neyamicu@gmail.com

Tiana Vanessa Cándelo Aguilar

Universidad del Pacífico, Buenaventura, Colombia

Email: tianfer@hotmail.com

ORCID: <https://orcid.org/0009-0006-0351-2580>

Diana Lucia Alegría Vélez

Universidad del Pacífico, Buenaventura, Colombia

Email: dianaluciaalegriavelez@gmail.com

ORCID: <https://orcid.org/0009-0007-0767-1172>

Jhon Edier Lerma Riascos (Corresponding author)

Universidad del Pacífico, Buenaventura, Colombia

Email: jelerma@unipacifico.edu.co

ORCID: <https://orcid.org/0000-0002-4963-2952>

Abstract

The Research on the impact of Artificial Intelligence (AI) on the optimization of logistics processes in port companies in Buenaventura shows great potential to transform the sector. From an analytical point of view and more from a methodical approach, it is valid to reference the impact that artificial intelligence has, influencing changes within departments, areas among others that have to do with transportation, cargo loading, logistics and route planning. It is there where it is worth noting that the field of foreign trade and especially in the port terminal sector, this variable presents new forms of development where opportunities are identified that allow developing processes within a competitive market in an efficient manner, by developing processes that allow minimizing time, cost, increasing response times to processes, reducing vehicle income vs. unloading. However, the incorporation of artificial intelligence in logistics processes within the port sector, especially in logistics processes, can have a positive approach on issues of security, productivity of innovative ideas in an efficient manner, through this adaptation of new business models; However, the adaptation of these new processes often confronts companies with significant challenges and/or challenges which can be seen by some entrepreneurs as a business risk. Today, the economic and social development of the Pacific Region, especially the district of Buenaventura in customs matters, presents a great challenge where the biggest driver is the innovative factor, therefore this tool; with good training strategies, implementation, adaptation processes among others will allow companies in Buenaventura in this sector

to be more productive compared to others that are in different port terminals; aspects that are being targeted according to the growing and thriving port investment.

Keywords: Foreign Trade; Process Automation; Logistics, Artificial Intelligence

1. INTRODUCTION

Today, the integration of artificial intelligence into logistics processes has significantly transformed supply chain management and port operations globally. However, in the context of the port sector in the District of Buenaventura, a key port for the Colombian economy; AI-powered automation promises to optimize operational efficiency, reduce costs, and improve inventory management. However, the adoption of these technologies faces multiple challenges due to factors specific to the local environment and the existing infrastructure in companies in the sector.

Specifically, automation through this tool offers considerable benefits, such as improved accuracy and speed of logistics processes, reduced human errors, and the ability to handle large volumes of data in real time [\(Smith, J., & Johnson, L. 2023\)](#). In the port field, these advances can translate into more efficient cargo management, better coordination between actors and an optimization of waiting times and operations.

Therefore, it should be noted that the effective implementation of this tool in the port sector of the Special District is conditioned by several variables. These include current technological limitations, staff training needs, and regulatory constraints that may influence the success of these automation processes [\(Odimarha et al, 2024\)](#). Despite the potential, the reality of its correlation in the local context reveals a complex interaction between these variables.

This analysis presents the incorporation and application of AI technologies in the logistics processes and operations of the port sector; this implies the use of intelligent systems to improve efficiency and decision-making, this leads to automated inventory management, cargo tracking systems, and optimization of transport routes where companies operating within the port ecosystem, Including terminal operators, shipping companies, freight forwarders, and logistics service providers develop the activities that allow it to compete in the growing market of the global port industry [\(Mckinsey.com\)](#).

Therefore; The present statement of the problem has the objective after making an analysis of documentary research; to show how the articulation of artificial intelligence impacts logistics automation in companies in the port sector in Buenaventura. Likewise, the technological, organizational and regulatory variables that affect the effectiveness of this implementation will be evaluated. This study will provide a comprehensive view of the challenges and opportunities associated with the adoption of such a process in this crucial sector for the economy of the Colombian Pacific region.

2. METHODOLOGY

For the development of this article, the methodology used was qualitative and descriptive, aimed at analyzing the impact of the articulation of artificial intelligence in the logistics processes of port companies in the District of Buenaventura. The contributions on the incidents and shortcomings presented in the research topic were based on the analysis and compilation of secondary information in different documentary sources, such as reports of port companies, reports of the port society of Buenaventura, academic articles among other specialized sources.

However, within the sources of information we find academic documents, where a detailed review of port reports was made, articles with topics correlated with the implementation and use of artificial intelligence in port processes, with the aim of looking at the affectation and/or impact of technology in port terminals. As for specialized news; Publications of specialized media and periodical sources of different news concerning port terminals at a national and international level that have carried out processes of implementation of tools integrated with AI for their internal processes were reviewed and analyzed, and as for business sources, documents concerning management reports, cancellations, newsletters, strategic documentation of companies in the port sector such as TC Buen, Sociedad Portuaria, Agua Dulce, among others, which document the use of technologies that today are called emerging and that are integrated with AI, so that their logistics operations are more efficient and effective, allowing them to reduce time and reprocesses.

For the process of analyzing the information, it was done through an inductive approach, where trends were oriented between sources of information consulted. Based on this, the main challenges, opportunities, benefits, among others, that can be generated through the implementation of artificial intelligence in the logistics processes of companies in the port sector were identified, however, parallels were also made between the implementation of new emerging technologies in local and international companies.

However, for the development of the research through the analysis carried out, key criteria were taken into account that allowed classifying the pertinent information such as: Automation of logistics processes, automation in the supply chain of port companies, correlated challenges with the adaptation of emerging technologies, operational efficiency in port terminals and impact on port security.

3. RESULTS

The automation of logistics processes in the port sector of Buenaventura presents a complex scenario. The port of Buenaventura, being one of the most important in Colombia, faces the challenge of modernizing its operations to improve

competitiveness and efficiency. However, the adoption of advanced technologies, such as AI, has not been uniform and faces significant barriers that need to be understood and addressed (Alavi A, et al; 2019).

Within the port sector, those companies that are in the process of organizational growth today present great challenges at a technological level, considering that it influences both infrastructure processes with a lack of these processes, as well as the absence of systems that simultaneously respond to the adaptation of new technologies of automated processes within the processes of port terminals. It is there where it can be said that these weaknesses that companies have directly influence the capacity they develop in order to implement processes that respond to a need that makes processes more productive through the implementation of AI in logistics processes in companies in the port sector of the district of Buenaventura. however, there are some factors such as: resistance to change, the search for innovative solutions, financial uncertainty, lack of adaptation, little culture of educational strengthening; These are some variables that hinder the implementation processes of new technologies for the mitigation of response times in logistics processes.

On the other hand, the regulatory issue plays a very important role for companies that work within port terminals, taking into account all the restriction factors that a good implementation of AI in these processes entails. However, today we see that not having intelligent machines that help regulate, minimize processes, among others that have regulatory support correctly, can generate a level of uncertainty in entrepreneurs, in terms of the investment of machines and processes generated through AI. This is due to the fact that both port agents and companies usually have a high level of uncertainty regarding the investments of these new technological methods, which are offered without guarantees of their use, protection of information and/or above all of the processes of the incorporated technology. That is why the non-incorporation of AI today generates delays in automated processes in port companies, which affects the inefficiency of logistics in port terminals.

However, part of the uncertainty of companies in this sector has been influenced by issues of the absence of good regulation on the impact that AI can generate in the implementation of logistics processes, such as the control of processes, the security of the data of the processes generated within the commercial activity called port, it can resort to what is colloquially called trial and error. But if we look at this implementation as an opportunity, companies can realize that a good investment in new forms of technological development can contribute to optimizing processes, port entrances, management processes, among others. It is there where it should be noted that there can be thousands of limitations; however, if there is no regulatory process for these procedures, it will not be possible to achieve the entrepreneur's mission objective, in order to maximize his income.

Therefore, a regulatory environment that promotes the adoption of AI effectively in the port sector must provide a balance between safety, flexibility and support for innovation. Only in this way will it be possible to maximize the positive impact of AI on logistics processes, improving efficiency, reducing costs and strengthening the competitiveness of ports globally. It is essential to examine how these regulatory variables affect the implementation of advanced technologies and what measures can be taken to overcome these challenges (Almat M, 2023).

On the other hand, when we talk about entities that are part of these logistics processes, we are referring to the International Maritime Organization (IMO); which have been directly playing an important role in validation issues on the effectiveness of logistics, maritime and security processes. However, according to the changes in the environment and in order to incorporate more effective solutions over time, it has referenced certain policies and directions for the port sector that wishes to implement AI as a tool to facilitate logistics processes, such as:

Automated Process and Digitalization:

- **Tablados, Digital Platforms:** IMO agrees that the implementation of these digital platforms is important for the efficiency, effectiveness and clarity of operations in port sectors.
- **Systematization of Processes:** The international maritime organization has worked every day to raise awareness of the importance of systematization and automation of the processes developed in port terminals, in terms of access control to these ports, data and information management, among other procedures.
- **Implementation of Artificial Intelligence:** IMO states that through the implementation of platforms, mechanisms generated with artificial intelligence, this directly contributes to improving the safety, efficiency and sustainability of port operations.

In the environment, the relevance of Artificial Intelligence for the logistics sector has expanded significantly, also highlighting five key factors: generative AI, AI and audio ethics, computer vision and advanced analytics. Together, they all aspire to transform logistics processes by leveraging advanced analytics and data generation tools, improving human-machine interaction through voice and sound analysis, automating the interpretation of visual data, and automatically generating new content based on already learned patterns. (<https://www.mundomaritimo.cl/>, 2024).

Systematization analysis

According to the approach of the problem, it should be noted that, in order to

address the integration of artificial intelligence in the automation of all the processes involved in the activities in the port sector of Buenaventura, it is necessary to systematize the problem through a multidimensional approach. Where first, an exhaustive analysis of the technological variables involved in the process must be carried out, including that of the existing technological infrastructure, the ease of the updating processes and the interruption of information systems.

On the other hand, it is valid to take into account the impact of organizational variables, staff preparation, knowledge about new technologies, resistance to change, and organizational adaptability are factors that affect the effectiveness of AI implementation. Training and skills development in new technologies are essential to overcome these challenges in ports [\(Martinez\] 2023\).](#)

Similarly, we can say that companies that promote a culture of innovation and flexibility tend to more easily integrate new technologies such as AI. Continuous training and the development of technological skills among personnel are not only essential to improve their performance, but also to generate confidence in the use of these tools within international trade; that is why it is said that companies in the customs sector that invest in the training of their human resources and in the creation of an environment that facilitates learning are better positioned to make the most of the benefits of AI, thus optimizing their processes and increasing their competitiveness. [\(Pérez, L. 2023\)](#)

The challenges associated with the integration of AI in the port sector are numerous; Despite significant benefits, such as reduced wait times and operational costs, obstacles such as the need for large upfront investments, staff training, and data protection come with them.

However, although there are challenges to overcome, the articulation of AI-based technologies in logistics processes is essential to maintain competitiveness and adapt to the growing demands of global trade. [\(Martínez, J.2024\).](#) It is valid to affirm that the analysis of regulatory variables is essential to understand how regulations and policies affect this logistics process; therefore, companies must, in addition to the operational, evaluate existing regulations and their impact on the ability of companies to integrate new technologies, as well as identify possible areas for improvement in the regulatory environment [\(Rodriguez, P 2022\).](#) Also, "Security and Privacy" represents how it is significantly impacting digital security and data privacy. AI technologies can be powerful tools for detecting cyberthreats and attacks, but they also raise questions about privacy and the handling of personal data. Finally, "Research and Development" highlights how it is driving advances in various areas of research and the development of new technologies. The techniques and algorithms of this method are an active area of study today and are giving rise to numerous discoveries and innovative applications. [\(You have 2023\).](#) Artificial intelligence is a term that encompasses those computer systems capable of detecting their

environment, thinking, learning and making decisions based on the inputs they receive and their objectives. Some forms of AI that we find integrated into our daily lives include virtual assistants, such as Apple's famous Siri or Amazon's Alexa. [Rodríguez I, et al; 2023](#). This will not necessarily replace workers, but may change the nature of jobs and require different skills and knowledge. [\(Piernext 2023\)](#).

In various industries, this incorporation of what has been addressed; It can foster an environment of continuous learning, where workers must constantly adapt and update their skills. Not only does this improve productivity, but it also offers opportunities for professional development. By facing these changes, companies and workers have the opportunity to collaborate in the creation of a more dynamic and enriching future of work, where technology and humanity can coexist and complement each other.

According to the different concepts of artificial intelligence (AI), given by the European Commission, it can be determined that it is a field of computer science that focuses on generating systems that can perform **tasks that particularly require human intelligence**, such as learning, reasoning and perception. These systems can perceive their environment, reason about knowledge, process information derived from data, and make decisions to achieve a given goal.

Ports around the world, including those in Colombia, are increasingly adopting automation and AI technologies to improve efficiency, competitiveness and productivity. (www.allread.ai, 2023). These technologies can include automated container handling systems, automated guided vehicles (AGVs), drones, Automated Storage and Retrieval Systems (AS/RS), and AI-based port management systems. The implementation of these technologies usually results in a higher speed of cargo processing, reduced errors, and improved security of port operations.

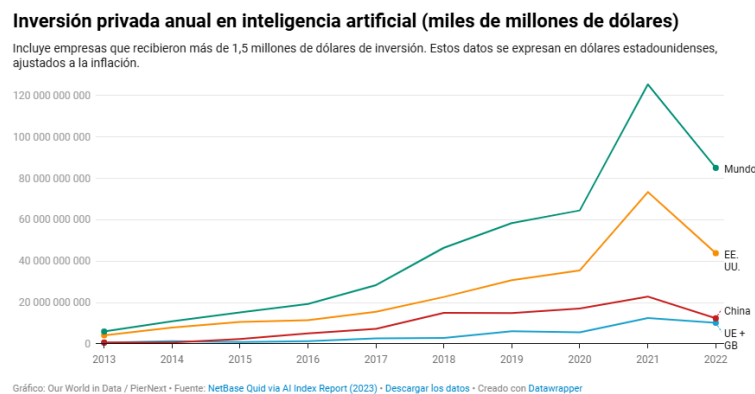
The **impact of AI on the port sector**

Artificial Intelligence (AI) is transforming the port sector by optimizing operational processes, increasing efficiency, and strengthening global competitiveness. Thanks to AI, ports can automatically manage inventories and cargo traffic, optimize maritime and land transport routes, and perform predictive maintenance of equipment, minimizing downtime. In addition, real-time cargo tracking and AI-based security systems improve transparency and security in port operations. These advances not only streamline logistics flow and reduce costs, but also position ports as key players in the global supply chain, improving their ability to meet the demand of domestic and international trade. (<https://klog.co>, 2022).

Today it can be seen that the use of artificial intelligence in logistics processes will continue to increase, followed by innovative processes, such as intelligence articulated with the skills generated by humanity, updates to drone systems and automated vehicles. These factors represent a competitive advantage for companies that adapt to change.

Buenaventura's port terminals have experienced exponential growth in recent years, radically transforming the way logistics operations are managed. The implementation of artificial intelligence (AI) and automation technologies at the Buenaventura Container Terminal (TCBuen) represents a significant milestone in the modernization of Colombian port infrastructure and an increase in the port's efficiency, productivity, and competitiveness. (<https://www.mundomaritimo.cl/>, 2019)

Investments in AI implementation can be seen as they have grown rapidly over the past decade. The following graph explains annual private investment worldwide.



Source (piernext.portdebarcelona.cat, n.d.). In original Spanish language

Considering the shipping sector, AI models can be useful as a perfect support for ship planning, for fleet management and optimization, helping to select the best navigation route, thus reducing costs and another use case could be an alert system to reduce the likelihood of incidents, not only at sea, but also within the limits of a port. (Saragani, 2024).

4. DISCUSSION

Today, according to all the referenced approaches, it can be said that artificial intelligence has contributed to the transformation of logistics processes in port terminals both internationally and in the Buenaventura District. For this reason, for this research it is worth highlighting the most discussed points during the development of this article, such as:

Improvement of processes in the supply chain: For this variable, the use of algorithms that are part of AI allows logistics processes to present an efficient management of this variable, in order to improve loading and unloading logistics, transport and demand capacity. This being a fundamental factor for the development of Buenaventura, considered as one of the main and important ports of the district of Buenaventura, however, it is known that the adaptation of artificial intelligence is a tool that is in the

process of being accepted in the region. in order to contribute to the improvement of the different logistical components.

Impact of artificial intelligence on operational processes: In Buenaventura, it is observed that companies are investing in automation technologies in order to minimize delays in operations processes. This is because among the most referenced variables is the improvement in the efficiency of operational processes that have been managed through artificial intelligence and that in addition to the port applies to various global port terminals.

Impact on the security area of port terminals: This is one of the challenges faced by customs agencies and port terminals in the District of Buenaventura, considering that the improvement in security articulated with the use of AI has been a fundamental commitment in their mission processes. in order to be used to instantly monitor the operational and logistical processes of companies; detecting risks for the sake of prevention and protection for both workers and companies.

Challenges in the implementation of Artificial Intelligence:

Port terminals face multiple challenges in the processes of adaptation of Artificial Intelligence such as: resistance of people to change, the lack of good infrastructures in the entrances and machinery of the ports, emerging technology, full and/or backup internet and above all a good investment as a process of initiation to change, with the aim of integrating these already existing challenges that are considered an obstacle to the optimal development of logistics processes.

5. CONCLUSION

Automation, Artificial Intelligence, the Internet of Things, and blockchain technology are revolutionizing the way supply chains are managed, improving efficiency, visibility, and security. (aden.org, 2024). You must have a comprehensive vision of modern logistics. This includes the process of mobilizing goods from origin to the final destination market. These systems consider transportation and inventory management, to reduce costs throughout the logistics chain (Barbero, 2010).

Companies that are pioneers in the development of information technology and real-time data collection will create a competitive advantage in their industries and will be able to adapt to the new needs of customers who require Internet access or the ability to track orders on the Internet and implement new electronic equipment in the market ([Mora, 2023](#)).

Within the future perspectives of artificial intelligence in logistics processes in the different activities carried out in the port terminals in Buenaventura, it is seen as an interesting expectation, therefore a growing digitization and a greater integration of this variable in the decision-making processes, optimization of processes and resources, among others, is expected. It is pointed out that it has a great diversifier in order to change

the logistics processes in the entities of the port terminals. That is why the future prospects within this environment are optimistic, but for that to happen, a joint effort is necessary between the various sectors, commercial, private, and government activities in order for the process of transition from one technology to another to facilitate adaptation.

Conflict of Interest: The authors affirm that there are no conflicts of interest in this study and that the processes established by this journal have been ethically followed. In addition, they assure that this work has not been published partially or totally in any other journal.

BIBLIOGRAPHIC REFERENCES

- Alavi A, et al; (2019). Port Logistics Integration: Challenges and Approaches. Researchgate.
<https://www.researchgate.net/publication/330212790>
- Boon J et al; (2022). Barriers to the adoption of new safety technologies in construction: a developing country context. Journal of Civil Engineering and Management.
<https://jau.vgtu.lt/index.php/JCEM/article/view/16014>
- Boulouha, H., & Saidi, R. (2022). Enhancing port logistics through AI technologies: Challenges and opportunities. Journal of Maritime Research, 19(1), 19-32.
<https://doi.org/10.1051/jmr/2022004>
- Camila. (2023, May 31). Democratizing automation in ports with AI. AllRead.
<https://www.allread.ai/es/la-inteligencia-artificial-para-democratizar-la-automatizacion-en-puertos/>
- Castro, J. B. L. (n.d.). Logistics infrastructure. Towards a matrix of burdens for competitiveness and sustainable development. Cippec.org. Retrieved November 11, 2024, from
<https://www.cippec.org/wp-content/uploads/2017/03/1396.pdf>
- En, E. 30117. (n.d.). Towards an operational definition and taxonomy of artificial intelligence. Europa.Eu. Retrieved November 11, 2024, from
https://publications.jrc.ec.europa.eu/repository/bitstream/JRC118163/jrc118163_ai_watch_defining_artificial_intelligence_1.pdf
- García, M. (2023). The future of artificial intelligence in port management. Nauche Global.
<https://www.naucher.com/futuro-inteligencia-artificial-gestion-portuaria>
- Gutarra M (2020). Artificial Intelligence In The Maritime Port Field. WistaPeru.
<https://wistainternational.com/wp-content/uploads/Inteligencia-Artificial.pdf>
- Ilin et al; (2019). Logistics Industry 4.0: Challenges And Opportunities. Logic.
https://logic.sf.bg.ac.rs/wp-content/uploads/LOGIC_2019_ID_33.pdf
- Li, K., & Chen, C. (2023). Smart ports: The role of AI in optimizing maritime logistics. Journal of Marine Science and Engineering, 11(3), 589.
- Liu, Y., Zhang, S., & Wang, L. (2020). Applications of artificial intelligence in port operations: A review. Journal of Shipping and Trade, 5(1), 1-20. <https://doi.org/10.1186/s41072-020-00066-4>

- Martínez, J. (2023). AI tools and their applications in ports. LOSE NEXT.
<https://www.piernext.com/herramientas-ia-aplicaciones-puertos>
- Mora, L. A. (2023). Integral Logistics Management: The best practices in the supply chain. Bogotá, Colombia: ECOE Ediciones. Sustainability and artificial intelligence stand as pillars in logistics in the next decade. (n.d.). Mundomaritimo.Cl. Retrieved November 12, 2024, from
<https://www.mundomaritimo.cl/noticias/sostenibilidad-e-inteligencia-artificial-se-erigen-como-pilares-en-la-logistica-en-la-proxima-decada>
- Mukhtarov , (2023). The Role Of Artificial Intelligence, Sensors, And Other Innovations In Facilitating Logistics Processes In The United States. Haykobi Nepcknetnbn.
<http://perspectives.pp.ua/index.php/vp/article/view/7398>
- Odimarha, et al; 2024). The role of technology in supply chain risk management: Innovations and challenges in logistics. Magna Scientia Advanced Research and Reviews.
<https://magnascientiapub.com/journals/msarr/content/role-technology-supply-chain-risk-management-innovations-and-challenges-logistics>
- Pérez, L. (2023). Artificial Intelligence and its usefulness in international trade. Legisblog.
<https://www.legisblog.com/inteligencia-artificial-comercio-internacional>
- Piernex I, (2023, May 11). Will AI take control of port management?. Innovation by port Barcelona.
<https://piernext.portdebarcelona.cat/tecnologia/tomara-la-ia-control-of-port-management>
- Rodríguez I et al; 2023. Artificial Intelligence: Great Opportunity of the 21st Century. Reflection document and proposal for action. Inter – Americam Development Bank
<https://www.google.com/url?sa=t&source>
- Rodríguez, A. (2022). Digital transformation in organizations. Universidad del Rosario.
<https://www.urosario.edu.co/transformacion-digital-organizaciones>
- Romero D (2023,26 de mayo) Artificial intelligence (AI), present and future of port-logistics management. Linked. <https://www.linkedin.com/pulse/artificial-intelligence-ai-present-future-management-romero-faz>
- Saragani, C. (2024, May 16). AI tools and their applications in ports. PierNext.
<https://piernext.portdebarcelona.cat/tecnologia/las-herramientas-de-ia-y-sus-aplicaciones-en-los-puertos/>
- SearchPosts. (n.d.). Imo.org. Retrieved November 11, 2024, from
<https://www.imo.org/es/GoogleSearch/SearchPosts/Default.aspx?q=implementacion%20te%20tecnologias%20en%20los%20puertos>
- Smith, J., & Johnson, L. (2023). The role of artificial intelligence, sensors, and other innovations in facilitating logistics processes in the United States. Journal of Logistics Innovation, 10(2), 123-145. <https://doi.org/10.1016/j.jli.2023.03.004>
- Succeeding in the AI supply-chain revolution. (2021, April 30). Mckinsey.com; McKinsey & Company.
<https://www.mckinsey.com/industries/metals-and-mining/our-insights/succeeding-in-the-ai-supply-chain-revolution#/>

- Tenés E (2023, June 01) Impact of Artificial Intelligence on Companies. Polytechnic University of Madrid. https://oa.upm.es/75532/1/TFG_EDUARDO_TENES_TRILLO_2.pdf
- Wang, J., & Lu, Y. (2019). Intelligent port: A framework for the application of AI in port logistics. *Maritime Policy & Management*, 46(4), 401-414.
<https://doi.org/10.1080/03088839.2019.1579003>
- Weng, Z., & Huang, Y. (2021). The impact of AI on port management efficiency. *Transportation Research Part E: Logistics and Transportation Review*, 145, 102164.
<https://doi.org/10.1016/j.tre.2020.102164>