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THE ERA OF ROBOTICS, AI, AND SERVICE AUTOMATION: SMART PORTS AS A MODEL FOR INTERNATIONAL TRADE

Abstract

This study aimed to investigate the application and impact of Robotics, Artificial Intelligence, and Service Automation (RAISA) technologies within the port and maritime logistics sector. Through a comprehensive analysis of existing literature and empirical studies, the research employed a systematic review methodology to synthesize findings across operational, strategic, and human dimensions.

The study concluded that RAISA technologies significantly enhance port operational efficiency by optimizing vessel traffic, automating container handling, and reducing waiting times and costs. Key findings also underscore their role in advanced risk prediction, improved economic competitiveness through dynamic pricing, and notable gains in environmental sustainability. However, successful implementation hinges on overcoming challenges related to system integration, workforce reskilling, and managing customer acceptance. The research affirms that strategic RAISA adoption is imperative for ports to thrive.

Key words: *Robotics, AI, Service Automation, Smart Ports, International Trade.*

JEL classification: *L91, O33, M15, Q55, F18.*

ЕРА РОБОТИКЕ, ВЕШТАЧКЕ ИНТЕЛИГЕНЦИЈЕ И АУТОМАТИЗАЦИЈЕ УСЛУГА: ПАМЕТНЕ ЛУКЕ КАО МОДЕЛ МЕЂУНАРОДНЕ ТРГОВИНЕ

Апстракт

Ова студија имала је за циљ да истражи примену и утицај технологија роботике, вештачке интелигенције и аутоматизације услуга (RAISA) унутар сектора поморске логистике и лука. Кроз свеобухватну анализу постојеће литературе и емпиријских студија, истраживање је применило методологију систематског прегледа како би синтетизовало налазе у оперативним, стратешким и људским димензијама.

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Студија је закључила да RAISA технологије значајно побољшавају оперативну ефикасност лука оптимизацијом саобраћаја бродова, аутоматизацијом руковања контејнерима и смањењем времена чекања и трошкова. Кључни налази такође наглашавају њихову улогу у напредном предвиђању ризика, побољшаној економској конкурентности кроз динамичко одређивање цена и значајним добитницима у еколошкој одрживости. Међутим, успешна имплементација зависи од превазилажења изазова везаних за интеграцију система, преквалификацију радне снаге и управљање прихватањем од стране корисника. Истраживање потврђује да је стратешка примена RAISA технологија императив за просперитет лука.

Кључне речи: *Роботика, Вештачка интелигенција, Аутоматизација услуга, Паметне луке, Међународна трговина.*

Introduction

There is an urgent need for more research on the applications of Artificial Intelligence (AI), which is one of the latest technological trends impacting our daily lives. Consequently, various industries are increasingly pursuing the enhancement of their applications in robotics and automation technologies to deliver meticulously flawless services in an engaging manner (Similar to the fields of education, industry, agriculture, logistics, transportation, tourism, commerce, and finance…) (Ivanov & Webster, 2017, p. 1). By leveraging artificial intelligence, these sectors aim to establish a unique and unparalleled experience for their customers.

However, research in this area remains limited across various sectors. This lack of research underscores the importance of focusing on how modern technologies can be utilized to improve operational efficiency and increase customer satisfaction. Institutions need to explore the potential of AI and robotics to meet growing market demands and enhance the services provided. Promoting research in this field can contribute to developing effective strategies, helping to boost competitiveness in the face of global challenges.

Scholarly investigations have indicated that Robotics (R), Artificial Intelligence (AI), and Service Automation (SA) (collectively referred to as RAISA) technologies have emerged as vital and dependable assets for organizations across multiple sectors. This trend of adoption is on the rise, driven by the increasing recognition of these technologies as critical drivers for innovation and profitability enhancement. Nations such as Japan, the United Kingdom, the United States, and China are at the forefront of this technological evolution, committing substantial financial resources, amounting to billions of dollars annually, towards the development and implementation of RAISA solutions.

This investment reflects these countries' commitment to improving their competitiveness through technological innovation. It also highlights the significance of RAISA in enhancing operational efficiency and reducing costs (Meziane & Bouguetaia, 2023, p. 7), contributing to the improvement of service quality provided to customers.

The increasing reliance on RAISA is considered a strategic step toward a more advanced and innovative future, contributing to the creation of a more effective work environment across various industries (Yassin, Gharieb, & Saad, 2022, p. 52).

From the aforementioned, it is imperative for us as researchers, academics, entrepreneurs, and consumers to strive for an understanding of the changes brought about by this electronic revolution. We must proactively anticipate its consequences in order to navigate them effectively. Humanity should not remain passive but should actively seek to manage and frame these changes. There is a consensus that this transformation is unlike any previous experiences, such as the industrial revolution, economic crises, globalization, world wars, or the Cold War. The current issue has not waited for our academic contributions; rather, it has preceded them and shown a clear impact on societies, behaviors, and policies.

Therefore, this study aims to enhance understanding as a foundation for formulating policies that maximize benefits and positives while minimizing potential risks and deviations.

Literature review

The existing body of research on smart ports demonstrates a clear evolution from exploring technological feasibility to examining the strategic, human, and procedural factors that underpin successful digital transformation. Scholars have approached this field from various methodological angles, providing a multi-faceted understanding of the opportunities and challenges.

A significant strand of literature focuses on the tangible operational benefits and technical implementation of artificial intelligence. For instance, (Korostin, 2025) developed AI solutions for port automation utilizing natural language processing and time-series analysis. The study's findings indicated that these technologies can significantly enhance container management, coordinate vessel movements, and predict operational risks with high accuracy, leading to a notable reduction in costs and waiting times. Similarly, (Foster & Rhoden, 2020) provided a regional case study, highlighting the growing importance of AI in Caribbean logistics for improving efficiency and revenue. Their research noted a positive willingness among industry participants to adopt such technologies, despite acknowledged challenges related to resources and awareness. However, these studies also reveal consistent impediments, including the difficulty of integrating new systems with traditional infrastructure and the critical need for employees to develop new technical skills.

Complementing this technical focus, another group of studies employs advanced statistical modeling to investigate the deeper drivers and strategic frameworks necessary for adoption. (Ghazaleh, 2023) investigated the business drivers behind AI transformation in ports using Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM). The research established that fundamental drivers like enhancing productivity and predictive capabilities are paramount, but their success is contingent upon rigorous guarantees of reliability and interpretability. The study cautioned against the consequences of immature applications and proposed a methodological framework to mitigate implementation risks. Expanding on the strategic perspective, (Kuo, Huang, & Chen, 2022) explored the integration of AIoT and blockchain to create sustainable operational schemes. Their use of SEM allowed them to analyze the key factors influencing adoption, concluding that investment in smart port technology is a critical strategic decision even in regions with low labor costs. The study identified operator attitudes and motivations as pivotal, ultimately providing a valuable framework for implementing smart, sustainable ports by outlining the key drivers of success.

Concept of RAISA Technologies

The reliance on robots, artificial intelligence, and automation represents the realization of goals that were once deemed science fiction in the recent past (Agah, Cabibihan, Howard, Salichs, & He, 2016). "RAISA" is a term coined by researchers (Ivanov & Webster, 2017, p. 1). This was the first attempt to study RAISA in the tourism and hospitality sector from a social sciences perspective. Their research focuses on analyzing theoretical issues related to the adoption of these technologies in tourism, as well as examining the principles of service automation and societal attitudes toward robots. Their studies also address the impact of RAISA on business operations.

Robots can be characterized as "physically intelligent systems" endowed with varying levels of autonomy, mobility, and sensory perception, which enable them to execute designated tasks effectively. The term autonomy pertains to the robot's capacity to perform its functions independently, without reliance on human oversight. This autonomous capability significantly enhances the robot's operational efficiency and its adaptability in managing a diverse array of tasks across multiple environments (Chen & Hu, 2013, pp. 164-165), The (International Organization for Standardization, 2012) classifies robots into industrial and service categories based on their economic application. Industrial robots are defined as programmable, multipurpose manipulators with three or more axes, designed for fixed or mobile use in industrial automation. In contrast, service robots perform beneficial tasks for humans or equipment outside industrial settings, with the categorization determined solely by the application domain rather than the robot's technical design.

The integration of robotic systems into industrial and service sectors represents a significant technological shift with profound operational implications. The following table systematically outlines the key advantages and disadvantages associated with the deployment of robots, providing a balanced overview to support strategic decision-making regarding automation investments.

The theoretical conceptualization of artificial intelligence denotes a system's capacity to identify problems, engage in analytical reasoning, and execute precise actions to resolve them—essentially emulating human cognitive functions. AI-enabled systems possess advanced capabilities for autonomous learning and dynamic interaction with external environments, including nuanced communication with users, processing of contextual messages, and adaptive responses to real-world events and stimuli (Huang & Rust, 2018, p. 156). Artificial Intelligence (AI) refers to computational systems designed to exhibit intelligent behavior by processing information, learning from data, and making decisions or responding to stimuli in a manner that emulates human cognitive functions (Poole & Mackworth, 2010, p. 49). AI appears in various forms, whether human-like or non-human, such as automated services capable of simulating or performing human tasks (Mellit & Kalogirou, 2008, pp. 588-604). AI has rapidly evolved from performing simple tasks, such as voice assistants, to the ability to carry out more complex social functions, such as recognizing and interacting with customer emotions.

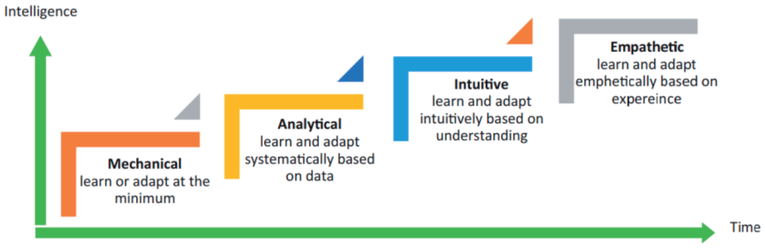
Figure 1: Taxonomy of Robots and Automated Systems.

	Category	Core Definition	Key Characteristics	Examples	Exceptions & Notes
Based on (ISO, 2012)	**Industrial Robot**	An automatically controlled, reprogrammable, multipurpose manipulator for industrial automation.	- Programmable in 3+ axes - Fixed or mobile - Designed for industrial tasks - Physical alteration may be needed to adapt	Articulated arms for welding, assembly, or painting on a production line.	The definition is based strictly on the application within the industrial automation sector.
	Service Robot	A robot that performs useful tasks for humans or equipment, excluding industrial automation applications.	- Defined by its **sector of application** (services) - Task-oriented, not design-oriented	An articulated robot used for serving food in a restaurant.	A robot physically identical to an industrial model is classified as a service robot if used outside industrial automation (e.g., food service).
Based on Working Definitions	**Service Robot**	A physical, mobile device with autonomy performing tasks professionally in the service sector.	- **Physical device** - Mobile - Some autonomy - Professional use in services	Delivery robots in hospitals, cleaning robots in airports, automated guided vehicles in warehouses.	Explicitly excludes software-based systems like chatbots.
	Social Robot	A robot able to interact and communicate with humans, other robots, and the environment.	- Designed for interaction and communication - Can be a subset of service or personal robots	Customer-service robots (e.g., a concierge robot), companion robots.	Can be for professional (service) or personal use. Not all service robots require social capabilities.
	Cobot (Collaborative Robot)	A robot designed to work alongside humans in a shared workspace.	- Designed for physical collaboration and safety - Focus on proximity to humans	A robot that assists a human worker with lifting heavy parts in a workshop.	A design distinction crucial in industry. For service robots, working near humans is often the default assumption.
	Bot / Chatbot	A software interface that connects users with services or performs automated digital tasks.	- **Purely software** - No physical form - Automates digital routines or provides an interface	Web crawlers, automated customer support chatbots, virtual assistants like ChatGPT.	**Excluded** from the working definition of a service robot because it is not a physical device.

Source: (Sostero, 2020, pp. 7-10)

Information Technology (IT) is a key factor that has facilitated the entry of AI into the business world. AI has become an effective tool for streamlining internal processes within companies and managing external transactions with customers in various contexts, whether personal or impersonal (Prentice, Weaven, & Wong, 2020).

Figure 2: The four intelligences.



Source: (Huang & Rust, 2018, p. 158)

The figure 2 presents a sophisticated analytical framework for artificial intelligence, classifying it into four main categories that escalate in complexity and proximity to human capabilities. The classification begins with mechanical intelligence, representing the foundational layer for automation and routine tasks, and progresses to analytical intelligence based on big data processing and statistical prediction. It then ascends to intuitive intelligence, which mimics human creative thinking in solving complex problems, reaching its peak with empathic intelligence that adds a human dimension to interactions through understanding and responding to emotions. The figure clearly highlights the functional integration between these layers and how they operate sequentially and interconnectedly to achieve near-comprehensive intelligence, where analytical capabilities feed intuitive intelligence, and intuitive flexibility paves the way for advanced emotional interactions.

Service automation refers to the use of machines to complete a series of predefined or reprogrammable tasks in service delivery. The earliest manifestations of service automation included ATMs, conveyor belts, self-checkout systems in stores, and vending machines (Law, Buhalis, & Cobanoglu, 2014, pp. 730-741).

Opportunities for Artificial Intelligence, Robotics, and Automation in ports

As the development of smart ports accelerates, the transition toward global port intelligence is becoming a defining trend in the modernization of maritime operations. As the development of smart ports accelerates, the transition toward global port intelligence is becoming a defining trend in the modernization of maritime operations.

Fully automated terminals deliver four core advantages: they significantly reduce the impact of adverse weather on terminal productivity, improve safety by limiting the number of personnel required in operational zones, diminish labor intensity and associated human errors, and cut down overall labor expenses. These advantages provide a clear set of key performance indicators for evaluating the efficiency and effectiveness of next-generation port infrastructure (Kuo, Huang, & Chen, 2022).

Table 2: Applications of AI and Big Data in Smart Ports

Technology	Application & Function	Key Benefit	Source
Automatic Identification System (AIS)	Uses AI to analyze real-time ship data (position, speed, course) for predicting traffic flow and optimizing berth allocation.	Enables proactive planning and reduces vessel waiting times.	(Huang, Li, Zhang, & Liu, 2020)
Artificial Neural Networks (ANNs)	Employs deep learning for optical character recognition (OCR) to automatically identify and verify container numbers.	Streamlines logistics, reduces errors, and accelerates container processing in the supply chain.	(Cepowski & Chorab, 2021)
Automated Guided Vehicles (AGVs)	AI-powered, self-navigating vehicles that transport containers within automated terminals without human drivers.	Increases operational efficiency, safety, and enables 24/7 unmanned container movement.	(Kosiek, Kaizer, Salomon, & Sacharko, 2021)
Autonomous Robots	Used for inspecting ship hulls and underwater port infrastructure for damage or security threats. Also developed for automated container stacking and retrieval.	Enhances port security through consistent monitoring and automates labor-intensive, physical tasks.	(Blokus & Dziula, 2019) (Yuan, et al., 2010)
Smart Grids	AI-managed energy systems that integrate renewable sources (e.g., wind, solar) to power port operations dynamically.	Promotes environmental sustainability and reduces the carbon footprint of port activities.	(Kanellos, Volanis, & Hatziargyriou, 2017)

Source: (Kuo, Huang, & Chen, 2022, p. 33)

Impact on Productivity and Performance

AI algorithms allow ports to monitor vessel traffic, manage schedules, assess container conditions, and determine resource needs in real-time. This functionality improves operational efficiency, minimizes delays, and facilitates data-driven decision-making using immediate, vital information (Korostin, 2025, pp. 74-76). RAISA technologies, leveraging historical data and machine learning, can be employed to improve operational efficiency and shorten loading periods. Consequently, RAISA provides greater flexibility in reducing wait times and accelerating the delivery of goods among various stakeholders, including suppliers and customers (Ghazaleh, 2023, p. 80). Artificial intelligence enhances the coordination of vessel movements within ports, effectively preventing congestion and optimizing the use of available berths. This capability is particularly crucial for large ports operating at high throughput rates, ensuring continuous operations and boosting overall productivity.

Furthermore, RAISA is expected to develop advanced digital dashboards that will replace traditional communication systems based on radio and radar between ship crews, port pilots, and terminal operators (Huang, Wang, Xu, Zhu, Tang, & Xu, 2018, pp. 1-5).

(Lestari, 2022, October) identifies key drivers of employee performance in technology-driven work environments. The research establishes that employee self-efficacy—an individual's belief in their own capability—is a significant positive predictor of performance. Furthermore, the quality of the relationship between employees and their supervisors is emphasized as a critical factor in achieving higher performance levels. The study also confirms that a positive attitude towards the adoption of smart technology directly enhances employee performance. These findings highlight the importance of fostering a supportive work environment that builds self-confidence, promotes strong supervisory relationships, and encourages the integration of advanced technologies to improve overall performance and achieve sustainable organizational success.

Predicting imminent risks

RAISA's ability to predict delays and plan operations is a critical application area. The system analyzes historical and current temporal data to identify operational risks related to weather conditions, terminal congestion, or infrastructure failures. For instance, RAISA can forecast peak operational periods in advance and suggest proactive measures such as rescheduling vessels, rerouting shipments, or increasing workforce in critical areas. Additionally, RAISA enhances the performance of cranes, loading platforms, and autonomous vehicles through precise and timely operational planning (Korostin, 2025). These integrated functions enable ports to optimize resource utilization and mitigate financial losses caused by operational disruptions. By leveraging data-driven insights, RAISA helps ensure smoother operations, ultimately contributing to greater efficiency and productivity within the port environment. This comprehensive approach not only addresses immediate challenges but also supports long-term strategic planning for enhanced resilience in port operations.

The potential of RAISA and machine learning in improving port risk management is highlighted through the analysis of unstructured data along with internal and external operational data. These technologies can provide accurate predictive insights to enhance operational efficiency, reduce wait times, and mitigate operational risks. Additionally, AI-based models offer effective tools for monitoring systemic risks across different ports, thereby enhancing safety and reducing costs. The development of these models is a crucial step toward digitizing maritime risk management and ensuring more resilient supply chains (Van Thiel & Van Raaij, 2019, p. 167).

Impact on Operations

Automating port operations, including loading and unloading, is crucial for saving time and labor while reducing costs and workplace accidents. This efficiency attracts customers, enhancing satisfaction and loyalty. Automation also improves customs processes, speeding up clearance and decreasing bureaucratic inefficiencies and corruption. The reliance on robots and automated systems boosts service capacity, allowing ports to handle more vessels and cargo simultaneously. Continuous operation without human limitations facilitates better scheduling and planning. Additionally, this shift fosters environmental sustainability by minimizing resource consumption and waste, leading to more efficient and responsible port operations (Stuart-Hill, Vienna, p. 46).

Impact of RAISA on Port Pricing Strategies

Automated pricing systems leverage AI to adjust prices dynamically based on operational costs and demand. Customized strategies enhance customer retention, while competitive pricing makes tech-driven services more accessible. Premium pricing for high-value services reflects superior quality. Overall, RAISA boosts ports' competitiveness and revenue by optimizing pricing efficiency and flexibility.

Impact on Port Distribution and Logistics

- Predictive Analytics for Cargo Flow Management: AI-driven systems analyze historical and real-time data to forecast shipment volumes, vessel arrivals, and potential disruptions. This enables proactive resource planning, optimized inventory management, and reduced turnaround times.
- Dynamic Resource Allocation Across Channels: Smart distribution systems automatically assign cargo and vessels to optimal terminals, berths, and transport routes based on capacity, urgency, and cost-efficiency. This minimizes congestion and maximizes throughput.
- AI-Powered Digital Assistants for Operational Coordination: Integrated voice and chat-based AI platforms (e.g., port-specific digital assistants) provide stakeholders with instant updates on cargo status, documentation, and logistics coordination. This streamlines communication and reduces administrative delays.
- Automated Intermodal Distribution Coordination: RAISA synchronizes sea, rail, and road transport by dynamically adjusting schedules and routes. This ensures seamless cargo handovers, reduces idle time, and enhances supply chain fluidity.
- Demand-Responsive Storage and Retrieval: AI algorithms predict short-term storage needs and automate container positioning within yards, optimizing space utilization and accelerating retrieval processes.

User Satisfaction and RAISA Usage

Understanding user acceptance of AI technologies in service delivery is crucial, and the RAISA user satisfaction model offers significant insights. It combines Cognitive Dissonance Theory, which explains users' discomfort when AI conflicts with their beliefs, leading to resistance (Festinger, 1962), and Cognitive Appraisal Theory, which focuses on how users evaluate AI based on perceived benefits and risks (Lazarus, 1991). Positive evaluations enhance satisfaction, while negative ones can impede acceptance. Together, these theories illuminate factors influencing AI adoption.

The acceptance process for RAISA technologies by port customers involves multiple stages, starting with awareness of potential benefits and moving to evaluation of pros and cons. Supporting factors include operational convenience through automation, enhanced efficiency via AI-driven optimization, and service customization with tailored data analytics. However, opposing factors like fear of operational disruption and loss of professional interaction may hinder acceptance, as customers value flexibility and traditional relationships in the maritime sector.

These supporting and opposing factors interact dynamically. A customer might highly value the efficiency gains from an automated booking system while simultaneously worrying about the depersonalization of service and the potential for errors in a fully automated workflow.

This complex interplay directly dictates customer satisfaction. If the tangible benefits of RAISA—such as predictability, speed, and transparency—consistently materialize, customer acceptance and loyalty are likely to grow. Conversely, if concerns about inflexibility and impersonal service dominate the experience, satisfaction will be negatively impacted, potentially hindering the long-term adoption of these technologies (Wu, Sorokina, & Putra, 2023, pp. 1230-1243).

Leveraging AI and Automation for Environmental Sustainability in Port Operations

The environmental sustainability benefits of employing AI-driven systems and Automated Guided Vehicles (AGVs) in container terminals are significant. This approach quantifies the potential reductions in emissions and energy consumption achieved through optimized vehicle routing and automated shoreside operations. AI has the capacity to facilitate synergistic actions within an automated port environment, leading to substantial improvements in eco-efficiency (Tsolakis, Zissis, Papaefthimiou, & Korfiatis, 2022, p. 4530).

Conclusion

This study investigates the impact of Robotics, Artificial Intelligence, and Service Automation (RAISA) technologies in the port and maritime logistics sector. Key findings reveal that RAISA enhances operational efficiency through optimized vessel traffic management and automated container handling, reducing waiting times and costs. Its predictive analytics capabilities improve risk management, while economic advantages arise from customized pricing and reduced operational costs. Additionally, RAISA supports environmental sustainability by minimizing energy consumption and emissions. However, successful implementation also hinges on human factors, including employee acceptance and customer satisfaction. The transition to automated systems, though requiring significant investment, offers long-term benefits. This research underscores that strategic RAISA adoption is essential for ports to thrive amid market demands and environmental challenges.

References

Agah, A., Cabibihan, J. J., Howard, A., Salichs, M. A., & He, H. (2016). Social Robotics. Proceedings of the 8th International Conference, ICSR 2016, Kansas City, MO, USA, November 1-3, 2016. (Vol. 9979). Springer.

Blokus, A., & Dziula, P. (2019). Safety analysis of interdependent critical infrastructure networks. TransNav, International Journal on Marine Navigation and Safety od Sea Transportation , 13 (4), pp. 781-787.

Cepowski, T., & Chorab, P. (2021). Determination of design formulas for container ships at the preliminary design stage using artificial neural network and multiple nonlinear regression. Ocean Engineering (238), p. 109727.

Chen, Y., & Hu, H. (2013). Internet of intelligent things and robot as a service. Simulation Modelling Practice and Theory , 34, pp. 159-171.

Festinger, L. (1962). Cognitive dissonance. Scientific American , 207 (4), pp. 93-106.

Foster, M. N., & Rhoden, S. L. (2020). The integration of automation and artificial intelligence into the logistics sector: A Caribbean perspective. Worldwide Hospitality and Tourism Themes , 12 (1), pp. 56-68.

Ghazaleh, M. A. (2023). Smartening up ports digitalization with artificial intelligence (AI): A study of artificial intelligence business drivers of smart port digitalization. Management and Economics Review , 8 (1), pp. 78-97.

Huang, M. H., & Rust, R. T. (2018). Artificial intelligence in service. Journal of service research , 21 (2), pp. 155-172.

Huang, X., Wang, J., Xu, Y., Zhu, Y., Tang, T., & Xu, F. (2018). Dynamic modeling and analysis of wave compensation system based on floating crane in smart port. In 2018 International Symposium in Sensing and Instrumentation in IoT Era (ISSI) (pp. 1-5). IEEE.

Huang, Y., Li, Y., Zhang, Z., & Liu, R. W. (2020). GPU-accelerated compression and visualization of large-scale vessel trajectories in maritime IoT industries. IEEE Internet of Things Journal , 7 (11), pp. 10794-10812.

International Organization for Standardization. (2012). ISO 8373:2012(en) Robots and robotic devices — Vocabulary. Retrieved from https://www.iso.org/obp/ui/#iso:std:iso:8373:ed-2:v1:en

Ivanov, S. H., & Webster, C. (2017). Adoption of robots, artificial intelligence and service automation by travel, tourism and hospitality companies–a cost-benefit analysis. International Scientific Conference "Contemporary tourism – traditions and innovations. 19-21 October 2017. Sofia University.

Kanellos, F. D., Volanis, E. S., & Hatziargyriou, N. D. (2017). Power management method for large ports with multi-agent systems. IEEE Transactions on Smart Grid , 10 (2), pp. 1259-1268.

Korostin, O. (2025). Development Of Ai Solution For Port Operations Automation And Cargo Flow Management. Молодий вчений .

Kosiek, J., Kaizer, A., Salomon, A., & Sacharko, A. (2021). Analysis of modern port technologies based on literature review. TransNav: International Journal on Marine Navigation and Safety of Sea Transportation , 15 (3), pp. 667-674.

Kuo, S. Y., Huang, X. R., & Chen, L. B. (2022). Smart ports: Sustainable smart business port operation schemes based on the Artificial Intelligence of Things and blockchain technologies. IEEE Potentials , 41 (6), pp. 32-37.

Law, R., Buhalis, D., & Cobanoglu, C. (2014). Progress on Information and Communication Technologies in Hospitality and Tourism. International Journal of Contemporary Hospitality Management , 26, pp. 727-750.

Lazarus, R. S. (1991). Progress on a cognitive-motivational-relational theory of emotion. American psychologist , 46 (8), p. 819.

Lestari, N. S. (2022, October). Impact of robots, artificial intelligence, service Automation (RAISA) acceptance, self-efficacy, and relationship quality on job performance. (IEEE, Ed.) In 2022 4th International Conference on Cybernetics and Intelligent System (ICORIS) , pp. 1-6.

Mellit, A., & Kalogirou, S. A. (2008). Artificial Intelligence Techniques for Photovoltaic Applications: A Review. Progress in Energy and Combustion Science , 34, pp. 574-632.

Meziane, M. T., & Bouguetaia, S. (2023). Impact of financial technology on Algerian bank performance., 7(4), . Journal of Innovations and Sustainability , 7 (4), pp. 07-07.

Poole, D. L., & Mackworth, A. K. (2010). Artificial Intelligence: Foundations of Computational Agents. Cambridge University Press.

Prentice, C., Weaven, S., & Wong, I. K. (2020). Linking AI Quality Performance and Customer Engagement: The Moderating Effect of AI Preference. International Journal of Hospitality Management , 90, p. 102629.

Sostero, M. (2020). Automation and robots in services: review of data and taxonomy y, JRC Working Papers Series on Labour, Education and Technology, No. 2020/14. Seville: European Commission, Joint Research Centre (JRC).

Stuart-Hill, T. (Vienna). Big Bang Theory: 360 Overview of Automation Technology Impacts in Travel, Tourism &Hospitality. innovation description the evolution of hospitality .

Tsolakis, N., Zissis, D., Papaefthimiou, S., & Korfiatis, N. (2022). Towards AI driven environmental sustainability: an application of automated logistics in container port terminals. International Journal of Production Research , 60 (14), pp. 4508-4528.

Van Thiel, D., & Van Raaij, W. F. (2019). Artificial intelligence credit risk prediction: An empirical study of analytical artificial intelligence tools for credit risk prediction in a digital era. Journal of Risk Management in Financial Institutions , 12 (3), pp. 268-286.

Wu, F., Sorokina, N., & Putra, E. D. (2023). Customers satisfaction on robots, artificial intelligence and service automation (RAISA) in the Hotel Industry: A comprehensive review. Open Journal of Business and Management , 3, pp. 1227-1247.

Yang, Y., & et al., .. (2018). Internet of things for smart ports: Technologies and challenges. IEEE Instrumentation & Measurement Magazine , 21 (1), pp. 34-43.

Yassin, ,. E., Gharieb, ,. A., & Saad, ,. H. (2022). Robots, artificial intelligence, and service automation (RAISA) technologies in the Egyptian hotel sector: A current situation assessment. International Journal of Heritage, Tourism and Hospitality , 16 (1), pp. 51-60.

Yuan, S., Skinner, B. T., Huang, S., Liu, D. K., Dissanayake, G., Lau, H., et al. (2010). Mathematical modelling of container transfers for a fleet of autonomous straddle carriers. In 2010 IEEE International Conference on Robotics and Automation (pp. 1261-1266). IEEE.

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