SUSTAINABLE SOLUTIONS IN WAREHOUSING OPERATIONS IN UAE BUSINESS LOGISTICS

Ananthakrishnan MANGALATH PRAKASH, Vytautas Magnus University Agriculture Academy, Faculty of Bioeconomy Development, email: ananthakrishnan.mangalath.prakash@vdu.lt

Abstract

This study investigates sustainable solutions to improve warehouse operations in the UAE for logistics in business. Warehousing is essential for logistics as it helps store goods, manage the inventory, and distribute products. With e-commerce growing and global climate change, warehousing is facing increased pressure to be more sustainable. The study is based on a systematic review of the most recent studies conducted in the past 5 years (2020-2026) on how to create sustainable warehousing operations; identifying the major challenges faced by the industry; and recommending ways to overcome them. The findings of the study show that using energy-efficient facilities, using renewable energy, automating operations, and applying advanced inventory management practices all lead to substantial increases in logistics operational efficiencies while reducing environmental impacts. Yet, in the UAE specifically, there are still issues such as high energy consumption due to the extreme weather conditions, the waste generated through improper packaging, the emissions from transporting goods, and rapid growth of infrastructure that present significant challenges to creating a sustainable warehousing operation. In conclusion, the research indicates that while there are many sustainable options available, lack of implementation is due to either high capital expense, technological complexities, or lack of infrastructure to support these options. Lastly, the research highlights that integrated strategies, technological adoption, and long-term planning are required to achieve sustainable warehousing in the UAE.

Keywords: warehousing, business logistics, sustainable solutions, UAE

Introduction

The importance of effective logistics management to accomplish the seamless flow of products between manufacturer and consumer is undeniable in the current scenario (Grant and Grant, 2024). Among the various activities constituting logistics, the storage of goods in a warehouse has become a major aspect of logistics and an important support to any logistics organization because warehousing supports many key functions including product storage, inventory management, order fulfilment, and distribution (Batarlienė and Jarašūnienė, 2024). In addition to the increased demands causing from global e-commerce, and growing consumer demands for fast shipment have placed intense pressure for warehouses to re-evaluate their existing systems to meet current and future demand trends. The current operation and environmental challenges that many warehouse facilities face include inefficient use of space, excessive energy consumption and emissions, operational inefficiencies, and increased carbon emissions from warehouse operations (Perotti and Colicchia, 2023). In light of these issues, organizations are continuing to implement sustainable operational strategies to continue to improve the performance of their warehouse operations while also being environmentally responsible. Sustainable practices within the warehousing environment including energy-efficient design and automatic technology for product handling not only improve operational efficiency, but they also contribute to a lower total impact to the environment (Minashkina, 2024). Countries like UAE has been implementing modern technologies within the logistics system, especially in operations like warehousing (Rahman et al., 2022). Focusing sustainability along with the development of UAE warehousing will help the country to enhance the overall logistics operations. Consequently, the article explores the sustainable solutions in warehousing operations in UAE business logistics.

Research aim: to propose sustainable solutions to enhance warehousing operations in United Arab Emirates (UAE) business logistics.

The following **objectives** have been set to achieve the aim:

1. To examine the sustainable methods to enhance warehousing operations in business logistics.
2. To find out the challenges of warehousing operations from a sustainability perspective in UAE business logistics.
3. To recommend sustainable solutions to improve the warehousing operations in UAE business logistics.

Research object and methods

The object of the research: sustainable solutions in UAE warehousing operations

This research uses secondary research formatting and a systematic literature review to discover sustainable solutions for improving warehouse operations. The systematic literature review evaluates only articles published academically from 2020 to 2026, in order to ensure that the results will be recent and relevant, especially due to recent technology developments and increased focus on sustainability in logistics. Studies that offered valuable insights were identified by conducting structured keyword searches using Google Scholar as the main database. A combination of keywords is used, including: "sustainable warehousing," "green logistics," "challenges in warehousing," "warehouse

management systems," "energy-efficient storage" and "warehousing operations," as well as using Boolean Operators (AND or OR) to narrow down or broaden the results returned by the searches. To validate the credibility and academic reliability of each of the selected sources, the majority of sources are peer-reviewed journal articles published by major organisations including Elsevier, Springer Nature and Sustainability journal.

Inclusion criteria: direct connection with research object, published between 2020 and 2026, and published in English language.

Exclusion criteria: does not have any connection to research object, published before 2020, and published other than English language.

Research results and discussion

Sustainable methods to enhance warehousing operations in business logistics

Sustainable strategies for improving warehousing operations in business logistics aim to enhance operational efficiencies without negatively impacting the environment or utilising nature's resources. One important method is to implement energy-efficient warehouse infrastructure. Many new warehouses are now using LED fixtures, motion sensors, and automated lighting controls to decrease their activities throughout the day (Batarlienė and Jarašūnienė, 2024). Given that lighting is required for long periods of time in large warehouses, this technology will greatly reduce both energy costs and carbon foot-printing. Additionally, by putting solar panels on the roofs of warehouses, companies are able to generate renewable power to support the electrical needs of lighting, automated equipment, and other temperature control systems in their warehouses (Duque-Jaramillo et al., 2024). An example of this is Amazon which has included solar systems and energy-efficient lighting in some of their distribution centres' operations. By adopting these sustainable infrastructure practices, companies can drive down the costs of getting products to customers, while at the same time supporting the environment with sustainable practices (Duque-Jaramillo et al., 2024). IKEA is another example of using renewable energy in logistics because they have committed funds to purchase solar panels and develop energy-efficient warehouses so that their logistics centres operate with minimal carbon generation and maximum energy efficiency (Cannava et al., 2025). An additional sustainable strategy utilizes warehouse automation and intelligent technologies. Implementing such automated storage and retrieval systems, robotics, and artificial intelligence can improve warehouse performance through reduced movement, increased inventory accuracy, and reduced energy consumption, amongst others (Odeyinka and Omoegun, 2023). Furthermore, smart warehouse management systems analyse real-time operational data to determine the most efficient storage locations and order-picking routes for both employees and automated machines, resulting in reduced travel distances and, ultimately, decreased energy consumption, thereby improving productivity (Minashkina, 2024). There are many different types of automated technologies, such as Automated Guided Vehicles and Autonomous Mobile Robots, that allow for more successful transportation of materials within warehouses compared to traditionally using manual handling techniques. Such technological advancements reduce labour-intensive functions, operational delays, and support sustainable logistics practices by providing enhanced material transport capabilities (Ali et al., 2022). An example of a major company using robotic and automated technologies in its warehouses is Amazon. These technologies are used to enhance performance in the areas of picking, sorting, and packaging, resulting in increased speed, accuracy, and decreased energy waste.

Table 1. Sustainable methods to enhance warehousing operations

Area	Methods
Green infrastructure	Installation of solar panels Temperature control system
Technologies	Automated Storage and Retrieval Systems (AS or RS) Robotics and Artificial Intelligence Automated Guided Vehicles (AGVs) Autonomous Mobile Robots (AMRs) Smart Warehouse Management Systems (WMS)
Space optimization	High-density storage systems Strategic product placement near packing or shipping areas Zoning techniques for grouping similar products
Inventory Optimization and Digital Tracking	Predictive inventory management and demand forecasting Barcode systems RFID technology Real-time inventory tracking systems

Sustainable warehouse layout planning is key to improving warehouse performance. When warehouses are designed and configured in a way that maximizes available storage space while minimizing the footprint needed for handling product-related activities, they will perform better (Ali et al., 2022). High-density storage solutions such as vertical racking and mezzanine levels can provide more storage volume within a given area than other types of storage methods and can eliminate the need for additional warehouses, reducing land use, construction materials, and overall environmental impact to the warehouse. In addition, placing frequently needed products closer to the packing and shipping areas reduces the amount of time and energy it takes to pick up those products during order fulfillment. Grouping like items in a warehouse also improves efficiency through various zoning techniques that allow for fewer wasted motions

during the handling process (Odeyinka and Omoegun, 2023). Using sustainable layout strategies will benefit the warehouse in many ways, both through improved operations and reduced energy consumption and resource usage (Batarlienė and Jarašūnienė, 2024).

Improving warehouse efficiency through the use of inventory optimization is a sustainable strategy. By utilizing modern inventory management tools and using predictive analysis to forecast demand, warehouses can keep appropriate amounts of inventory on hand. Appropriate amounts of inventory prevent warehouses from experiencing overstock or understock scenarios (Odeyinka and Omoegun, 2023). Over-stocking causes warehouses to require more space for storing excess inventory and use more energy, increasing the likelihood of inventory being damaged or going past the point of usefulness. Not having enough inventory can disrupt the operation of the supply chain, which causes the shipping of the same items to be shipped more frequently, which contributes to greenhouse gas emissions resulting from the transportation of the same products multiple times (Minashkina, 2024). Predictive inventory systems facilitate warehousing of items for as long as required, thus improving warehouse space utilization and decreasing operational waste. In addition, utilizing digital technologies such as bar code systems, RFID and real-time inventory tracking, improves inventory accuracy and provides operational visibility (Ali et al., 2022).

Challenges of warehousing operations from a sustainability perspective in UAE business logistics

Sustainability challenges within UAE logistics primarily stem from high energy demand and intense operational activity within warehouse spaces (Alherimi et al., 2025). Due to the rapid growth of trade and distribution systems, many warehousing companies are continuing to run 24 hours a day to accommodate these deals involving large volume shipments. As a result of this continual operational schedule, warehouses heavily depend on continuous lighting and air conditioning as well as electricity to perform automatic processes. In addition, given the extreme heat of the UAE, warehouses utilize a higher volume of cooling equipment than would normally be utilized in other countries, therefore dramatically increasing their total energy consumption (Mohsen and Mohsen, 2025). Additionally, warehouse buildings necessitate a much greater volume of lighting and cooling. Older warehouses are less energy efficient because they do not use sufficient insulation, adequate HVAC equipment or effective lighting, resulting in a significant waste of energy. Another sustainability issue affecting UAE warehousing is the improper management of packaging waste (Attia, 2025). The nature of the wide variety of products that are handled within warehouses results in the need for many different types of packaging materials including cardboard, plastics, bubble wrap, Styrofoam, and pallets. Additionally, daily warehouse operations that include receipts of products, storage, and shipments produce large amounts of waste material (Al Nuaimi and Williams, 2022). Furthermore, many products also have additional packaging when prepared for shipment. Due to the constantly changing pace of operations, it is very difficult to implement effective recycling and waste segregation systems within warehouses. Lastly, inconsistent packaging standards imposed by suppliers further complicate the inefficiencies of waste management systems working with multiple suppliers, as there is different handling, recycling, or disposing procedures for each type of packaging material (Attia, 2025).

Warehouses also raise many environmental issues through many of their transportation activities. The warehouse industry uses trucks as well as equipment such as forklifts and pallet jacks to move the material inside the building and between buildings in the warehouse distribution system (Lei, 2024). Most of these vehicles use diesel and electricity from non-renewable sources, which produces greenhouse gases and contributes to air pollution. There is continuous movement of vehicles in a warehouse, resulting in high energy consumption and significant environmental impacts. While switching to electric or low-emission vehicles can reduce the environmental impact of operations, it requires a substantial amount of investment in the infrastructure necessary to support the vehicles, such as charging facilities, and significant operational changes and training for employees (Iqbal et al., 2025). The design of the warehouse and how the inventory is managed are critical to performance with respect to sustainability. Poor design may cause longer distances to be travelled by handling equipment, therefore a greater amount of energy spent, and a greater amount of greenhouse gases emit, during the course of an operation. Additionally, the majority of warehouses in the UAE carry large amounts of inventory to provide assurance of available products and to allow for quick order processing (Kazim and Baskaran, 2025). This increases the amount of space and size of the facility which, in turn, increases the energy needed to light, cool and operate equipment in the facility. In addition, excessive inventory can lead to product obsolescence and waste. While implementing sophisticated forecasting and inventory management systems can assist in optimising inventory, such systems are generally complex and expensive to implement.

Sustainability-related issues are compounded by a greater number of large-volume distribution warehouses in the UAE as well as growing development of logistics facilities throughout the country (Attia, 2025). There is a growth in the development of distribution hubs on previously undeveloped land to meet the demand for logistics services, which can lead to destruction of natural habitat, green space and vegetation. Construction also consumes large amounts of building materials that contribute to high levels of greenhouse gases produced during their manufacture. Additionally, construction of large warehouses leads to problems such as increased surface runoff, retention of heat in built-up areas and greater vehicle traffic creating congestion in surrounding areas.

Sustainable solutions to improve the warehousing operations in UAE business logistics

Enhancing sustainability in warehousing throughout the UAE requires not just the adoption of energy-efficient technologies like LED lighting, motion sensors and automated energy systems that reduce overall electricity usage, but also a careful balancing of operational performance; financial aspects; and long-term environmental goals (Farhat and Kassem, 2025). The effectiveness of these solutions depends largely on the scale of your warehousing operations, as well as your ability to finance the initial investment. Larger logistics companies typically have an easier time absorbing these upfront costs and realizing the long-term benefits, so they are often more able to implement these types of improvements

than smaller companies (Saxena and Fernandes, 2025). Upgrading HVAC systems and improving insulation are also important in achieving the highest level of efficiency possible, particularly in UAE's extreme climate; however, upgrading older facilities may be technically complicated and expensive, so the timing of when to implement these improvements could also be a factor (Sheikha, 2024). Renewable energy, particularly solar energy, has significant opportunities for implementation in the UAE due to the abundance of sunshine (Sheikha, 2024). However, there are also other considerations that could potentially impact the installation including your financial capacity, available roof space, and the support and incentives offered through local and national government regulations. In addition, leveraging energy-monitoring technologies for identifying inefficiencies; enhancing energy management; and helping you obtain maximum value from the investment will be dependent upon what degree organizations incorporate knowledge derived from this data into their decision-making processes (Leal-Arcas, 2024). Therefore, without an ongoing commitment to incorporating data from energy-monitoring technologies in their operational strategies, these organizations may miss out on realizing the full benefits.

While recycling, reuse, and reducing packaging waste is crucial to sustainability, it is also challenging to implement. A fully standardized reusable packaging system can provide significant waste savings; yet, achieving this requires the supply chain, particularly suppliers and distributors, to be collocated. Because the UAE logistics sector is so diverse and reliant on imports, achieving such a level of collocation and standardization can be exceptionally challenging (Issac, 2024). Similarly, while using automated methods for producing packaging products or training employees to dispose of packaging materials represent significant opportunities to reduce waste within the logistics sector, the success of these initiatives depends on both their consistent implementation and the level of committed workforce to them; the extent of which will vary from organization to organization. Switching to electric materials handling equipment will generally reduce greenhouse gas emissions from transportation and the amount of maintenance required for the equipment (Iqbal et al., 2025). However, in the UAE, the extent to which this change can occur will depend on the availability of infrastructure to support such changes. In addition, improving warehouse layouts to minimize travel between locations will enhance efficiency; however, there will be physical limitations that will constrain the extent to which this can be accomplished.

Advanced inventory management systems, such as real-time tracking and predictive analytics, can help to reduce excess inventory and waste. However, these systems generally require a significant amount of capital investment and specialized personnel, which may limit their implementation by smaller businesses. In addition, unpredictable conditions in supply chains, especially in the UAE, a major logistics hub, also contribute to companies holding on to larger quantities of safety stock and potentially inhibiting sustainability efforts (Zakaria et al., 2024). Inventory control techniques like FIFO may help reduce product waste, but they must be consistently and effectively implemented in conjunction with appropriate systems. From an infrastructure perspective, vertical storage and high-density storage arrangements can help maximize the use of available land and limit the need for land expansion, particularly in densely populated areas such as cities (Khlie et al., 2025). However, vertical storage and high-density storage will typically require advanced technology and significant upfront capital, which will hinder smaller businesses from using them. Similarly, low-emission construction materials and the selection of appropriate warehouse locations will also contribute to reducing the environmental impact of warehousing. However, there are generally some trade-offs between cost, accessibility, and proximity to major logistics hubs when making these decisions.

Conclusions

1. The article analysed that, sustainable warehousing strategies improve operational efficiency and environmental performance by integrating energy-efficient infrastructure, renewable energy sources, advanced automation, and optimized inventory management systems.
2. In the UAE context, sustainability challenges are intensified by extreme climate conditions, continuous warehouse operations, excessive packaging waste, dependence on fossil-fuel-based transportation, and rapid expansion of logistics infrastructure.
3. Although various sustainable solutions are available, their effective implementation is often constrained by high initial investment costs, technical and operational complexities, infrastructure limitations, and the need for stronger supply chain coordination and long-term strategic planning.

References

1. Al Nuaimi, A. H., & Williams, L. G. (2022). Radioactive waste management in the UAE: proposal for an inventory management system. *Progress in Nuclear Energy*, *146*, 104140.
2. Alherimi, N., Alyaarbi, A., Ali, S., Bahroun, Z., & Ahmed, V. (2025). Prioritizing ERP System Selection Challenges in UAE Ports: A Fuzzy Delphi and Relative Importance Index Approach. *Logistics*, *9*(3), 98.
3. Ali, S. S., Kaur, R., & Khan, S. (2022). Evaluating sustainability initiatives in warehouse for measuring sustainability performance: an emerging economy perspective. *Annals of Operations Research*, *324*(1–2), 461–500. https://doi.org/10.1007/s10479-021-04454-w
4. Attia, A. (2025). The effect of commitment to sustainable supply chain management and reverse logistics on performance in context of UAE food industry. *Sustainable Futures*, *9*, 100442.
5. Batarlienė, N., & Jarašūnienė, A. (2024). Improving the quality of warehousing processes in the context of the logistics sector. *Sustainability*, *16*(6), 2595. https://doi.org/10.3390/su16062595

6. Cannava, L., Perotti, S., Najafi, B., & Rinaldi, F. (2025). A Simulation-Based approach to improve energy efficiency and environmental performance in warehouses: the case of IKEA. *IFAC-PapersOnLine*, *59*(10), 799–804. https://doi.org/10.1016/j.ifacol.2025.09.136
7. Duque-Jaramillo, J. C., Cogollo-Flórez, J. M., Gómez-Marín, C. G., & Correa-Espinal, A. A. (2024). Warehouse management optimization using a sorting-based slotting approach. *Journal of Industrial Engineering and Management*, *17*(1), 133. https://doi.org/10.3926/jiem.5661
8. Farhat, H., & Kassem, A. (2025). Between Containers and Warehouses: Rehabilitating Port Proximities in UAE Coastal Cities. *Ocean and Society*, *2*.
9. Grant, D., & Grant, D. B. (2024). *Logistics management*. BoD–Books on Demand.
10. Iqbal, H., Singh, A. K., Ram, S., Periwal, S., & Show, G. (2025). Driving Toward Sustainability: The Role of Eco-friendly Transportation in Reducing Carbon Emissions in the United Arab Emirates. In *Agile Business Transformations* (pp. 45-63). Apple Academic Press.
11. Issac, A. L. (2024). Reverse Logistics and Closed-Loop Systems in UAE Supply Chains: Leveraging Industry 4.0 for Sustainable Resource Management.
12. Kazim, A. M. J. H., & Baskaran, K. (2025). Examining How Integrated Smart Logistics Ecosystems Enhance E-Commerce Efficiency in the UAE Retail Sector. *Journal of Posthumanism*, *5*(5), 3340-3359.
13. Khlie, K., Pugalenthi, A., & Jebbor, I. (2025). Sustainable Supply Chains in the Industry X. 0 Era: Overcoming Integration Challenges in the UAE. *Administrative Sciences*, *15*(11), 417.
14. Leal-Arcas, R. (2024). A tale of three countries: Energy decentralization in Egypt, the United Arab Emirates, and Saudi Arabia. *QM Legal Studies Research Paper No. 8*, *2024*, 1-73.
15. Lei, M. (2024). Application of energy sustainability model based on optical sensing technology in intelligent warehousing performance management in green manufacturing industry. *Thermal Science and Engineering Progress*, *54*, 102789. https://doi.org/10.1016/j.tsep.2024.102789
16. Minashkina, D. (2024). A review and research agenda for recent socially and environmentally sustainable practices for warehouse management systems. *The International Journal of Logistics Management*, *35*(7), 60–98. https://doi.org/10.1108/ijlm-07-2023-0265
17. Mohsen, B. M., & Mohsen, M. (2025). AI-Driven Energy Optimization in Urban Logistics: Implications for Smart SCM in Dubai. *Sustainability*, *17*(18), 8301.
18. Odeyinka, O. F., & Omoegun, O. G. (2023). Warehouse Operations: An examination of traditional and automated approaches in supply chain management. In *Industrial engineering and management.* https://doi.org/10.5772/intechopen.113147
19. Perotti, S., & Colicchia, C. (2023). Greening warehouses through energy efficiency and environmental impact reduction: a conceptual framework based on a systematic literature review. *The International Journal of Logistics Management*, *34*(7), 199–234. https://doi.org/10.1108/ijlm-02-2022-0086
20. Rahman, N. S. F. A., Hamid, A. A., Lirn, T. C., Al Kalbani, K., & Sahin, B. (2022). The adoption of industry 4.0 practices by the logistics industry: A systematic review of the gulf region. *Cleaner Logistics and Supply Chain*, *5*, 100085.
21. Saxena, A., & Fernandes, K. (2025). Transforming UAE's Logistics through Artificial Intelligence: Case Studies and Insights. *Available at SSRN 5401989*.
22. Sheikha, A. (2024). Evaluating the Impact of Hybrid Ventilation Strategies on Reducing the Cooling Load and Achieving Thermal Comfort of Buildings: Regarding Arid Climate of UAE.
23. Zakaria, I. H., Lyn, J., Azizul, P. M., Mazlan, F. A. A., & Bakri, A. (2024). Smart warehousing solutions: enhancing efficiency and sustainability in logistics and transportation. *Journal on Technical and Vocational Education*, *9*(2), 409-420.