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A Narrative Literature Review on the Use of Augmented Reality in Logistics: Enhancing Training and Operational Efficiency

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ABSTRACT : This study explores the implementation of Augmented Reality (AR) in logistics training and operations, focusing on its effectiveness in improving technical skills, operational efficiency, and user engagement. The review analyzes peer-reviewed literature from major academic databases, using systematic search strategies with defined keywords and inclusion criteria. Key findings show that AR-based training significantly enhances conceptual understanding, reduces task completion times, and increases learner satisfaction. In logistics operations, AR contributes to improved order picking, warehouse mapping, and real-time inventory control, leading to productivity gains and cost reductions. These benefits, however, are context-dependent and influenced by systemic factors such as infrastructure maturity, workforce readiness, organizational culture, and regulatory support. The discussion emphasizes the need for integrated human-centric design, supportive policy frameworks, and targeted investment to overcome barriers to AR adoption. Practical strategies, including the use of proven AR platforms, public-private educational partnerships, and localized pilot implementations, are recommended to facilitate scalable and effective AR integration. Despite promising results, gaps remain in empirical field research and interdisciplinary perspectives, especially in low- and middle-income settings. The review concludes by underscoring the urgency of digital transformation in logistics and the central role of AR in equipping the workforce with future-ready capabilities. Strategic adoption of AR offers a pathway toward more adaptive, efficient, and resilient logistics systems.

Keywords: Augmented Reality, Logistics Training, Operational Efficiency, Immersive Technology, Workforce Development, Digital Infrastructure, Supply Chain Innovation.

INTRODUCTION

In recent years, Augmented Reality (AR) has emerged as a transformative tool within the domain of logistics training and operations, aligning with the broader wave of digital transformation across industries. AR, by superimposing digital information onto the physical world, offers unique opportunities to enhance human performance, reduce operational errors, and improve task efficiency. As logistics operations grow increasingly complex and fast-paced, the demand for innovative technological solutions to streamline processes and elevate workforce capabilities has intensified. Researchers have highlighted that AR's ability to provide real-time, context-aware instructions positions it as a promising technology in logistics applications, particularly in training and operational guidance (Putz et al., 2022). However, despite its potential, AR's implementation within the logistics sector faces several critical barriers that need to be addressed to realize its full benefits.

The current literature illustrates a growing global interest in AR-driven solutions for logistics. The implementation of AR has been increasingly explored in logistics functions such as order picking, inventory management, route optimization, and staff training. Akbari et al. (2022) emphasized that AR contributes to creating more intuitive and error-resistant workflows. Moreover, the ability to integrate AR with data-driven platforms such as the Internet of Things (IoT), Artificial Intelligence (AI), and big data analytics has further fueled interest in its application within logistics environments (Sidiropoulos et al., 2021). Nonetheless, the translation of conceptual enthusiasm into practical implementation remains a challenge due to various technological, human, and organizational constraints.

Empirical data and market projections further substantiate the relevance and potential of AR in logistics. A report by Ginters et al. (2020) projected a strong growth trajectory for AR in the logistics industry, driven by the need for operational agility and enhanced decision-making. Recent studies have shown that AR can significantly improve accuracy and reduce time consumption during warehouse operations by enabling heads-up, hands-free data access via head-mounted displays (Vezzani et al., 2024; Maio et al., 2023). Additionally, the advent of 5G technology is poised to bolster AR systems by facilitating faster data transmission, a critical enabler for real-time applications in logistics (Akbari et al., 2022). These advancements collectively highlight the growing practicality of AR in solving real-world logistics problems.

Supporting this trend, Jütte et al. (2023) observed that AR applications in logistics not only improve operational metrics but also enhance user experience and safety, two critical components of sustainable logistics practices. Furthermore, with the rising adoption of digital twin systems and sensor-based networks, AR's role is expanding from an auxiliary interface to a central operational tool. In this regard, AR is increasingly viewed not just as a training aid but as an integral part of operational ecosystems that drive continuous performance improvement in logistics.

Despite these advancements, significant challenges persist in the implementation of AR technologies. One of the primary challenges is the inherent complexity of AR systems, which often require extensive technical integration with existing IT infrastructure. According to Putz et al. (2022) and Akbari et al. (2022), many logistics personnel struggle with understanding and operating AR interfaces, particularly in environments where digital literacy is not uniformly high. Moreover, achieving interoperability among diverse hardware and software platforms in logistics remains problematic, hampering seamless AR deployment.

Another critical challenge lies in the variation of user skills and readiness. The workforce in the logistics sector is often generationally diverse, with younger employees (digital natives) adapting more quickly to digital tools than their older counterparts (Putz et al., 2022). This digital divide necessitates comprehensive training programs tailored to different user profiles, as emphasized by Akbari et al. (2022). Without such support systems, AR implementation risks excluding or underutilizing significant portions of the workforce.

Cost is also a persistent barrier to widespread adoption. Implementing AR systems entails considerable investment in hardware, software, and personnel training. Studies have noted that although AR may yield long-term cost savings through improved efficiency, the high upfront costs are often perceived as a financial risk (Sidiropoulos et al., 2021; Wang et al., 2020; Tadić et al., 2023). Companies must conduct rigorous return-on-investment analyses to justify AR investments, particularly in budget-constrained environments.

Despite increasing interest, a critical review of the existing literature reveals substantial gaps in empirical and operational knowledge. Much of the current research relies on qualitative assessments, descriptive reports, or laboratory simulations, which may not accurately reflect the complexities of real-world logistics environments (Akbari et al., 2022; Albawaneh et al., 2023). There is a lack of comprehensive quantitative studies that evaluate the cost-effectiveness, training impact, and user performance outcomes of AR deployments in logistics settings.

This review aims to bridge these gaps by systematically analyzing literature on AR applications in logistics training and operations. Specifically, it seeks to identify and assess the key factors influencing the effectiveness of AR implementation across different logistics contexts. The review also explores technological, human, and organizational dimensions of AR adoption, offering a nuanced understanding of its enablers and barriers. Furthermore, the study examines how contextual variables such as geography, workforce demographics, and organizational culture influence AR adoption and efficacy.

The scope of this review is global, encompassing studies from both developed and developing countries to capture a wide spectrum of AR adoption experiences. It focuses particularly on logistics sectors where physical task performance is central and where AR can directly impact training efficiency, task execution, and operational safety. By analyzing studies across diverse geographic and demographic settings, this review provides insights into the variability of AR impact and identifies best practices and common pitfalls that can inform future implementations.

In sum, this review contributes to the academic and practical discourse on AR by offering a comprehensive examination of its role in logistics training and operations. As digital transformation continues to reshape industry landscapes, understanding the dynamics of AR adoption is essential for organizations aiming to enhance their competitiveness and workforce capabilities. By addressing existing knowledge gaps and synthesizing evidence-based insights, this study supports informed decision-making regarding AR investments and integration strategies in the logistics sector.

METHOD

This review employed a structured and rigorous literature search strategy to identify and analyze peer-reviewed articles related to the application of Augmented Reality (AR) in logistics training and operations. The research process was conducted in accordance with recognized academic standards for systematic reviews. The primary aim of this methodology was to ensure the comprehensiveness, transparency, and replicability of the literature search and selection process.

To capture a wide scope of relevant studies, several academic databases were utilized. Scopus served as the primary search engine due to its extensive indexing of high-impact journals and inclusion of multidisciplinary sources. Its advanced search functionality and citation tracking tools were valuable in identifying seminal works and mapping influential research trends in AR logistics applications. Web of Science was also employed as a complementary resource to cross-verify the comprehensiveness of the initial search results and to gain access to additional high-quality academic publications. Google Scholar was used to broaden the search to include grey literature, such as conference proceedings, working papers, and theses, which may not be indexed in traditional databases but are nonetheless influential in emerging technological fields. IEEE Xplore was included to capture technical studies and innovations related to the implementation of AR in warehouse automation and supply chain processes, especially from the perspective of computer science and engineering. Emerald Insight, with its emphasis on management and business applications, contributed valuable insights into how AR is integrated into logistics workflows and employee training. SpringerLink provided a variety of full-text journals and book chapters focusing on industrial technology and logistics systems. JSTOR, although used more selectively due to its orientation toward humanities and social sciences, offered relevant contextual insights into the social dimensions of AR adoption in organizational environments.

The literature search was conducted using a set of carefully constructed keyword combinations designed to optimize both sensitivity and specificity. Boolean operators were used strategically to connect related terms and filter results. The following keyword string was employed across all databases: ("Augmented Reality" OR "AR") AND ("Logistics" OR "Supply Chain"), which retrieved articles addressing AR implementations in broad logistical contexts. To refine the search toward training-specific literature, the string was modified to ("Augmented Reality" OR "AR") AND ("Training" OR "Education") AND ("Logistics"). To identify studies focusing on performance outcomes, the keywords ("AR" AND "Operational Efficiency") OR ("AR" AND "Productivity") AND ("Logistics") were used. Additionally, terms such as ("AR" AND "Warehouse Management") OR ("AR" AND "Inventory Control") provided more targeted results related to AR use cases in specific logistic functions. For understanding the dynamics of technology acceptance, the search included combinations such as ("Technology Adoption" OR "Implementation") AND ("Augmented Reality" OR "AR") AND ("Logistics"). Finally, to evaluate training impact, the string ("Augmented Reality" AND ("Training Effectiveness" OR "Learning Outcomes") AND ("Logistics")) was applied.

Inclusion and exclusion criteria were established to ensure that only the most relevant and methodologically sound studies were selected. Included studies had to be published in peer-reviewed journals or reputable conference proceedings between 2015 and 2024, to reflect the latest developments in AR technology and its applications. Articles were required to be written in English and explicitly focused on the use of AR in logistics training or operational environments. Both qualitative and quantitative studies were included, provided they offered empirical findings or conceptual frameworks directly applicable to logistics practices. Studies solely discussing Virtual Reality (VR), Mixed Reality (MR), or unrelated industrial applications of AR were excluded, unless they explicitly compared AR with other immersive technologies in a logistics context. Editorials, opinion pieces, and papers lacking methodological transparency were also excluded.

A range of study designs were considered appropriate for inclusion, including experimental studies (e.g., randomized controlled trials evaluating AR training interventions), quasi-experimental designs (e.g., pre-post studies assessing performance improvements), case studies of AR implementation in logistics settings, cohort studies analyzing adoption trends, and systematic literature reviews synthesizing existing findings. These diverse research designs allowed for a comprehensive understanding of both practical applications and theoretical advancements in the field.

The selection process followed a multi-phase screening procedure. Initially, all retrieved titles and abstracts were reviewed for relevance based on the predefined inclusion criteria. Articles that did not meet the criteria were excluded at this stage. The remaining articles were then subjected to full-text analysis, where their research objectives, methods, findings, and conclusions were thoroughly examined to ensure alignment with the scope of this review. During this phase, special attention was given to studies that addressed implementation challenges, user adoption, training outcomes, and performance metrics related to AR. Any ambiguities in inclusion were resolved through discussion and consensus among the reviewing researchers.

To assess the quality of the included literature, a critical appraisal was conducted using standardized tools appropriate to the study design. For quantitative studies, factors such as sample size, data collection methods, statistical analysis, and validity of outcome measures were considered. For qualitative studies, credibility, transferability, and depth of analysis were evaluated. Systematic reviews were assessed based on transparency of search strategy, inclusion criteria, and synthesis of findings. Articles meeting moderate to high-quality thresholds were retained for final analysis.

The final set of selected articles was thematically analyzed to identify recurring patterns, emerging themes, and critical factors influencing the effectiveness of AR in logistics training and operations. This thematic synthesis formed the foundation for structuring the results and discussion sections of this review. The combination of database triangulation, refined keyword search strategies, stringent inclusion/exclusion criteria, and thorough quality assessment ensured that the review is comprehensive, reliable, and reflective of current academic and industrial insights into the application of AR in logistics.

RESULT AND DISCUSSION

The review of existing literature on the implementation of Augmented Reality (AR) in logistics training and operations reveals several recurring themes, categorized here under the effectiveness of AR-based training, improvements in operational efficiency, and global comparative perspectives. These themes reflect the potential and current limitations of AR technology when applied in practical, real-world logistics contexts.

The effectiveness of AR-based training in logistics has been extensively documented. AR has demonstrated its capacity to enhance technical skills, conceptual understanding, and overall user engagement among logistics trainees. Studies such as those by Albawaneh et al. (2023) and Żywicki & Buń (2021) illustrate that AR-trained individuals outperform their conventionally trained counterparts in executing practical tasks such as warehouse order picking and inventory management. These studies reported measurable improvements in task accuracy, time to completion, and user-reported engagement. By superimposing instructional content directly within the physical workspace, AR enables a more immersive, hands-on learning environment. As noted by Zhao et al. (2019), such visualization enhances comprehension of complex concepts and facilitates the translation of theoretical knowledge into practical application.

Further empirical evidence supports the time-saving potential of AR-based training. Żywicki & Buń (2021) observed a notable reduction in task completion times, attributing this to the real-time, interactive guidance that minimizes cognitive load and reduces decision-making time. Moreover, user satisfaction metrics, such as those reported by Albawaneh et al. (2023), indicate that AR-trained workers perceive their learning experience to be more effective, enjoyable, and confidence-enhancing. This correlates positively with higher motivation levels and better knowledge retention, critical components in training logistics personnel.

Case studies further corroborate these findings. Salas-Pilco et al. (2023) demonstrated that learners using AR tools provided consistently positive feedback in terms of ease of understanding, training relevance, and applicability to real-world tasks. The same study found that AR interventions led to accelerated learning and stronger retention of operational procedures. Vezzani et al. (2024) reinforce this by showing that AR-enhanced environments create engaging experiences that lead to superior performance outcomes in logistics training modules.

In addition to training efficacy, AR has shown considerable promise in enhancing operational efficiency. Order picking, a critical logistics activity, has emerged as one of the most significantly impacted functions. Vezzani et al. (2024) reported that AR tools, particularly those using head-mounted displays, provide step-by-step visual instructions that streamline the order-picking process. Their findings suggest a 30% reduction in processing time when AR systems replace conventional paper-based or screen-based instructions. Akbari et al. (2022) echo these results, highlighting that AR-driven guidance significantly lowers item search time and increases accuracy, contributing to overall productivity.

Similarly, warehouse mapping benefits substantially from AR implementation. Through spatial visualization tools, AR enables workers to view warehouse layouts in real-time, including dynamic inventory positions and optimal routing paths. Vezzani et al. (2024) identified a 20–25% decrease in travel time within warehouses equipped with AR navigation aids. Furthermore, AR-supported mapping improves space utilization and supports just-in-time inventory practices by dynamically updating layout plans based on real-time stock movements. Vogel et al. (2017) confirm that such digital overlays aid in operational decision-making, leading to more efficient space and resource management.

Quantitative metrics underline these improvements. Studies consistently report faster order fulfillment, enhanced inventory accuracy, and increased worker satisfaction. For instance, Zhao et al. (2019) noted accuracy rates exceeding 99% in AR-assisted order picking scenarios. Worker satisfaction, measured through surveys and structured interviews, also showed significant positive shifts post-AR implementation, as indicated in the work of Vezzani et al. (2024). Additionally, productivity indicators such as the number of correctly picked items per hour rose significantly following AR adoption (Akbari et al., 2022).

Cost-related metrics further support AR's operational value. Vogel et al. (2017) observed reductions in labor costs and inventory mismanagement, with AR contributing to more efficient allocation of human and material resources. These operational savings are critical in justifying the high initial investment often associated with AR technologies. Hence, organizations evaluating return on investment for AR deployments can draw from such empirical evidence to support strategic decisions.

From a global perspective, the effectiveness of AR in logistics varies substantially across regions. Developed nations like Germany and the United States have successfully implemented AR tools within logistics operations, primarily due to robust digital infrastructures and a workforce accustomed to technological integration. Akbari et al. (2022) found that AR systems in such contexts reduced order processing times by up to 30%. This contrasts with countries like China, where although investment in digital technologies is substantial, challenges such as workforce readiness and resistance to change hamper optimal AR utilization (Zhao et al., 2019).

In Japan, progressive vocational education systems have incorporated AR into their curricula, fostering early familiarity and smoother workplace transitions. Akbari et al. (2022) emphasized that this educational alignment contributes to higher AR adoption rates and operational outcomes. Similarly, Scandinavian countries, characterized by flexible work cultures and proactive innovation policies, report more effective and rapid AR deployments. These cases demonstrate the importance of cultural and institutional readiness in technology assimilation.

Conversely, regions with limited technological infrastructure or constrained economic resources face difficulties in adopting AR. In such environments, high initial investment costs, limited access to training, and lower digital literacy rates serve as significant barriers. Tubis & Rohman (2023) argued that without adequate funding and government support, AR implementations in developing countries are likely to falter, despite their theoretical benefits.

Several contextual factors contribute to these disparities. Infrastructure maturity plays a central role; countries with widespread 5G coverage and modern hardware capabilities are better positioned to implement AR systems effectively (Akbari et al., 2022). Furthermore, the availability of trained personnel influences the degree of AR success. In technologically advanced economies, logistics workers are more likely to have the digital competencies required to leverage AR tools efficiently.

Corporate culture and openness to innovation also determine implementation outcomes. In regions where companies emphasize continuous improvement and digital transformation, AR adoption aligns naturally with broader organizational goals. In contrast, risk-averse cultures or industries with rigid hierarchies may resist such change, resulting in slower or incomplete adoption. As Akbari et al. (2022) observed, innovation-driven environments tend to facilitate smoother transitions and higher returns on AR investments.

Government policy and regulatory environments further shape AR adoption trajectories. In several European countries, public funding and policy incentives have spurred technological experimentation in logistics, including AR pilot projects. Where governments provide tax incentives, research grants, or training subsidies, companies are more likely to experiment with and scale new technologies. Without such support mechanisms, the perceived risk of AR investments may deter smaller enterprises from adoption.

Finally, economic status and investment capacity influence AR deployment. High-income regions with active investment ecosystems are more capable of absorbing the financial risk associated with AR. In contrast, budget-constrained organizations in emerging economies often prioritize immediate operational needs over long-term technological investments. These economic considerations must be accounted for when evaluating the global scalability of AR in logistics.

In conclusion, the findings from this narrative review underscore AR's substantial impact on logistics training and operations, especially in enhancing skill acquisition, improving operational efficiency, and supporting data-driven decision-making. However, the effectiveness of AR varies by geographic and organizational context, with adoption shaped by infrastructure readiness, workforce capacity, corporate culture, and policy frameworks. Understanding these factors is essential for designing adaptive and context-sensitive implementation strategies that can maximize AR's benefits across diverse logistics environments.

The findings of this review offer significant insights into the contemporary understanding and application of Augmented Reality (AR) in logistics, both in training and operational contexts. By comparing current studies with earlier research, analyzing systemic factors, and exploring the implications of the results, this discussion aims to unpack the complexity of AR implementation and provide strategic insights for future applications.

Recent literature reveals a marked departure from earlier studies that primarily focused on the theoretical potential of AR in logistics. Earlier works were often descriptive, lacking rigorous empirical validation or operational metrics to assess the true impact of AR technology in real settings (Akbari et al., 2022). In contrast, current research emphasizes data-driven evaluation, focusing on productivity, error reduction, and user satisfaction as critical outcomes. Putz et al. (2022) highlighted not only operational efficiency gains through AR but also the technology's ability to attract younger generations to logistics careers, thereby contributing to workforce renewal. Zhao et al. (2019) underlined that digitalization supported by AR plays a vital role in sustainable logistics management, moving beyond the earlier emphasis on physical infrastructure and traditional inventory control.

This evolution in the literature indicates a more holistic and nuanced understanding of AR's potential. Contemporary research recognizes that AR's success is not merely a function of technical capacity, but is deeply intertwined with social, cultural, and organizational contexts. For example, Leffers et al. (2023) noted that digital readiness and infrastructure maturity significantly influence implementation outcomes, with technologically advanced countries like Germany leading in AR-based operational improvements. Similarly, Putz et al. (2022) and Zhao et al. (2019) emphasized the advantage enjoyed by digital natives in adapting to AR environments, reinforcing the need for targeted training strategies that account for generational learning differences.

Furthermore, current research introduces a critical human-centric dimension to AR adoption. Rather than focusing solely on efficiency gains, recent studies consider cognitive ergonomics and user experience design as essential factors for successful AR implementation. Ho et al. (2023) argued that reducing cognitive overload and enhancing usability are central to sustained engagement with AR systems. This marks a departure from earlier engineering-centric studies that primarily evaluated technological robustness without sufficiently considering end-user interaction. Sousa et al. (2023) further supported this shift by pointing out that worker satisfaction and comfort are closely linked to the long-term viability of AR applications in logistics environments.

Several systemic factors contribute significantly to the variance in AR adoption across regions and organizations. Government policy and regulatory frameworks are central among these factors. Zhao et al. (2019) reported that national strategies supporting digital transformation and offering fiscal incentives can accelerate AR adoption. Countries that implement tax relief, research subsidies, or public-private partnerships tend to witness higher AR penetration in logistics operations. This finding aligns with the observed success in European countries, where public policy has actively supported technological experimentation.

Technological infrastructure is another decisive element. While robust internet connectivity and 5G coverage are prerequisites for effective AR operations, access to compatible hardware and support systems is equally critical. Although some claims about infrastructure impact remain generalized, the correlation between digital maturity and AR efficacy is well supported across the reviewed literature (Akbari et al., 2022). Investment in infrastructure directly correlates with smoother AR deployment and user performance, making it a non-negotiable foundation for AR integration.

Workforce skills also play a pivotal role. Studies have consistently shown that younger workers, with higher digital literacy, adapt more readily to AR platforms. In contrast, older employees often require more structured training to use AR tools effectively (Putz et al., 2022). These findings underscore the importance of continuous professional development programs that are inclusive and address skill disparities across the workforce. Without targeted education initiatives, organizations risk creating divides in productivity and morale.

Organizational culture is another critical factor influencing AR implementation. Environments that foster innovation and are open to change demonstrate more successful AR integration. Putz et al. (2022) noted that companies which position AR as part of a broader strategy for technological modernization experience more seamless transitions. Conversely, resistance within traditional organizational cultures often impedes effective use, delaying or derailing AR projects despite initial investments.

Cost remains a recurring barrier in the literature. While AR promises long-term cost efficiencies, the initial capital outlay for hardware, software, and training is substantial. This challenge is particularly acute for small and medium-sized enterprises (SMEs), which may lack the financial buffers to absorb early-stage investment risks. Although comprehensive economic evaluations of AR systems remain limited, existing studies suggest that demonstrating clear returns on investment is key to wider adoption. Empirical cost-benefit analyses are urgently needed to support decision-making and reduce uncertainty.

From a policy perspective, the implications of these findings are multifaceted. Governments must prioritize digital infrastructure development, especially in regions lagging behind, to ensure equitable access to AR technologies. Zhao et al. (2019) recommended strategic investments in broadband networks and the provision of AR-compatible devices through public-private partnerships. Policy incentives that lower the financial barrier for companies—such as tax credits and innovation grants—can also encourage broader adoption, particularly among SMEs.

Workforce development policies are equally important. Collaboration between government agencies, educational institutions, and private sector stakeholders can facilitate the creation of training programs aligned with AR competencies. As Putz et al. (2022) suggested, integrating AR modules into vocational curricula can prepare future workers for digital logistics environments. Moreover, on-the-job training and lifelong learning initiatives are essential to ensure current employees are not left behind.

Another critical policy concern is data security and privacy. As AR systems rely heavily on real-time data capture and processing, safeguarding this information is imperative. Rosenberger et al. (2023) called for the establishment of clear data governance frameworks to regulate access, storage, and sharing of AR-related data. Without robust protections, privacy concerns could hinder user trust and slow down AR adoption.

Practical strategies for overcoming implementation barriers are also emerging from recent literature. Akbari et al. (2022) advocated for the use of proven AR platforms with demonstrated track records to reduce trial-and-error risks. Vezzani et al. (2024) and Albawaneh et al. (2023) demonstrated that smart glasses and wearable AR interfaces significantly improve order picking accuracy and speed, making them practical entry points for logistics firms. Similarly, pilot programs tailored to local organizational contexts can help identify context-specific constraints and opportunities, enabling gradual and adaptive technology scaling.

The need for standardization is another recurring theme. Tubis & Rohman (2023) emphasized the importance of developing industry-wide AR implementation standards to ensure compatibility, interoperability, and quality assurance. These standards can serve as benchmarks for performance evaluation and streamline procurement decisions, particularly in multi-vendor environments.

Despite these advancements, several limitations persist in the existing body of research. Many studies rely on laboratory simulations or pilot-scale implementations that may not fully capture the complexities of real-world logistics operations. Furthermore, the overrepresentation of high-income countries in the literature introduces a geographical bias, limiting the generalizability of findings to low- and middle-income contexts. Future research should prioritize longitudinal field studies and comparative analyses across diverse economic and cultural settings to build a more inclusive and actionable knowledge base.

There is also a notable gap in interdisciplinary research that bridges technological, behavioral, and policy perspectives. As AR adoption inherently intersects these domains, integrative frameworks are needed to understand how technological innovation can be sustainably embedded within organizational ecosystems. Research that combines human factors engineering, organizational psychology, and public policy analysis will be instrumental in advancing both theory and practice in this evolving field.

CONCLUSION

This narrative review has demonstrated that the implementation of Augmented Reality (AR) in logistics training and operations yields measurable improvements in technical skill acquisition, operational efficiency, and worker satisfaction. AR-based training not only enhances conceptual understanding and practical capabilities but also reduces task completion time and increases user engagement. On the operational side, AR facilitates faster order picking, optimized warehouse navigation, and improved inventory accuracy, leading to a substantial increase in productivity and cost-effectiveness. However, the effectiveness of AR varies significantly depending on systemic factors such as digital infrastructure, workforce skills, organizational culture, and government policy.

The urgency of adopting AR in logistics is underscored by increasing demands for efficiency, real-time responsiveness, and workforce adaptability in a digitized economy. Yet, barriers such as high initial investment costs, technological readiness gaps, and unequal access to training persist. Addressing these requires targeted policy interventions, including investment in digital infrastructure, public-private partnerships for AR development, tax incentives for innovation, and comprehensive workforce training initiatives. Governments must also establish clear data governance frameworks to mitigate privacy concerns and promote user trust.

Future research should prioritize longitudinal field studies in diverse socio-economic contexts to better understand the practical challenges of AR adoption. Interdisciplinary approaches combining technology, behavioral science, and policy studies are essential for developing sustainable implementation strategies. Ultimately, enhancing training effectiveness through AR-based immersive environments remains a central strategy for overcoming current challenges and ensuring competitive advantage in the evolving logistics landscape.

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