The Sustainability of Urban Postal Logistics and the AR Technology

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Abstract

Sustainable urban logistics encompasses a rational movement of goods via various modes of transport, as well as the management of warehouses, warehouse complexes, and delivery networks. Urban postal logistics is becoming gradually more important as the urban population and e-commerce are increasing. Efficient and sustainable delivery management in narrower city cores is important for the alleviation of traffic congestion, air pollution, and carbon emissions. In addition, it plays a crucial role in enabling fast and reliable delivery of goods to end users and companies. Some key challenges in urban logistics include limited room for warehousing and distribution, traffic congestion, pollution, noise, and gradually shorter expected delivery times. To tackle all these challenges, urban logistic solutions can include alternative transportation options, route and delivery optimization, as well as the application of smart technologies and data analysis. AR (augmented reality) has the potential to make postal-logistic operations more efficient, economical, and safer through the use of real-time data, visualization, and remote assistance. On the road to sustainability, the visualization of operations can be especially useful. This allows logistics managers to better understand the flow of goods and make timely decisions. Equally important is the education of personnel through simulations of technological processes or their parts, and remote assistance, which can engage users through an interactive experience and improve customer satisfaction through a 3D representation of goods in their environment.

Keywords*: urban postal logistics, augmented reality, logistic*

1 Introduction

More than 73% of the European population lives in urban environments, and this number is expected to rise to 85% by 2050 [1]. This urbanization phenomenon has resulted in an increasing demand for city transport, both for B2B and B2C purposes.

Consequently, one of the problems operators face is that of more efficient distribution in cities in terms of sustainable mobility policies. As a consequence, the problems facing postal-logistic operators is the question of efficient distribution of goods in cities in the context of sustainable mobility policies.

Accordingly, these operators continually work on innovative delivery methods, from various types of pickup stations to using drones. Unfortunately, customers usually aren't concerned with the delivery method. They put a focus on receiving the ordered article as quickly and cheaply as possible, in perfect condition, at their address.

This attitude can be altered by raising awareness of the importance of innovative methods and their impact on the environment. This can be done through education, awareness campaigns, or financial stimuli.

In [2], urban mobility is defined as sustainable mobility in the socio-economic context of the urban area that can be seen through actions on land use and occupation and on transport management, aiming to provide access to goods and services in an efficient way for all inhabitants, and thus maintaining or improving the quality of

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life of the current population without harming the future generation.

Sustainable urban mobility includes transportation systems and infrastructure designed to minimize negative ecological, social, and economic impacts tied to urban transportation. This includes the promotion of alternative modes of transport for certain distances, such as walking, cycling, and public transit. It also encompasses designing cities and transport networks in a way that will reduce the need for personal vehicles.

Paulraj and Chen in [3] state that the use of information technology in logistics has positively influenced the flexibility, speed of operations, delivery processes, and responsiveness. These are all critical dimensions of effective logistics operations.

2 Applying AR to Urban Mobility

AR is one of the technologies that enable Industry 4.0 [4]. Currently, various devices support AR technology, enabling users to see virtual objects and communicate with them in the real world. They can be divided into three categories: headsets, such as smart glasses, handheld devices, such as smartphones and tablets, and spatial devices, such as projectors.

Augmented reality has the potential to change urban mobility at its core. Various applications of the technology offer users a safer and more efficient movement through the city. They do this by providing relevant and necessary information about their environment in real time.

The simplest way to apply AR technology to urban mobility is during driver training in order to raise awareness about their surroundings and improve safety. With AR headsets, drivers can see virtual information which would help them find their way and avoid potential dangers. For instance, the AR system could display speed limits, traffic jams, road conditions, and other factors that affect driving.

AR provides information about nearby stores, restaurants, and attractions, as well as traffic, weather, and other factors that affect the user's movement.

In public transit, AR provides information on bus and train schedules, delays, and route changes, increasing the efficiency of the service. This would directly reduce the number of personal vehicles on the roads and, consequently, reduce gas emissions and the greenhouse effect. AR applications can provide travelers with information concerning bus and tram schedules, location, and routes to take to get to their destination most efficiently. Additionally, AR can help users navigate complex transit stations and nodes.

One of the most perspective applications of AR in urban mobility is navigation. By overlaying digital and real-world, AR can provide users with detailed directions, points of interest, and more. This way, users don't have to use a map or a GPS device.

Adjusting the use of AR technology to contemporary sustainability conditions in logistics allows for combining multiple modes of transport. Using AR, drivers and passengers can track and exchange information on traffic and travel times. This can further help them choose the best route and mode of transport.

3 Usage of AR by Postal-Logistic Operators

Faced with the many problems that affect their operations in urban environments, operators should have no issue accepting AR technology. That is, the transition to an alternative organizational model for delivery and routing based primarily on AR should be smooth. This model comprises interactions between real-world points or interactive graphic systems that produce an enriched image by overlaying information, including virtual elements, multimedia, or simple data.

The application of AR in postal-logistic systems includes support in tasks that rely on the current approach and a clear insight into relevant information. In [5] analyzing the scientific literature, the main logistic points where AR should be applied include warehouses, transportation, and training.

3.1 Warehouses

There are many aspects of warehouse operations that could be optimized using AR. This includes information on unloading points, the arrangement of goods, or assigned tasks. The AR device could also display the package and the

packaging process. The goal behind all of this is a more efficient use of time and space.

3.2 Transportation

In recent years, the development of e-commerce has significantly increased the number of transportation routes, and it dictates their organization. Logistics providers, regardless of financial gain, must navigate highly complex route organization and management. When the goods are sent, AR can shorten latencies by providing up-to-date, real-time traffic data and information on optimal routes. In case of traffic jams, the AR system enables the visualization of less encumbered routes and directs the driver to the right lane. The advantage of this technology is that the driver can either wear a headset or directly see this information projected on the windshield.

3.3 Education (training)

AR can be widely applied in the training phase, as it enables intuitive learning on how to solve a certain logistics task. In the Logistics 4.0 environment, it is crucial that the employees constantly receive training. That way, they are able to use new technological components and carry out tasks with minimal room for error. AR offers a good solution, providing visual direction in real time and training employees for fieldwork. The entire supply chain, from logistics to warehouse pickup, is explained on the spot, step-by-step, through a practical, interactive guide. AR enables the overlay of useful information on the object the trainees must interact with, thus helping them carry out the tasks.

3.4 Improvements Made Through the Application of AR

As object manipulation in logistics calls for extensive use of one's hands, the most applicable AR category, in this case, is headset devices. Based on [6], the application of these devices would, above all, improve visualization, interaction, benefits for the consumer, and navigation.

3.4.1 Improvements in Visualization

The virtualization of organizational activities necessitates an improvement in the visualization of real-life processes. This is important for a better understanding of the work environment and a faster identification of possible solutions for various logistical problems. AR smart glasses enable increased speed and flexibility compared to existing solutions. This is primarily done through the elimination of unnecessary movements and the minimization of time spent searching for necessary information. The authors in [7] state that, while the operator receives orders, AR glasses display certain information. This information reduces the time necessary for the task by eliminating excessive movements of the head and body. One example of an application is when the barcode reader makes it difficult to handle bulky goods with both hands. Here, using AR technology ensures that the operator's hands are completely free, allowing them to pick up objects more comfortably (DHL). In addition, in [8] the application of smart glasses in the search for specific articles on shelves has increased flexibility and reduced response. There are well-known examples demonstrating that smart glasses ensure safe and efficient task completion in the workplace. They also provide a larger amount of data that prevents accidents during activities and movements (Epson's Moverio BT-350 ANSI Edition, designed for industrial applications, has built-in safety features that warn workers of hazardous conditions). Thus, the visualization enabled by smart glasses leads to higher control and sustainability in logistics and the SCM environment. It also increases workplace safety and efficiency.

3.4.2 Improvements in Interaction

Improved interaction of modern business operations (Industry 4.0) includes sophisticated production and warehouse environments that are interoperable and can communicate with people, machines, and products [9]. Smart glasses can provide real-time notifications of upcoming maintenance tasks. Schneider Electric utilizes smart glasses to give technicians real-time access to maintenance data and schedules, ensuring proper upkeep of equipment.

AR, above all, brings the ability to interact with objects in real time. Modern displays, including smart glasses, have the ability to improve the interaction between people and their environment. This increases human perception while completing tasks. A good example of this is Google Glass, which allows employees to take

photographs and videos by using the touchscreen or voice commands.

One of the improvements to interaction is the drowsiness and fatigue detection system based on wearable smart glasses designed to improve road safety. The suggested system in [10] can survey the driver's status in terms of drowsiness and fatigue in real time. It does this using a miniature infrared (IR) sensory transceiver attached to the glasses. The transceiver continuously scans the driver's eyelids for signs of fatigue and warns them. This system helps the user avoid dangerous situations by providing detailed information in real time related to the risk of fatigue. Besides the abovementioned improvements in visualization, smart glasses can reduce errors and speed up logistical processes through a dynamic information flow and interactive communication.

3.4.3 Benefits for the Consumer

Academic literature often notes simplicity of use as the main benefit for the consumer. This is one of the widely-used parameters for determining the degree of adoption of this technology. AR technology in logistics should be as efficient and comfortable as possible. Unlike tablets and smartphones, which can distract the user, [11] reported that smart glasses display information in a hands-free mode. This allows the user to safely carry out other tasks. This functionality makes smart glasses more practical and varied than traditional mobile devices and portable screens. With hands-free access to computer-generated content, such as routing information, employees can avoid having to carry hand-held scanners or paperwork as shown in [12].

3.4.4. Improvements in Navigation

The application of sophisticated navigation tools is in accordance with the new concepts of Industry 4.0. With the advances of VR and AR, shown in [13], smart glasses are making navigation in various logistical settings easier. They constantly provide employees and operators with information regarding their environment to enable easier navigation with optimal routes. AR navigation proposed for cars allows the user to be free from additional information sources. This is achieved by embedding the operating equipment into the user's environment, that is, the vehicle.

Precise positioning for navigation in closed spaces and the ability of smart glasses to precisely determine locations are suitable for logistical environments. Smart glasses can be applied to order commissioning and warehouse pickup, even in larger warehouses and factories. Navigation through smart glasses, thus, has the potential to be more efficient than using conventional practices of order pickups. Given that orders can contain various products in various amounts, according to [14] the AR technology can provide operators with a reduction in cognitive load with real-time information in an industrial environment.

Smart glasses are paving the way for more intelligent navigational mechanisms with timely directions, improved navigation, and more precise localization. Rejeb et al. [6] indicate that they represent the next generation of navigation assistants, as they increase the area of view and support dynamical situational awareness. This leaves more space for multitasking, positioning, and orientation.

There are some deficiencies that have thus far been identified through technical challenges. This includes a limited field of vision, problematic lighting, hardware limitations, device weight, heat generation, and other design-related issues. Organizational challenges are a result of a different kind of problems. This includes user inexperience, resistance to new technologies, privacy and budget considerations, and the necessary changes to the existing infrastructure. Ergonomic challenges include, for example, making smart glasses compatible with regular glasses or balancing the weight of the device.

3.5 Conclusion

AR brings numerous benefits and improvements to the area of logistics owing to the cognitive support for employees. It provides the right information at the right time and through the right medium. This reduces issues with high expenses, errors, low efficiency, and extensive use of paper in the process of warehouse management. Similarly, high expenses, long waiting times, and poor coordination in transportation management can be alleviated by improving safety and support for operators and reducing latencies.

Clearly, the use of AR in urban mobility can make life in cities more convenient, efficient, and pleasant. However, this requires simple, user-

friendly AR technologies and their integration into the existing urban infrastructure and transportation systems.

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