Account Based Ticketing (ABT) Integration for Seamless Multi-Modal Transport Systems in Smart Cities

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Abstract

The digital transformation of urban transportation systems remains a critical challenge in Smart Cities' development. This paper addresses the pervasive issue of inadequate digitalization within public transportation systems. The paper highlights the promise of Account Based Ticketing (ABT) as a pivotal solution for integrating diverse public and private transportation modes allowing users to access different transportation services with a single account, without the need for new physical tickets or cards. ABT approach represents a breakthrough in seamlessly amalgamating various transportation operators' systems, transcending city limits into broader metropolitan spheres, and fostering integration and interoperability across transportation modes operated by disparate entities. Emphasizing beyond-city-scale integration, it explores the potential value of ABT to connect transportation networks extending into metropolitan influences. The proposed approach involves analyzing the implementation and functionality of ABT systems, underlining their capacity to overcome existing barriers in multi-modal transportation. The results anticipate enhanced accessibility, increased ridership, and streamlined user experiences, contributing to the realization of efficient and interconnected urban transport networks. This study not only underscores the value of ABT in revolutionizing contemporary transportation systems but also examines its broader implications for future urban planning and smart city development, highlighting the transformative potential and essential role that ABT plays in shaping the future of integrated transportation and Mobility as a Service in Smart Cities.

Keywords: Urban Mobility, MaaS, Intermodal, Account based System.

1. Introduction

Urban mobility emerges as a fundamental pillar in the configuration of liveable, sustainable and dynamic environments in contemporary cities. In an ever-changing world, urban dynamics face significant challenges in different areas of management, including urban mobility in all its aspects, from traffic congestion management, through derived pollution and its mitigation to the unequal distribution of transport services throughout the city. In this context, mobility becomes a key element that shapes the quality of life, social equity, public health and economic development of urban areas [1].

The paradigm of sustainable urban mobility emerges as an imperative response to the problems that afflict modern cities. The concept goes beyond simply managing the flow of people and goods; It involves redefining infrastructure, rethinking transport models and promoting practices that minimise environmental impact. This transformation towards a sustainable urban mobility system is not only a desirable option, but also an urgent necessity to ensure resilient and liveable cities for future generations.

Throughout this paper, we explore in detail the critical importance of sustainable urban mobility in which public transport must play a leading role in the transition to a sustainable

urban mobility model and where we will analyse in a multidimensional way the current challenges it faces, innovative strategies to improve its provision and best practices in the field of urban mobility to drive positive and sustainable change in our cities towards more sustainable and smart cities.

2. The digitalisation of transport systems

As the world moves towards an increasingly interconnected era, the integration of digitalization into urban transport systems is proving to be a crucial component for efficiency, safety and sustainability. Technological advances offer significant opportunities to radically transform mobility in urban environments, enabling smarter and more adaptable management of traffic flows, route optimization, and improved user experience.

However, despite advances in technology, transportation systems in most cities have yet to reach their full digital potential. Challenges remain related to the interoperability of systems, the collection and analysis of real-time data, as well as the implementation of connected infrastructures in a comprehensive manner. This gap between technological potential and current reality limits the ability of urban transport systems to adapt to the changing needs of urban communities and to effectively address issues such as congestion, pollution, and accessibility.

In this context, it is essential to explore how digitalisation can be harnessed more effectively in urban transport systems, identifying barriers and proposing innovative solutions to achieve a transition towards more integrated, efficient and sustainable systems [2]. This critical analysis is essential to drive the evolution towards smart and connected cities, where urban mobility is not only efficient, but also inclusive and environmentally friendly.

2.1. Impact, Areas for Improvement and Challenges in the Digitalization of Urban Transport Systems

In the following sections, we will examine in detail the impact of digitalization on urban transport systems, identifying key areas for improvement, remaining challenges, and strategies to achieve a more complete and effective implementation of digital solutions in urban mobility.

2.1.1. Impact

Digitalization in urban transport systems promises a number of significant impacts. The implementation of sensors, IoT (Internet of Things) devices, and real-time data analytics platforms enables more accurate and adaptable traffic management, reducing congestion and improving fluidity in cities. In addition, the integration of advanced technologies in public transport can improve operational efficiency, increase user satisfaction and promote more sustainable modes of mobility.

2.1.2. Areas for Improvement and Remaining Challenges

However, there are still critical areas that require specific attention to enhance digitalization in urban transport systems. Interoperability between different systems and service providers is a key challenge, as the lack of common standards hinders the effective

integration of digital solutions. In addition, cybersecurity is emerging as a growing concern, as increased connectivity exposes these systems to vulnerability risks and malicious attacks.

Addressing these challenges requires innovative strategies and solutions. The establishment of interoperability standards and protocols, together with collaboration between the public and private sectors, can facilitate the integration of digital technologies into transport systems. In addition, investing in robust cybersecurity measures and designing resilient infrastructures are essential to ensure that systems are protected from potential threats [3].

In summary, digitalization offers transformative potential in urban transport systems, but its full implementation faces significant challenges. Detailed analysis of these challenges, along with identifying effective strategies, is crucial to drive the transition to smarter, more efficient and sustainable urban mobility systems.

In the following sections, we will delve into each of these points, exploring in detail innovative strategies and practical solutions to overcome the existing challenges in the digitalization of urban transport systems.

2.2. Urban Mobility and the crucial role of ABT Systems

Urban mobility faces a number of multifaceted challenges, already described in previous sections. In addition to this complexity, there are others derived from integration, such as payment systems in public transport, with fragmented systems and obsolete payment methods that hinder the user experience and operational efficiency.

Digitalization is revealed as a key process to address these challenges. In this context, Account Based Ticketing (ABT) systems emerge as an innovative and promising solution. These systems allow users to make transportation payments without the need to possess a physical ticket, instead using smart cards, mobile devices, or other forms of digital identification.

2.2.1 ABT as a Solution Proposal

ABT systems play a crucial role in the transformation towards smarter and more efficient urban mobility. By simplifying access to public transport, encouraging intermodality, and providing accurate data on travel patterns, these systems pave the way for mobility that is more sustainable and adapted to the changing needs of urban communities. Account Based Ticketing (ABT) systems offer a number of substantial benefits in urban mobility. They simplify the checkout process by eliminating the need for physical tickets, allowing users to use smart cards, mobile devices, or even their credit cards to access public transportation [4]. In addition, they facilitate integration between different modes of transport, giving users the ability to access integrated fares and optimize their trips.

ABT systems not only simplify the payment process, but also offer greater flexibility by allowing users to use different modes of transport and access integrated fares using a single

account. In addition, the data generated by these systems allows for a better understanding of travel patterns, making it easier to plan and optimize transportation infrastructure.

Despite its benefits, the implementation of ABT systems faces challenges of its own. Interoperability between different transport providers and payment systems, as well as protecting the privacy and security of user data, are important concerns that need to be addressed to ensure the success and acceptance of these systems.

Therefore, ABT systems represent a solid proposal to address the challenges in urban mobility through digitalization. By simplifying payment and encouraging integration between different modes of transport, these systems offer a path to smoother, more convenient and sustainable mobility. However, its effective implementation requires solving technical, regulatory, and security challenges that still persist in the current landscape.

2.2.2. Benefits, Risks and Strategies for Implementing ABT Systems

Successful implementation of ABT systems faces significant challenges. Interoperability between different transport and payment systems is essential to ensure a smooth experience for users. Likewise, protecting the privacy and security of personal data associated with payments and travel patterns is a critical concern that must be effectively addressed.

To successfully implement ABT systems in urban environments, it is crucial to adopt specific strategies. This includes establishing interoperability standards between transport operators and payment systems, enabling seamless integration [5].

Similarly, highlighting the advantages of an ABT system on territorial cohesion is crucial, as this system facilitates the integration of different transport systems operated separately, even by different actors, into a single unified platform [6]. In this sense, the following fundamental advantages can be defined:

- Integration and Simplification of Transportation Access: A unified ABT system allows users to seamlessly access multiple modes of transportation, regardless of region or operator. This greatly simplifies the travel experience, as users can use a single account or card to access different transportation services, eliminating the need for multiple region-specific tickets or cards.
- Interoperability and Convenience for Travelers: Integrating different transportation systems into an ABT system offers users the convenience of being able to switch between different modes of transportation, such as buses, trains, trams, bike shares, etc., without having to worry about making separate payments or having different cards for each operator.
- Territorial Cohesion and Connectivity between Regions: By unifying transport systems from different regions into a single payment system, territorial cohesion is fostered and greater connectivity between geographical areas is promoted. This facilitates cross-border travel or between urban and rural areas, promoting smoother and seamless mobility.

- Promoting Sustainable Mobility: The integration of different transport services into an ABT system can drive the adoption of more sustainable modes of transport. By providing a unified and convenient solution, greener mobility options such as public transport and bike sharing can be incentivized, thus contributing to the reduction of traffic and pollution.
- Increased Operational Efficiency: For transport operators, adopting a unified ABT system can lead to greater operational efficiency. Consolidating payment systems and standardizing processes reduces the administrative complexity and costs associated with managing different payment systems.

Overall, the successful implementation of ABT systems represents a significant step towards improving urban mobility and plays a crucial role in territorial cohesion by integrating transport systems from different regions and operators into a common platform. Not only does this benefit users by offering a more convenient travel experience, but it also promotes greater connectivity between areas, encourages sustainable mobility, and improves operational efficiency for transportation providers. By harnessing the benefits of digitalisation in public transport and addressing existing challenges, these systems are positioned as a central element in the evolution towards more connected, efficient, smart and sustainable cities.

2.3. The analysis of key data in the use of ABT systems

Data analytics plays a crucial role in harnessing the information generated by ABT systems in urban mobility. Here are some areas where data analytics is critical:

- Optimization of Transport Services: Data analytics from ABT systems allows public transport authorities and companies to identify travel patterns, congestion points, peak demand times and user preferences. This information is essential to optimize routes, service frequencies and vehicle capacities, improving the efficiency and quality of transport.
- Personalization of Travel Experiences: By analyzing detailed data from users' trips, ABT platforms can personalize recommendations and offers, tailoring them to users' individual needs. Data analytics allow for a better understanding of travel preferences, resulting in more tailored and relevant services for each user.
- Data-Driven Decision Making: Data analytics provides valuable insights for strategic decision-making in public transportation. The data generated by ABTs provides a comprehensive view of transport demand, helping authorities plan investments, design policies and improve infrastructure in a more accurate and informed manner [7].
- Continuous Improvement and Adaptability: Data analytics facilitates continuous feedback and iterative improvement of transportation services. By constantly monitoring and analyzing ABT data, companies and authorities can adapt and improve services in real time, responding nimbly to changing user needs and environmental conditions.
- Identifying Trends and Predictions: Advanced analytics applied to ABT data allows you to identify long-term trends and predict future mobility patterns. This is essential

for anticipating demand, planning the capacity of transport services and making future-oriented strategic decisions.

Data analytics in the context of ABT systems not only allows us to understand user behavior and the efficiency of services, but also opens up opportunities for continuous improvement, personalization of services and more informed decision-making in the field of urban mobility. It is a valuable resource for optimising and transforming the travel experience and the management of public transport in cities.

2.4. MaaS as a reference point on the horizon

MaaS (Mobility as a Service) is a revolutionary approach to the delivery of mobility services that integrates various modes of transportation, such as public transportation, ride-sharing services, bike and scooter rentals, taxi services, and more, into a single digital platform. This model seeks to provide users with a comprehensive and seamless mobility experience, allowing them to plan, book, and pay for different transportation services using a single app or platform [8].

MaaS and ABT complement each other perfectly in the digital transformation of urban mobility. MaaS focuses on the integration and accessibility of different transport options, while ABT simplifies and unifies the payment process for users accessing those services [9].

The combination of both systems generates improvements in several areas:
- Improved User Experience: The combination of MaaS and ABT offers users a smoother and more convenient mobility experience. Travelers can plan and access different modes of transportation from a single platform and pay for them without the need for multiple cards or apps.
- Mobility Services Integration: ABT facilitates the integration of mobility services into a MaaS platform. Users can seamlessly switch between different transport services, and the ABT system ensures a unified and transparent payment process, regardless of the mode of transport used.
- Data for Service Improvement: The combination of these systems provides valuable data on users' travel patterns and preferences. This data can be used to optimize the supply of transport services, improve urban planning and provide a more personalized experience to users.

In this way, it can be said that the integration of a MaaS system with an ABT strategy in the digitalization of urban mobility offers a holistic solution that simplifies access to and payment for different transport services, improves the user experience and provides valuable data for decision-making in urban mobility planning.

2.5. DataSpace as a response to the digitalization and interoperability of data

Finally, it is important to point out DataSpaces as the latest trend that plays a fundamental role in the digitalization of public transport by working together with ABT (Account Based Ticketing) and MaaS (Mobility as a Service) systems. A DataSpace, broadly speaking,

refs to a secure environment where data can be shared in a controlled and secure manner between different entities [10].

The advantage of relying on DataSpaces to solve data interoperability allows us to improve in several areas:

- Data Integration into Public Transportation Systems: DataSpaces allow the collection and aggregation of data from multiple sources in public transportation, including trip data, user preferences, mobility patterns, traffic conditions, among others. This information becomes valuable inputs for analyzing and better understanding user behaviors and mobility needs in a specific city or region. In the same way, it allows the optimization of services. By combining data from different transport services (both public and private) into a DataSpace, broader insights into the availability, use and efficiency of mobility services can be obtained. This allows for better planning and optimization of routes and schedules, as well as the identification of areas where improvements or new services are needed.
- Improved User Experience: DataSpaces, by allowing access to and analysis of large data sets, facilitate the personalization of transport services for users. This involves offering more accurate recommendations and solutions tailored to travelers' individual preferences, which can significantly improve their mobility experience.
- Data Security and Privacy: DataSpaces are designed to ensure data security and privacy, allowing multiple actors to share information in a controlled and protected manner. This is especially crucial when it comes to sensitive data related to travel patterns and user preferences on public transport.
- Driving Innovation and Development of New Services: DataSpaces foster innovation by allowing companies, developers, and public entities to access data to create and develop new mobility services and solutions. This can drive the emergence of more advanced apps and platforms that further enhance the user experience on public transport.

The integration of DataSpaces with ABT systems and MaaS platforms enhances the ability to collect, share, and use data to improve operational efficiency, service planning, and user experience in public transportation. This is essential in the digital transformation of urban mobility, allowing smarter management adapted to the needs of communities.

3. Summary
The digitalisation of public transport has become a vital component for the evolution of urban mobility. In this scenario, Account Based Ticketing (ABT) systems emerge as the most complete solution to address the current complexities and demands in the field of transportation.

ABT systems play a crucial role in integrating different modes of transport, operated by multiple agents and in various regions, into a unified payment platform. This integration not only simplifies user access and experience, but also fosters territorial cohesion by enabling seamless interconnection between geographical areas and promoting more sustainable mobility.

Similarly, ABT systems stand as the centerpiece for future strategies in the field of transport. In the context of Mobility as a Service (MaaS), ABTs enable seamless integration of mobility services, offering users access to different modes of transport from a single platform. In addition, ABTs are perfectly aligned with DataSpaces, as the collection and analysis of data from ABT systems provide valuable information for decision-making, strategic planning and the continuous improvement of urban mobility.

In conclusion, the digitalization of public transport through ABT systems represents a significant milestone towards smarter, more unified and sustainable mobility. These systems not only meet the current needs of transport users and operators, but also establish themselves as the fundamental basis for future strategies, such as MaaS and DataSpaces, in the evolution towards a more efficient and cohesive transport system.

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