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Integration of Public Transport Systems for Enhanced Passenger Mobility: A Systematic Review

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ABSTRACT

Airports serve as critical nodes for tourist ingress within nations and cities; yet, the efficacy of public transportation systems connecting these gateways to final destinations remains suboptimal. This systematic literature review interrogates public transport integration systems (PTIS) to elucidate determinants of their efficacy and to explore their capacity as a service that enhances passenger mobility. An analysis of the extant literature indicates that the success of PTIS is contingent upon an array of factors that collectively influence the physical, operational, and institutional quality of transport integration. It has been identified that governmental entities play a pivotal role in provisioning reliable transport amenities, with an emphasis on infrastructure and operations predicated on integration to augment passenger mobility, diminish expenses, and curtail transfer durations. Nonetheless, the enactment of collaborative measures between regulatory bodies and service providers in the PTIS domain emerges as a formidable challenge, given its intrinsic linkage to business operations, revenue allocation, promotional strategies, and fiscal policies regarding subsidies.

1. INTRODUCTION

Airport accessibility is a critical determinant for the utilization of connecting transportation modalities, influenced by factors such as distance, time, and cost [1, 2]. Enhanced accessibility is imperative for air travelers, ensuring timely arrivals and preventing economic losses [3]. It has been observed that road infrastructure near airports has undergone significant improvements, with some airports benefiting from proximity to toll roads, thereby facilitating more efficient and rapid access. Concurrently, advancements have been made in public transportation services to and from airports, encompassing buses and trains. Additionally, taxi and ridesharing services have proliferated across various cities, offering passengers alternative means to reach airports with greater convenience and swiftness.

The choice of public transport by air passengers is heavily influenced by the airport's distance from the city center [4, 5]. This distance exhibits considerable variability, with some airports situated mere kilometers from city centers, while others are significantly more remote. A study drawing on Euromonitor data from 2014 indicates that, within the top 100 tourist cities (spanning seven regions), the average travel distance from the airport to the city center stands at 20 km for half of these cities, ranging from a minimum of 2.5 km to a maximum of 194 km, as depicted in Figure 1. However, such measurements do not encompass the total travel distance to specific tourist destinations, underscoring the need for an integrated transportation connectivity system. Transportation connectivity, defined as the linkages among diverse modes of transportation within a region [6], is pivotal for enhancing the efficiency and effectiveness of people and goods movement, thereby catalyzing regional economic advancement [7].

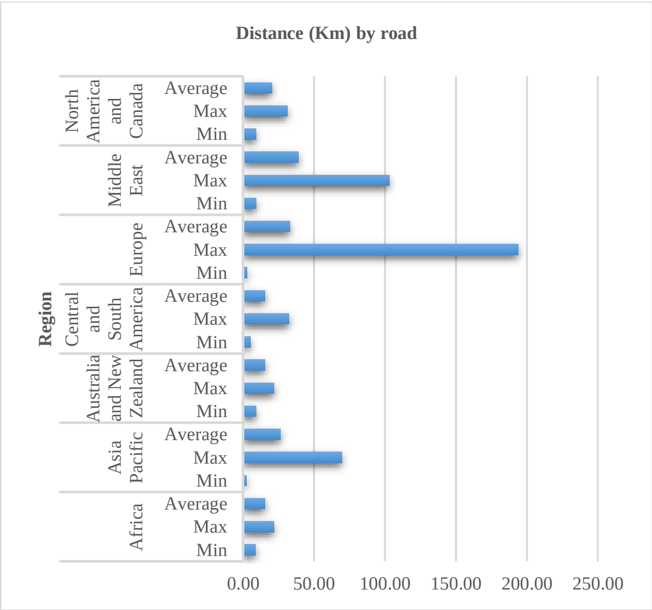

Figure 1. Distance of airport from city center

Furthermore, transportation connectivity transcends the mere integration of facilities and infrastructure. In an age marked by technological advancement, connectivity is increasingly associated with technological integration, encompassing aspects such as payment systems and scheduling applications [8]. The application of technology is posited to expedite service delivery to the public and passengers. According to Allard and Moura [9], transportation integration systems can be realized through various approaches, including the integration of tariffs, schedules, information, networks, and institutional frameworks.

Airport rail services often focus narrowly on facilitating transfer points, while a comprehensive integration of fares, tickets, and schedules remains to be established. Airplane passengers utilizing airport trains typically find their travel confined to intercity connections. Upon reaching the city center, a subsequent mode of travel is required to arrive at their final destination, highlighting a discontinuity in the public transport integration system (PTIS) from airports to urban locales. Hence, there is a pressing need for advanced public transportation options to bridge the service gap within PTIS.

The extension of PTIS must transcend airport and train station precincts to encompass urban transport networks. As indicated by research [10], addressing these integration challenges necessitates a collaborative approach among multiple stakeholders, including transportation authorities, service providers, and local governments. The employment of surveys or the collation of traveler feedback is instrumental in pinpointing specific areas of concern, thus enabling the refinement of solutions that effectively address user needs.

Currently, a systematic literature review expressly addressing these integration issues within the PTIS framework has not been conducted. As illustrated in Figure 2, the travel patterns of airplane passengers from origin to destination necessitate examination.

The problem identified herein pertains to the inefficacy of PTIS in bridging inter-city to urban transit for air travelers, compounded by a lack of regulatory benchmarks to assess service provision within PTIS. The research objective is to discern the factors that influence the effective enactment of PTIS and to evaluate its potential as a service facilitating passenger mobility.

This research endeavors to provide an academic foundation for the formulation of scientific perspectives on PTIS implementation. Additionally, it strives to contribute insights to government bodies and stakeholders, advocating for the inclusion of public transport operators in the provision of integrated transportation services. The anticipated outcomes of this endeavor are multifaceted, encompassing reduced waiting times, alleviation of congestion, improvements in air quality, heightened safety, and enhanced passenger comfort.

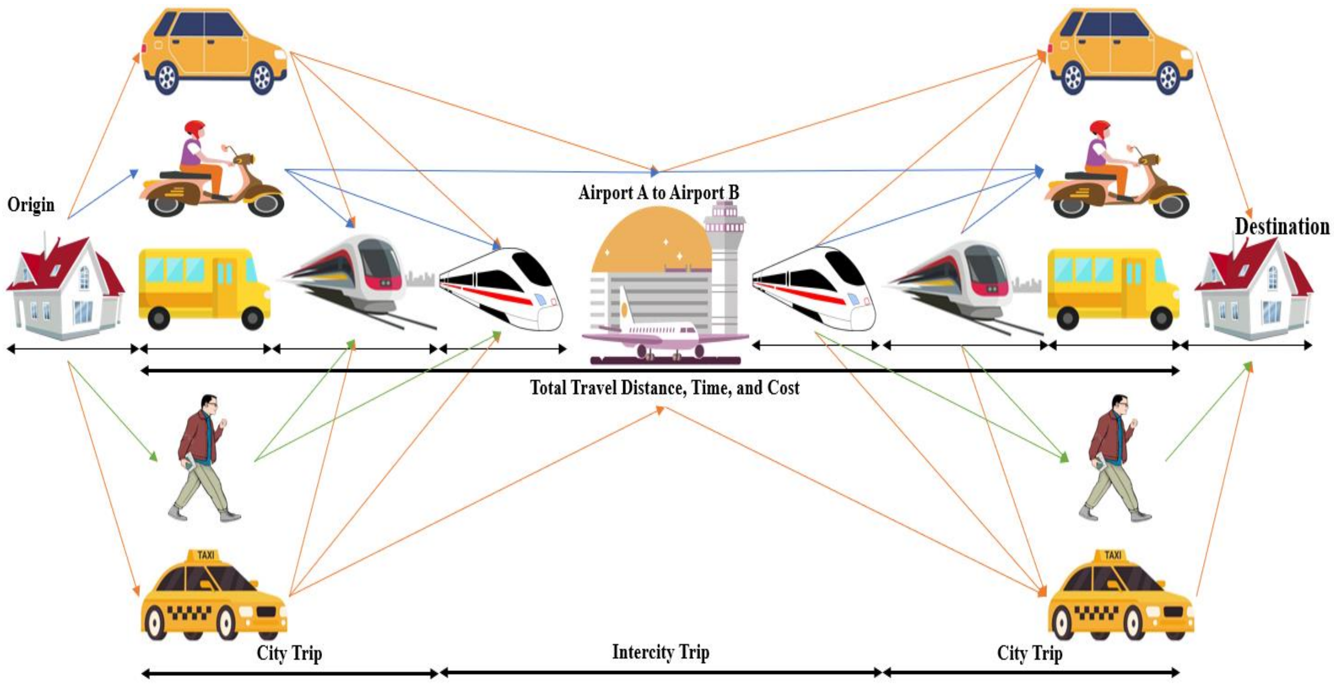

Figure 2. Travel pattern of airplane passengers

2. METHOD

A literature review on the public transport integration system (PTIS) was conducted, focusing on articles published in scientific journals and conference proceedings, and identified through a systematic search in Scopus. The keyword used in finding the suitability of research topics in journal publications is "passengers AND integration AND transportation". These keywords were chosen because they describe the conditions of this research to determine the development of research in providing integrated public transport service to passengers. The documents found in the initial search stages were 1,173 articles (downloaded October 3, 2023).

In research, inclusion and exclusion criteria are crucial in article screening, especially in systematic reviews and meta-analyses. These criteria define the characteristics of studies to be included or excluded from analysis, ensuring a comprehensive and accurate analysis [11]. In this research, four limits are used as subject areas, namely language (english), source type (journal and conference proceeding), document type (article and conference paper), and research subject area (engineering), database search results can be seen in Table 1. This was chosen to enhance comprehension of article in terms of language, scientific field, and the quality of articles that have gone through the review process and have been published.

This study analysed bibliographic descriptions of 536 Scopus-indexed publications, including author's, names, title, publication dates, and affiliations. Biblioshiny, a shiny software, was utilized to generate maps and graphs detailing summary statistics such as publication number, type, and distributions by country, journal, and author. Biblionhiny is a valuable resource for providing current scientific developments and aiding in the analysis of research objectives. Additionally, according to the study [11], science mapping analysis can aid in bibliometric analysis, identifying critical research areas, offering insights into emerging technologies, and highlighting areas requiring further investigation. The program can create a conceptual map, trend topic graph, and map of the most active geographic regions in this field.

Table 1. Database search results

Database	Records after the Initial Search	Records after Applying Field Restrictions
Scopus	1,173	Limited to subject areas: 1. Language: English, reduced to 1,068 articles 2. Source type: Journal and Conference proceeding, reduced to 917 articles 3. Document type: Article and Conference paper, reduced to 875 articles 4. Subject area: Engineering, reduced to 536 articles

The study analysed 536 articles on transport integration systems, including public transport, urban transport, multimodal transport, intelligent systems, integrated optimalization, artificial intelligence, and sustainable development, obtained from the results of science mapping analysis. This is very helpful in further analysis to answer research objectives specifically for the implementation of PTIS services.

3. RESULT

3.1 Trends in literature

Based on 536 selected article, then analyzed using VOS viewer. The study analyzed keywords in research publications from 1952 to October 2023 to identify recent trends, current focuses, and future development directions. A co-word map was created using the VOS viewer with a threshold co-occurrence. The terms forming each cluster were combined to identify literature-based themes. Figure 3 displays four cluster of keywords derived from cross correlating the articles' primary keywords. The links within the same cluster are stronger than those between distinct clusters, as shown in Table 2. The clusters are closely related and can be categorized based on their subject matter. The first cluster (purple lines and nodes) mainly focuses on the Integration causes, such as urban transportation, railroad transportation, air transportation, bus transportation, travel behaviour, travel time, and travel demand. The second cluster (green lines and nodes) explores various Railroad Transportation, including data integration, information management, and intelligent systems. The third cluster (yellow lines and nodes) corresponds mainly to Urban Transportation, such as scheduling, sustainability, passenger transportation, rapid transit, and transport infrastructure. The last cluster (red lines and nodes) includes Public Transport, including mobility, transport planning, mass transportation, and transportation routes.

The PTIS research area, which has recently emerged and is expanding, is characterized by the emergence of topic clusters providing more specific information in each period. Figure 4 shows topic clusters primarily referring to PTIS during the third, fourth, and fifth periods, including integration, passenger flows, public transportation, and travel demand. Integration emerged first as an independent theme in the third period, followed by transportation system. The research in transportation integration systems has been extensive indicating that integration and transportation systems are the two central research areas for transportation integration systems.

Figure 5 shows the trend topics of research from 1952 to 2023. Currently, the trending topic of research related to PTIS is the pattern of air mobility. The development of this research is based on previous research topics related to the activities of aircraft passengers' travel routes to the airport. Airplane passengers are faced with the problem of travel time and the choice of transportation modes based on public transportation and the use of private vehicles. The airport's location is also a determining factor for airplane passengers in choosing the mode. The train that connects urban trips to the airport is one of the modes of interest for airplane passengers. Research themes related to integration have colored the scientific repertoire in transportation system services so that the development of research topics in carrying out PTIS for airplane passengers needs to be studied further in supporting the mobility of airplane passengers.

The study analyzed the origins of scientific work based on the author's affiliation countries, as depicted in Figure 6, finding that China and the United States of America (USA) produced the most scientific articles on PTIS, with many of these publications resulting from collaborations.

Table 2. Four keyword cluster from 536 publication

No.	Cluster	Keyword
1	Integration (purple)	Urban Transportation Railroad Transportation Air Transportation Bus Transportation Travel Behaviour Travel Time Travel Demand
2	Railroad Transportation (green)	Data Integration Information Management Intelligent Systems
3	Urban Transportation (yellow)	Scheduling Sustainability Passenger Transportation Rapid Transit Transport Infrastructure
4	Public Transport (red)	Mobility Transport Planning Mass Transportation Transportation Routes

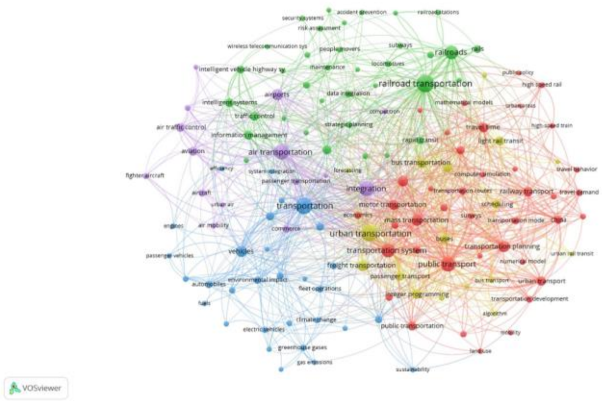

Figure 3. Network visualization keyword co-occurrence

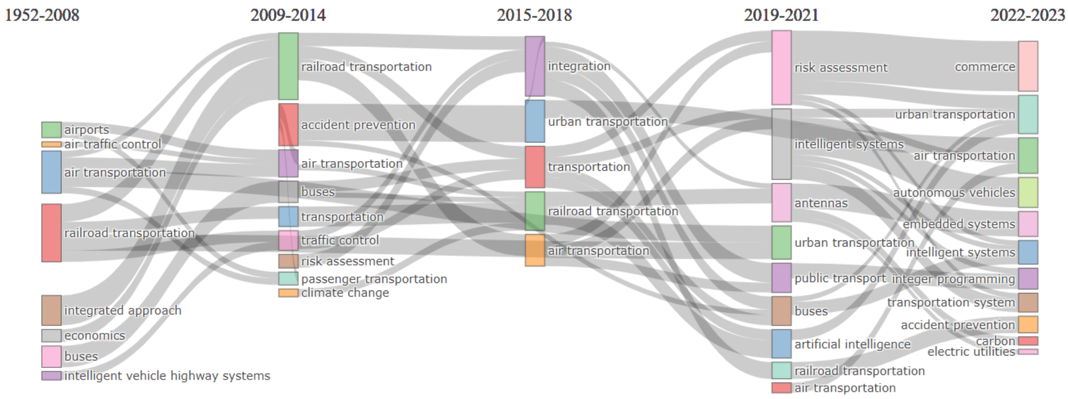

Figure 4. Thematic evolution

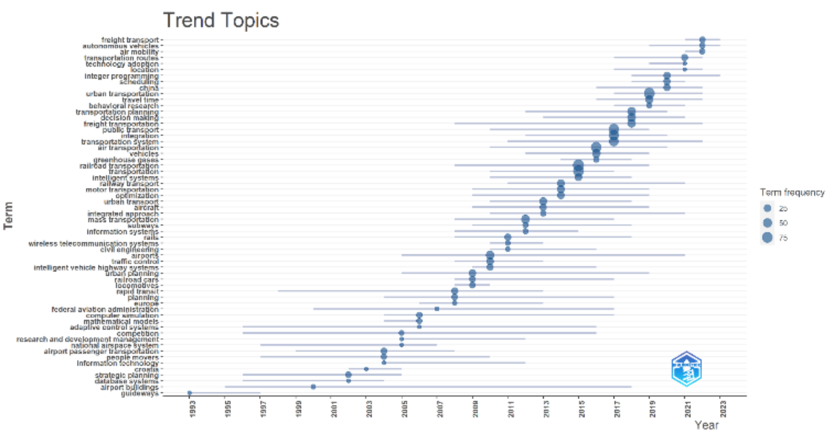

Figure 5. Trend topics

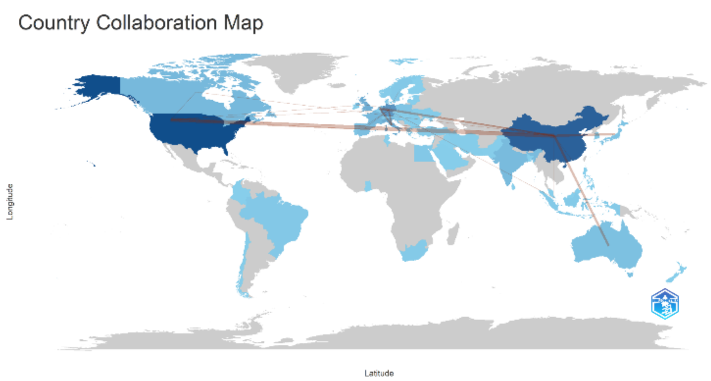

Figure 6. Countries' collaboration world map

3.2 The public transport integration system concept

The public transportation integration system (PTIS) refers to the coordination and seamless operations of various modes of public transportation within a city or region. The goal is to create a unified, efficient, and user-friendly transit network that allows passengers to switch between different modes of public transport without hassle. Three concepts are needed to achieve this goal: combining transport connectivity, transport integration, and providing passengers mobility service.

3.2.1 Transport connectivity

Connectivity is a measure of a passenger's ability to use multiple transit systems for a single trip, used to quantify and evaluate transit efficiency [12]. Transport Connectivity represents the effectiveness of the transport network (irrespective of mode) at getting people from one location to another study [13]. Connectivity enhances transit ridership and retention by reducing travel times, providing reliable connections, simplifying payment, and ensuring safe and easy transfers. Poor connectivity can negatively impact user service quality and make transit unattractive for new customers [6, 7, 14].

The performance of a combination of multiple transit stops through which passengers change their mode of transportation is significantly influenced by the connectivity of transfer centers [12]. A transport network refers to a network of permanent tracks or schedule services, such as roads, rail, and canals, that facilitate mobility and can be extended to cover various types of links, with its relevance being linked to its connectivity. According to the study [15] connectivity refers to the ability of a node to connect with other nodes directly or indirectly. It is derived from graph theory, which examines the arrangement of nodes and links in networks. Connectivity is relative, as nodes have varying levels of connectivity relative to other nodes. Transportation and trade connectivity typically focuses on fundamental nodes like ports and airports, and the carrier service between them.

3.2.2 Transport integration

Integration in transport aims to enhance mobility and accessibility for individuals and goods by connecting different modes of transportation, infrastructure, and services, thereby facilitating smooth and efficient transportation of goods and people between different locations.

Transport integration involves technical, economic, organizational, policy, and informational concepts and solutions that ensure continuous travel from door to door. It connects different transportation modes in a specific system, facilitating passengers/good transfer and ensuring safe, smooth, and efficient flow of passengers/goods from origin to destination [16].

The term "transport integration" utilized in various publication in various contexts. Several researchers who conducted an in-depth study related to the implementation of the transportation integration system explained that the connectedness concept is part of the transport integration concept in the form of physical integration, institutional integration, service and operational integration, and fare integration [17]. Transport integration is realized as physical, operating and managerial, which mainly states the integration in 3 fields: Transport Integration, Organizational-Economic Integration, and Tariff Integration [18]. Transportation integration encompasses various forms such as public and private transportation, policy integration, spatial integration, infrastructure integration, organizational integration, economic integration, and informational integration, aimed at enhancing efficiency, promoting economic growth, and enhancing overall transportation systems [16]. Intermodal integration aims to coordinate and promote smooth, convenient service of high quality, and organizational, operational, and physical integration must be achieved [19].

According to the study [9], the implementation of the transportation integration system can be done in several ways, including (i) tariff integration, which refers to the use of a single ticket that can be used to pay for various types of transportation in one integrated system, can increase the ease of access and use of vehicles, and reduce user costs; (ii) schedule integration involves schedule coordination between various types of transportation so that users can easily switch from one mode to another without waiting too long; (iii) information integration involves providing integrated transportation information, such as online transportation applications or transportation information centers so that users can easily find schedules, routes, and ticket prices for various types of transportation; (iv) network integration, which involves the connection between various modes of transportation through an integrated network, can increase the availability of vehicles and allow users to choose the most efficient routes; (v) institutional integration, more specific recommendations for improving intramodality require improved institutional capabilities and, in some cases, require the creation of entirely new independent institutions.

According to the study [20], the integration of ticket booking data involves three stages: recording origin, destination, and transfer cities, expanding HSR and rail operation data, and matching transfer-related data with the passenger's transfer city. A multi-source database is created by fusing data. A study analyzed the impact of ticket prices, travel distance, and travel time on transfer behavior among three passenger groups, finding significant differences. Night departure and long-distance travelers were less sensitive to transfer time. The study suggests ticket managers should design intermodal ticket schemes that cater to different passenger groups' travel habits and design long-distance trips with night departures and longer transfer times. Research conducted by the study [21] stated that Mobile Network Big Data (MNBD) integrates urban and rural areas, influence travel behavior, selects public transportation modes, and implements big data transportation, empowering users, operators, and authorities to control traffic.

According to Takahashi [8], tariff integration refers to unifying the fares and ticketing system of different public transport operators, such as buses, trains, and subways, to create a seamless and integrated network. This can involve using electronic cards with or without IC chips to facilitate the usability of public transport. The goal of tariff integration is to improve the accessibility of public transport and induce a shift from automobile use to public transport while reducing transaction costs for users and operators. Tariff integration in public transportation can positively affect the economy's welfare. Specifically, removing distortions in consumer choices and achieving economies of scale in production can increase consumer surplus and decrease the cost of providing public transport service. These benefits can be achieved when public transport operators have complex networks of transport routes. However, the research needs to provide a definitive answer on the effectiveness of tariff integration in all contexts, and further research may be needed to understand the implications of this policy thoroughly. In another research by Triana et al. [17], the integration of fares can increase the number of public transportation ridership. This causes a change in the movement pattern of mass public transport users. Meanwhile, according to the study [22], results of analysis for ticket fare optimalization in air-rail intermodal transport. The results show that the proposed model can effectively optimize ticket fares and improve the competitiveness of air-rail intermodal transport. This research also provides suggestions for operators in different markets, such as increasing the frequency of flights or trains, improving service quality, and reducing transport cost.

Integration of locations: According to the research [23], air-rail integration service benefits passengers by providing a more convenient and efficient travel experience, as well as cost-saving and reducing travel time. For the transportation industry, air-rail integration can increase passenger traffic and revenue, as well as reduce congestion and environmental impact.

The study by Setiawan et al. [24] reveals the challenges and constraints in implementing the PTIS, highlighting the need for regional development conditions and the role of regulators in managing the transportation sector. However, challenges include regulatory linkages, coordination, and limited authority. The study suggests optimizing regulators' role and coordinating with public transport operators to create an integrated transport system that meets community travel needs.

Benefits of integration in transport (i) efficiency: integrated transport systems can lead to more efficient use of resources and reduce overall travel time. By optimizing connections between different modes, passengers can reach their destinations faster; (ii) sustainability: encouraging the use of public transportation and non-motorized modes can reduce the environmental impact of transport by lowering emissions and traffic congestion; (iii) accessibility: integrated system can improve accessibility for people with disabilities and those who rely on public transport for mobility; (iv) economic growth: a well-integrated transport network can promote economic development by enhancing connectivity between regions, attracting businesses, and increasing the overall movement of goods and services; (v) reduce congestion: by offering attractive public transportation alternatives, integration can help alleviate traffic congestion in urban areas.

Effort to achieve transport integration vary from city to city and country to country, depending on their specific needs, resources, and challenges. It often requires long-term planning, investment, and collaboration among multiple stakeholders.

3.2.3 Aspect of implementing public transport integration system

There are three determining aspects in realizing a transportation integration system: physical, operational, and institutional. Based on a literature study of these three aspects, the indicators influencing the success of the connectivity and transportation integration system are known. The physical aspect is part of the realization of transportation connectivity because it is directly related to infrastructure, transportation, and accessibility, which is a direct part of the physical integration assessment. Meanwhile, in the operational aspect, the indicators used are time, cost and payment, ticket, schedule, information and communication technology (ICT), and location. In the institutional aspect, the indicators used are institutional design, contractual issues, implementation methods, competition law, and specific modal issues. Table 3 displays the indicators used to assess transportation connectivity and integration implementation.

Table 3. Indicator of connectivity and integration transport

Aspect	Indicator	Connectivity	Integration
Physical	Infrastructure [16, 19, 25]	√	√
	Transportation [16, 25]	√	√
	Accessibility [13, 26, 27]	√	√
Operational	Time [23, 28]		√
	Cost and Payment [8, 17-19, 26, 28]		√
	Ticket [8, 17, 18, 22]		√
	Schedule [9]		√
	Information and Communication Technology (ICT) [9, 16, 18, 25, 28]		√
	Location [23, 28]		√
Institutional	Institutional Design [9]		√
	Contractual Issues [9]		√
	Implementation Methods [9]		√
	Competition Law [9]		√
	Specific Modal Issue [9]		√

The chosen indicator was based on research by multiple researchers. The evaluation of each indicator was not based on statistical methods like correlation coefficients, significance level, or model outputs. The indicators obtained can guide an in-depth investigation into the conditions requiring improvement in the implementation of PTIS in different cities.

According to the Urban Mobility Readiness Index, 2022 [29] Public Transit sub-index is a way to measure cities' performance on public transit density, efficiency, and utilization rate. Table 4 shows the top 10th cities with the best public transit in the world from 60th cities. From these data, we find out how the implementation of the transportation integration system in each of these cities, with the application of aspects of physical integration, operational integration, and institution integration. Based on the search, it is known that the cities with the best public transit index apply a transportation integration system.

Several specific infrastructure improvements contribute to better connectivity and integration in transportation systems, playing a significant overall efficiency and user experience. Here are key infrastructure improvements: intelligent transportation system (ITS), intermodal facilities, integrated ticketing and payment systems, smart traffic management system, bike and pedestrian infrastructure, real time information displays, communication network and 5G technology, digital mapping and navigation systems.

These infrastructure improvements collectively contribute to a more connected, integrated, and efficient transportation system. By leveraging technology and thoughtful design, these enhancements address the challenges of modern urban mobility and create a more user-friendly and sustainable transportation experience.

Based on Table 3, the indicators offer valuable insights that can inform policymakers and transport operators in making strategic decisions and improving overall system performance. Here are the practical implications of these indicators: for policymakers (performance monitoring and evaluation, infrastructure planning, service equity and accessibility, environmental impact, and economic viability) and for transport operators (operational efficiency, customer satisfaction, technology integration, safety and security, cost and management, and adaptability to demand).

By leveraging these indicators, policymakers and transport operators can collaboratively work towards creating a more efficient, accessible, and sustainable public transport system that meets the diverse needs of the community. Regular monitoring and adaptation based on indicator insights contribute to continuous improvement and the success of integrated public transport.

Table 4. The integrated public transport system in various countries

Ranking*	City	Physical Integration	Operational Integration	Institutional Integration
1	Hongkong	√	√	√
2	Zurich	√	√	√
3	Stockholm	√	√	√
4	Singapore	√	√	√
5	Helsinki	√	√	√
6	Oslo	√	√	√
7	Tokyo	√	√	√
8	Paris	√	√	√
9	Berlin	√	√	√
10	London	√	√	√

* Public Transit sub-index [29]

3.3 Mobility as a service

Mobility as a Service (MaaS) is a concept that refers to the integration of various forms of transport services into a single mobility service accessible on demand. It aims to provide users with a seamless and convenient travel experience by allowing them to plan, book, and pay for their journeys using a single platform. MaaS can include a range of transport modes, such as public transport, car-sharing, bike-sharing, taxi, and ride-hailing services. The goal of MaaS is to encourage a shift from private car ownership to more sustainable and efficient modes of transport, while also improving the overall quality of transport services [30, 31].

The benefit of MaaS for accessibility is that it can improve transit accessibility for all users. By integrating different modes of transportation, MaaS can help reduce congestion, improve air quality, and enhance the overall quality of life for urban residents. Therefore, the benefit of MaaS for accessibility is that it can provide a more convenient, affordable, and sustainable transportation option for all users, while also improving transit accessibility in areas where it is lacking [32].

MaaS is an integrated information and communication technologies (ICT) platform that offers flexible, customized mobility services on a contract or 'pay-as-you-go' basis, reducing travel costs and providing an innovative solution for environmental sustainability. It encourages individuals to shift from private vehicle dependence and provide a more environmentally friendly alternative to traditional transportation [33].

Ding et al. [34] compare multimodal transport systems with and without a MaaS platform. Without a MaaS platform, travellers access mobility resources separately, with each service provider operating independently. A MaaS platform acts as a broker, purchasing resources from providers, creating seamless services, and selling them to travellers. This allows for a single payment for accessing various resources and providing personalized services. The challenge lies in matching travellers to service providers, ensuring individual needs are met, nonnegative profits for providers, and system efficiency.

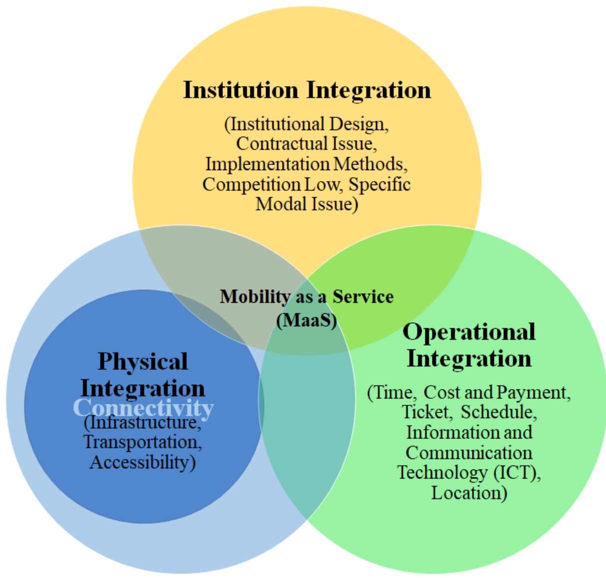

Figure 7. Diagram of relationship between integration, connectivity, and MaaS

Several factors can influence the adoption of MaaS. Public attitudes towards new mobility services, such as curiosity about technology and innovations, and pro-environment awareness, are strong factors in the adoption of MaaS. Attitudes towards multimodal transport are also important. Factors influencing MaaS adoption include socio-demographic characteristics, built environment, travel behaviour, user personalities, attitudes, perceived usefulness, social influence, and privacy concerns, as MaaS operates primarily via digital platforms [31]. Research on MaaS preferences reveals that preference differ based on socio-demographic profiles and attitudes towards mobility. Most studies use stated preference experiments, which combine service attributes and level to gather data on users' preferences and willingness to pay [35].

Figure 7 shows a diagram of the relationship between integration, connectivity, and MaaS are interconnected components that, when combined effectively, contribute to the development of smart, user-friendly, and efficient transportation ecosystems. This integration is crucial for addressing the complexities of modern urban mobility challenges.

4. DISCUSSION

PTIS is a system that coordinates various transportation modes within a city or region, offering efficiency, connectivity, cost savings, increased ridership, environmental benefits, reduced traffic congestion, better land use, user experience, safety, and economic growth. It streamlines transport operations, optimizes routes and schedules, and provides real-time updates for passengers. The integrated system often offers discounts for multi-modal trips, encouraging more people to use public transport. This reduces vehicle emissions, traffic congestion, and pollution. Public transport hubs can serve as focal points for urban development, fostering more compact and sustainable cities. The system also provides real-time information platforms for passengers, enhancing their journey planning. Emphasizing public transport development can lead to better-maintained vehicles and infrastructure, enhancing passenger safety. An efficient transport system can boost tourism, increase property values near transport hubs, and improve the overall economy by making it easier for people to access jobs and services. Overall, PTIS can lead to more sustainable and efficient urban environments, benefiting individuals and the community.

PTIS is beneficial but also faces challenges such as complexity, initial cost, technology integration, operational differences, revenue sharing, inflexibility, maintenance coordination, public resistance, data privacy concerns, interdependencies, bureaucratic challenges, and unequal development. These challenges can be administratively complex and challenging, as they require coordination among multiple agencies and can be capital-intensive. Technology integration can be cumbersome, and operational differences can pose challenges. Revenue sharing can be contentious, and inflexibility can make it difficult to adapt to future changes. Maintenance coordination can be challenging, and public resistance can arise from users resisting changes to established routes. Data privacy concerns arise from the reliance on data collection and sharing, and interdependencies can cause broader disruptions. Bureaucratic challenges can arise when dealing with multiple jurisdictions or regulatory bodies. Unequal development can occur if underserved or overlooked areas or communities lead to unequal access to transport services. Therefore, it is crucial to be aware of these potential weaknesses when planning and implementing a PTIS to ensure its long-term success.

The success of PTIS depends on addressing both its benefits and challenges. Cities can build sustainable transportation networks that meet their communities' needs by addressing challenges and capitalizing on the benefits. A holistic and strategic approach to these factors contributes to the overall success of PTIS.

Implementing PTIS offers numerous opportunities for cities, regions, and their inhabitants. These include urban revitalization, environmental leadership, tourism boost, innovation hub, economic opportunities, land value increase, reduced dependency on private vehicles, health benefits, expansion of services, data-driven decision-making, inclusive growth, brand development, private sector partnerships, education and awareness, and regional connectivity. Improved public transportation can stimulate economic activity, reduce carbon footprints, and promote greener solutions. It can also attract tourists, make it easier for them to explore cities and regions, and position a city or region as a hub for transport innovation. The integration of public transport can lead to cost savings, reduced traffic congestion, and decreased emissions. It can also promote physical activity, expand services, and foster data-driven decision-making. It can prioritize underserved regions, promote equitable development, and access, and serve as a brand for the city or region. Public-private partnerships can emerge, and integration initiatives can educate the public about the benefits of public transport and sustainable practices. Furthermore, integrated systems can enhance connectivity between cities, promoting regional development beyond city limits. Overall, PTIS presents vast opportunities for the socio-economic and environmental fabric of regions that embrace them.

PTIS is a vital component of the transportation system, offering numerous benefits and opportunities. However, they also face several threats that can hinder their success. These include funding shortfalls, political instability, technological obsolescence, economic downturns, natural disasters, service threats, competing modes, regulatory changes, public opposition, legal challenges, operational challenges, infrastructure aging, dependency risks, health crises, and environmental concerns. Financial constraints, unexpected budget cuts, political instability, rapid technological changes, economic downturns, natural disasters, service threats, competing modes, regulatory changes, public opposition, legal challenges, operational challenges, infrastructure aging, dependency risks, health crises, and environmental concerns. These threats can impact the development and maintenance of the integrated system, requiring careful planning, consistent stakeholder engagement, and flexibility in adapting to changing circumstances. To ensure the long-term sustainability and success of PTIS, it is crucial to recognize and proactively address these threats. Proper planning, consistent stakeholder engagement, and flexibility in adapting to changing circumstances can help mitigate many of these risks.

Understanding and addressing these opportunities and threats is crucial for policymakers and transport operators to sustain and improve the current state of public PTIS. Proactive measures, strategic planning, and stakeholder collaboration are essential for overcoming challenges and maximizing the positive impact of integration efforts.

Each city's PTIS has its unique strengths and challenges. A comparative analysis helps identify best practices, areas for improvement, and potential strategies that can be applied to enhance the efficiency and effectiveness of public transportation systems across different urban contexts.

Policymakers and transport should utilize integrated transportation strategic planning [36] to improve PTIS efficiency by utilizing strengths, weaknesses, opportunities, and threats (SWOT) analysis and developing a priorirt scale for integrated transportation services, ensuring uninterrupted travel between intercity and urban areas.

5. CONCLUSIONS

This research provides the conclusion that implementing PTIS is a multifaceted challenge. Best practices in the field have been developed based on experiences from cities and regions worldwide. Here are some of the most prominent best practices: comprehensive planning, stakeholder engagement, pilot programs, integrated ticketing, real-time information systems, infrastructure development, unified branding, technology adoption, safety and security, financial sustainability, monitoring and evaluation, and legislative and regulatory support. By adhering to these best practices, cities and regions can maximize the benefits of PTIS and minimize potential pitfalls or challenges.

The study reviews and analyses literature on PTIS for inter-city to urban travel. It provides insights into factors influencing public transport use, such as infrastructure quality, accessibility, and operational systems. The study reveals that PTIS can enhance the performance of existing public transport systems and offer social and environmental benefits, improving the overall performance of the system.

This research suggests conducting a priority scale analysis to determine indicators during PTIS implementation stages, considering the capabilities of regulators and operators in each city.

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