SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2023
ORGANIZATION AND MANAGEMENT SERIES NO. 176

SMART MOBILITY IN SMART CITY – SINGAPORE AND TOKYO COMPARISON

Radosław WOLNIAK[1*], Wies GREBSKI[2]

[1] Silesian University of Technology, Organization and Management Department, Economics and Informatics Institute; rwolniak@polsl.pl, ORCID: 0000-0003-0317-9811
[2] Penn State Hazletonne, Pennsylvania State University; wxg3@psu.edu, ORCID: 0000-0002-4684-7608
* Correspondence author

Purpose: The goal of the paper is to analyze the main differences between the smart mobility idea implementation in Singapore and Tokyo.
Design/methodology/approach: Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.
Findings: This paper analyzes the smart mobility solutions implemented in Singapore and Tokyo to improve urban transportation. Singapore and Tokyo have taken proactive measures to address transportation challenges and enhance the overall mobility experience in their respective cities. Singapore has emerged as a global leader in smart mobility, employing initiatives such as a well-connected MRT system, dedicated bus lanes, electronic road pricing, and intelligent transport systems. These measures have significantly improved transportation efficiency, reduced congestion, and promoted the use of public transport. Singapore has also embraced shared mobility options like bike-sharing and e-scooter sharing services, offering sustainable and convenient alternatives to private vehicle ownership. In contrast, Tokyo has focused on developing an integrated and efficient public transportation system. The city's extensive network of trains, subways, and buses enables seamless transfers and convenient travel across the city. Real-time information systems, multimodal integration, and sustainable initiatives have further enhanced transportation efficiency and connectivity in Tokyo. Additionally, Tokyo has prioritized pedestrian-friendly infrastructure, encouraged the use of electric vehicles, and implemented smart parking systems to alleviate congestion and support sustainable mobility.
Originality/value: Detailed analysis of differences between Singapore and Tokyo in the case of smart mobility implementation.

Keywords: Smart City, smart mobility, smart biking, sustainability, cycling.

Category of the paper: research paper.

1. Introduction

Singapore is often regarded as a global leader in smart mobility. It has implemented a comprehensive Intelligent Transportation System (ITS) that includes electronic road pricing, smart parking systems, and an extensive network of autonomous vehicles for public transport.

Tokyo has made significant advancements in smart mobility, including advanced public transportation systems, intelligent traffic management, and the integration of various transportation modes. It also hosts several pilot projects involving autonomous vehicles and smart infrastructure.

The goal of the paper is to analyze the main differences between the smart mobility idea implementation in Singapore and Tokyo.

2. Smart Mobility in Asia

Smart cities and smart mobility systems aim to optimize resource usage, reduce energy consumption, and minimize environmental impact. By integrating advanced technologies and data-driven solutions, these systems can streamline transportation, optimize traffic flow, reduce congestion, and promote the use of clean and sustainable modes of transportation, such as electric vehicles or public transportation (Jonek-Kowalska, Wolniak, 2021, 2022; Jonek-Kowalska et al., 2022; Kordel, Wolniak, 2021, 2023; Rosak-Szyrocka et al., 2023; Gajdzik et al., 2023, Orzeł, Wolniak, 2021, 2022; Ponomarenko et al., 2016; Stawiarska et al., 2020, 2021; Stecuła, Wolniak, 2022; Olkiewicz et al., 2021).. This leads to more efficient and environmentally friendly cities. Smart mobility solutions can greatly enhance the quality of life for residents (Wolniak, 2016; Czerwińska-Lubszczyk et al., 2022; Drozd, Wolniak, 2021; Gajdzik, Wolniak, 2021, 2022; Gębczyńska, Wolniak, 2018, 2023; Grabowska et al., 2019, 2020, 2021). Efficient transportation systems reduce commute times, minimize traffic congestion, and improve air quality. Smart city infrastructure can also facilitate easier access to essential services, such as healthcare, education, and public safety. By leveraging technology and data, smart cities can provide better services and amenities to their residents, making urban living more convenient and enjoyable (Wolniak, Sułkowski, 2015, 2016; Wolniak, Grebski, 2018; Wolniak et al., 2019, 2020; Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021; 2022; Wolniak, 2013, 2016; Hys, Wolniak, 2018).

Smart cities rely on vast amounts of data collected from various sources, including sensors, IoT devices, and citizen inputs. This data is analyzed to gain insights and make informed decisions about urban planning, infrastructure development, and service delivery. Data-driven decision making enables cities to identify patterns, anticipate future needs, and allocate

resources more efficiently (Sułkowski, Wolniak, 2015, 2016, 2018; Wolniak, Skotnicka-Zasadzień, 2008, 2010, 2014, 2018, 2019, 2022; Wolniak, 2011, 2013, 2014, 2016, 2017, 2018, 2019, 2020, 2021, 2022; Gajdzik, Wolniak, 2023).

Smart mobility in Asia has seen significant advancements and has become a key focus for many cities and countries in the region. Asian cities have embraced ITS (Intelligent Transportation Systems) technologies to improve traffic management and enhance transportation efficiency. These systems often include traffic signal optimization, dynamic traffic routing, real-time traveler information, and smart parking solutions. Cities like Singapore, Tokyo, and Seoul have implemented comprehensive ITS frameworks to manage their urban transportation networks effectively (Su et al., 2022).

Smart mobility in Asia is driven by the region's rapid urbanization, increasing population density, and the need for sustainable transportation solutions. Governments, city planners, and technology companies are collaborating to address transportation challenges and improve the overall mobility experience for residents and visitors congestion.

Those cities are known for their well-developed public transportation systems. Many cities have integrated smart features into their transit networks, such as contactless fare payment systems, real-time arrival information, and digital ticketing options. Cities like Hong Kong, Tokyo, and Seoul have efficient metro systems with extensive coverage, while cities like Beijing and Shanghai have advanced bus rapid transit (BRT) systems. Asian cities have been at the forefront of promoting bike-sharing programs and other micro-mobility solutions. Cities like Beijing, Shanghai, and Taipei have large-scale bike-sharing networks, allowing residents and visitors to easily access bicycles for short trips (Muñoz, Bolivar, 2021). Additionally, electric scooters and shared electric vehicles are becoming increasingly popular in cities like Singapore, Taipei, and Bengaluru (Feardous et al., 2022).

Asian countries have been actively exploring and testing autonomous vehicles. Singapore, for instance, has conducted numerous pilot projects for autonomous taxis and buses on designated routes. China has also been a significant player in AV development, with companies like Baidu, Didi Chuxing, and Pony.ai conducting extensive testing and deployment of autonomous vehicles in cities like Beijing, Shanghai, and Guangzhou. Asian cities face significant challenges with parking availability and congestion. As a result, many cities have implemented smart parking systems using technologies like sensors, real-time occupancy information, and mobile applications. Cities like Seoul, Tokyo, and Singapore have introduced smart parking initiatives to help drivers find available parking spaces quickly and reduce traffic congestion caused by parking-related issues.

Several Asian cities have been exploring Mobility-as-a-Service concepts, where different transportation modes are integrated into a single platform or app. For example, cities like Singapore and Tokyo have developed platforms that provide users with access to multiple modes of transportation, including public transit, ride-sharing, bike-sharing, and even taxis, all through a single app. Asia is a significant market for electric vehicles, and many cities have

been investing in charging infrastructure to support their adoption. Countries like China and Japan have extensive networks of charging stations, and cities like Beijing, Shanghai, and Tokyo have been encouraging the use of electric vehicles through incentives and subsidies (Henriot et al., 2018).

3. Smart Mobility solutions in Singapore

Singapore is widely recognized as a global leader in smart mobility solutions. The city-state has implemented numerous initiatives to enhance transportation efficiency, reduce congestion, and promote sustainable mobility. Singapore's MRT (Mass Rapid Transit) system is a highly efficient and well-connected network of train lines that covers most parts of the city. It provides fast, reliable, and convenient transportation for commuters, reducing reliance on private cars (Sukawan, Rachmawati, 2021).

Singapore has implemented various measures to prioritize buses on the roads, including dedicated bus lanes, bus priority traffic signals, and bus priority boxes at intersections. These measures aim to improve bus speeds, enhance reliability, and encourage more people to use public transport. Singapore was also one of the first cities to introduce electronic road pricing as a means to manage traffic congestion. The ERP (Electronic Road Pricing) system charges vehicles for road usage during peak hours in congested areas, effectively controlling traffic volume and encouraging the use of public transport (Chin, 2021).

Singapore utilizes advanced ITS (Intelligent Transport Systems) technologies for efficient traffic management. These include real-time traffic monitoring, dynamic message signs, and smart traffic control systems that optimize signal timings based on traffic conditions, reducing congestion and travel time. These systems include traffic monitoring, dynamic message signs, and smartphone applications that help users plan their journeys and make informed travel decisions. ITS enables the optimization of traffic flow, reduces congestion, and enhances the overall efficiency of transportation in Singapore. By analyzing data and utilizing smart technologies, ITS contributes to a safer and more convenient travel experience for residents and visitors alike (Zhong et al., 2016).

Singapore has embraced shared mobility options, including bike-sharing and e-scooter sharing services. In Singapore, bike-sharing services provide a convenient mode of transportation for short trips. Users can easily locate available bicycles using mobile apps that show the real-time availability of bikes at various docking stations across the city. Once located, users can unlock the bikes using a mobile app or a membership card. These bikes are designed for easy riding and typically come equipped with features like adjustable seats, baskets, and built-in GPS systems (Joo, 2023).

The introduction of bike-sharing and e-scooter sharing systems has had a positive impact on Singapore's urban mobility. These services provide a practical and convenient alternative to private vehicle ownership, reducing traffic congestion and air pollution. They also promote a healthy and active lifestyle by encouraging physical activity through cycling and offer first/last-mile connectivity to public transportation nodes, making multi-modal journeys more accessible.

Furthermore, the availability of shared mobility options supports the government's vision of creating a car-lite society in Singapore. By reducing the reliance on private cars, these systems contribute to a more sustainable and efficient transportation network (Ferro-Escobar et al., 2022).

In the table 1 there is a description of realization of main factors of smart mobility concept realization in Singapore.

Table 1.
Main factors of smart mobility in Singapore

Factor	Realization
Integration and Interconnectivity	Singapore emphasizes the integration of different modes of transportation into a seamless network. The Mass Rapid Transit (MRT) system, buses, taxis, and other mobility options are interconnected, allowing passengers to switch between modes easily.
Advanced Infrastructure	The city-state has invested heavily in building a comprehensive and advanced transportation infrastructure. This includes a well-developed road network, efficient public transport systems, dedicated bus lanes, and pedestrian-friendly walkways.
Intelligent Transport Systems (ITS)	Singapore utilizes ITS technologies to enhance traffic management and provide real-time information to commuters. This includes traffic monitoring, dynamic message signs, and smartphone applications that help users plan their journeys and make informed travel decisions.
Data-Driven Planning and Optimization	The government leverages data analytics to analyze travel patterns, traffic flow, and passenger demand. This data-driven approach helps in optimizing transportation systems, identifying bottlenecks, and making informed decisions regarding infrastructure development and service improvements.
Smart Payment and Ticketing Systems	Singapore has introduced contactless payment systems and smart ticketing options across various modes of transportation. Commuters can use contactless smart cards or mobile payment methods to pay for fares, facilitating convenient and hassle-free travel.
Sustainable and Green Initiatives	Singapore promotes sustainable mobility solutions, such as electric vehicles (EVs) and bike-sharing services. The government provides incentives and infrastructure support to encourage the adoption of EVs and reduce carbon emissions.
Multi-Modal Integration	Mobility-as-a-Service (MaaS) platforms play a crucial role in Singapore's smart mobility landscape. MaaS apps integrate different transportation options, including public transport, ride-sharing services, and micro-mobility solutions, allowing users to plan, book, and pay for their entire journey seamlessly.
Smart Traffic Management	Singapore uses technologies like electronic road pricing (ERP) to manage traffic congestion. ERP dynamically adjusts toll charges based on demand, encouraging the use of public transport and reducing private vehicle usage during peak periods.
Autonomous Vehicles (AVs)	Singapore is at the forefront of testing and deploying autonomous vehicles. AVs are being trialed in various applications, such as autonomous shuttles for first/last-mile connectivity and autonomous taxis for on-demand transportation.
Proactive Government Policies	The Singaporean government plays a proactive role in implementing smart mobility solutions. It sets policies, provides funding and incentives, collaborates with industry stakeholders, and actively engages the public to ensure the successful adoption of smart mobility initiatives.

Source: Authors own work on the basis of: (Sukawan, Rachmawati, 2021; Chin, 2021; Zhong et al., 2016, Jhoo, 2023; Ferro-Escobar et al., 2022; Shamsuzzoha et al., 2021, Zhang, 2021).

In the table 2 there is an analysis of main advantages and problems in implementation of smart mobility solutions in Singapore.

Table 2.
Comparison of advantages and problems of implementing smart mobility in Singapore

Advantages	Problems
Efficient and reliable transportation	Initial high implementation costs
Reduced traffic congestion	Integration and interoperability of different systems and modes
Improved air quality and reduced carbon emissions	Technological complexities and maintenance
Enhanced connectivity and accessibility	Potential privacy and data security concerns
Seamless multi-modal integration	Public acceptance and behavior change
Promotes sustainable and eco-friendly mobility	Resistance from traditional transport industries
Optimized transportation planning and management	Potential job displacement in certain sectors
Enhances overall quality of life	Limited physical infrastructure in some areas
Economic opportunities and job creation	Ensuring equitable access and affordability
Proactive government support and collaboration	User education and awareness

Source: Authors own work on the basis of: (Sukawan, Rachmawati, 2021; Chin, 2021; Zhong et al., 2016, Jhoo, 2023; Ferro-Escobar et al., 2022; Shamsuzzoha et al., 2021, Zhang, 2021, Elm, Carvalho, 2020; Lim et al., 2020; Ng, Kim, 2020; Chang, Das, 2020).

4. Smart Mobility solutions in Tokyo

Smart mobility in Tokyo refers to the implementation of advanced technologies and innovative solutions to enhance transportation efficiency, connectivity, and sustainability in the city. Tokyo, as a bustling metropolis, faces various transportation challenges, and smart mobility initiatives aim to address these issues. One key aspect of smart mobility in Tokyo is its highly integrated public transportation system. The city boasts an extensive network of trains, subways, and buses that provide efficient and extensive coverage. This integrated system enables commuters to navigate the city seamlessly, with well-connected transportation hubs and synchronized schedules facilitating smooth transfers between different modes of transportation (Yagi, 2016).

Real-time information plays a crucial role in Tokyo's smart mobility infrastructure. Commuters have access to timely updates on train schedules, delays, and platform changes through mobile apps and announcements. This enables them to plan their journeys more effectively and make informed decisions, ultimately reducing wait times and improving overall travel experiences. Tokyo also places emphasis on multi-modal integration. The city recognizes the importance of providing a range of transportation options to cater to diverse commuter needs. This includes efficient integration of trains, buses, and bicycles, allowing commuters to choose the most convenient and suitable mode for their travel. Well-designed transportation hubs and synchronized schedules facilitate seamless transfers, ensuring a hassle-free journey (Vinod, 2022).

Sustainability is another crucial aspect of smart mobility in Tokyo. The city actively promotes the use of electric vehicles (EVs) and has been developing EV charging infrastructure to reduce carbon emissions and air pollution. By incentivizing the adoption of EVs, Tokyo aims to contribute to a cleaner and greener transportation system. Furthermore, Tokyo implements smart parking systems that utilize sensors and digital signage to guide drivers to available parking spaces. These systems optimize parking resource utilization, reduce the time spent searching for parking, and alleviate traffic congestion (Smart Tokyo, 2019).

Collaboration and innovation are key drivers of smart mobility in Tokyo. The government, transportation operators, and research institutions collaborate to foster innovation, implement advanced technologies, and improve transportation services continually. This collaborative approach ensures that Tokyo remains at the forefront of smart mobility solutions and adapts to evolving transportation needs (Manabu, 2020).

In the table 2 there is a description of realization of main factors of smart mobility concept realization in Tokyo. Smart mobility in Tokyo focuses on enhancing transportation efficiency, connectivity, and sustainability. Through the integration of advanced technologies, real-time information systems, multi-modal integration, and sustainable initiatives, Tokyo strives to provide its residents and visitors with convenient, efficient, and environmentally friendly transportation options.

Table 3.
Main factors of smart mobility in Tokyo

Factor	Realization
Integrated Public Transportation	Tokyo has a highly integrated and extensive public transportation network, which includes trains, subways, buses, and trams. The seamless integration of these modes allows for convenient and efficient travel across the city, reducing the reliance on private vehicles.
Advanced Ticketing and Fare Systems	Tokyo utilizes contactless smart cards, such as Suica and PASMO, for fare payment across multiple transportation modes. These cards enable passengers to easily access and pay for various services, promoting seamless transfers and eliminating the need for separate tickets.
Real-time Information and Updates	Tokyo provides real-time information to commuters through digital displays, mobile apps, and announcements. This includes updates on train and bus schedules, delays, and platform changes, allowing passengers to plan their journeys and make informed decisions.
Intelligent Transport Systems	Tokyo employs advanced ITS technologies to manage traffic flow and improve transportation efficiency. This includes traffic monitoring systems, dynamic message signs, and smart traffic control mechanisms, which help optimize signal timings based on real-time traffic conditions.
Bike-sharing and Micro-mobility Options	Tokyo has embraced bike-sharing services and other micro-mobility options as an eco-friendly and convenient means of transportation. Bike-sharing programs allow users to rent bicycles for short trips, promoting last-mile connectivity and reducing congestion.
Walkability and Pedestrian Infrastructure	Tokyo prioritizes the development of pedestrian-friendly infrastructure, including well-designed sidewalks, pedestrian crossings, and pedestrian-only zones. This promotes walking as a viable mode of transportation, particularly for short distances, reducing reliance on motor vehicles.
Multi-Modal Integration	Tokyo emphasizes the seamless integration of various transportation modes, including trains, buses, and bicycles. This involves well-connected transportation hubs, synchronized schedules, and clear signage, facilitating easy transfers and providing passengers with flexible travel options.

Cont. table 3.

Sustainable Initiatives	Tokyo actively promotes sustainable transportation solutions, including the adoption of electric vehicles (EVs) and the development of EV charging infrastructure. The city incentivizes the use of EVs, aiming to reduce carbon emissions and air pollution from transportation.
Smart Parking Systems	Tokyo implements smart parking systems that utilize sensors and digital signage to guide drivers to available parking spaces. These systems reduce the time spent searching for parking, alleviate traffic congestion, and optimize the utilization of parking resources.
Collaboration and Innovation	Tokyo's smart mobility initiatives are driven by collaboration between the government, transportation operators, private companies, and research institutions. This collaborative approach fosters innovation and facilitates the implementation of cutting-edge technologies and solutions.

Source: Authors own work on the basis of: (Yagi, 2016; Vinod, 2022; Smart Tokyo, 2019; Manabu, 2020; Tokyo Smart City, 2015; Adachi, 2021; Sadayuki, 2018).

In the table 4 there is an analysis of main advantages and problems in implementation of smart mobility solutions in Tokyo.

Table 4.
Comparison of advantages and problems of implementing smart mobility in Tokyo

Advantages	Problems
Improved transportation efficiency and reduced congestion	Balancing the demand for transportation services with the existing infrastructure
Enhanced accessibility and connectivity across the city	Integration of various transportation modes and systems
Reduced reliance on private vehicles, promoting sustainable transportation	Managing the increasing demand for public transportation during peak hours
Real-time information and updates for better trip planning	Ensuring reliable and accurate real-time data for commuters
Integration of multiple modes of transportation for seamless transfers	Overcoming potential resistance to change from commuters accustomed to traditional transportation methods
Promotion of eco-friendly options such as bike-sharing and micro-mobility	Addressing safety concerns and establishing regulations for new mobility solutions
Implementation of intelligent transport systems to optimize traffic flow	Managing and maintaining advanced technologies and systems for efficient operation
Emphasis on pedestrian-friendly infrastructure, promoting walking as a viable mode of transportation	Balancing the needs of pedestrians, cyclists, and motorists in shared spaces
Collaborative approach between government, operators, and technology providers	Ensuring inclusivity and accessibility for all segments of the population
Innovation and technological advancements driving continuous improvement	Balancing the costs associated with implementing and maintaining smart mobility systems

Source: Authors own work on the basis of: (Yagi, 2016; Vinod, 2022; Smart Tokyo, 2019; Manabu, 2020; Tokyo Smart City, 2015; Adachi, 2021; Sadayuki, 2018; A tale of…, 2018; Kawamura, Yai, 2019).

5. Singapore and Tokyo comparison

In Singapore, the transportation system boasts an extensive and efficient network of trains, buses, and taxis. The public transportation system is highly integrated, allowing for seamless transfers and convenient travel across the city. The use of contactless smart cards,

such as EZ-Link, enables commuters to pay for fares across multiple modes of transportation, including buses and trains, with ease. Real-time information on train and bus schedules, delays, and disruptions is readily available through mobile apps and digital displays, helping commuters plan their journeys more effectively. Singapore also promotes sustainable transportation by actively encouraging the adoption of electric vehicles and developing the necessary charging infrastructure. Additionally, bike-sharing programs with mobile app access and designated parking areas provide residents and visitors with a convenient and eco-friendly last-mile connectivity solution (Elm et al., 2020; Ng, Kim, 2020; Manabu, 2020; Yagi, 2016).

Similarly, Tokyo has a highly integrated public transportation system that includes trains, subways, and buses. The city's transportation network provides extensive coverage and efficient services, catering to the needs of millions of commuters. Contactless smart cards like Suica and PASMO allow passengers to seamlessly pay for fares across various transportation modes. Real-time information on train schedules, delays, and platform changes is readily available through mobile apps and announcements, facilitating smoother and more informed travel. Tokyo also emphasizes multi-modal integration, ensuring well-connected transportation hubs and synchronized schedules for convenient transfers between different modes of transportation. The city actively promotes walking as a viable mode of transportation by prioritizing pedestrian-friendly infrastructure and implementing pedestrian zones. Additionally, smart parking systems guide drivers to available parking spaces, optimizing parking resources and reducing congestion (Adachi, 2021; Sadayuki, 2018; Chang, Das, 2020).

Both Singapore and Tokyo prioritize collaboration between government, transportation operators, and technology providers to drive innovation and implement advanced smart mobility solutions. They recognize the importance of sustainable initiatives and are actively promoting the adoption of electric vehicles and developing charging infrastructure. Furthermore, the integration of technology, such as mobile apps, contactless payment systems, and real-time information, enhances the overall travel experience for residents and visitors in both cities.

In the table 5 there is a comparison of smart mobility implementation in Singapore and Tokyo. The more extensive comparison was prepared in the table 6.

Table 5.
Comparison of Singapore and Tokyo smart mobility solutions

Factor	Singapore	Tokyo
Public Transportation	Extensive and efficient network of trains, buses, and taxis. High integration and seamless transfers.	Highly integrated public transportation system including trains, subways, and buses. Efficient and extensive coverage.
Fare Payment Systems	Contactless smart cards (e.g., EZ-Link) for seamless fare payment across multiple modes. Integration with retail and other services.	Contactless smart cards (e.g., Suica, PASMO) for integrated fare payment.

Cont. table 5.

Real-time Information	Real-time updates on train and bus schedules, delays, and disruptions through mobile apps and digital displays.	Real-time information on train schedules, delays, and platform changes through mobile apps and announcements.
Bike-Sharing Services	Bike-sharing programs with mobile app access, real-time bike availability, and designated parking areas.	Bike-sharing programs with mobile app access, real-time bike availability, and efforts to promote last-mile connectivity.
Walkability	Pedestrian-friendly infrastructure with well-designed sidewalks and crossings. Promotion of walking as a viable mode of transportation.	Emphasis on pedestrian infrastructure, including pedestrian zones and improved walking facilities.
Multi-Modal Integration	Seamless integration of various modes of transportation, including buses, trains, and bicycles.	Emphasis on multi-modal integration with well-connected transportation hubs and synchronized schedules.
Sustainable Initiatives	Active promotion of electric vehicles (EVs) and development of EV charging infrastructure. Incentives for EV adoption.	Active promotion of EVs and EV charging infrastructure to reduce emissions and air pollution.
Smart Parking Systems	Implementation of smart parking systems to guide drivers to available parking spaces.	Implementation of smart parking systems utilizing sensors and digital signage for efficient parking management.
Collaboration and Innovation	Collaborative approach among government, operators, and technology providers to drive innovation.	Collaboration between government, operators, and research institutions to foster innovation and implement advanced technologies.
Unique Characteristics/ Considerations	Emphasis on bike-sharing for last-mile connectivity and eco-friendly transportation. Utilization of advanced digital payment systems.	Prioritization of walking infrastructure and pedestrian zones. Cultural considerations for transportation planning.

Source: Authors own work on the basis of: (Sukawan, Rachmawati, 2021; Chin, 2021; Zhong et al., 2016, Jhoo, 2023; Ferro-Escobar et al., 2022; Shamsuzzoha et al., 2021, Zhang, 2021; Yagi, 2016; Vinod, 2022; Smart Tokyo, 2019; Manabu, 2020; Tokyo Smart City, 2015; Adachi, 2021; Sadayuki, 2018).

6. Conclusion

The paper analyzes the smart mobility solutions implemented in Singapore and Tokyo to improve urban transportation. Singapore and Tokyo have implemented smart mobility solutions to address transportation challenges and improve the overall mobility experience in their respective cities. Singapore has emerged as a global leader in smart mobility, with initiatives such as the well-connected MRT system, dedicated bus lanes, electronic road pricing, and intelligent transport systems. These measures have enhanced transportation efficiency, reduced congestion, and encouraged the use of public transport. Singapore has also embraced shared mobility options like bike-sharing and e-scooter sharing services, promoting sustainable and convenient alternatives to private vehicle ownership.

On the other hand, Tokyo has focused on creating an integrated and efficient public transportation system. The city's extensive network of trains, subways, and buses enables seamless transfers and convenient travel across the city. Real-time information systems, multi-modal integration, and sustainable initiatives have further improved transportation efficiency and connectivity in Tokyo. The city has also emphasized pedestrian-friendly infrastructure, promoted the use of electric vehicles, and implemented smart parking systems to reduce congestion and support sustainable mobility.

Analyzed cities have realized the importance of collaboration, innovation, and the use of advanced technologies to drive their smart mobility initiatives. However, they also face challenges such as integrating different systems and modes, managing technological complexities, ensuring public acceptance, and addressing potential privacy and data security concerns. Singapore and Tokyo have made significant progress in implementing smart mobility solutions, but there is still work to be done to overcome challenges and fully realize the potential of smart mobility in creating efficient, sustainable, and user-friendly transportation systems. By continuing to invest in infrastructure, fostering innovation, and engaging with stakeholders, both cities can further enhance their smart mobility landscapes and provide residents and visitors with seamless, eco-friendly, and accessible transportation options.

References

1. *A tale of 3 Smart Cities – London, New York and Tokyo* (2017). https://www.telehouse.com/wp-content/uploads/2018/04/Telehouse_SmartCity_WP_2018.pdf, 26.06.2023.
2. Adachi, Y. (2021). The impact of improvement in public transportation: evidence from the Tokyo metropolitan area. *Letters in Spatial and Resource Sciences, 14(3),* 287-308.
3. Chang, F., Das, D. (2020). *Smart Nation Singapore: Developing Policies for a Citizen-Oriented Smart City Initiative, Developing National Urban Policies: Ways Forward to Green and Smart Cities,* 425-440.
4. Chin, K.-K. (2021). Singapore perspective: Smart mobility. *Smart Sensing for Traffic Monitoring*, 43-60.
5. Drozd, R, Wolniak, R. (2021). Metrisable assessment of the course of stream-systemic processes in vector form in industry 4.0. *Quality and Quantity*, 1-16, DOI: 10.1007/s11135-021-01106-w.
6. Drozd, R., Wolniak, R. (2021). Systematic assessment of product quality. *Journal of Open Innovation: Technology, Market, and Complexity, 7(4),* 1-12.

7. Elm, J., Carvalho, L.C. (2020). Best practices to become a sustainable smart city: The case of Singapore, Conceptual and Theoretical Approaches to Corporate Social Responsibility. *Entrepreneurial Orientation, and Financial Performance*, 247-265.
8. Feardous, J., Anubhove, M.S.T., Hossain, E., Ahmed, S.M.M., Zeyad, M. (2022). *Evaluation of Modern Smart Cities in South Asian Countries: Advanced Applications of Internet of Things (IoT).* Proceedings of International Conference on Smart Systems and Technologies, SST 2022, 197-202
9. Ferro-Escobar, R., Vacca-González, H., Gómez-Castillo, H. (2022). Smart and Sustainable Cities in Collaboration with IoT: The Singapore Success Case. *Intelligent Systems Reference Library, 121*, 213-243.
10. Gajdzik, B., Grebski, M., Grebski, W., Wolniak, R. (2022). *Human factor activity in lean management and quality management.* Toruń: Towarzystwo Naukowe Organizacji i Kierownictwa. Dom Organizatora.
11. Gajdzik, B., Jaciow, M., Wolniak, R., Wolny R., Grebski, W.W. (2023). Energy Behaviors of Prosumers in Example of Polish Households. *Energies, 16(7),* 3186; https://doi.org/10.3390/en16073186.
12. Gajdzik, B., Wolniak, R. (2021). Digitalisation and innovation in the steel industry in Poland - selected tools of ICT in an analysis of statistical data and a case study. *Energies, 14(11),* 1-25.
13. Gajdzik, B., Wolniak, R. (2021). Influence of the COVID-19 crisis on steel production in Poland compared to the financial crisis of 2009 and to boom periods in the market. *Resources, 10(1),* 1-17.
14. Gajdzik, B., Wolniak, R. (2021). Transitioning of steel producers to the steelworks 4.0 - literature review with case studies. *Energies, 14(14),* 1-22.
15. Gajdzik, B., Wolniak, R. (2022). Framework for R&D&I Activities in the Steel Industry in Popularizing the Idea of Industry 4.0. *Journal of Open Innovation: Technology, Market, and Complexity, 8(3),* 133.
16. Gajdzik, B., Wolniak, R. (2022). Influence of Industry 4.0 Projects on Business Operations: literature and empirical pilot studies based on case studies in Poland. *Journal of Open Innovation: Technology, Market, and Complexity, 8(1),* 1-20.
17. Gajdzik, B., Wolniak, R. (2022). Smart Production Workers in Terms of Creativity and Innovation: The Implication for Open Innovation. *Journal of Open Innovations: Technology, Market and Complexity, 8(1),* 68.
18. Gajdzik, B., Wolniak, R. Grebski, W. (2023). Process of Transformation to Net Zero Steelmaking: Decarbonisation Scenarios Based on the Analysis of the Polish Steel Industry. *Energies, 16(8),* 3384, https://doi.org/10.3390/en16083384.
19. Gajdzik, B., Wolniak, R., Grebski, W.W. (2023). Electricity and heat demand in steel industry technological processes in Industry 4.0 conditions. *Energies, 16(2),* 1-29.

20. Gajdzik, B., Wolniak, R., Grebski, W.W. (2022). An econometric model of the operation of the steel industry in Poland in the context of process heat and energy consumption. *Energies, 15(21),* 1-26, 7909.
21. Gębczyńska, A., Wolniak, R. (2018). *Process management level in local government.* Philadelphia: CreativeSpace.
22. Grabowska, S., Saniuk, S., Gajdzik, B. (2022). Industry 5.0: improving humanization and sustainability of Industry 4.0. *Scientometrics, 127(6),* 3117-3144, https://doi.org/10.1007/s11192-022-04370-1.
23. Grabowska, S., Grebski, M., Grebski, W., Saniuk, S., Wolniak, R. (2021). *Inżynier w gospodarce 4.0.* Toruń: Towarzystwo Naukowe Organizacji i Kierownictwa – Stowarzyszenie Wyższej Użyteczności "Dom Organizatora".
24. Grabowska, S., Grebski, M., Grebski, W., Wolniak, R. (2019). *Introduction to engineering concepts from a creativity and innovativeness perspective.* New York: KDP Publishing.
25. Grabowska, S., Grebski, M., Grebski, W., Wolniak, R. (2020). *Inżynier – zawód przyszłości. Umiejętności i kompetencje inżynierskie w erze Przemysłu 4.0.* Warszawa: CeDeWu.
26. Hąbek, P., Wolniak, R. (2013). Analysis of approaches to CSR reporting in selected European Union countries. *International Journal of Economics and Research, 4(6),* 79-95.
27. Hąbek, P., Wolniak, R. (2016). Assessing the quality of corporate social responsibility reports: the case of reporting practices in selected European Union member states. *Quality & Quantity, 50(1),* 339-420.
28. Hąbek, P., Wolniak, R. (2016). Factors influencing the development of CSR reporting practices: experts' versus preparers' points of view. *Engineering Economy, 26(5),* 560-570.
29. Hąbek, P., Wolniak, R. (2016). Relationship between management practices and quality of CSR reports. *Procedia – Social and Behavioral Sciences, 220,* 115-123.
30. Henriot, C., Douay, N., Granier, B., Languillon-Aussel, R., Leprêtre, N. (2018). Asian perspectives on Smart Cities, *Flux, 114(4),* 1-8.
31. Hys, K., Wolniak, R. (2018). Praktyki przedsiębiorstw przemysłu chemicznego w Polsce w zakresie CSR. *Przemysł Chemiczny, 9,* 1000-1002.
32. Jonek-Kowalska, I., Wolniak, R. (2021). Economic opportunities for creating smart cities in Poland. Does wealth matter? *Cities, 114,* 1-6.
33. Jonek-Kowalska, I., Wolniak, R. (2021). The influence of local economic conditions on start-ups and local open innovation system. *Journal of Open Innovations: Technology, Market and Complexity, 7(2),* 1-19.
34. Jonek-Kowalska, I., Wolniak, R. (2022). Sharing economies' initiatives in municipal authorities' perspective: research evidence from Poland in the context of smart cities' development. *Sustainability, 14(4),* 1-23.
35. Jonek-Kowalska, I., Wolniak, R., Marinina, O.A., Ponomarenko, T.V. (2022). *Stakeholders, Sustainable Development Policies and the Coal Mining Industry.*

Perspectives from Europe and the Commonwealth of Independent States. London: Routledge.

36. Joo, Y.-M. (2023). Developmentalist smart cities? the cases of Singapore and Seoul. *International Journal of Urban Sciences, 27(S1),* 164-182.
37. Kawamura, T., Yai, T. (2019). *Trip Characteristics and Potential Higher Publicity of Bike-Sharing System in Tokyo.* 2019 IEEE Intelligent Transportation Systems Conference, ITSC 2019, 968-973, 8917168.
38. Kordel, P., Wolniak, R. (2021). Technology entrepreneurship and the performance of enterprises in the conditions of Covid-19 pandemic: the fuzzy set analysis of waste to energy enterprises in Poland. *Energies, 14(13),* 1-22.
39. Kwiotkowska, A., Gajdzik, B., Wolniak, R., Vveinhardt, J., Gębczyńska, M. (2021). Leadership competencies in making Industry 4.0 effective: the case of Polish heat and power industry. *Energies, 14(14),* 1-22.
40. Kwiotkowska, A., Wolniak, R., Gajdzik, B., Gębczyńska, M. (2022). Configurational paths of leadership competency shortages and 4.0 leadership effectiveness: an fs/QCA study. *Sustainability, 14(5),* 1-21.
41. Lim, T.K., Rajabifard, A., Khoo, V., Sabri, S., Chen, Y. (2020). The smart city in Singapore: How environmental and geospatial innovation lead to urban livability and environmental sustainability. *Smart Cities for Technological and Social Innovation: Case Studies, Current Trends, and Future Steps*, 29-49.
42. Manabu, M. (2020). *Smart Tokyo Implementation Strategy*, https://fpcj.jp/wp/wp-content/uploads/2020/02/7804158048eebdaac90be2faa07ef31c.pdf, 26.06.2023.
43. Muñoz, L.A., Bolívar, M.P.R. (2021). Different levels of smart and sustainable cities construction using e-participation tools in European and central Asian countries. *Sustainability (Switzerland), 13(6),* 3561.
44. Ng, V., Kim, H.M. (2020). Autonomous vehicles and smart cities: A case study of Singapore, *Smart Cities for Technological and Social Innovation: Case Studies, Current Trends, and Future Steps*, 265-287.
45. Olkiewicz, M., Olkiewicz, A., Wolniak, R., Wyszomirski, A. (2021). Effects of pro-ecological investments on an example of the heating industry - case study. *Energies, 14(18),* 1-24, 5959.
46. Orzeł, B., Wolniak, R. (2021). Clusters of elements for quality assurance of health worker protection measures in times of COVID-19 pandemic. *Administrative Science, 11(2),* 1-14, 46.
47. Orzeł, B., Wolniak, R. (2022). Digitization in the design and construction industry - remote work in the context of sustainability: a study from Poland. *Sustainability, 14(3),* 1-25.
48. Ponomarenko, T.V., Wolniak, R., Marinina, O.A. (2016). Corporate Social responsibility in coal industry (Practices of Russian and European companies). *Journal of Mining Institute, 222,* 882-891.

49. Rosak-Szyrocka, J., Żywiołek, J., Wolniak, R. (2023). Main reasons for religious tourism - from a quantitative analysis to a model. *International Journal for Quality Research, 1(17),* 109-120.
50. Sadayuki, T. (2018). Measuring the spatial effect of multiple sites: An application to housing rent and public transportation in Tokyo, Japan. *Regional Science and Urban Economics, 70*, 155-173.
51. Shamsuzzoha, A., Niemi, J., Piya, S., Rutledge, K. (2021). Smart city for sustainable environment: A comparison of participatory strategies from Helsinki, Singapore and London. *Cities, 114*, 103194.
52. *Smart Tokyo: Mobility Projects Changing Landscape* (2019), https://blog.horyou.com/smart-tokyo-mobility-projects-changing-landscape/, 26.06.2023.
53. Stawiarska, E., Szwajca, D., Matusek, M., Wolniak, R. (2020). *Wdrażanie rozwiązań przemysłu 4.0 w wybranych funkcjonalnych obszarach zarządzania przedsiębiorstw branży motoryzacyjnej: próba diagnozy.* Warszawa: CeDeWu.
54. Stawiarska, E., Szwajca, D., Matusek, M., Wolniak, R. (2021). Diagnosis of the maturity level of implementing Industry 4.0 solutions in selected functional areas of management of automotive companies in Poland. *Sustainability, 13(9),* 1-38.
55. Steculа, K., Wolniak, R. (2022). Advantages and Disadvantages of E-Learning Innovations during COVID-19 Pandemic in Higher Education in Poland. *Journal of Open Innovation: Technology, Market, and Complexity, 8(3),* 159.
56. Steculа, K., Wolniak, R. (2022). Influence of COVID-19 Pandemic on Dissemination of Innovative E-Learning Tools in Higher Education in Poland. *Journal of Open Innovations: Technology, Market and Complexity, 8(1),* 89.
57. Su, Y., Miao, Z., Wang, C. (2022). The Experience and Enlightenment of Asian Smart City Development—A Comparative Study of China and Japan. *Sustainability (Switzerland), 14(6),* 3543.
58. Sukawan, H.A.R., Rachmawati, R. (2021). MyTransport.SG as a new communication platform in implementing smart mobility in Singapore. *Journal of Physics: Conference Serie*s, *1834(1),* 012006
59. Sułkowski, M., Wolniak, R. (2016). Przegląd stosowanych metod oceny skuteczności i efektywności organizacji zorientowanych na ciągłe doskonalenie. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacja i Zarzadzanie, 67*, 63-74.
60. Sułkowski, M., Wolniak, R. (2018). *Poziom wdrożenia instrumentów zarządzania jakością w przedsiębiorstwach branży obróbki metali.* Częstochowa: Oficyna Wydawnicza Stowarzyszenia Menedżerów Produkcji i Jakości.
61. *Tokyo Smart City Development in Perspective of 2020 Olympics* (2015). EU-Japan Centre for Industrial Cooperation, https://www.eu-japan.eu/sites/default/files/publications/docs/smart2020tokyo_final.pdf, 26.06.2023.

62. Vinod Kumar, T.M. (2022). *International Collaborative Research: "Smart Global Mega Cities" and Conclusions of Cities Case Studies Tokyo, New York, Mumbai, Hong Kong-Shenzhen, and Kolkata, Advances in 21st Century Human Settlements*, 411-460.
63. Wolniak, R, Skotnicka-Zasadzień, B. (2014). The use of value stream mapping to introduction of organizational innovation in industry. *Metalurgija, 53(4)*, 709-713.
64. Wolniak, R. (2011). *Parametryzacja kryteriów oceny poziomu dojrzałości systemu zarządzania jakością.* Gliwice: Wydawnictwo Politechniki Śląskiej.
65. Wolniak, R. (2013). A typology of organizational cultures in terms of improvement of the quality management. *Manager*, *17(1)*, 7-21.
66. Wolniak, R. (2013). Projakościowa typologia kultur organizacyjnych. *Przegląd Organizacji*, *3*, 13-17.
67. Wolniak, R. (2014). Korzyści doskonalenia systemów zarządzania jakością opartych o wymagania normy ISO 9001:2009. *Problemy Jakości*, *3*, 20-25.
68. Wolniak, R. (2016). Kulturowe aspekty zarządzania jakością. *Etyka biznesu i zrównoważony rozwój. Interdyscyplinarne studia teoretyczno-empiryczne*, *1*, 109-122.
69. Wolniak, R. (2016). *Metoda QFD w zarządzaniu jakością. Teoria i praktyka*. Gliwice: Wydawnictwo Politechniki Śląskiej.
70. Wolniak, R. (2016). Relations between corporate social responsibility reporting and the concept of greenwashing. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacji i Zarządzanie, 87,* 443-453.
71. Wolniak, R. (2016). The role of QFD method in creating innovation. *Systemy Wspomagania Inżynierii Produkcji*, *3*, 127-134.
72. Wolniak, R. (2017). Analiza relacji pomiędzy wskaźnikiem innowacyjności a nasyceniem kraju certyfikatami ISO 9001, ISO 14001 oraz ISO/TS 16949. *Kwartalnik Organizacja i Kierowanie, 2*, 139-150.
73. Wolniak, R. (2017). Analiza wskaźników nasycenia certyfikatami ISO 9001, ISO 14001 oraz ISO/TS 16949 oraz zależności pomiędzy nimi. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacji i Zarządzanie*, *108*, 421-430.
74. Wolniak, R. (2017). The Corporate Social Responsibility practices in mining sector in Spain and in Poland – similarities and differences. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacji i Zarządzanie*, *111*, 111-120.
75. Wolniak, R. (2017). The Design Thinking method and its stages. *Systemy Wspomagania Inżynierii Produkcji, 6,* 247-255.
76. Wolniak, R. (2017). The use of constraint theory to improve organization of work. 4th International Multidisciplinary Scientific Conference on Social Sciences and Arts. SGEM 2017, 24-30 August 2017, Albena, Bulgaria. Conference proceedings. Book 1, *Modern science. Vol. 5, Business and management*. Sofia: STEF92 Technology, 1093-1100.

77. Wolniak, R. (2018). Functioning of social welfare on the example of the city of Łazy. *Zeszyty Naukowe Wyższej Szkoły, Humanitas. Zarządzanie, 3,* 159-176.
78. Wolniak, R. (2018). Methods of recruitment and selection of employees on the example of the automotive industry. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacja i Zarządzanie*, *128*, 475-483.
79. Wolniak, R. (2019). Context of the organization in ISO 9001:2015. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *133*, 121-136.
80. Wolniak, R. (2019). Downtime in the automotive industry production process - cause analysis. *Quality, Innovation, Prosperity*, *2,* 101-118.
81. Wolniak, R. (2019). Leadership in ISO 9001:2015. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *133*, 137-150.
82. Wolniak, R. (2019). Support in ISO 9001:2015. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *137*, 247-261.
83. Wolniak, R. (2019). The level of maturity of quality management systems in Poland-results of empirical research. *Sustainability*, *15*, 1-17.
84. Wolniak, R. (2020). Design in ISO 9001:2015. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *148*, 769-781.
85. Wolniak, R. (2020). Operations in ISO 9001:2015. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *148*, 783-794.
86. Wolniak, R. (2020). Quantitative relations between the implementation of industry management systems in European Union countries. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *142*, 33-44.
87. Wolniak, R. (2021). Internal audit and management review in ISO 9001:2015. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *151*, 724-608.
88. Wolniak, R. (2021). Performance evaluation in ISO 9001:2015. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *151*, 725-734.
89. Wolniak, R. (2022). Engineering ethics – main principles. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *155*, 579-594.
90. Wolniak, R. (2022). Individual innovations. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *166*, 861-876.
91. Wolniak, R. (2022). Management of engineering teams. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *157*, 667-674.
92. Wolniak, R. (2022). Problems of Covid-19 influence on small and medium enterprises activities – organizing function. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *167*, 599-608.
93. Wolniak, R. (2022). Project management in engineering. *Silesian University of Technology Scientific Papers. Organization and Management Series*, *157*, 685-698.

94. Wolniak, R. (2022). Project management standards. *Silesian University of Technology Scientific Papers. Organization and Management Series, 160*, 639-654.
95. Wolniak, R. (2022). Sustainable engineering. *Silesian University of Technology Scientific Papers. Organization and Management Series, 160*, 655-667.
96. Wolniak, R. (2022). The role of the engineering profession in developing and implementing sustainable development principles. *Silesian University of Technology Scientific Papers. Organization and Management Series, 155*, 595-608.
97. Wolniak, R. (2022). Traits of highly innovative people. *Silesian University of Technology Scientific Papers. Organization and Management Series, 166*, 877-892.
98. Wolniak, R. (2023). Analysis of the Bicycle Roads System as an Element of a Smart Mobility on the Example of Poland Provinces. *Smart Cities, 6(1),* 368-391; https://doi.org/10.3390/smartcities6010018.
99. Wolniak, R. (2023). European Union Smart Mobility - aspects connected with bike road systems extension and dissemination. *Smart Cities, 6,* 1-32.
100. Wolniak, R. (2023). European Union Smart Mobility–Aspects Connected with Bike Road System's Extension and Dissemination. *Smart Cities, 6(2),* 1009-1042; https://doi.org/10.3390/smartcities6020049.
101. Wolniak, R. (2023). Innovations in industry 4.0 conditions. *Silesian University of Technology Scientific Papers. Organization and Management Series, 169*, 725-742.
102. Wolniak, R. (2023). Smart mobility jako element koncepcji smart city. *Zarządzanie i Jakość, 1(5),* 208-222.
103. Wolniak, R. (2023). Team innovations. *Silesian University of Technology Scientific Papers. Organization and Management Series, 169*, 773-758.
104. Wolniak, R. Sułkowski, M. (2015). Rozpowszechnienie stosowania Systemów Zarządzania Jakością w Europie na świecie – lata 2010-2012. *Problemy Jakości, 5*, 29-34.
105. Wolniak, R., Grebski, M.E. (2018). Innovativeness and creativity as factors in workforce development – perspective of psychology. *Zeszyty Naukowe Politechniki Ślaskiej. Seria Organizacja i Zarządzanie, 116*, 203-214.
106. Wolniak, R., Grebski, M.E. (2018). Innovativeness and creativity as nature and nurture. *Zeszyty Naukowe Politechniki Ślaskiej. Seria Organizacja i* Zarządzanie, *116*, 215-226.
107. Wolniak, R., Grebski, M.E. (2018). Innovativeness and Creativity of the Workforce as Factors Stimulating Economic Growth in Modern Economies. *Zeszyty Naukowe Politechniki Ślaskiej. Seria Organizacja i Zarządzanie, 116*, 227-240.
108. Wolniak, R., Grebski, M.E., Skotnicka-Zasadzień, B. (2019). Comparative analysis of the level of satisfaction with the services received at the business incubators (Hazleton, PA, USA and Gliwice, Poland). *Sustainability, 10*, 1-22.
109. Wolniak, R., Hąbek, P. (2015). Quality management and corporate social responsibility. *Systemy Wspomagania w Inżynierii Produkcji, 1*, 139-149.

110. Wolniak, R., Hąbek, P. (2016). Quality assessment of CSR reports – factor analysis. *Procedia – Social and Behavioral Sciences, 220,* 541-547.
111. Wolniak, R., Jonek-Kowalska, I. (2021). The level of the quality of life in the city and its monitoring. *Innovation (Abingdon*), *34(3),* 376-398.
112. Wolniak, R., Jonek-Kowalska, I. (2021). The quality of service to residents by public administration on the example of municipal offices in Poland. *Administration Management Public*, *37*, 132-150.
113. Wolniak, R., Jonek-Kowalska, I. (2022). The creative services sector in Polish cities. *Journal of Open Innovation: Technology, Market, and Complexity, 8(1),* 1-23.
114. Wolniak, R., Saniuk, S., Grabowska, S., Gajdzik, B. (2020). Identification of energy efficiency trends in the context of the development of industry 4.0 using the Polish steel sector as an example. *Energies, 13(11),* 1-16.
115. Wolniak, R., Skotnicka, B. (2011).: *Metody i narzędzia zarządzania jakością – Teoria i praktyka, cz. 1.* Gliwice: Wydawnictwo Naukowe Politechniki Śląskiej.
116. Wolniak, R., Skotnicka-Zasadzień, B. (2008). *Wybrane metody badania satysfakcji klienta i oceny dostawców w organizacjach.* Gliwice: Wydawnictwo Politechniki Śląskiej.
117. Wolniak, R., Skotnicka-Zasadzień, B. (2010). *Zarządzanie jakością dla inżynierów.* Gliwice: Wydawnictwo Politechniki Śląskiej.
118. Wolniak, R., Skotnicka-Zasadzień, B. (2018). Developing a model of factors influencing the quality of service for disabled customers in the condition s of sustainable development, illustrated by an example of the Silesian Voivodeship public administration. *Sustainability, 7, 1*-17.
119. Wolniak, R., Skotnicka-Zasadzień, B. (2022). Development of photovoltaic energy in EU countries as an alternative to fossil fuels. *Energies, 15(2),* 1-23.
120. Wolniak, R., Skotnicka-Zasadzień, B., Zasadzień, M. (2019). Problems of the functioning of e-administration in the Silesian region of Poland from the perspective of a person with disabilities. *Transylvanian Review of Public Administration, 57E,* 137-155.
121. Wolniak, R., Sułkowski, M. (2015). Motywy wdrażanie certyfikowanych Systemów Zarządzania Jakością. *Problemy Jakości, 9,* 4-9.
122. Wolniak, R., Sułkowski, M. (2016). The reasons for the implementation of quality management systems in organizations. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacji i Zarządzanie, 92,* 443-455.
123. Wolniak, R., Wyszomirski, A., Olkiewicz, M., Olkiewicz, A. (2021). Environmental corporate social responsibility activities in heating industry - case study. *Energies, 14(7),* 1-19, 1930.
124. Yagi, T. (2016). *The outlook of smart city project in Tamachi district, Tokyo, CIGRE Session 46*.

125. Zhang, X. (2021). *Analysis of Smart Cities in Singapore Based Artificial Intelligence*. 2021 IEEE International Conference on Robotics, Automation and Artificial Intelligence, RAAI 2021, 73-77.
126. Zhong, C., Batty, M., Manley, E., Chen, F., Schmitt, G. (2016). Variability in regularity: Mining temporal mobility patterns in London, Singapore and Beijing using smart-card data. *PLoS ONE, 11(2),* e0149222.