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The Utilization of Intelligent Traffic Systems for Managing Traffic Problems in Tourism Areas: A Literature Review

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Abstract: This research aims to investigate the utilization of intelligent traffic systems (ITS) to address traffic issues in regions popular among tourists. The present study employs a literature review methodology to systematically analyze and compile diverse research findings about the utilization of technology in traffic engineering within tourist destinations. The results indicate that implementing intelligent transportation systems (ITS) can be viable for addressing traffic management challenges in tourist destinations. Integrating information and communication technology (ICT) can optimize traffic management, enhance transportation infrastructure, augment transportation coordination and management, and bolster traffic security in tourist destinations. The prescribed steps for implementing ITS involve conducting a thorough analysis of needs, devising, and designing an appropriate ITS solution, executing the implementation process, and operationalizing and maintaining the ITS system. The study's findings suggest that Intelligent Transportation Systems (ITS) hold significant promise for enhancing traffic management in tourist regions. Implementing suitable measures by Intelligent Transportation Systems (ITS) can effectively address traffic congestion, insufficient infrastructure, inadequate coordination, and safety concerns in managing traffic in tourist destinations. Furthermore, implementing Intelligent Transportation Systems (ITS) can enhance efficiency, safety, and the overall tourist experience while mitigating the environmental footprint of transportation systems in tourist destinations. The Intelligent Traffic System (ITS) is a traffic management solution that utilizes information and communication technology to enhance traffic flow and safety. ITS is particularly relevant in tourist areas where traffic congestion can be a significant issue.

Keywords: Intelligent Transportation Systems; Traffic Engineering; Tourism Areas; Traffic Problems; Indonesia

Abstrak: Penelitian ini bertujuan untuk menyelidiki pemanfaatan sistem lalu lintas cerdas (ITS) untuk mengatasi masalah lalu lintas di daerah yang populer di kalangan wisatawan. Studi ini menggunakan metodologi tinjauan literatur untuk menganalisis dan menyusun berbagai temuan penelitian secara sistematis tentang pemanfaatan teknologi dalam rekayasa lalu lintas di daerah tujuan wisata. Hasil penelitian ini menunjukkan bahwa penerapan sistem transportasi cerdas (ITS) dapat dilakukan untuk mengatasi tantangan manajemen lalu lintas di tujuan wisata. Mengintegrasikan teknologi informasi dan komunikasi (TIK) dapat mengoptimalkan manajemen lalu lintas, meningkatkan infrastruktur transportasi, meningkatkan koordinasi dan manajemen transportasi serta meningkatkan keamanan lalu lintas di tujuan wisata. Langkah-langkah yang ditentukan untuk mengimplementasikan ITS meliputi melakukan analisis kebutuhan secara menyeluruh dan merancang solusi ITS yang tepat,

melaksanakan proses implementasi, dan mengoperasionalkan serta memelihara sistem ITS. Temuan studi ini menunjukkan bahwa Intelligent Transportation Systems (ITS) menjanjikan peningkatan manajemen lalu lintas di kawasan wisata. Menerapkan langkah-langkah yang sesuai dengan Intelligent Transportation Systems (ITS) dapat secara efektif mengatasi kemacetan lalu lintas, infrastruktur yang tidak memadai, koordinasi yang tidak memadai, dan masalah keselamatan dalam mengelola lalu lintas di tujuan wisata. Selain itu, penerapan ITS dapat meningkatkan efisiensi, keamanan, dan pengalaman wisata secara keseluruhan sekaligus mengurangi dampak lingkungan dari sistem transportasi di destinasi wisata. ITS adalah solusi manajemen lalu lintas yang memanfaatkan teknologi informasi dan komunikasi untuk meningkatkan arus dan keselamatan lalu lintas. ITS sangat relevan di kawasan wisata dengan masalah tingkat kemacetan lalu lintas yang tinggi.

Kata kunci: Sistem Transportasi Cerdas; Rekayasa Lalu Lintas; Kawasan Pariwisata; Masalah Lalu Lintas; Indonesia

Introduction

The issue of heavy traffic in tourist destinations poses a significant challenge that impacts both the quality of the tourist experience and the long-term viability of the tourism industry. Traffic congestion in tourist destinations has been exacerbated by the surge in tourist influx and the expansion of tourist amenities in recent times. The primary obstacles government officials, tourist area managers, and visitors encounter are sluggish vehicular mobility, congestion, and parking complications. The utilization of technology in traffic engineering within tourist areas has garnered significant attention from researchers and practitioners to mitigate this issue. The utilization of technology can significantly contribute to enhancing mobility efficiency, decreasing travel duration, enhancing the quality of the tourist experience, and mitigating adverse environmental and societal effects on local communities. Intelligent Transportation System (ITS) involved in utilizing diverse systems and structured technologies to manage, mitigate, and resolve traffic congestion issues.

The examples of this traffic congestion problem occurred in many tourism destinations in Bali. According to Central Bureau of Statistics (BPS) figures from 2019, the number of visitors to the Lovina Beach Tourism Area reached 57,627 each year, with a daily total of 1,038 (Wardhana, 2021). Meanwhile, Penimbangan Beach had 15,433 tourists every year, with 435 visitors per day (Wardhana, 2021). Such visitor numbers have a considerable impact on the flow of people within the Tourism Area's Road network, which features a linear road plan incorporating the National Road and District Road. As a result, these roads are the primary means of access for the community to the beach region, resulting in a somewhat high traffic volume on various road sections within this area, compromising the performance of the road network (Wardhana, 2021). The Volume to Capacity (V/C) ratio on the National Road sections in the Lovina Beach and Penimbangan Beach Tourism Areas reached 0.83 in 2020, with a road

density of 53.6 passenger car units (smp) per kilometer and an average vehicle speed of 35.67 km/h, indicating a level of service D for the road sections, according to data from the Buleleng Regency Field Work Team (Wardhana, 2021). Furthermore, Wardhana (2021) explained that two intersections in this area had high saturation levels, reaching 0.91, and delays of 37.4 smp/second, resulting in a level of service D for the intersections as well.

The significance of investigating technology implementation in traffic engineering within tourist regions lies in acquiring a more comprehensive comprehension of technology's advancements and prospective utilization in this field. This literature review examines the implementation of technology that has been conducted thoroughly. Furthermore, a comprehensive comprehension of the technological applications utilized in traffic engineering within tourist destinations can provide significant perspectives for decision-makers, tourism area administrators, and other pertinent stakeholders in formulating efficacious tactics to enhance mobility, tourist satisfaction, and the overall sustainability of tourism.

This article employs the phrase "traffic engineering." Traffic engineering pertains to the fields and procedures associated with the strategic development, conceptualization, implementation, and regulation of vehicular traffic and its corresponding infrastructure (Suthanaya, 2023). Traffic engineering aims to attain optimal levels of efficiency, safety, and seamless flow of vehicular traffic on highways (Guidoni et al., 2020). Traffic engineering assumes significance in tourist regions due to the amplified tourist mobility and augmented vehicular movement near tourist destinations. The utilization of technology in traffic engineering within tourist destinations is anticipated to enhance the quality of the tourist encounter, mitigate traffic congestion, and promote the sustainability of tourism.

Traffic management in popular tourist areas is frequently confronted with intricate and demanding problems. Srisusilawati et al., (2022) noted that traffic congestion is a common problem. The rise in the number of tourists leads to a corresponding surge in vehicular traffic within the tourist zone, resulting in pronounced congestion. The presence of congestion not only impedes the mobility of visitors but also exerts an adverse influence on the adjacent ecosystem and the overall quality of the tourist encounter.

Apart from traffic congestion, the insufficiency of infrastructure to accommodate the substantial volume of vehicles in tourist destinations is another prevalent issue (Nugroho & Nicholas, 2018). Insufficient road width and inadequate parking facilities may be observed in specific tourist destinations,

leading to difficulties in accommodating the influx of vehicles (Parwata et al., 2021; Sumarabawa et al., 2015). This phenomenon has the potential to result in disarray in vehicular movement, haphazard parking, and discomfort for the visiting populace.

Moreover, optimizing transportation planning and arrangements in tourist destinations is frequently inadequate. Insufficient collaboration among pertinent stakeholders (Poli et al., 2022), including regional administrations, transportation service providers, and tourism organizers, may lead to suboptimal traffic control and the absence of a cohesive approach. Furthermore, the lack of precise and up-to-date information poses a challenge, impeding tourists ability to ascertain traffic conditions, alternate routes, or modifications in transportation arrangements (Indiani et al., 2021).

Security is a commonly encountered issue in traffic management within tourist destinations (Yuniarto, 2019). The escalation of vehicular and pedestrian traffic within tourist destinations heightens the likelihood of vehicular mishaps. The existence of non-native visitors who lack familiarity with the regional traffic conditions may also engender hazardous circumstances. Hence, it is imperative to implement efficacious security measures, including heightened police surveillance, enhanced traffic control, and augmented tourist safety education.

Implementing intelligent transportation systems (ITS) is a viable solution for addressing traffic management issues in tourist destinations. Information and communication technology (ICT) can offer efficacious remedies to mitigate traffic congestion, enhance transportation infrastructure management, augment coordination among relevant stakeholders, and enhance traffic safety in tourist destinations. By implementing appropriate Intelligent Transportation Systems (ITS), it is possible to access real-time traffic information, offer alternative lanes for tourists, optimize traffic management, and implement effective safety measures to enhance the tourist experience and ensure their safety.

Numerous research endeavors have investigated the utilization of technology in traffic engineering management. These previous studies aim to discover novel approaches that can enhance transportations effectiveness, security, and eco-friendliness. Various technological advancements have been investigated in transportation, such as intelligent transportation systems (ITS), using sensors and smart devices for traffic data collection, and implementing artificial intelligence and data analysis for traffic prediction and optimization. The studies mentioned above establish a crucial basis for formulating novel approaches to enhance the future efficacy of traffic engineering administration.

The study by Wen et al., (2019) proposed using tourism traffic matching curves to evaluate the equilibrium and sustainability of resources within tourism traffic networks. The study employs the concept of conceptual transfer to produce a curve for matching tourism traffic. This curve streamlines the sustainability and balance assessment while yielding more efficient and unambiguous outcomes. The present investigation involved an analysis of the primary determinants underlying the establishment of tourism traffic networks. To this end, a comprehensive multi-objective model based on profit maximization was employed, utilizing MATLAB as the primary analytical tool. The current approach incorporates the frequently disregarded impacts of tourisms economic radiation and uses genetic algorithms in its resolution. Furthermore, the present investigation furnishes the attributes of the curve that matches the tourism traffic, along with two crucial equilibrium indicators, specifically the Tourism Traffic Network Uniformity Coefficient (TLCU) and Curvature Coefficient (TLCC). The findings of this study demonstrate that the proposed system exhibits superior efficiency and precision compared to alternative approaches. These results suggest that additional research is necessary to establish effective criteria and theoretical analysis methods for dynamic adjustment.

The article by Li et al., (2017) examines techniques to establish enduring traffic systems during the new urban planning phase. The study focuses on implementing integrated traffic planning for new tourism cities in southern China. This study addresses the key considerations that must be taken into account to achieve convenient transportation, encompassing the incorporation of transit-oriented development (TOD) directives, the design of traffic infrastructure, the adaptation of urban operations, and the formulation of land use strategies that promote the objectives of public transportation entities. Furthermore, the research suggests incorporating resident and tourist mobility to facilitate the utilization of transportation infrastructure for tourism and urban transportation purposes. The study additionally suggests establishing a transportation system that is not reliant on motor vehicles and aligned with the inherent geographical features of the metropolitan area. The study recommends developing a comprehensive transportation center and implementing policies to address the seasonal fluctuations in tourism traffic.

Mrnjavac & Marsanic, (2007) study focuses on using intelligent transportation systems (ITS) to improve traffic flow in tourist areas. The proliferation of motorization, coupled with limited investments in transportation infrastructure in urban and tourist locales, has resulted in significant challenges for vehicular mobility within public thoroughfares. Intelligent transportation systems have the potential to be deployed in urban hubs and popular tourist locales where expanding traffic infrastructure may not be feasible.

In their study, Qin et al., (2019) employed big data technology, call detail record (CDR) data, and real-time mobile phone location information to monitor tourist flow and analyze tourist behavior in popular tourist destinations. This study utilizes CDR data and modeling analysis to offer substantial data-driven assistance in mitigating traffic congestion at popular tourist destinations and routes within urban areas while also promoting the rational allocation of traffic resources. Using big data analysis techniques that rely on mobile call detail records (CDR), data can furnish prompt and efficient insights into the conduct of travelers. The data above can be utilized in the operational management of tourist destinations, offering immediate big data assistance for implementing "smart tourism."

Through cyber-physical systems (CPS), Wang et al., (2020) study presents a novel strategy for effective traffic management in tourist areas. This approach involves exchanging information among tourists through mobile phone applications, traffic information platforms, and parking areas. Intelligent traffic management has implemented through interactions, information exchange, and physical mobility. The present study employed AnyLogic simulations to model a cyber-physical system for traffic control and information sharing in the Wuyuan tourist area located in Jiangxi province. The Markov model was applied to facilitate the simulation process. The simulation findings indicate that disseminating information can effectively reduce the duration of vehicle waiting times and enhance the utilization rate of tourist destinations. The techniques suggested in this research have the potential to mitigate traffic congestion and facilitate intelligent traffic control in popular tourist destinations during peak periods.

Kadkhodaei & Shad (2018) used the Analytical Hierarchy Process (AHP) technique to examine and evaluate traffic congestion management strategies in urban tourism. Frequently employed strategies for managing traffic congestion in urban regions include the implementation of limited traffic zones, adopting alternate traffic schemes based on even and odd numbers, and utilizing congestion pricing. The present study involved a comparative and evaluative analysis of traffic congestion control techniques through analytical hierarchy analysis. The findings indicate that the optimal means of evaluating traffic congestion management strategies in urban areas include enhancing traffic flow, promoting societal well-being, mitigating environmental degradation, and enhancing safety during intra-city travel. Practical strategies for managing traffic congestion include implementing congestion pricing, utilizing alternate traffic plans based on even and odd-numbered license plates, and installing traffic barriers. The software "Expert Choice" is utilized to derive the analysis outcomes and compare pairs in analytical hierarchy analysis.

The reviewed literature presents several significant contributions. Wen, Zeng, and Tang (2019) have proposed a tourism traffic matching curve to assess tourism traffic networks' sustainability and resource equilibrium. Li, Li, Ju, and Zhang (2017) conducted a study on sustainable traffic systems during the planning phase of new tourism cities in China. The study by Mrnjavac and Marsanic (2007) sheds light on using intelligent transportation systems (ITS) to improve traffic flow in tourist areas. Qin et al. (2019) conducted a study utilizing big data technology to monitor tourist flow and analyze travel behavior in popular tourist destinations. According to Wang, Zhang, and Liu's (2020) study, a potential solution for efficient traffic management in tourist areas is the implementation of cyber-physical systems (CPS) and exchanging information among tourists, traffic information platforms, and parking facilities. Kadkhodaei and Shad's (2018) study analyzed and evaluated traffic congestion control techniques in popular tourist destinations in metropolitan cities, utilizing the Analytical Hierarchy Process (AHP) methodology.

Numerous scholarly works have explored the topic of traffic management in the tourism sector. These studies have delved into various aspects, such as assessing sustainability, establishing sustainable traffic systems, implementing intelligent transportation systems (ITS), and utilizing big data technology. While the aforementioned studies offer valuable insights, there remains a requirement for research that amalgamates diverse literature findings to holistically examine the integration of information and communication technology (ICT) in traffic management within tourist destinations. This article will offer an enhanced understanding of the utilization of technology to improve sustainability, efficiency, and the tourist experience in transportation hubs within the tourism industry. This research addresses the requirement for efficient criteria and theoretical techniques for analyzing dynamic adjustments in traffic engineering within tourist destinations.

Method

The present investigation employs a literature review methodology to scrutinize diverse research findings pertaining to the utilization of technology in traffic engineering within tourist destinations. This methodology facilitates acquiring and examining pertinent scholarly literature, encompassing peer-reviewed articles, conference proceedings, monographs, and additional resources germane to the subject of inquiry.

The initial phase of this research methodology involves the discernment of pertinent keywords on the research subject matter, including but not limited to "traffic engineering," "technology," "tourist area," and other associated terminology. Subsequently, scholarly inquiries had conducted utilizing

academic databases, electronic repositories, and scientific search engines like Google Scholar. The objective of this inquiry is to gather literature that is pertinent to the subject matter under investigation. Moreover, the literature selection process entails assessing the pertinence and caliber of the collected sources. The evaluation method involves scrutinizing each publication's abstracts, summaries, and introductions to ascertain their relevance to the research topic. In the analysis process, sources deemed irrelevant or lacking in qualifications are eliminated, while those deemed relevant have been retained for subsequent stages of analysis.

The literature analysis process involves examining and documenting significant discoveries, techniques employed, and research outcomes pertaining to the utilization of technology in traffic engineering within tourist destinations. The procedure entails meticulously examining the subject matter, discerning recurring themes, commonalities, disparities, and the merits and demerits of implementing technology within the examined framework. The present research methodology aims to facilitate a comprehensive comprehension of antecedent studies concerning the utilization of technology in traffic engineering within tourist destinations. By incorporating a thorough literature review, this study can enhance comprehension and knowledge regarding the utilization of technology to enhance efficacy, security, and user satisfaction within tourist destinations.

Results and Discussion

Intelligent Transportation System

The Intelligent Transportation System (ITS) is a sophisticated network of technologies and infrastructure designed to improve transportation systems' safety, efficiency, and sustainability. The Intelligent Transportation System (ITS) is a theoretical framework that integrates transportation infrastructure with information and communication technology to enhance its effectiveness, safety, and sustainability (Laksana, 2019; Suthanaya, 2023). The field of Intelligent Transportation Systems (ITS) is concerned with the utilization of various technological tools such as sensors, computers, networks, and software to gather, analyze, and disseminate pertinent data to enhance transportation management (Guerrero-Ibanez et al., 2015; Popescu et al., 2017).

The Intelligent Transportation Systems (ITS) framework uses sensors strategically placed on transportation infrastructure such as roads and vehicles to gather pertinent information on various factors, including traffic conditions, weather patterns, and special events. The information is subsequently transmitted to a control center, which employs computer systems and software to scrutinize and handle the data (Guerrero-Ibanez et al., 2015; Popescu et al.,

2017). The outcomes of this analysis possess the potential to facilitate well-informed judgments in the domains of traffic management, accident management, traffic signal configurations, and the dissemination of information to drivers.

According to Saputra & Slameta (2020), using vehicle detection mechanisms at road junctions connected to the central control center is an example of the implementation of Intelligent Transportation Systems (ITS). The sensor has the capability to perceive the number of vehicles traversing and transmitting said data to the central command hub. The control center can use the information to dynamically adjust traffic signals, reducing traffic congestion and wait times. Furthermore, the Intelligent Transportation System (ITS) has the capability to furnish drivers with up-to-date data regarding road conditions, traffic congestion, and viable alternate routes, thereby facilitating informed decision-making by drivers.

Regarding security, ITS can employ communication technology to enable interaction between infrastructure and vehicles (Huang et al., 2017; Khan et al., 2021). A collision notification system can be installed in a vehicle, automatically transmitting signals to the control center in the event of an accident. This enables the relevant authorities to address the incident and offer the requisite aid promptly.

The ITS concept generally presents a comprehensive framework for enhancing transportation management by applying information and communication technology. Implementing intelligent transportation systems (ITS) can facilitate the optimization of transportation infrastructure, enhance efficiency, mitigate congestion, enhance safety, and minimize the environmental footprint of the transportation system through the collection, analysis, and transmission of pertinent data.

Traffic Management Issues in Tourist Areas

Traffic management in tourist destinations is frequently confronted with intricate and multifaceted obstacles. Traffic congestion is a prevalent issue that frequently arises (Srisusilawati et al., 2022). A notable rise in tourist influx can lead to a corresponding surge in vehicular traffic within the tourism zone, posing a considerable traffic congestion risk. The congestion mentioned above not only hinders the mobility of tourists but also adversely influences the adjacent ecosystem and the holistic tourism encounter.

Aside from traffic congestion, the insufficiency of infrastructure to accommodate the substantial influx of vehicles in tourist destinations is a prevalent issue (Nugroho & Nicholas, 2018). Specific tourist destinations may

lack sufficiently broad thoroughfares or appropriate parking facilities to cater to the volume of automobiles arriving. This phenomenon may lead to disordered traffic, haphazard parking, and discomfort for visitors.

In addition, the planning and organization of transportation in tourist destinations frequently fall short of optimal. Inefficiencies in traffic management and a lack of integrated strategies may arise due to inadequate coordination among pertinent stakeholders, including local governments, transportation operators, and tourism managers (Poli et al., 2022). The absence of precise and up-to-date data can pose a challenge, impeding commuters' ability to ascertain traffic status, substitute pathways, or modify conveyance schedules.

Security is a commonly encountered issue in traffic management within tourism destinations (Yuniarto, 2019). The rise in vehicular and pedestrian traffic within tourist destinations has been observed to elevate the likelihood of road accidents. The existence of non-home-grown visitors who lack knowledge of the regional traffic norms may also result in perilous circumstances. Hence, it is imperative to implement efficacious security measures, such as augmenting police patrols, enhancing traffic management, and promoting greater safety consciousness among tourists.

Intelligent Transportation System (ITS) as a Solution for Traffic Management Problems in Tourist Areas

In general, managing traffic in regions that attract tourists presents complex challenges. Some primary concerns that require attention include congestion, insufficient infrastructure, inadequate coordination, inaccurate information, and security challenges. Overcoming these obstacles necessitates meticulous strategizing, effective collaboration among diverse stakeholders, the utilization of advanced information and communication technologies, and recognition of the significance of ensuring tourists' safety and good encounters.

The utilization of intelligent transportation systems (ITS) has the potential to serve as a viable remedy for addressing traffic management issues in tourist destinations. Integrating information and communication technology in transportation systems, commonly referred to as "intelligent transportation systems" (ITS), aims to enhance efficiency, security, and comfort in the transportation sector. Adopting intelligent transportation systems (ITS) can enhance the efficacy, organization, and sustainability of traffic control in tourist destinations, yielding favorable outcomes for tourist mobility, ecological sustainability, and the regional economy.

Initially, implementing an intelligent transportation system (ITS) can aid in mitigating traffic congestion in popular tourist destinations through an advanced traffic management system. The utilization of sensor and sensing technologies that are linked to communication networks can gather traffic data promptly, as evidenced by studies conducted by Guerrero-Ibanez et al., (2015), Nellore & Hancke (2016), and Saputra & Slameta (2020). The data above can be utilized to enhance traffic light configurations, forecast traffic trends, and furnish drivers with details regarding feasible alternate lanes. Therefore, the alleviation of congestion can lead to a reduction in travel time for tourists.

According to Nugroho & Nicholas (2018), implementing ITS can potentially enhance the transportation infrastructure in tourist destinations. By utilizing sensors, vehicle-to-infrastructure (V2I) communication, and intelligent parking management systems, tourist area managers can increase the utilization of parking spaces, prevent traffic disruption from illegal parking, and direct vehicles towards open parking spaces (Lin et al., 2017; Litman, 2016). Furthermore, using mobile applications or tourist information systems linked to Intelligent Transportation Systems (ITS) can furnish instantaneous details regarding parking, public transportation, and the most efficient tourist itineraries.

Thirdly, implementing intelligent transportation systems (ITS) can enhance the coordination and management of transportation in tourist destinations. Implementing a communication system that integrates vehicles, tour managers, and authorities can facilitate the rapid and precise dissemination of crucial information to tourists, including but not limited to public transportation schedules, traffic arrangement modifications, and road conditions. Implementing this measure can prevent ambiguity and inconvenience during travel, promoting a seamless travel encounter.

Ultimately, the implementation of intelligent transportation systems (ITS) has the potential to enhance traffic safety in regions frequented by tourists. According to Ko & Song, (2021) and Mahmoud (2019), the utilization of closed-circuit television (CCTV) cameras and sensors as detection and monitoring systems can aid in the identification of potentially hazardous occurrences or traffic-related mishaps. The efficient distribution of this information to the relevant authorities or travelers via the Vehicle-to-Infrastructure (V2I) system can facilitate the prompt implementation of appropriate measures. Furthermore, employing intelligent transportation systems (ITS) can facilitate the deployment of preemptive measures to mitigate the likelihood of road mishaps and enhance the consciousness of safety among commuters.

The empirical implementation of Intelligent Transportation Systems (ITS) as a solution to overcome traffic congestion draws inspiration from the successful implementation of a similar program in Jogjakarta, known for its smart city initiatives (Alkis, 2018). Furthermore, in her research, Alkis (2018) elaborated and described in using of ITS in Yogyakarta. In the context of a smart city, the application of Intelligent Transportation Systems (ITS) involves the use of CCTV as sensors for traffic monitoring (Alkis, 2018). The data collected from CCTV cameras is analyzed at the Control Center (CC Room) to understand traffic patterns. Twitter is utilized to provide information and updates to the public. Red light durations at the Sunan Kalijaga intersection can be adjusted from the control center to optimize traffic flow (Alkis, 2018). Bus tracking using CCTV allows for real-time updates on Trans Jogja bus movements. The implementation of e-ticketing for Trans Jogja buses serves as a sensor, but further details on data management and actions are unknown (Alkis, 2018). The utilization of speed sensors and social media data from netizens in Yogyakarta requires clarification regarding data management processes and subsequent actions (Alkis, 2018). The case mentioned above is the data that depicts how the ITS implemented integrally in broader concept of smart city which effectuates the traffic flow in the city, especially in the tourist areas.

In general, the utilization of intelligent transportation systems (ITS) in the management of traffic within tourist destinations has the potential to address a number of prevailing issues. The implementation of information and communication technology has the potential to mitigate congestion, enhance infrastructure, optimize coordination, and fortify security measures.

Intelligent Transportation System (ITS) Implementation on Traffic Management in Tourist Areas

Deploying an intelligent transportation system (ITS) for traffic control in tourist areas necessitates adhering to a series of procedural stages. Initially, it is imperative to comprehensively examine the traffic management requirements in regions that attract tourists. During this phase, an analysis has been conducted to identify issues that may arise in traffic management in tourist destinations. These problems may include traffic congestion, non-compliant parking, and inadequate coordination of transportation services. The analytical process also encompasses comprehending the attributes of traffic in tourist destinations, comprising factors such as the number of vehicles, travel patterns of tourists, and locations of high tourist density.

Subsequently, the subsequent phase involves strategizing and formulating intelligent transportation systems (ITS) solutions tailored to the unique attributes

and requirements of the tourism destination. Opting for appropriate technology, including sensors, vehicle-to-infrastructure (V2I) communication, and integrated information systems, is imperative. The planning and designing process involves identifying suitable locations for sensor installations and Intelligent Transportation Systems (ITS) infrastructure, establishing communication networks, and integrating data management systems. Incorporating the ITS solution necessitates considering its security, interoperability, and scalability aspects.

Following the completion of the planning and design phases, the subsequent course of action involves the execution of intelligent transportation systems (ITS) solutions to manage traffic in tourist destinations. The present phase encompasses installing both hardware and software components, along with conducting system testing procedures to verify that the system's performance is in line with the anticipated outcomes. The implementation process may be executed incrementally, commencing with a particular region or center of attention, such as an intersection or parking facility. Experiments are carried out to validate the system's capacity to gather and analyze traffic data instantaneously, furnish precise data to users, and enhance traffic efficacy and security in regions frequented by tourists.

The following phase involves the processes of operationalization and maintenance. Following the completion of the implementation phase, the Intelligent Transportation System (ITS) designed for traffic management in tourist destinations is now fully operational. This phase encompasses the establishment and execution of the system, including monitoring performance, maintaining hardware and software, and implementing system upgrades in response to user input. In the process of operationalization, it is crucial to engage pertinent stakeholders, including managers of tourist areas, transportation authorities, and tourists themselves. Maintaining a seamless and efficient Intelligent Transportation System (ITS) in tourist regions necessitates collaboration among diverse stakeholders involved in traffic management.

Conclusion

The implementation of the Intelligent Transportation System (ITS) has the potential to serve as a viable remedy for addressing traffic management issues in tourist destinations. By incorporating information and communication technology, intelligent transportation systems (ITS) can enhance traffic management, upgrade transportation infrastructure, refine transportation coordination and management, and heighten traffic security in tourist destinations. The successful implementation of Intelligent Transportation

Systems (ITS) in tourist areas necessitates adherence to crucial steps such as conducting a needs analysis, devising, and designing ITS solutions, executing the plan, and ensuring the operationalization and maintenance of the system.

When conducting a needs analysis, it is crucial to recognize the developing issues in traffic control within tourist destinations and comprehend the attributes of traffic flow in such locations. Subsequently, the subsequent phase entails devising and formulating information technology solutions tailored to the tourist region's requirements, encompassing the identification of appropriate technologies and the incorporation of data management systems. Subsequently, the implementation of ITS solutions may be executed incrementally, beginning with specific regions or centers of attention. System testing aims to validate the system's capacity to gather, manipulate, and transmit real-time traffic data.

The Intelligent Transportation System (ITS) is considered operational upon completion of the implementation phase. Engaging relevant stakeholders and facilitating communication among diverse parties, including tourism site administrators, transportation regulatory bodies, and visitors, is crucial during this phase. The operationalization process entails establishing and managing intelligent transportation systems, including monitoring system performance, maintaining hardware and software components, and implementing system upgrades in response to user input.

The effective implementation of intelligent transportation systems (ITS) has the potential to address issues related to traffic congestion, inadequate infrastructure, poor coordination, and safety concerns in managing traffic flow within tourist areas. Intelligent Transportation Systems (ITS) have the potential to enhance operational efficiency, promote safety, and augment the overall tourist experience. Additionally, ITS can contribute to mitigating the environmental footprint of transportation systems in tourist destinations. Hence, there is a requirement for research that integrates the diverse findings of the previous literature to comprehensively comprehend and synchronize the deployment of intelligent transportation systems (ITS) in managing traffic in tourist areas.

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