Transforming Urban Traffic Systems with Artificial Intelligence

1st Leangchheng Phorn
Institute of Digital Technology
Cambodia Academy of Digital
Technology
Phnom Penh, Cambodia
leangchheng.phorn@student.cadt.edu.kh

2nd Rothanak Khov
Institute of Digital Technology
Cambodia Academy of Digital
Technology
Phnom Penh, Cambodia
rothanak.khov@student.cadt.edu.kh

3rd Sunhak Oeng
Institute of Digital Technology
Cambodia Academy of Digital
Technology
Phnom Penh, Cambodia
sunhak.oeng@student.cadt.edu.kh

4th Kimhong Yan
Institute of Digital Technology
Cambodia Academy of Digital
Technology
Phnom Penh, Cambodia
kimhong.yan@student.cadt.edu.kh

5th Porcheu Leng
Institute of Digital Technology
Cambodia Academy of Digital
Technology
Phnom Penh, Cambodia
porcheu.leng@student.cadt.edu.kh

Abstract - Artificial intelligence (AI) is completely disrupting our interaction with urban traffic. Having a genius sidekick that can crunch information in real-time, determine where traffic is going to bunch up, and enable cool technology such as traffic lights with a mind of their own or mechanisms that can detect accidents before they can ruin your commute is like having. AI can eliminate those irritating traffic jams, reduce accidents on the road, and ensure that buses and trains operate so smoothly that you may not hate your commute to the office. Nevertheless, the introduction of AI to the traffic is not that straightforward. Its adoption can be hindered or made challenging by high costs, absence of technical expertise, concerns on privacy and obsolete infrastructure.

In this study, we explored AI applied to traffic management, AI technology used in Traffic, Case Study of global AI application, Cambodia Smart City Strategy, benefits of Integration with AI and Challenges in Adoption. We have summarized fifty relevant research articles that were discovered using databases such as Google Scholar, ResearchGate, and IEEE Xplore. Those articles allowed us to recognize the existing developments and opportunities in the field of AI application in municipal traffic. We reveal that AI has a great potential to help in making the transportation in cities more efficient, safer, and smarter, however, to succeed, cities should plan well and invest in appropriate resources.

***Keywords*— Artificial Intelligence, Urban Traffic Systems, Smart Cities, Traffic Management, Benefits and Challenges, AI Adoption Risks**

I. INTRODUCTION

Cities are now more wildly busy with traffic than ever. As cities expand at abnormally high rates and the traffic infrastructure fails to cope up with the increased traffic, traveling to and back home has turned into an energy-consuming ordeal. The use of conventional approaches into management of traffic such as the use of fixed-timers and manual control has proved ineffective in managing dynamic and unpredictable flow of modern traffic in urban areas. Congestion means more carbon emissions, more accidents, and less tolerance by the citizens. Artificial Intelligence (AI) is the solution that comes in here. Consider intelligent systems capable of real-time traffic analysis, signal optimization, redirection of the traffic flow prior to the development of a jam and service of the emergency vehicles to the lines before anyone notices the emergency. The largest experiences of controlling traffic with the use of AI have started in a few big cities, and most of the examples are small-scale or
concentrated on high-tech cities only. The key issue is that the the problem of adaptation of such innovations to smaller or developing cities still exists: the severity of traffic problems in these cases is equally intensive, yet the resources are scarce. The purpose of this paper is to discuss how AI-based solutions should

be scaled and modified to enhance traffic patterns, safety, and environmental sustainability of cities of any size. We are going to research the existing solutions of AI in traffic systems, analyze the applicability, and figure out the limits preventing more widespread implementation, whether they are technical, logistical, or regulatory. Finally, this study aims to come up with practical ideas on how to redesign efficient urban traffic infrastructure into smart and flexible systems that can accommodate everyone and everywhere.

II. LITERATURE REVIEW

A. AI in Traffic Management System

The speed of urbanization has resulted in traffic jams which are overwhelming the available means of transportation through vehicles. This progressive traffic congestion has led to the introduction of Artificial Intelligence (AI)-based traffic management systems that ease gridlocks, eliminate commuting duration and improves general urban mobility. There is a steady increase in the amount of literature pointing to the transformative power of AI in optimising traffic, reducing environmental effects and enabling sustainable development of urban regions. A major use of AI in the traffic system is in the domain of intelligent vehicle routing and congestion mitigation. AI technologies are very dynamic as they apply road conditions to changes by considering real-time information, personal travel patterns, and road network attributes. This can be used to find the best pathways as well as absorption of vehicle movement to prevent the hotspots of congestion. Through simulation based tests, such systems have demonstrated quantifiable improvements in terms of travel times, fuel uses and emissions [1]. The combination of deep learning and big data analysis is another important breakthrough in AI management in traffic, especially in performing real time prediction on traffic. In one such case, more than 11 years of data collected by the California Department of Transportation was utilized to train deep neural networks that could create real-time forecasts of large scale. The system combines the concepts of big data, GPU acceleration, in-memory computing and new model structures to make congestion prediction faster and accurate [2]. Such predictive features may greatly improve in terms of traffic control and the navigation process. Traffic signals are also undergoing a revolution with the use of AI-based traffic control devices. The fixed timing systems are being more and more replaced by the intelligent controllers, which react to the real-time conditions in the traffic. As an example, AI-based adaptive traffic light systems can reduce the amount of carbon emissions, fuel inefficiency, and waiting time by adjusting signal time depending on traffic congestion. These systems lower the issue of policing traffic manually especially during hour-peak and health and environmental issues that arise due to extended exposure to traffic generated air and noise pollution [3]. Using IoT devices, drones, and computer vision technologies is another way of new frontiers in terms of monitoring and controlling traffic. Some of the systems can now be used to identify the cause of the traffic jams, as well as the congestion zones, using AI models trained on live data obtained by sensor, drones, and CCTV cameras. These models are able to recall more than 87 percent of the objects they have been trained on with a up to 12 objects classification ability, these models have been proven in enhancing the situation awareness and lower the operational expenditure on traffic [4]. In addition, such AI powered systems would encourage investment in other forms of technology such as drones to further improve the level of live traffic analysis and urban planning. The role of computer vision in the monitoring of vehicles and pedestrians is also core. In one of the methods, convolutional neural networks are used to track human movement deviation along time intervals to inform roadside traffic flow. The Internet of Vehicles Traffic Management System The Internet of Vehicles Traffic Management System is a concept that transfers traffic density information to adjacent vehicles to enhance navigation. This technique is at least 37 percent more successful than standard systems, according to experiments, which reveals the possibility that AI-powered visual systems will be essential to a future traffic ecosystem [5].

Although there is a lot to celebrate, there are still gaps in the manner in which AI systems have been deployed comprehensively to manage urban traffic. According to some of the studies, what is required is a comprehensive Traffic Management System (TMS) focusing on every aspect of urban traffic, including intersections, rerouting, and pollution. A formal typology of literature has uncovered the shortcomings of mainstream TMS solutions, and the need exists to move to more integrated, scalable and adaptive solutions that control network-wide systems, as opposed to individual subsystems [6]. The introduction of autonomous mobility solutions and AI-based predictive analytics is further boosting transportation planning. The use of machine learning models allows predicting areas of congestion and adjusting signals to accommodate it. Driving technologies based on AI and typically autonomous vehicles make it safer to be on the road and help lessen human error. Moreover, AI can lead to the best operation of the routes of public transportation, matchings in the rideshares, and forecasting the variety of energy consumption that are the essential features of sustainable urban transportation planning [7]. It is also worthy to note the contribution of AI to larger smart city systems. AI can allow unified and automated responses to urban needs due to its ability to integrate different systems in the city (e.g., traffic, energy,safety). This real-time, cross-functional decision-making ability provides immediate as well as long-term value to not only the stakeholders in the cities but also the citizens, which makes AI an inevitable driver of urban resilience and responsiveness [8].

The most fundamental requirement of an advanced AI traffic management system is to have smart judgement when deciding on how to proceed at an intersection, particularly in a scenario with mixed traffic of human driven cars and an autonomous vehicle. A new approach is prediction-based, graph-based, and optimization-

based. The systems experience the advantage of vehicle to infrastructure communication, whereby automated and semi-automated vehicles coordinate at signalized and unsignalized roads in a bid to ensure that the risk in collision is minimized and throughput is enhanced [9].

Lastly, most of the attention in AI has been gravitating towards automation and pattern-recognitions to achieve autonomous driving, other potentially promising fields of traffic management that could benefit with the application of AI have started to be examined. These are intelligent parking systems, accident detection, infrastructure planning and road safety monitoring. Such projects as Traffic Quest are being utilized to evaluate all the applications of AI outside of autonomous navigation, showing the increasing complexity and potential of the field [10].

B. AI Technologies used in Traffic Management

Artificial Intelligence (AI) has provided disruptive technologies on how urban traffic systems operate providing efficiency, safety, and sustainability. According to the existing research findings, it is possible to identify ten remarkable AI technologies adopted in traffic management:

1. Autonomous Vehicles

Artificial Intelligence (AI) in the development of autonomous vehicles is one of the recent developments in the field of intelligent transportation. AI has made it possible to place a rider in the vehicle to be controlled without human operation by means of processing current data, inputs of sensors and cameras. Such technologies as Tesla Autopilot reflect in themselves the capability of AI to contribute to the safety by means of lane-keeping, adaptive cruise control, and emergency braking features [11]. In addition to single cars, AI facilitates smart traffic management systems such as those used to manage the timing of signals on the road, clear up congestion, and ultimately better traffic flow leading to fewer accumulated emissions. The idea of the Fully Autonomous Ground Vehicles under the framework of Smart City (FAVGinSC) demonstrates how AVs can freely, but safely converge with the urban infrastructure and other vehicles to achieve safe and efficient mobility without requiring expensive modifications on the infrastructure [12]. These advancements will result in safer streets, easier traffic, and green outcomes, which will fall into the same line with sustainable urban mobility and smart city objectives.

2. Internet of Things (IoT) and AI Integration

The Internet of Things (IoT) conjunction with Artificial Intelligence (AI) has led to the provision of smart traffic technologies, which enhance urban mobility without massive structural expansion [13]. Cameras, sensors and base stations are IoT devices that gather and archive real-time traffic information, which facilitate adaptive systems in both manned and autonomous vehicles [14]. By monitoring the congestion, governing condition of the routes, and the linking of the traffic lights, these systems increase the reactivity of traffic management in the city. IoT is also beneficial when watching the environment since this would monitor the level of pollution with the help of sensor networks, and the swarm optimization algorithms would determine the areas with the most emissions. This enables active measures like rerouting or limiting emissions. The Urban Street Models (USM) also integrate the environmental and traffic information in a bid to enhance air quality [14]. Artificial Intelligence (AI) and Machine Learning (ML) can add to this ecosystem through such models as Machine Learning-based Motor Vehicle Restriction (MVR), prescribing travel behavior that reduces emissions.

3. Deep Learning Applications in Traffic Management

Deep learning (DL) has emerged as one of the essential elements of traffic monitor systems, particularly in combination with such technologies as unmanned aerial vehicles (UAVs). A more recent method, RTFM-DL, uses DL models, Faster R-CNN with ResNet to recognize, count, and speed up the automobile on the spot using live aerial feeds [15]. This is an effective way to analyse traffic patterns so that the authorities can respond to any traffic jam in a timely manner. It has shown a strong detection accuracy of 0.975 making the system effective in the urban settings. Traffic monitoring not only deals with collecting and recording traffic data, which can be implemented more dynamically and at scale with the help of UAVs and advanced DL models but also provides more insight into how the traffic behaves and can help create smart cites.

4. Blockchain Technology for Secure Traffic Systems

Blockchain technology (BT) has come as a potential way they can achieve the said data reliability as well as collaboration in the case of intelligent transportation systems (ITS). The latest proposals include blockchain-based platforms where cyber taxi drivers and the administrations of the cities interact with each other through use of secure, transparent and reward-driven platforms [16]. The platforms will enable those traveling to share real time traffic information in exchange of digital tokens thus fostering cooperative behavior and efficient use of infrastructure. The blockchain can also enhance forensic examination, reporting accidents, and data security in consumer-level system networks [17]. Blockchain in Transport Alliance (BiTA) is one of the industry initiatives to understand the possibilities of blockchain in tracking logistics and supply chains. The transportation of comparable values to management of urban traffic will be characterized by transparency, quicker data validation, and more trust between the different stakeholders of smart mobility ecosystems.

5. Intelligent Parking Systems (iParking)

Such problems as parking in densely populated cities have a considerable impact on the movement and on everyday life. Bearing in mind these capital problems, smart parking systems use superior technologies to wake up resource distribution, booking, and charging. Recently, a model is considered that leads to practical solutions to mixed-integer linear programming (MILP)

models to determine the best decision-making strategies to minimize the total cost of drivers and maximize the parking-space occupancy and manager revenue [18]. The system ensures that parking reservation can occur at the minimum cost and in the shortest time of search, it enhances convenience of drivers, and minimizes wastage of fuel in parking cruises. Further, equitable pricing policy is offered to maintain equilibrium between the demand and supply. These intelligent parking systems are critical in improving traffic within the cities as well as the entire transport system.

6. Cybersecurity in Intelligent Transportation Systems (ITS)

Complex data dynamics and strict timing needs identify Intelligent Transportation Systems (ITS) as systems in which cybersecurity is a high priority when it comes to safety and efficiency. A fine-tuned security concept in ITS is safeguarding many layers of architecture, starting with the configuration of the devices at the perception layer, performing credentials of the anonymous access of nodes in vehicular ad hoc networks (VANETs) on the network layer, and protecting fog computing infrastructures at support layer [19]. New solutions incorporate new technologies including blockchain, artificial intelligence, game theory, and ontologies to enhance security control procedures. Traditional means of security such as cryptography, network segmentation are modified to suit the ITS requirements. The presented innovative strategies help to establish security at various levels of ITS architecture, thus, protecting vital transportation infrastructures against the latest existing cyber threats and promoting greater trust in intelligent transportation settings.

7.Machine Learning for Traffic Prediction and Optimization

Machine learning (ML) is a transformative technology that can deliver the demanding requirements of 5G and beyond 5G (B5G) networks and supports use cases such as autonomous vehicles, industrial automation, and intelligent applications [20]. The ML methods, i.e., supervised, unsupervised, and reinforcement learning, assist in optimizing network performance, efficient management of resources, and solving mobile communications deployment issues. ML models are used to predict traffic in urban traffic management and optimize the timing of signals to alleviate congestion, as shown in Singapore adaptive traffic signal system in real-time [21]. In combination with smart infrastructure facilitated by IoT, including connected cars and smart sensors, these systems improve the flows on roads as well as decision-making. Moreover, autonomous vehicles based on AI are expected to redefine the traffic control system in the future by incorporating ML-based predictive analytics and big data to generate more efficient, dynamic, and environmentally friendly urban transport infrastructure.

C. Case Studies of Global AI Applications

The high rate of urbanization has resulted in intense traffic congestion problems forcing cities to implement Artificial Intelligence (AI)-based traffic management platforms that will enhance urban mobility, curb emissions, as well as, streamline the traffic [22]. The dynamic capability of AI enables the processing of real-time data on traffic data, personal travel behaviour and road status to come up with intelligent routing of vehicles and congestion optimisation leading to quantifiable reductions in travel times and fuel consumption [22][25]. Big data and big data analytics have facilitated real-time large-scale traffic forecasting, which improves the predictive accuracy to control the traffic [22][25].

Fixed-timing traffic signals are being augmented with AI-powered adapting traffic light systems, that changes the timing of traffic signals according to existing instances of congestion, resulting into a tightened emissions and shortened delays, which further neutralizes the effect of traffic policing by man and its environmental consequences [22][25][26]. IoT-device-drones-computer-vision integration continues to reinforce traffic surveillance because traffic jams are easy to detect, and based on these perceptions, a high level of situation awareness is achieved [22][26][27]. State-of-art AI, such as convolutional neural networks, monitors the movement of people and cars to guide traffic flow and enhance safety [22][27].

The idea behind Internet of Vehicles (IoV) in traffic management goes much further as far as the traffic density information is the shared one between the vehicles, which means that the navigation efficiency would be improved by far, and the traffic would be less congested than with the traditional systems [22][28]. Nonetheless, current Traffic Management Systems (TMS) are usually not so tightly integrated, which is why there is a demand in scalable, network-wide AI-based solutions that would coordinate intersections, rerouting, and pollution control in a flexible manner [22][29].

The progressive development of autonomous vehicles and AI-based predictive analytics helps make transportation systems of cities more cleverly structured as it helps predict congestion, optimize the design of preferred bus and train lines, match rideshares, and predict sustainably consumed energy [22][30][31]. The ability of AI to integrate different systems in the city (traffic, energy, safety) contributes to cross-sector decision-making in real-time and city resilience and responsiveness [22][32].

State-of-the-art AI based traffic systems implement

prediction-, graph- and optimization-based methods to enable vehicle-infrastructure communication, aligning human driven and autonomous vehicles at the intersections to avoid collisions and maximize the throughput [22][29]. In the context of autonomous driving, AI is also being applied in the field of intelligent parking, collision detection, infrastructure planning, and road safety monitoring, which shows that the complexity and possibilities of AI in the traffic management scope continue increasing [22][30][31].

D. Cambodia's Smart City Strategy

Cambodia has begun strategic planning to use smart technologies as part of the country's urban infrastructure, specifically enhancing traffic and improving the safety of residents. The capital of Phnom Penh plans to incorporate AI in land use mapping, more effective traffic signal control, CCTV deployments, and the unification of traffic services to the people [33][34]. Parking regulation, walkability, and shared mobility applications are among the processes, which are currently being done, as part of the larger agenda of sustainable and smart urban development.

Another major city, Siem Reap is undergoing a 150 million Infrastructure upgrade which includes laying smart traffic lights, 5,143 AI-powered LED streetlights, underground network cabling, CCTV surveillance in 100 locations (collaborating with Huawei) and smart waste and sewerage management solutions [36][37]. JICA has initiated feasibility study in areas of tourism, mobility and data management that makes Siem Reap having the status of smart tourism hub.

The provincial government of Battambang has started early partnership with development partners in smart city collaboration based on main domains of projects, including traffic, mobility and environmental monitoring [38]. Such local plans demonstrate how Cambodia is increasingly interested in incorporating the faculty of AI and digital technologies into traffic control, the improvement of urban services, and correlation of the increased environmental and mobility needs.

E. Benefits of Integration with AI

Artificial Intelligence (AI) implementation in transportation and city systems is becoming rapidly sustainable and yielding transformational results on the passenger-mobility front, and also on sustaining the environment and the emerging smart infrastructure. Traffic management systems like the ones driven by AI have helped a great deal in improving the environment through consumption of less fuel, less emission of carbon, and lesser consumption of idling at traffic lights. Cost advantage is also economic to such a system, since it reduces cost of transportation and infrastructure cost as well as enhances better logistics productivity [39]. The Autonomous Intersection Management, (AIM), is one of the innovations that have been central in this area. Recent research suggests two level programming models which optimize vehicle routing and intersection control. These models reduce conflict zones and vehicle throughput within an intersection by discretizing its intersections and in the grids using mixed-integer linear programming (MILP), minimizing advancement vehicle delays and improving energy consumption and the crossing levels [40]. On a larger scale, AI can offer much more than it can do in terms of safety by utilizing such concepts as predictive maintenance and self-driving vehicles, with such organizations as FedEx and Tesla already using AI to minimize accidents, optimize delivery routes, and decrease operating costs. Adaptive traffic signal control through AI has decreased traffic congestion by more than 20 percent in such cities as Los Angeles [41]. Digital twins are also critical in the development of smart cities since they provide real-time simulations of the performance of infrastructure and urban planning environments. The case studies of such cities as Singapore and Dubai demonstrate the role of digital twins in topping the operations of a city using IoT, predictive analytics, and AI. Nevertheless, there are still issues of standardization, data interoperability and higher costs of implementation [42]. In addition, artificial intelligence is proving innovative in predictive maintenance, intelligent routing, ride-hailing algorithms, fleet management, drone logistics, and shipping in the maritime field. Such apps are transforming the operations of transportation systems into faster, safer, and more flexible real-time conditions-conscious [43]. Nevertheless, the massive usage of AI in the field of traffic management is not in full bloom, as there are a range of regulatory, technical, and infrastructural factors that hinder its advent. Some of the challenges associated with it include lack of enough infrastructure, data privacy issues as well as division within urban system integration. Researchers state that more thorough AI deployment strategies are required with regards to rerouting, pollution management and intersection management [44]. Lastly, Urban Digital Twins (UDTs) have turned out as a pillar in countering the realization of sustainable and smart, city objectives. They deal with integrated information services in traffic, infrastructure systems and energy. Nevertheless, the literature requires interdisciplinary research teamwork, superior forms of governance, and cross examination to achieve their capability in full [45].

F. Challenges in Adoption

Although AI-driven traffic management systems have the potential to transform the way traffic is handled, there are some major issues that prevent their successful performance. Of concern is the access and accuracy of the real-time traffic information, which is usually undermined by sensors failures, poor weather and poor communication lines. Such inconsistencies of data can defame AI models and decrease system credibility. System integration is a complex activity too because legacy infrastructure in most cities will not work with new advanced AI technology and

they will need to upgrade it, which will cost a lot of money. Moreover, there are threats related to cybersecurity and privacy risks; IoT devices are widely used in traffic systems, and their security is usually weak because of the absence of powerful authentication and encryption mechanisms and cyberattacks, and data breaches. Data synchronization across systems Network overload and ineffective interoperation of heterogeneous devices further introduces the challenge of carrying out real-time data exchange and synchronization across the systems. Also, there are no common rules of communication that prevent the free communication between vehicles and infrastructure. Another obstacle is the fact that installation and maintenance are costly and in developing nations where the budget is low. Adoption is also inhibited by social and organizational barriers such as the unwillingness of some people to adopt, lack of technical capacity, and decentralized administration. The complexity of the issues mentioned above points to the necessity of a more advanced data governance approach, security architecture, upgrading of the infrastructure, and a coherent policy response that can guarantee the scaling and enhancement of AI-powered traffic systems within an urban setting.

III. Research Methodology

In this study, we performed the systematic literature review to examine the use of Artificial Intelligence (AI) technologies in the traffic management systems. In order to gather applicable academic information, we have resorted to the highly popular and trusted search engine to scholarly documents, namely, Google Scholar. On this platform, we managed to discover studies that fit the scope of our research as well as keywords associated with AI, traffic systems, smart cities, and transportation optimization. The process of the literature review started with the use of fifty research articles individually, as they were traced, using their titles and relevance to the central topics of AI-driven traffic solutions. We then proceeded to distribute the papers among our research team so that ten papers each were to be thoroughly looked through. At this step we picked out important words and ideas contained in every paper and formed a list of keywords focal in the research. After making analysis individually, a discussion was held with the team, where the findings were compared, and common meaning of keywords was provided to design the review. Using the completed list we then read each chosen paper in detail making notes of all methodologies, technologies utilized and significant information. This procedure allowed us to synthesize the information in an effective way and come up with this literature review that is targeted at AI technologies that transform the traffic management within the city.

IV. Recommandation

In order to guarantee the successful implementation of the Artificial Intelligence (AI) in the field of urban traffic systems, it is proposed to advise governments and city planners to pay more attention to upgrading obsolete infrastructure and invest in multi-smart technologies. This involves the use of smart sensors, responsive traffic movements and live data platforms to improve on the mode of traffic monitoring and decision making. Moreover, we should ensure that there are effective policies to protect data privacy, cybersecurity, and ethical use of artificial intelligence to earn the trust of the population and avoid its misuse. Cooperation among governments, research centers and commercial technology companies should be promoted so that AI solutions can become scalable and cost-effective and can finally be adjusted after the specific needs of individual cities. Moreover, training, education, and awareness campaigns can help with the softening of the adoption of AI-driven traffic systems and the development of the populationThere may be capacity-building programs that can be offered to those citizens who are running traffic, as well as those who are following traffic because citizen awareness and understanding are important. Adopting these measures, cities can utilize AI to decrease traffic and ensure safe roads and sustainable city mobility.

V. Discussion

Through the study, it is identified that Artificial Intelligence (AI) can bring about a revolution in the contemporary traffic management in cities that provide the solutions like adaptive signal control, predictive congestion estimates, automobile navigation, and congestion management in real time. Such capabilities have already shown their results in traffic efficiency, low emissions, and improved road safety in various case studies in the world. But even in spite of all these advancements, the effective introduction of AI into the traffic systems is surrounded by numerous challenges. The quality and availability of data are also the key concerns since AI requires high-quality, real-time data obtained by IoT devices and sensors. Moreover, AI incorporation on legacy infrastructure is very expensive and technically-demanding, especially in the developing nations where there might be low levels of digital readiness. The issue of privacy in terms of the traffic and user data collection and utilization despite the necessity to provide the platform with the means of traffic and user data can become a vital consideration. Also, a uniformity in the structures and cross-compatibility in AI systems surmounts regions, thus discouraging mass application. These observations support the fact that multi-stakeholder cooperation, effective governance systems, and strategic investments are required to address these challenges. With continued development of AI technology, the need to tackle these barriers will be essential to implement all the opportunities the technology has to offer in establishing safer, smarter, and more environmentally friendly mobility urban systems.

VI. CONCLUSION

Artificial intelligence (AI) is transforming traffic management in cities and facilitating the deployment of intelligent traffic systems including adaptive traffic controls, real-time traffic sensors and automated traffic signal management, as well as intelligent vehicle routing. Such AI technologies take the data

volumes received by cameras, sensors, and networked vehicles and use it to make real-time decisions by modifying traffic flows, improving congestion, road safety, and increasing the efficiency of transport systems, in general. AI can predict traffic behavior, best signal timing, and reduce travel delays as well as transit fuel consumption to help make cities more sustainable. Nevertheless the introduction of AI to the traffic system is not unproblematic. The high implementation and maintenance expenses are also major obstacles especially with the developing regions. That is also why most cities cannot implement an integration between AI and heritage infrastructure which is usually incompatible with contemporary digital technology. Privacy of data and the issue of cybersecurity also appear because using real-life data collection that happens continuously and 24 hours a day, there needs to be intense state regulation and prevention. In spite of this, the benefits that AI can bring through the establishment of intelligent, responsive, and sustainable systems of traffic promising are tremendous. AI has the potential to become a significant driver of the construction of intelligent cities, presenting a long-term solution to traffic jams and inefficiencies in urban transport organization with the help of proper investment, planning, and political support.

VII. ACKNOWLEDGMENT

We wish to thank our lab class lecturer, Dr. Cheab Sovuthy for providing practical insights, helpful comments on our tasks, assistance during the experimental phase of our study and process of writing the literature review. Your support has helped us to succeed in this literature review.

VIII. REFERENCES

[1] Dikshit, S., Atiq, A., Shahid, M., Dwivedi, V., & Thusu, A. (n.d.). The use of artificial intelligence to optimize the routing of vehicles and reduce traffic congestion in urban areas. Noida Institute of Engineering & Technology & Galgotias University. https://pdfs.semanticscholar.org/512c/88cb74771cd52d0dc2fc72a93324633ebbe0.pdf

[2] Muhammad Aqib, Rashid Mehmood, Ahmed Alzahrani, Iyad Katib. https://www.researchgate.net/publication/333074590_Smarter_Traffic_Prediction_Using_Big_Data_In-Memory_Computing_Deep_Learning_and_GPUs

[3] Prof. Eshwaraj, Dr. Ananthayaa M B, Prof. Gowtham B, Prof. Pooja A https://www.researchgate.net/publication/390093292_A_Literature_Review_On_Smart_Traffic_Management_System_Using_AI

[4] Yukta Mehta, Aishwarya A, Deepthi D., Phadmavathy C., Sowmya, Department of Applied Data Science, Jeery Gao, Department of Computer Science.https://www.researchgate.net/publication/389628377_Smart_City_AI_Traffic_Cloud_-City_Traffic_Analysis_and_Monitoring_Using_AI_Models

[5] Aldosary Saad, Ahmed Shalaby, Abdallah A. Mohamed https://www.sciencedirect.com/science/article/abs/pii/S004579062200355X

[6] Asma Ait Ouallane, Assia Bakali, Ayoub Bahanasse, Said Broumi, Mohamed Talea https://www.sciencedirect.com/science/article/abs/pii/S1566253522000859

[7] Farzan. T, Muskan. R. The Role of Artificial Intelligence in Urban Transportation for Smart City Development and Sustainable Transportation Planning.https://www.researchgate.net/publication/388485734

[8] Venturous Group (2024) AI Cities: Transforming Smart Urban Development with Artificial Intelligence.

[9] Planning and Decision-making for Connected Autonomous Vehicles at Road Intersections. Volume 34, article number 133 (2021). https://link.springer.com/article/10.1186/s10033-021-00639-3

[10]Erwin Walraven (TNO), Dawn Spruijtenburg (TNO), Isabel Wilmink (TNO), Max Schreuder (TNO), V1.0. https://www.traffic-quest.nl/downloads/2021-10_report_challenge_ai_in_traffic_management_v1.0.pdf

[11] Hayrettin Kpan, Ayse Nur Turan. Artificial Intelligence in Autonomous Vehicles and Smart Traffic Systems. https://www.researchgate.net/publication/388815781

[12] Kaya Kuru, Wasiq Khan. A Framework for the Synergistic Integration of Fully Autonomous Ground Vehicles With Smart City. DOI:10.1016/j.scs.2021.102850

[13] Asma A, Ayoub B, Assia Bakali, Mohamed Tales.Overview of Road Traffic Management Solutions based on IoT and AI. https://www.sciencedirect.com/science/article/pii/S1877050921025187

[14] Ali Mohd Ali, Ahmad Al-Qerem, Mohammad R. Hassan, Ahmed Abu-Khadrah, Muath Jarrah , Traffic Monitoring and Control System for Smart City Pollution Regulation Using IoT and Correlated Capsule Networks. https://www.researchgate.net/publication/389868549_Traffic_Monitoring_and_Control_System_for_Smart_City_Pollution_Regulation_using_IoT_and_Correlated_Capsule_Networks

[15] Sachin U., S. Neelakandan, K. Thangaraj, D. Vijendra Babu, N. Arulkumar, Kashif Qureshi. Modeling of Real Time Traffic Flow Monitoring System Using Deep Learning and Unmanned Aerial Vehicles. https://ieeexplore.ieee.org/document/10966264

[16] Vittorio A. Vincenzo P., Giuseppe Guido, Alessandro V. The use of a Blockchain-based System in Traffic Operations to promote Cooperation among Connected Vehicles https://www.sciencedirect.com/science/article/pii/S1877050920322985

[17] Wanxin Li, Mark Nejad, Rui Zhang.A Blockchain-Based Architecture for Traffic Signal Control Systems. https://www.researchgate.net/publication/333650101_A_Blockchain-Based_Architecture_for_Traffic_Signal_Control_Systems

[18] Amir O. Kotb, Yao-Chun Shen, Xu Zhu, Yi Huang. **iParker—A New Smart Car-Parking System Based on Dynamic Resource Allocation and Pricing.**https://ieeexplore.ieee.org/abstract/document/7465828

[19] Teodora Mecheva, Nikolay Kakanakov. Cybersecurity in Intelligent Transportation Systems. https://www.mdpi.com/2073-431X/9/4/83

[20] Manual Engenio M. Haeyoung Lee, Wansu Lim.Machine Learning for 5G/B5G Mobile and Wireless Communications: Potential, Limitations, and Future Directions. https://ieeexplore.ieee.org/abstract/document/8844682

[21] Satheerth Pk. Transforming Urban Traffic with AI: Insights from Singapore and Opportunities in India. https://www.researchgate.net/publication/390448156_

[22] Aravind Sasidharan Pillai, University of Illinois Urbana-Champaign. https://www.researchgate.net/publication/383436318_TRAFFIC_MANAGEMENT_IMPLEMENTING_AI_TO_OPTIMIZE_TRAFFIC_FLOW_AND_REDUCE_CONGESTION

[23] Mitu Karmakar, Pravakar Debnath, Azam Khan, Huxley, Harris. https://www.researchgate.net/publication/386142960_AI-Powered_Solutions_for_Traffic_Management_in_US_Cities_Reducing_Congestion_and_Emissions

[24] Driving into the Future: The Unstoppable Rise of AI in Transportation. https://numalis.com/ai-in-transportation/

[25] Lorenzaj Harris, Stanford University https://www.researchgate.net/publication/392595483_AI_in_Urban_Settings_The_Intelligence_Behind_the_Latest_Traffic_Signal_Systems

[26] O.I Olayode, L.K Tartibu, M.O Okwu. Application of Artificial Intelligence in Traffic Control System of Non-autonomous Vehicles at Signalized Road Intersection. https://www.sciencedirect.com/science/article/pii/S2212827120308076

[27] Juan Pedro Tomas https://www.rcrwireless.com/20200729/internet-of-things/china-xian-deploys-ai-based-intelligent-traffic-management-system

[28] The Solution: an intelligent traffic management system from Hikvision https://www.hikvision.com/cis/newsroom/success-stories/traffic/intelligent-traffic-management-helping-vehicles-to-flow-through-an-ancient-city/

[29] Xuaning Zhang, Institute of College of Intelligent Manufacturing and Control Engineering, Shanghai Polytechnic University, Shanghai, China.https://www.researchgate.net/publication/389019464_Artificial_Intelligence_in_Intelligent_Traffic_Signal_Control

[30]Big data, AI help manage traffic in east China city https://www.chinadaily.com.cn/a/201812/27/WS5c24f1c7a310d91214051564.html

[31] AI in China's transportation industry: shaping the future of transportation Daxue Consulting. https://daxueconsulting.com/ai-china-transportation-industry/

[32] Smita Vempati. Journal of Electric System 20(5s): 2817-2827

https://www.researchgate.net/publication/380313495_Securing_Smart_Cities_A_Cybersecurity_Perspective_on_Integrating_IoT_AI_and_Machine_Learning_for_Digital_Twin_Creation
[33] Mr. KEO CHANNARITH, Governor of Phnom Penh City Bus Authority Phnom Penh, Cambodia. The Smart City of Phnom Penh
https://uncrd.un.org/sites/uncrd.un.org//files/2023sctw_s2_cp1_phnom_penh.pdf
[34] Seiya Matsuoka, Traffic management project in Phnom Penh.
https://www.researchgate.net/publication/329852724_Traffic_management_project_in_Phnom_Penh
[35] Provincial Governor Tea Seiha, SIEM REAP SMART, Siem Reap Smart City Roadmap.https://siemreap.gov.kh/wp-content/uploads/sites/22/2023/10/SRSCRoadmap_ENG.pdf
[36] SMART CITY IN SIEM REAP CITY
https://www.jasca2021.jp/ascnjapan2020/dl/document/piseth_tip.pdf
[37] SMART CITY OF SIEM REAP,Ms. LIM PHALLIKA, Vice Mayor of Siem Reap Municipality, 29th August- 1st September 2023, NAGOYA, JAPAN.
https://uncrd.un.org/sites/uncrd.un.org//files/2023sctw_s2_cp2_siem_reap.pdf
[38] H.E SOK Lou, Governor of Battambang Province,The 4th ASEAN-Japan Smart Cities Network High Level Meeting, Fukushima, 4-5 December 2022. Solutions to Smart City Development in Battambang, Cambodia.
https://www.jasca2021.jp/ascnjapan2022/files/pdf_1_ymeng.pdf
[39] Sophia (2024). The role of AI in Improving Urban Traffic management: Smart Solutions of Modern Cities. https://mattsedlar.net/the-role-of-ai-in-improving-urban-traffic-management-smart-solutions-for-modern-cities/

[40] Yang Liu, Kejun Long, We. A Route Planning and Traffic Control Model.https://ieeexplore.ieee.org/document/10274960.
[41] AI in Transportation Benefits and Applications https://maticz.com/ai-in-transportation
[42] Hivez Luz, Paul Josual, Oluwaseyi Joseph, Shalom B.Joseph.
https://www.researchgate.net/publication/387932481_Role_of_digital_twins_in_modeling_and_optimizing_city_designs
[43] Anurag Jain https://oyelabs.com/ai-in-transportation-benefits-use-cases-examples/
[44] Syeda F., Nazia A, NED University of Engineering and Technology, Asma Q., Umm E., Iqra University
https://www.researchgate.net/publication/377130487_Implementation_of_AI_in_Traffic_Management_Need_Current_Techniques_and_Challenges
[45] Silvia Mazzetto, A Review of urban Digital Twins Integration, Challenges and Future In Smart City Development. https://www.mdpi.com/2071-1050/16/19/8337 [46] Tommy Fred, University of London, Victoria Mark. AI-Powered Adaptive Traffic Light control system.
https://www.researchgate.net/publication/390233439_AI-Powered_Adaptive_Traffic_Light_Control_Systems_for_Congestion_Reduction
[47] AI Traffic Monitoring to inform design. Kier Transportation: A417 – November 2023.
https://www.highwayssafetyhub.com/uploads/5/1/2/9/51294565/case_study_kier_ai_traffic_monitoring_to_inform_design.pdf
[48] Samah Adel Gamel, Ahmed Ibrahim Saleh, Hesham Arafat li.
https://www.researchgate.net/publication/354873371_Intelligent_Traffic_Management_system_based_on_IoT_Challenges_and_Applications
[49] Ruhul Amin Khalil; Ziad Safelnasr; Naod Yemane; Mebruk Kedir; Atawulrahman Shafiqurrahman; NASIR SAEED, Advanced Learning Technologies for Intelligent Transportation Systems: Prospects and Challenges
https://ieeexplore.ieee.org/document/10444919
[50] Ehab Shahat, Chang T.Hyun Department of Architectural Engineering, Chunho Yeom, International School of Urban Science.
https://www.mdpi.com/2071-1050/13/6/3386