Post Implementation Studies of Intelligent Transport System for Smart City: A Review

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Abstract **- To handle heavy traffic on highways, smart cities require an intelligent transportation system (ITS). To control easy traffic on the roads, an active structure is essential. The rapid growth of the urban population poses a significant problem for smart cities. The truth of cities is shown through disorganised traffic. The existing road infrastructure cannot manage with the expanded quantity of vehicles on the roads. This difficulty can be confronted by Information and the communication technologies (ICT). ITS will reduce delays, traffic congestions, energy consumption and the pollution emission affected by the extensive delays on roads. Smart city mission is important for urbanization and globalization to improve quality-of-life of their citizens. This study tries to clarify the often-enigmatic understanding of the term "smart city." It presents a focused and operational definition of smart cities in many countries, as well as consistent proof of smart cities in different countries. The most recent version of the urban assessment data collection for analysing the aspects that influence how smart cities perform. This finding has sparked the establishment of a new smart city strategic agenda in several countries, with the goal of achieving sustainable urban growth and a better urban landscape.**

Index Terms **- smart city, urban development, transport infrastructure, Intelligent Transport System (ITS).**

I.INTRODUCTION

The global population's urbanisation has become a big issue that demands attention. In the 1950s, only 30% of the world's population lived in cities; by 2014, that number had climbed to 54%, and the UN estimates that by 2050, it will be 66 percent [1]. Asia and Africa's developing countries are urbanising at a faster rate than the rest of the world. China's urbanisation rate has risen from 40.53 percent to 53.73 percent in the last ten years [2]. Because of the irreversible trend of urbanisation, metropolises, and megacities (towns with populations more than 10 million) are rising at an accelerating rate [3]. Urbanization generates numerous essential and major economic, social, and demographic alterations because Cities aren't only centers of human endeavour; they're also hotbeds of financial, ecological, and sociological pressures [4].

By supporting water reserves and sewer systems, residential and commercial buildings, learning and wellness facilities, and accessible transportation, the development of urbanisation has substantially enhanced people's living standards [5]. Cities are frequently economic hubs for provinces, assisting in the expansion of wealth and job creation. Cities with a high concentration of qualified people serve to improve industrial construction and stimulate creation productivity [6]. Urbanization, on the other hand, brings with it additional obstacles and complications. Cities' growing populations and intensive use of natural resources create ecological and environmental concerns, as well as public syndrome challenges [7]. Overcrowding, air and water pollution, environmental degradation, communicable diseases, and crime negate the economic benefits of India's cities; urban challenges such as lowering air pollution and providing clean water, safe neighbourhoods, and efficient infrastructure are urgently needed [8]. The air quality in Mexico City has deteriorated due to a significant rise in gas and particle matter radiations [9]. According to a 2011 study, 493 city districts in the United States faced extreme traffic congestion, resulting in Americans spending 4.8 billion additional hours travelling and paying an additional 1.9 billion gallons of fuel, totalling a $101 billion congested cost [10]. According to a recent study of Japanese crime statistics, urbanisation is the most important factor within prevalence of violence [11]. Individuals,

organizations, and investors are compelled to pay attention to environmental issues and the long-term growth of cities, as well as to seek a set of technical solutions to alleviate these urban obstructions, because of these concerns and difficulties. Rapid urbanisation brings new challenges and concerns, and the smart city concept offers ways to manage these issues, ease urban problems, and provide a better living environment for residents. This study gives a comprehensive review of the literature on Intelligent Transportation Systems and Smart Cities. It begins by outlining the roots of the smart city concept as well as the fundamental challenges it faces, before moving on to explain the concepts of a smart city through an examination of its concept and implementation sectors. The second segment offers a data-driven perspective on smart city designs and essential enabler technologies. Finally, a summary of ongoing smart city research is given. This publication is intended to serve as a resource for smart city academics and practitioners.

II. CRITICAL REVIEW ON ITS TECHNOLOGY AND SMART CITY IN VARIOUS COUNTRIES

ITS technology: - The ITS application over the phase in the advanced countries has risen into successful supervision of traffic, the ITS and its design with various elements are discussed in this section of study. S.A.Mulay, C.S.Dhekne, R. M. Bapat, T. U. Budukh, S. D. Gadgil [12] mainly focuses on the ITS encompassing various fields like evolutionary computing and intelligent systems, mobile computing and applications, GPS etc. During the peak hours such as business and university timings there is time-consuming traffic lines and more awaiting time on traffic signals which most likely leads to breaking of traffic rules. The scholar presented in this paper three modules which addressing the issues of traffic supervision. Overcrowding Recognition and Administration uses an approach of real time in which data about overcrowding on the road can be identified and connected to the traveller to through internet, SMS on their mobile phones, so as traveller can adjust their routes appropriately. Second, the Intelligent Public Transportation system displays the most recent available bus positions near the user. The projected time for the bus to arrive at the location, as well as the bus number and routes, are all notified via mobile phones. The usage of CCTV cameras and GPS equipment in the bus gives the user with real-time information about the bus's location and traffic density. The third module is dedicated to traffic signal synchronisation, which modifies signal timers in response to traffic congestion. Using this module, traffic congestion at lights can be avoided. All these modules operate without the need for human involvement, resulting in fewer errors. To deploy these modules, data centres must be constructed, resulting in effective traffic management, reduced fuel consumption in transportation, and reduced pollution.
Ioanna Spyropoulou, Matthew Karlaftis, John Golias, George Yannis, Merja Penttinen [13] are reviewed in their paper about current research carried out in the ITS impact assessment and future potential focusing upon road safety. The first half of this study evaluates recent research on the topic of ITS and its impact on road safety. Different research has been conducted, and the outcomes of these investigations have varied, with sometimes contradictory results and conclusions, resulting in an ambiguous image of ITS influence. A questionnaire was created, and responses and opinions from various groups, including engineers, psychologists, ergonomists, and attorneys, were recorded using Delphi survey. The Delphi study preliminary results were discussed in the study's second phase. The influence of several systems on road safety is assessed, including intelligent speed adaption, lateral warning, junction alert, traffic and environmental conditions, user integration, driver comfort, anti-lock brake system, and better navigation and system.
Robert L. Bertini, Christopher M. Monsere [14] exemplified in their research the advantages of ITS in the Urban areas focus on the overcrowding and safety issues. The researcher examined the extent of ITS benefits based on real-life experiences while studying the literature relevant to ITS. This paper presents international and domestic examples in each category and blends demonstrated ITS advantages. Arterial and freeway management systems, freight management systems, incident management systems, transit management systems, regional multimodal and traveller information systems, emergency management systems, and information management are all topics of discussion. The following are some of the potential benefits of ITS installation in metropolitan areas: The Arterial Management System may reduce implementation delays; the Freeway

Management System may reduce crash frequency and overall travel time; the Transit Management System focuses on automatic vehicle location and transit signal priority; and the Incident Management System improves public support for DOT activities. The benefits like enhanced safety, efficiency, accessibility, mobility etc can be more effective with regional cooperation.

Indian scenario in ITS: - Indian traffic circumstances are vastly different from those in industrialised countries since traffic density and infrastructure availability have a significant impact on ITS adaption to Indian requirements. In India, ITS technology necessitates a totally different strategy than in other countries.

Gurdit Singh, Divya Bansal, Sanjeev Sofat [15] described in their paper present practices used in India for limiting of road traffic and ITS need in the current situation. India has a non-lane road traffic structure, which allows all types of vehicles to use the roadways, causing traffic congestion in various areas. The problem of traffic congestion is particularly severe in metro and medium cities. In India, the traditional traffic management system is used, which includes traffic signals, traffic cops, and traffic signs, among other things. The inability to develop road infrastructure owing to a lack of space is a barrier to addressing the traffic congestion problem. Because there is a significant difference between traffic management in developed countries and traffic management in India, ITS approaches employed in developed countries may not be applicable in India. Instead of focusing on fixed sensor technology, in India, cell phones with sensors such as GPS, Wi-Fi, camera, and microphone can be useful in evaluating traffic conditions and avoiding traffic jams.

Sumit Mallik [16] undertaken research to understand the problems due to traffic congestion and role of information technology in creating synergetic effect in communication networks. Due to traffic congestion, transportation efficiency is lowered, and travel time, pollution, and other factors increase. As the road infrastructure improves, the number of accidents increases. The purpose of this study is to discuss the impact on various application fields. Earlier work problems were discovered to be divided into three groups. First, traffic congestion came from the lack of a traffic management system, which was caused by a large increase in the number of vehicles on the road. Second, the lack of development of Homeland Security and Vehicle Operations has resulted in the cars not being tracked. Finally, the final cluster is Vehicle to Vehicle Coordination and New Technology Implementation. To address these issues, the researcher proposed solutions such as the use of GPS, GIS, and remote sensing, among others, which resulted in effective traffic mobility. The identification of cars became easier to track by keeping a close eye on the road traffic. The use of Bluetooth, Wi-Fi, and sensors will improve vehicle-to-vehicle coordination. Because of ITS, people are more likely to use public transportation, which leads to fewer people driving their own cars.

Rijurekha Sen and Bhaskaran Raman [17] studied the congestion in the road traffic particularly focusing on developing nation or fast-growing economy like India. Their research focuses on the issue of slow infrastructural growth in terms of roads, motorways, and other infrastructure, as well as the relationship between this and the fast-expanding volume of automobiles. The financial and space constraints that are impeding infrastructure development. Another issue mentioned in relation to India is that Indian traffic is not lane-based, which makes installation of Intelligent Transportation Systems challenging (ITS). As a result, ITS developed in developed countries cannot be deployed in India immediately. Different ITS applications for traffic management are addressed in this study, including revenue collection, incident detection, vehicle classification, monitoring, intersection control, and so on. Sensing with multiple modalities such as static sensing, mobile sensing, and hybrid sensing can be used to collect information from the road. This research looks at the ITS architecture from the perspectives of application, sensing, and communication method.

Implementation of ITS in India: - As previously said, ITS in the Indian context necessitates a completely different strategy due to its unique circumstances. The adoption of ITS necessitates adaptation of the local environment; as a result, sensors, infrastructure, modules, and other components are adapted to meet current local needs. The role of travellers in the adoption of ITS in India is critical, as user awareness is necessary from an Indian perspective.

Chinta Sudhakar Rao, M. Parida, and S.S. Jain [18] studied in their paper the influence of the ITS devices in the trade of data to drivers and response of the

drivers to traffic supervision. With special reference to Delhi, a survey was done on the interpretation of information provided utilising ITS modules such as APMS, VMS, and ATIS. In their research, they discovered that age and education are important factors in how these ITS modules help people grasp information. The frequency of journeys has a significant impact on the drivers' understanding of the system. During their travels, drivers are aware of the parking sign boards. Drivers anticipate a parking guidance system and a Parking Site Map to help them park their vehicles in the most optimal location. The information displayed on the VMS board was viewed by most of the drivers, who acted on it according to their needs. The main finding of the poll was that, due to the significant traffic congestion in Delhi, respondents expect more traffic congestion information to be displayed on the VMS board.

Prof. U.J Phatak, Mr. Lintu Abraham, Miss Nivedita Kaushik, Mr. Sudeep Mitra, Mr. Sagar Dalal [19] commenced a study on the traffic overcrowding in India with case study methodology choosing Pune with affected region of SH60 from Kharadi Bypass to Bakoriphata. While commuting to metropolis, the surrounding areas of metro cities confront a huge traffic challenge. By examining the selected location, the researcher was able to focus on the primary issues that cause traffic congestion. Poor infrastructure design is one of the causes of traffic congestion, which could become a serious issue in the future. The traffic intensity survey was conducted by manually counting vehicles, which provided data on traffic volume on the SH60 for a given day. A road profiling survey was also conducted, and it was discovered that due to the uneven road surface and elevation, heavier vehicles are unable to maintain a consistent speed, which is one of the causes of traffic congestion. This paper recommends that city planners place a greater priority on the development of road infrastructure in the form of highways on the periphery of metro cities to address traffic congestion issues.

Realization of Smart-City Key Features: - Smart city technology have been much more widely available in recent years. As a result, each city can use technological solutions to become wiser. Rather than focusing exclusively on innovations, the challenge today is to effectively implement good solutions. Smart city regions cannot be built haphazardly, but rather via the deliberate adoption of incremental reforms. Forming a volunteer-led smart structure operating unit that specifies its manageableness concept and then prepares an electric perfectly organized manual and performance plan is the finest technique for realising a smart city. Participation and strong specialised knowledge are required to identify the most acute blockages, propose coordinated and flexible solutions, and then incorporate the results into other smart community activities.

Transportation, Climate Change, Energy, Utilities, Security Surveillance, Healthcare, Business Management, and other Smart City Key Resources

Associated cities increase the understanding of manual workers and smart city controllers by analysing data and splitting down data from broadcasting contexts involving as devices, wayside photographic camera, bright examining systems, and velocity inspection signs. Using IoT technology to address metropolitan group challenges consist of collecting data from sensors, recording from cameras, interpersonal organisations, and dazzling gadgets that analyse real data. This data is presented in large chunks of knowledge that are utilised to activate actuators attached to smart devices. Flexible smart city assets linked by repercussions, for example, can assist in making policy decisions and streamlining employment processes. These arrangements in smart urban communities include GPS trackers and RFID labels on cars [20], constructs, buildings, and energy plants, as well as breaking down vehicle movement to identify incidents or obstructions. Smart building safety measures, personal organisations, and city organizations are continually changing structures to manage the flow of activity during city events, execute security investigations, and reduce traffic congestion. Genuine analysis of urban traffic, security investigation and movement obstruction, and information from roadside sensors can be utilised to decrease time delays, misread security remarks, and city toll tax, and activity stream in more flows for long-term benefits. Sensors also track the condition of streets, weather updates, building structures, road lights, and extensions used to route traffic around events, allowing for maintenance to be arranged as needed.

Transportation, utilities, smart buildings, and smart security will all be new activities in smart cities. Leaders of the smart city proposed design convened a working group of ecosystem system partners to assess

the city's capabilities and develop a long-term vision that really is consistent with the city's long-term plans. Smart city planners have advocated for the digitalization of citywide assets such as the fast transport network, building automation, smart security, and electric mobility, as well as the creation of the far IoT hub that will lead smart city infrastructure.

The four basic pillars that make up a smart-city blueprint are: The foundational pillar of a smart city is connectivity. Smart sensors capture real-time data about people, places, and objects, which is then saved on cloud application servers for analysis and use in making well real-time judgments and design.

The efficient and effective movement of people, goods, and information is referred to as mobility. Economic mobility demonstrates that, irrespective of their considerations, online employment searchers in smart cities can locate the most employment that is not accessible by public transportation.

The next stage is to strengthen security in public and private spaces, as well as data protection and cyber-security, by implementing cutting-edge ICT technologies both online and offline.

Environmentally friendly practises in important metropolitan sectors such as transport, energy usage, global warming, utilities, security management, and financial services are all prime consideration.

Every day, smart-city solutions may do three things for their citizens: add value, earn revenue, and cut costs, all of which rely on value exchanging smart systems and advanced projects.

M.R.Mat Yazid, R. Ismail, R. Atiq [21] The goal of this article is to build sustainable non-motor automobile transportation for a town that will provide a safer world for upcoming peers. Through the combination of land usage and shipping development, it proposes solutions to shift road users' mobility modes from motor cars to non-motor vehicles. By enhancing the pedestrian walkway and cycling zone, non-motorized transport will grow while motor vehicle travel decreases. Cycling and walking are examples of non-motorized transportation that not only cut carbon emissions but also promote a healthy lifestyle and physical activity. Sustainable transportation has the following characteristics: It is safe, comfortable, and cost- and energy-efficient, and it helps to minimise pollution. Most European cities prioritise non-motorized automobiles on specific routes and locations when creating green times at traffic lights. Several one-way roads have been changed to two-way roads for non-motorized automobiles, and they are now free of several car turning limitations. Non-motorized lanes or parking spaces have been designated in some European cities for non-motorized vehicles. The same thing can be done in Malaysia by enhancing non-motorized facilities. To increase non-motorized quality, Malaysia needs to focus on developing networks in neighbourhood areas and connecting with existing road infrastructure. These goals can be met by developing a non-motorized transportation strategy based on the European model.

Tatsuo Okuda Shigeki Hirasawa Nobuhiko Matsukuma Takashi Fukumoto, Ph.D. Akitoshi Shimura, Ph.D. [22] This article explains Hitachi's notion of mobility in smart cities, as well as a mobility architecture for putting it into practise and examples of solutions. Hitachi believes that seamless coordination of different transportation companies will play an important role in the future of transportation in balancing people's desire to move around smoothly with an emphasis on comfort against society's desire for transportation to operate sustainably for reasons of safety, practicality, and continuity. Hitachi is not taking on this task by itself. Instead, it sees this as a challenge that must be tackled in collaboration with partners from all around the world. Hitachi aspires to contribute to society's progress by i mplementing smart mobility internationally and achie ving a seamless and sustainable approach through wi nwin collaborations with partners across the world w ho believe in this vision.

Success factors of Smart cities, Abdulaziz Aldegheishem (2019), Journal of land use, Mobility and Environment [23] Intelligent city, innovative city, flexible city, appealing city, and resilient city, digital city, high-tech city, green city, and low carbon city are all terms used in the literature to describe smart cities. Many countries around the world are attempting to establish their own smart city to address issues such as increased pollution, increased air pollution, and global warming. Physical infrastructure, social factors, human factors, the Internet of things, monitoring of resources and life activities in a country such as roads, ports, communications, natural resources, transportation, socio-economic development, improved governance, and innovative resource

management are all indicators of smart city extraction from the definitions.

The basic goal of smart city development is to make cities more flexible to problems in various environments. The following pillars support smart cities: smart living, smart economics, smart environment, smart education, smart government, smart energy, smart safety, smart mobility, smart technology, smart hospitals, smart structures, and smart people. Stadiums, theatres, public libraries, and entertainment venues are examples of smart living. Smart cities help governments handle a variety of issues, including air pollution, population expansion, and environmental issues like global warming.

M. R. Mat Yazid, R. Ismail, R. Atiq [24] Long-term sustainability necessitates non-motorized existence. Sustainable transportation has the following qualities: it is safe, comfortable, and cost- and energy-efficient, and it decreases pollution. Most cities' transportation infrastructures are no longer environmental due to a scarcity of environmental resources such as oil resources, resulting in an increase in the number of fatalities and grievances caused by automobile accidents and traffic overcrowding. Carbon discharges into the environment lead to ecological pollution, which has a negative influence on transportation in general. The purpose of this research is to create a city with sustainable non-motorized transportation that will leave a safer world for upcoming peers. By enhancing the pedestrian walkway and cycling zone, non-motorized transport will grow while motor vehicle travel decreases. Cycling and walking are examples of non-motorized transportation that not only cut carbon emissions but also promote a healthy lifestyle and physical activity.

III. CONCLUSION

A smart city is typically viewed through the eyes of different researchers. Through an examination of its meaning and purpose fields, we give a doorway to a deeper interpretation of the concept of a smart city in this article. Researchers that are working on smart city research and implementation might use our survey as a resource.

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