



## Smart Cities can Benefit from Energy Savings Made Possible by Spending on Intelligent Transportation System for Society 5.0

Dipak Mahat<sup>1\*</sup>, Reeya Agrawal<sup>2</sup>

Researcher, Institution of Research and Innovation, <sup>1</sup>APU

<sup>2</sup>GLA University

**Corresponding Author:** Dipak Mahat, [dipakmahatdm2047@gmail.com](mailto:dipakmahatdm2047@gmail.com)

### ARTICLE INFO

*Keywords:* Intelligent Transportation System, Internet of Things, Service Provider, Society 5.0

*Received :* 20, December

*Revised :* 25, January

*Accepted:* 23, February

©2024 Mahat, Agrawal: This is an open-access article distributed under the terms of the [Creative Commons Atribusi 4.0 Internasional](https://creativecommons.org/licenses/by/4.0/).



### ABSTRACT

Studies highlighted the interconnectedness of Intelligent Transportation Systems (ITS), Smart Cities, and Society 5.0, envisioning a future where these concepts collectively propel urban development. The study emphasized the role of ITS in Society 5.0, promoting safer, more efficient, and environmentally friendly transportation options. The methodology entailed a thorough review of academic sources and a variety of data collection methods. The findings indicated an increased reliance on ITS in smart cities, with a focus on adapting to multiple information sources. The discussion emphasized the critical role of ITS in achieving Society 5.0's goals, establishing a synergistic path for innovative, human-centric urban environments. Overall, the study envisions a future in which seamless integration of technology within smart cities improves urban mobility, reduces congestion, and promotes data-driven decision-making for societal progress.

## **INTRODUCTION**

These devices, which are like nodes in a computer network but are installed along roads, allow cars to talk to one another. Traffic and safety updates are among the topics they cover. They can make travelling easier and safer by reducing congestion and accidents. DSRC equipment is hosted on both physical and fictitious nodes (Bottarelli, Karadimas, Epiphaniou, Ismail, & Maple, 2021; Fatemidokht, Rafsanjani, Gupta, & Hsu, 2021) . Many different terms have been used to describe the relationships between vehicles. Modern PR tools enhance transportation systems' dependability and adaptability. There is a lot of extra work that needs to be done in order to combine these technologies. The rapid expansion of this transport method comes as no surprise. Modern vehicles and drivers have state-of-the-art communication and information systems. Intelligent transportation systems use cutting-edge electronics, network architecture, and sensor technology (Baloch, Memon, Memon, Lal, Viyas, & Jan, 2021; Janakbhai, Saurin, & Patel, 2021) Access to this kind of information is crucial to the efficiency of the transportation system, and this programme makes that possible. Vehicles operated on public roads are not the only ones obligated to use ITS.

The photophone, which uses a beam of light to carry audio, was invented in 1880. Charles Sumner Tainted and Alexander Graham Bell are credited with the invention. The photophone needed both light and line of sight between the sender and the receiver for it to work (Zhang, Wang, Fan, Zhang, Gao, & Yang, 2021). The photophone's utility was diminished as a result of these factors, hastening its inevitable obsolescence. Originally designed for use in military communications, the photophone's utility has been expanded to encompass fiber-optic lines. Only gradually did its ideas enter the mainstream sphere. Before radio systems were widely used, electricity was often transmitted through water and the ground using electrostatic and electromagnetic induction in the late 19th century. Thomas Edison wired his invention of a telegraph into the overhead railway cables. William Peerce's induction telegraph Mirboland & Smarsly, (2021) allowed for the transmission of system messages across oceans and other bodies of water. Many earths conduction telegraph and telephone systems were in use or being developed. The ball really started rolling in the 1990s, with the advent of digital wireless networks. After the initial social upheaval and transition from wired to wireless technology, commercial wireless technologies such as cell phones, wireless telephony, pagers, and wireless computer networks were developed. The number of people using laptops and smartphones, both of which can connect to the internet wirelessly, has increased. This understanding is the result of recent investigations in radio wave physics and radio frequency engineering. This has led to an increase in the transfer of digital information such as text messages, photographs, and live video. Ultimately, this was the impetus for the development of wireless technology, which caused a revolution (Sharma, Singh, Singh, & Dhull, 2021; Chand & Karthikeyan, 2018) .

Wireless sensor networks (WSNs), as proposed by Pratik Goswami et al., would serve as the backbone of the Internet of Things in the not-too-distant future. For wireless sensor networks to function, sensors must be built into each user's device. It is challenging to design routing protocols for WSNs at the OSI Service Provider (SP) layer. Various forms of user feedback from Internet of Things (IoT) app users are essential for a successful implementation of multi-access edge computing (MEC). The simplicity of 6G's inter-sensor communication is one of its most appealing features (Salazar-Cabrera, Cruz, & Madrid, 2021). Consequences from these two variables cannot be understated in terms of how future Intelligent Transportation Systems are developed. The research programme lays out in detail how neural networks can be utilised to construct distributed artificial intelligence (DAI) in a way that is both efficient and rapid for communication between cluster nodes. This contributes to the effort to resolve issues that ITS must address. Although there is a lot of research already done on the topic of energy-efficient intercluster networks, our study presents a novel technique by combining DAI with Self-Organizing Maps (Goswami, Mukherjee, Hazra, & Yang, 2021).

## LITERATURE REVIEW

Management Methods Fit for the Twenty-First Century: A "smart city" is a neighbourhood where high-tech devices and sensors are employed to increase people's awareness of their immediate surroundings. "Smart cities" are increasingly relying on ICTs to enhance their services in order to better manage scarce public resources and prioritise citizen goals like comfort and environmental friendliness (ICT). In theory, all devices might be linked once 5G wireless mobile connectivity becomes commonplace. This system employs a novel network topology known as a mesh. The introduction of 5G will have far-reaching consequences on industry and society as it will serve as the networking backbone for numerous future urban applications. The arrival of 5G wireless networks will enable a wide variety of cutting-edge urban applications. This is but one instance among many. ITS is an obvious outlier in this regard. This article examines the various ways in which 5G will impact the ITS. The monetary and technological benefits of adopting 5G are summarised in the research paper. Energy, healthcare, industry, entertainment, and transportation are just few of the fields where smart cities have been shown to have an impact (Gohar & Nencioni, 2021).

To give just one example, to bring up Subramaniam Thangavel's 2021. "Industry 4.0" encompasses far more than just IoT. It plays an important role in a wide variety of industrial processes, including the production of automobiles. On top of that, it may help oil pipeline transit be more efficient. The breakthrough success of the Internet of Things can be directly attributed to the development of pervasive computing and wireless sensor networks. Wireless sensor networks are extensively utilised in the oil industry as they allow for safe, efficient, and long-distance pipeline transmission. This is how things are right now due to problems with diversity and uniformity. A tiny, integrated IoT module that can power wireless networks and reduce overall energy

consumption is not yet available to the oil industry. Some specific areas of interest for this essay are: It is an example of how to create a bespoke Internet of Things (IoT) module, which may be used in place of costly commercial data loggers and sensors, negating the need for management, and running on specialised software in order to store and analyse data, and so generating cost savings. Sensors with predetermined objectives, vendor-exclusive maintenance, and complicated troubleshooting due to lengthy wire runs are just a few of the restrictions placed on commercial software buyers. Boosting the Internet of Things: The smart module communicates with a cloud server through Wi-Fi using the hypertext transfer protocol (HTTP) and the message queuing and telemetry transport (MQTT) (Priyanka, Maheswari, & Thangavel, 2020).

Among these are Ning (2021) and Sun (2021). In this essay, we look at how AI and other cutting-edge technologies can be most effectively incorporated into the design of future transportation infrastructure. The highest levels of satisfaction with ITS would be expected to be reported by people living in Yunnan. Everyone needs to make the situation in China their top focus right now. If we're being completely frank here, the building sector might benefit from enhanced data management, cutting-edge technology, and a centralised hub for traffic data (Sun, 2021).

Also, look for the 2021 work by Azzedine Boukerche. When integrated into a city's infrastructure, ITS provides real-time traffic data to all transportation stakeholders, enabling more precise regulation of traffic flow (Vanitha, Radhika, Maheshwari, Suresh, & Meenakshi, 2021; Roy & Misra, 2021). The so-called Internet of Vehicles traffic monitoring system is crucial to this endeavour. There is a lot of space for improvement in the transportation sector with regards to both productivity and safety. To guarantee the smooth operation of ITS, many new data transfer protocols are being developed with the help of AI. If you're interested in learning more about how AI can improve data transfer in the VNE, you should read this message. In order to reduce transfer times, VNE employs predictive handover/pre-caching algorithms and data routing protocols that take into consideration traffic patterns (Sun & Boukerche, 2020).

In Addition to the Moazzami, Sheini-Shahvand, Kabalci, Shahinzadeh, Kabalci, & Gharehpetian, (2021) the concept known as "the Internet of Things" has been around for a while, but it has not caught on with the general public just yet (IoT). There are several areas of technology that have enthusiastically embraced this concept. The Internet of Things (IoT) has captured the interest of numerous businesses, organisations, and other groups due to its potential to stimulate innovation across numerous sectors. Smart cities are a key use of IoT, but the network also has many other important uses. More services are becoming more readily available to customers. Research is needed to fully realise the potential of Internet of Things-based intelligent transportation systems (Moazzami, Sheini-Shahvand, Kabalci, Shahinzadeh, Kabalci, & Gharehpetian, 2021).

## METHODOLOGY

Study involved a comprehensive exploration of Intelligent Transportation Systems (ITS) in the context of smart cities and their alignment with the principles of Society 5.0. The initial phase comprised a thorough literature review, encompassing academic articles, books, and research papers, to establish a foundational understanding of the then-current knowledge in ITS, smart cities, and Society 5.0. Subsequently, data was collected from diverse sources, including academic databases, government reports, and industry publications, to obtain up-to-date information on trends, technologies, and applications in the field. Content analysis techniques were then employed to examine key themes from the provided article, identifying patterns and practical implementations of ITS in urban transportation.

## RESEARCH RESULT

### *Smart Cities will Increasingly Rely on ITS*

There will come a day when ITS is no longer required in the many levels that make up the internet (i.e., cyber, social, and physical). Cyber sources, CSP network modelling, and flow models are the focus of this study (Cheema, Ullah, Noor, Rehman, Rehman, & Aziz, 2021).

#### 1. Examining online sources for public opinions and perceptions

How people in a community feel about their public transportation options can be gauged by their participation in online discussion platforms like social media. One can get a fuller picture of the state of a city and its transportation network with the help of these data sets (Li, Wu, & Zhao, 2021). This means that in the future ITSs will require information from multiple sources to effectively manage and track their operations. The suggested method uses natural language processing to analyse data gathered from social network sources like Twitter user comments (NLP). The system considers previously known semantic structures to facilitate analysis. This NLP algorithm attempts to determine public remarks and social events that contribute to traffic problems (such as traffic after a football game) or reveal people's views and thoughts on the present transportation and policy environment (Manogaran & Nguyen, 2021).

#### 2. Modeling of the CSP traffic network

It is crucial to be able to merge and link models for CSP spaces and other multi-source data. Combining and organising data from multiple sources will be simplified by this. A traffic network model that incorporates physical, semantic, logical, and perceptual networks Xia, Wu, Wu, Chen, Yang, & Yu, (2021) should be used in future digital recreations of CSP domains. We must give this model significant thought. Integrating cognitive computing with probabilistic inference models is one way to depict the intricate nature of a network's interactions. Statistical and NLP methods can be used to probe the nature of connectivity in cross-domain datasets. With the use of a spatial-temporal connection rule, we can deduce that the proximity of heavy traffic is correlated with weak Bluetooth signals. This proposal hypothesises a link

between the number of people who enter and exit a facility and its overall energy use. As part of building this traffic network model (Tyagi & Sreenath, 2023), it will be necessary to identify and specify the types and amounts of data necessary to ensure services are delivered as expected.

### *ITS in Smart Cities*

Throughout the world, new modes of transportation are continually appearing. Lime and Bird, two rental businesses, have seen significant growth in the past few years as a mode of mobility (Garg, Mehrotra, Pandey, & Pandey, 2021). Charging facilities for electric vehicles are mushrooming in number, and the connected automobile is becoming increasingly common. Different creative approaches can help communities address their problems. Mobile network operators are becoming embedded in a diverse set of supply chains. Apps can be made by anyone, allowing for web-like digital commerce to take place in brick-and-mortar establishments (Bagga, Das, Wazid, Rodrigues, Choo, & Park, 2021).

To get from one point to another, "smart transportation" users rely on systems that integrate cutting-edge technology with innovative management strategies. It is necessary to know this in order to locate the car precisely on the road. With the use of image recognition technology, licence plates can be found and their information decoded. Current technologies are hastening the development of intelligent transportation networks. Connecting them has the added benefit of protecting the environment (Vanamaa & Sheetlani, 2021). Figure 1 demonstrates how this information can be used to improve the quality of manufactured goods like cars and structures.

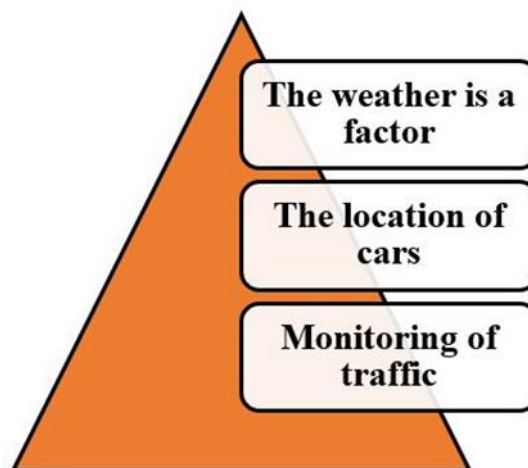


Figure: 1 Vehicles and Infrastructure Change with Time

As new technologies are implemented, made possible by the Internet of Things, the transportation sector is set to undergo profound shifts. Using cutting-edge technology and satellite information, getting around will be a breeze. Satellite information, which is currently used to relay messages between mobile objects and stationary infrastructure, will soon be obsolete in the transportation system. As of right now, this is being handled by terrestrial networks, but that will change very soon (Zhao & Jia, 2021). Satellite

information allows for the rapid dissemination of knowledge. Even if no other networks are available, satellites can still receive and send data. Figure: 2 depicts many ways of transportation.

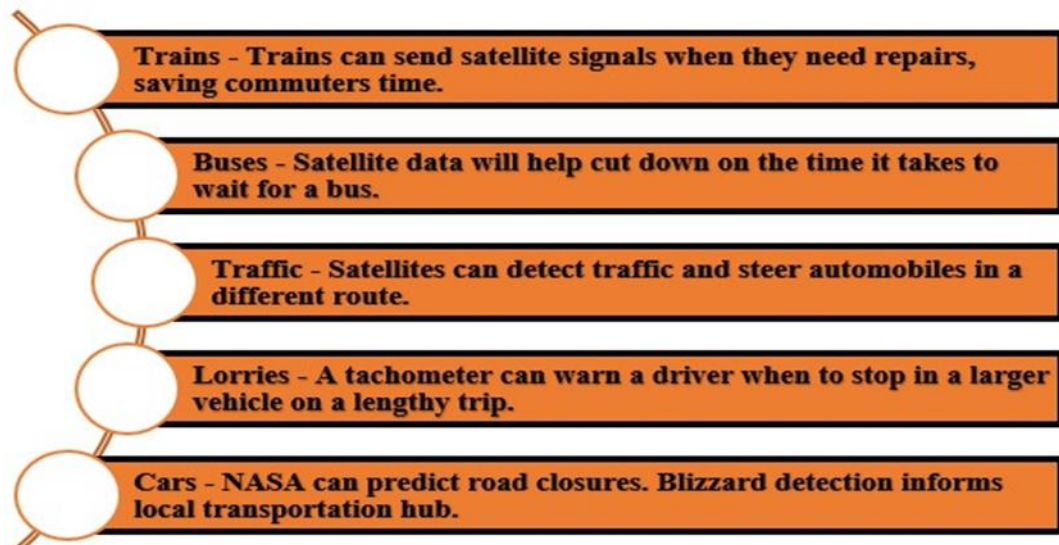


Figure: 2 Different Transportation Types

### *Modern Tendencies in ITS for Transport*

Traffic, accidents, and pollution all raise in tandem with population density. Those who fit this description either don't want to or can't bring a car with them. Technology in the fields of sensors, communication, information dissemination, and traffic management have all contributed to finding solutions to these issues (Azam, Priyadarshi, Nagar, Kumar, & Bhoi, 2021). There is an abundance of supplementary equipment that can be used in conjunction with these devices. Collecting data, analysing it, and sharing the results are all essential functions of any worthwhile ITS. Transportation network planners can observe all aspects, including data on road signs and lighting. The number of cars on the road, the travel time along a specific section of road, the number of people using a specific subway line, and so on are all examples of such variables. In the past, basic traffic statistics like the number of cars and their average speed at a given location were determined using tools like inductive loop detectors and pneumatic tubes (Dibaei, et al., 2022). The volume of traffic has previously been measured using pneumatic lines and inductive loop detectors. The approach has been used to derive average speeds and traffic volumes. Due to the prohibitive cost of installation and the inevitable traffic delays that accompany construction, their occurrence has declined in recent years. This is especially true in crowded cities (Naeem, Marcos, & Urooj, 2021). Due to their sensing and seeing capabilities, video cameras and radio-frequency identification (RFID) scanners are gaining popularity for traffic data collection. Multiple cameras can be placed in strategic locations to capture data as it moves through the system. It is possible to analyse traffic flows, speeds, and vehicle kinds with the help of image processing tools like RFID matching. The information can be used by tourists to

plan their trips more efficiently. It is now easier to analyse traffic conditions and trip patterns thanks to new forms of communication technology (L & Xu, 2021), such as mobile phone data, GPS data, Bluetooth and Wi-Fi component MAC addresses, smartphones, and other types of mobile devices. This shift in perspective has been brought about by the widespread availability of information. Enhanced utilisation of the new data necessitated updating these models. They can now expand and improve their previous studies thanks to this new data. ITSs are useful for everyone on the road by facilitating the sharing of information about vehicle and road conditions, maintenance, and safety among drivers, passengers, and pedestrians (Firdaus & Rhee, 2021). Apps, VMS, and in-car screens, among other modern forms of public communication, have surpassed them. Today's world is much more favourable than days gone by thanks to advancements in communication technology. As shown in Figure 3, these fundamental components are indispensable when building ITSs.

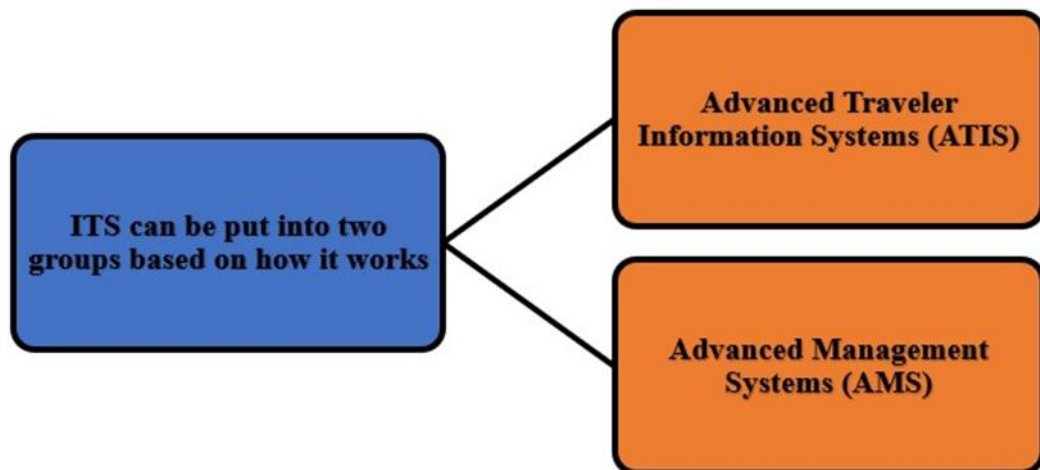


Figure: 3 Types of ITS

ATIS (Advanced Traveler Information Systems) - In order to help people, plan their journeys, ATISs are helpful (for instance, the best mode of transportation to use, the best route to take, the best time to leave, etc.). Travellers' decisions, especially those about which route to take, might be heavily influenced by these factors, thus they are getting a lot of attention (Sengul, Tarhan, & Tecim, 2022). An estimated trip time or location is the most sought piece of data. Time and distance estimates can be calculated more precisely using this method.

AMS (Advanced Management Systems) - The attempts of AMSs to control and oversee the transportation sector may influence any operator or piece of infrastructure in the sector. Nothing could ever go wrong with the public transportation system. Examples abound in the literature, including roads, freeways, freight transport, and public transit networks (Ismae, et al., 2021). With more data at our disposal and more sophisticated methods of disseminating knowledge, we will be better equipped to manage complex systems in real time. The bus's speed reduces on its own at scheduled stops according to its current location.

### *IC and Related AI Techniques*

The importance of so-called "smart cities" has been rising as of late. We frequently use the term "smart mobility" when talking about these ITSs. There are a variety of possible explanations for this occurrence (Liu, Yu, Tang, & Zhu, 2021 ). A smart city would enable its citizens to make the most of their resources through the effective scheduling of preventative maintenance, monitoring of security, and provision of the highest quality of service. The following is an illustration of how a "smart city" might operate. The language used to describe the current situation is determined by the goals and ideology of whoever is in power. Those in modern urban areas tend to focus on improving their quality of life, while those working for private companies may prioritise productivity gains. "Smart" cities use cutting-edge electronic/digital technology such as IT, integrate IT or other electronic gear with municipal infrastructure, and widely disseminate information about these advancements. "Smart cities" provide residents with cutting-edge services and infrastructure, including cutting-edge government, an innovative economy, human intellectual capital, a breath-taking environment, smart housing, and smart transportation. You can classify them into one of six different groups (Poon, 2021). "Smart Governance" is an initiative to modernise the operation of governments via the use of advanced information and communication technologies. Using ICT and other technologies, a "smart economy" seeks to increase the volume and quality of digital trade. More information on the smart city will be made available to the public to boost citizen engagement and education. Members of the smart city community share their insights. Feedback from citizens is highly valued by the government since it represents some of the most reliable information citizens can supply.

Using technology to reduce rubbish will make cities safer for citizens and the environment. Smart living capitalises on the increasing technological sophistication of urban environments and infrastructures to improve residents' quality of life (such as their safety and the quality of their homes, as well as their social cohesion). Smart mobility, which emphasises time-saving transit, has been nicknamed "smart life." Improved transportation efficiency, safety, and sustainability are the goals of this programme that employs state-of-the-art information and communication technology. However, it may be difficult to analyse the development of an intelligent city and identify specific areas for improvement due to the sheer quantity of relevant indicators (Lamssaggad, Benamar, Hafid, & Msahli, 2021 ). Mobility, production, and pollution all need meticulous planning when it comes to urban areas. More than that, though, these measurements can help researchers get insight into how smart cities can be made better overall.

### *Intelligent Transport System, Smart Cities and Society 5.0*

Intelligent Transport Systems (ITS) play a crucial role in guiding smart cities towards the realisation of Society 5.0 (Deguchi, 2020). Integrating advanced technologies that involve data analytics and real-time monitoring,

Intelligent Transportation Systems (ITS) enhance urban mobility by mitigating traffic jams and reducing energy consumption (Oladimeji, Gupta, Kose, Gundogan, & Liang, 2023). The convergence mentioned aligns with the fundamental principles of Society 5.0, which aims to achieve a harmonious collaboration of technology and human requirements. Smart cities, through the adoption of Intelligent Transportation Systems (ITS), demonstrate the ideals of Society 5.0 by fostering data-centric decision-making, active citizen participation, and cooperative governance (Tavares, Azevedo, & Marques, 2022). The integration of multi-dimensional data in Intelligent Transportation Systems (ITS) reflects the comprehensive approach of Society 5.0, which encompasses the convergence of physical, digital, and societal domains (Wang & Zhang, 2017). Through welcoming the adoption of Information Technology Systems (ITS), smart cities establish the fundamental framework for the development of Society 5.0. This approach promotes the integration of technology within urban landscapes, aiming to achieve comprehensive societal progress.

## **DISCUSSION**

**Information Transportation System and Smart Cities:** The availability of real-time information on transport patterns, traffic flow, and infrastructure issues is made possible by Intelligent Transport Systems (ITS), which plays an important part in the evolution of Smart Cities. The provided data serves as valuable input for urban planning and decision-making processes with the aim of optimising traffic management, mitigating congestion, and enhancing public transportation systems. The transport system in a Smart City benefits from Intelligent Transport Systems because of its effectiveness and long-term viability.

**ITS and Society 5.0:** Intelligent Transport Systems are vital for accomplishing Society 5.0's objectives because they provide safer, more efficient, and green transportation options. Key elements of both ITS and Society 5.0 include autonomous cars, electric vehicles, and linked infrastructure because of their benefits in areas like accident prevention, increased mobility, and reduced environmental impact. **Smart Cities and Society 5.0:** Society 5.0 has its roots in the idea of "Smart Cities," which incorporate technological innovations into urban life to make cities more environmentally friendly and creative places to live. Both of these concepts highlight human-centered methods that use technology to solve social concerns and increase people's well-being.

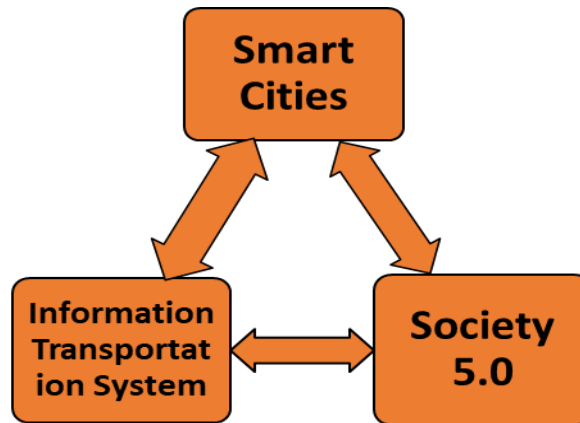


Figure 4  
Relation between information transportation system,  
Smart Cities and Society 5.0

In short, the synergy between Intelligent Transport Systems, Smart Cities, and Society 5.0 looks well for the development of innovative, human-centric urban environments. Effective transportation in Smart Cities is fuelled by ITS, which is in line with Society 5.0's objective of bringing technology and society into balance. Together, these concepts offer the way to a future in which urban areas are progressive in terms of technology and sustainability, with a focus on the happiness of their citizens.

## CONCLUSION

All the information gleaned from the car's performance logs is saved in the database. The deployment of sensor networks in cities also enables the gathering of information on vehicular traffic. One common name for these devices is "radar detectors," however "traffic detectors" is also in use. Sensors are essential for secure data sharing between vehicles and infrastructure. TMSs collect the data and use it to optimise the way transportation services are coordinated. Some bottlenecks persist even though traffic flow and infrastructure problems have eased. Nothing tops the Intelligent Transportation System (ITS) when it comes to monitoring and controlling traffic. Consequently, more people will use public transportation. The Internet of Things is the foundation for all these novel modes of mobility. Productivity can be improved by integrating sensors and ACS into a strong computational framework. Data that could be useful is routinely gathered and analysed. The ITS market should grow as more applications are made to make use of the Internet of Things. Recent traffic jams and other issues can be traced back to a rise in the number of cars on the road. Smart cities are guided by intelligent transportation systems. Society 5.0 is the product of future smart cities. Society 5.0 "Lead the Whole World Towards welfare of humanity".

## ADVANCED RESEARCH

In writing this article the researcher realizes that there are still many shortcomings in terms of language, writing, and form of presentation considering the limited knowledge and abilities of the researchers themselves. Therefore, for the perfection of the article, the researcher expects constructive criticism and suggestions from various parties.

## REFERENCES

- Azam, F., Priyadarshi, N., Nagar, H., Kumar, S., & Bhoi, A. K. (2021). An Overview of Solar-Powered Electric Vehicle Charging in Vehicular Adhoc Network. In *Green Energy and Technology*. [https://doi.org/10.1007/978-981-15-9251-5\\_5](https://doi.org/10.1007/978-981-15-9251-5_5)
- Bagga, P., Das, A. K., Wazid, M., Rodrigues, J., Choo, K.-K. R., & Park, Y. (2021). On the Design of Mutual Authentication and Key Agreement Protocol in Internet of Vehicles-Enabled Intelligent Transportation System. *IEEE Transactions on Vehicular Technology*. <https://ieeexplore.ieee.org/document/9319539>
- Baloch, A., Memon, T. D., Memon, F., Lal, B., Viyas, V., & Jan, T. (2021). Hardware Synthesize and Performance Analysis of Intelligent Transportation Using Canny Edge Detection Algorithm. *I. J. Engineering and Manufacturing*, (pp. 22-32). <https://doi.org/10.5815/ijem.2021.04.03>
- Bottarelli, M., Karadimas, P., Epiphaniou, G., Ismail, D. K., & Maple, C. (2021). Adaptive and Optimum Secret Key Establishment for Secure Vehicular Communications. *IEEE Transactions on vehicular technology*, (pp. 2310-2321). <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9346002>
- Chand, H. V., & Karthikeyan, J. (2018). Survey on the Role of IoT in Intelligent Transportation System. *Indonesian Journal of Electrical Engineering and Computer Science*, 936-941. <http://doi.org/10.11591/ijeecs.v11.i3.pp936-941>
- Cheema, T. A., Ullah, I., Noor, F., Rehman, S. U., Rehman, A. U., & Aziz, M. A. (2021). A Dual-Mode Medium Access Control Mechanism for UAV-Enabled Intelligent Transportation System. *Edge Intelligence in Internet of Things using Machine Learning*. <https://doi.org/10.1155/2021/5578490>
- Deguchi, A. (2020). From Smart City to Society 5.0. In *Society 5.0* (pp. 43-65). Springer, Singapore. [https://doi.org/10.1007/978-981-15-2989-4\\_9](https://doi.org/10.1007/978-981-15-2989-4_9)

- Dibaei, M., Zheng, X., Xia, Y., Xu, X., Jolfaei, A., Bashir, A. K., et al. (2022). Investigating the Prospect of Leveraging Blockchain and Machine Learning to Secure Vehicular Networks: A Survey. *Computer Engineering and Science*, 23(2), 683-700. <https://doi.org/10.1109/TITS.2020.3019101>
- Fatemidokht, H., Rafsanjani, M. K., Gupta, B. B., & Hsu, C.-H. (2021). Efficient and Secure Routing Protocol Based on Artificial Intelligence Algorithms With UAV-Assisted for Vehicular Ad Hoc Networks in Intelligent Transportation Systems. *IEEE Transactions on Intelligent Transportation Systems* (pp. 1-13). IEEE.
- Firdaus, M., & Rhee, K.-H. (2021). On Blockchain-Enhanced Secure Data Storage and Sharing in Vehicular Edge Computing Networks. *Intelligent Transportation Systems: Beyond Intelligent Vehicles*, 11(1). <https://doi.org/10.3390/app11010414>
- Garg, S., Mehrotra, D., Pandey, H. M., & Pandey, S. (2021). Accessible review of internet of vehicle models for intelligent transportation and research gaps for potential future directions. *Peer-to-Peer Networking and Applications*, 978-1005. <https://doi.org/10.1007/s12083-020-01054-6>
- Gohar, A., & Nencioni, G. (2021). The Role of 5G Technologies in a Smart City: The Case for Intelligent Transportation System. *Sustainability*, 13, 5188. <https://doi.org/10.3390/su13095188>
- Goswami, P., Mukherjee, A., Hazra, R., & Yang, L. (2021). AI Based Energy Efficient Routing Protocol for Intelligent Transportation System. *IEEE Transactions on Intelligent Transportation Systems*, 23(2), 1-10. <https://doi.org/10.1109/TITS.2021.3107527>
- Ismae, H. R., Ameen, S. Y., Kak, S. F., Yasin, H. M., Ibrahim, I. M., Ahmed, A. M., et al. (2021). Reliable Communications for Vehicular Networks. *Asian Journal of Research in Computer Science*, 10(2), 33-49. <https://doi.org/10.9734/ajrcos/2021/v10i230238>
- Janakbhai, N. D., Saurin, M. J., & Patel, M. (2021). Blockchain-Based Intelligent Transportation System with Priority Scheduling. In *Data Science and Intelligent Applications*.
- L, C., & Xu, i. (2021). Application on traffic flow prediction of machine learning in intelligent transportation. *Neural Computing and Applications*, 33(11). <https://doi.org/10.1007/s00521-020-05002-6>

- Lamssaggad, A., Benamar, N., Hafid, A. S., & Msahli, M. (2021 ). A Survey on the Current Security Landscape of Intelligent Transportation Systems. *IEEE*. doi: 10.1109/ACCESS.2021.3050038.
- Li, N., Wu, Z., & Zhao, Z. (2021). Application of Internet of Things Compressed Sensing and Information Interaction Technology in Intelligent Transportation Layout. *Scientific Programming*, 11. <https://doi.org/10.1155/2021/9979198>
- Liu, S., Yu, B., Tang, J., & Zhu, Q. (2021 ). Invited: Towards Fully Intelligent Transportation through Infrastructure-Vehicle Cooperative Autonomous Driving: Challenges and Opportunities. In *58th ACM/IEEE Design Automation Conference* (pp. 1323-1326). Institute of Electrical and Electronics Engineers Inc.
- Manogaran, G., & Nguyen, T. N. (2021). Displacement-Aware Service Endowment Scheme for Improving Intelligent Transportation Systems Data Exchange. *IEEE Transactions on Intelligent Transportation Systems*. doi: 10.1109/TITS.2021.3078753.
- Mirboland, M., & Smarsly, K. (2021). BIM-Based Description of Intelligent Transportation Systems for Roads. *infrastructures*, 2-19. <https://doi.org/10.3390/infrastructures6040051>
- Moazzami, M., Sheini-Shahvand, N., Kabalci, E., Shahinzadeh, H., Kabalci, Y., & Gharehpetian, G. B. (2021). Internet of Things Architecture for Intelligent Transportation Systems in a Smart City. *3rd Global Power, Energy and Communication Conference (GPECOM)*. doi: 10.1109/GPECOM52585.2021.9587692.
- Naeem, T. M., Marcos, K., & Urooj, R. (2021). Analysis of VANET Wireless Networking Technologies in Realistic Environments. *IEEE Radio and Wireless Symposium*. doi: 10.1109/RWS50353.2021.9360381
- Oladimeji, D., Gupta, K., Kose, N. A., Gundogan, K., & Liang, F. (2023). Smart Transportation: An Overview of Technologies and Applications. *Sensors*, 23(8), 3880. <https://doi.org/10.3390/s23083880>
- Poon, S. (2021). Designing for Urban Mobility: The Role of Digital Media Applications in Increasing Efficiency of Intelligent Transportation Management System. In *Smart Cities: A Data Analytics Perspective*. Springer International Publishing.

- Priyanka, E. B., Maheswari, C., & Thangavel, S. (2020). A smart-integrated IoT module for intelligent transportation in oil industry. *Inernational journal of Numerical Modelling*. <https://doi.org/10.1002/jnm.2731>
- Roy, C., & Misra, S. (2021). Safe-Passé: Dynamic Handoff Scheme for Provisioning Safety-as-a-Service in 5G-Enabled Intelligent Transportation System. *IEEE Transactions on Intelligent Transportation Systems*, (pp. 1-11). doi: 10.1109/TITS.2021.3054694.
- Salazar-Cabrera, R., Cruz, Á. P., & Madrid, J. M. (2021). Design of a Public Vehicle Tracking Service Using Long-Range (LoRa) and Intelligent Transportation System Architecture. *Journal of Information Technology Research*, 14(1), 147-166. DOI: 10.4018/JITR.2021010109
- Sengul, M. K., Tarhan, C., & Tecim, V. (2022). Application of Intelligent Transportation System Data using Big Data Technologies. *2022 Innovations in Intelligent Systems and Applications Conference*. doi: 10.1109/ASYU56188.2022.9925457.
- Sharma, P., Singh, A., Singh, K. K., & Dhull, A. (2021). Vehicle identification using modified region based convolution network for intelligent transportation system. *Multimedia Tools and Applications*. <https://doi.org/10.1007/s11042-020-10366-x>
- Sun, N. (2021). Intelligent Transportation System Planning in the Age of Artificial Intelligence. *International Conference on Environmental and Engineering Management*, 5. <https://doi.org/10.1051/e3sconf/202125301036>
- Sun, P., & Boukerche, A. (2020). AI-assisted data dissemination methods for supporting intelligent transportation systems. *Internet technology letter*. <https://doi.org/10.1002/itl2.169>
- Tavares, M. C., Azevedo, G., & Marques, R. P. (2022). The Challenges and Opportunities of Era 5.0 for a More Humanistic and Sustainable Society – A Literature Review. *Societies*, 12, 149. <https://doi.org/10.3390/soc12060149>
- Tyagi, A. K., & Sreenath, N. (2023). Introduction to Intelligent Transportation System. *Intelligent Transportation Systems: Theory and Practice*.

- Vanamaa, b., & Sheetlani, J. (2021). Vehicular Cloud Data Collection for Intelligent Transportation System. *Turkish Journal of Computer and Mathematics Education*, 12(11), 3561-3566.
- Vanitha, N. S., Radhika, K., Maheshwari, M., Suresh, P., & Meenakshi, T. (2021). IoT-Based Intelligent Transportation System for Safety. Wiley. DOI:10.1002/9781119761846
- Wang, F.-Y., & Zhang, J. J. (2017). Transportation 5.0 in CPSS: Towards ACP-based society-centered intelligent transportation. *IEEE 20th International Conference on Intelligent Transportation Systems (ITSC)*. doi: 10.1109/ITSC.2017.8317905.
- Xia, Z., Wu, J., Wu, L., Chen, Y., Yang, J., & Yu, P. S. (2021). A Comprehensive Survey of the Key Technologies and Challenges Surrounding Vehicular Ad Hoc Networks. *ACM Transactions on Intelligent Systems and Technology*, 12(4). <https://doi.org/10.1145/3451984>
- Zhang, D., Wang, J., Fan, H., Zhang, T., Gao, J., & Yang, P. (2021). New method of traffic flow forecasting based on quantum particle swarm optimization strategy for intelligent transportation system. *International Journal of Communication System*, e4647. <https://doi.org/10.1002/dac.4647>
- Zhao, L., & Jia, Y. (2021). RETRACTED: Intelligent transportation system for sustainable environment in smart cities. *International journal of Electrical Engineering*, 60(1). <https://doi.org/10.1177/0020720920983503>