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IoT Based Smart Cities with Intelligent Transportation Systems for Sustainable Future

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Abstract

Infrastructure is very important for the progress of any nation. It provides work to the community to grow economically from transportation, electricity, industry etc. Infrastructure leads towards primary livelihood system and provides accommodation, transport, communication system, water and power supply in smart building/cities. Infrastructure growth is essential to uplift finance and decline penury. With the advancement in technology, transport system is facilitated with information and communication technology (ICT). The concept of smart city; integrates internet of things and ICT for intelligent transportation system. This mainly rely on four parameter; city planning from the aspect of smart cities, application of IoT for fast decision-making information, proper controlling technology to maximize congestion free lanes for vehicles to pass and smart taxation mechanism for changing customer behaviour. The author has presented the study emphasising intelligent transportation system based on Internet of Things (IoT), for optimizing the efficiency of city operations and maintenance of safe traffic services i.e. taking preventive action for accidents happening. This paper also showers light on challenges and benefit associated with intelligent transport management system. Lastly, the study gives a clear and crystal vision towards smart city with eco-friendly intelligent transportation system for sustainable future.

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Keywords

Information and Communication Technology (ICT), Internet of Things (IoT), Intelligent Transportation System (ITS), Traffic Congestion Condition (TCS), Real-Time Communication (RTC), Security, Challenges, Smart Cities, Sustainability

1. Introduction

Many cities proclaim to be smart city globally. But what smart city exactly mean and how it came into existence? After World War II, American industrial cities were facing difficulties related to infrastructure and population in support of economy [1]. Years passed away in solving the problems. New framework was set regarding financial transformation. It took yeas in remodelling the infrastructure with innovative technologies [2,3]. The new model comprising architecture and finance gave the concept of smart developments and explored these modifications into smart cities [4]. Smart cities became a driving force in visualizing and overcoming the problems related to population, economic development, employment and increased livelihood. The term "smart" is relate to intelligent devices having excellent features such as smart mobiles phones connecting people globally, smart TV (android, LED), smart car (e-vehicles, hybrid vehicles) for transportation [5] etc. In late 19th century, concept of smart city became eye-catching and spread like fire towards urban planning [6]. Developing smart cities is only possible with the growth of internet and mobile technologies. At every step the city improves its infrastructure by incorporating data driven connecting technologies, it is said to be more intelligent. Smart city having smart transportation involve sensors in IoT technologies for monitoring the quality of air, fluctuation in temperature. This IoT technology is incorporated in public buildings and transportation for safety and better transportation management system. High grade infrastructure always accomplishes SDGs in three domains i.e. People, Profit, and Planet (3P's)[7,8]. Today, innovations are playing a pivot role in digital market globally. The industrial developments are the foundation of economic growth.

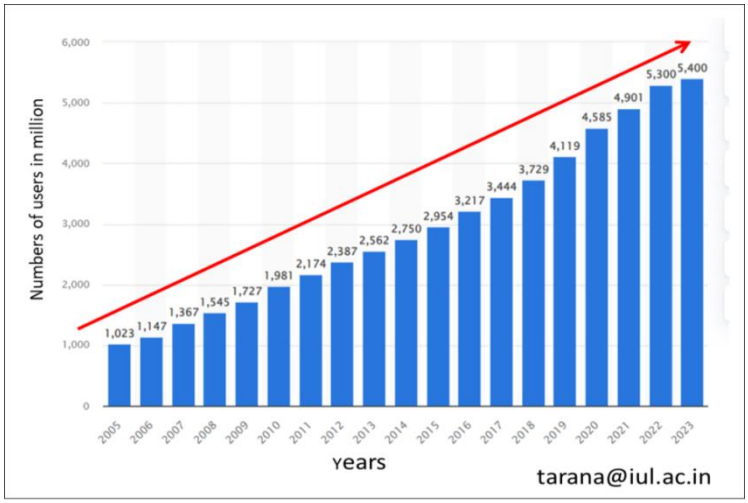

Figure 1. Internet subscribers since 2005, globally

Since last two decades, internet subscribers have increased globally from 1000 million users in 2005 to 5400 million users in 2023, continue to grow as shown in figure 1[9]. Internet technologies and communication networking technologies are moving together, making Internet of Things (IoT), a perfect approach in making smart cities [9]. The term IoT is associated with intersection of technologies permitting to access data/information collected from the devices having wire or wireless internet network [5]. Example such as sensor based embedded system are accessed by computerized system with a common interface link, collecting data and working tor upgrade devices/machines. The telemetry data (TD) and IoT enables managers/engineers on work; a command or signal to tackle the equipment's to maximize work in much better ways [10].

The project operation with ICT and digital networking, collaborate with public-private sectors, setting new framework and implementing new policies [10]. Sustainable smart city strategy is shown in figure 2 [7].

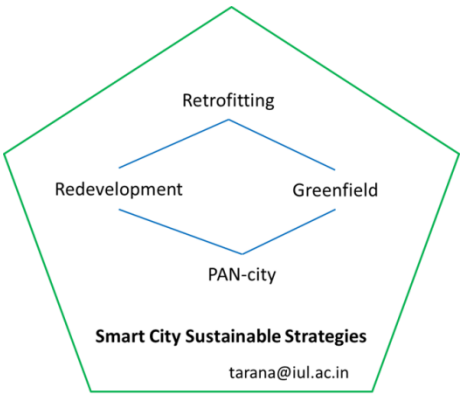

Figure2 Sustainable smart city strategy

With the increase in data collection and automation, local government has embraced the ideas of smart and intelligent transportation. Apart of it, it was very difficult for government to develop public Wi-Fi network with low price, generating new opportunities and taking initiative to develop smart and intelligent transportation system. Smart transportation involves partnership between public-private enterprises that can effectively handle several issues such as pollution from car emission, traffic lane congestion and public transport for all. Transportation department is divided into different sub-department providing real-time data for vehicles and electronic toll collection and public transport with smart cards. It needs comprehensive strategies and various intelligent innovative technologies for smart and intelligent transport system.

2. Literature review

2.1 Internet of Things (IoT):

The word IoT was first introduced by Kevin Ashton in 1999 [13]. Having in view a global vision, presentation was given for Procter & Gamble (P&G), highlighting the physical object connected through sensors via internet, enabling dual way transfer of real-time information [14]. After 6 years, this technology became popular when the International Telecommunication Union announced publically "The Internet of Things" (IoTs). This reflects that IoT as an integrated device allowing dual-way communication between human and machine with the help of embedded system comprising of sensors, processors, actuators along with communicating channels such as Wi-Fi, Bluetooth, zigbee [13,15]. The perception of IoT relies on research findings and conceptualisation i.e one is complete technical part and other is techno-social interaction [16]. In technical session, IoT is viewed as technically proof eco-friendly tool for intelligent transportation management section, defining their capabilities for safe and congestion free lane, traffic light management system along with communication between human and vehicle.

The concept of the IoT relies on the research condition. It is sensor based device connected to internet [23] According to Lynn et al. 2020, IoT have two main concepts. The first is technical aspects, while the second is interactions between technical and social elements [16]. Based on Sethi and Sarangi, 2017, the IoT is not based on single technology but it is a combination of a multiple integrated technologies and communication protocols [17]. These technology are cloud computing, fog computing [19,20], edge computing, Radio frequency

identification [19,20], wireless sensor and actuator networks (WSAN) [19,20], machine-to-machine (M2M) [19] communication, and Internet protocol version 6 (IPv6) [18, 19]. The structure of IoT is the summation of dual properties i.e. internet and thing. Internet is related to networking and the thing is related to sensor based device. It means that networking between various sensor devices via internet. According to Atzori, IoT consist of three elements, first and second mentioned above and the third element is semantic [21]. Big data are collected from the devices connect via internet. Iot function is based on three key parameters i.e. following/traceability, communication and interconnection. Based on these key parameters, architecture of IoT should guarantee safety and security, scalability, reliability and intercommunication ability. The IoTs, intelligent system with automatic control system have different levels of communication. It has four layers i.e. physical layer, networking layer, and middleware layer and application layer [20]. Physical layer i.e. the perception of devices, collects information from devices and surrounding, second layer is networking layer i.e. transmission and processing of information or data with the help of Wi-Fi, Bluetooth, 3G, UMTS or ZigBee. The information's are collected, stored, processed and analyzed in the middleware layer and fourth layer is the application. Applications of IoT in our daily life's lye in the field of smart health, smart education [20,24], smart building [2,5,8], smart entrepreneurship [8] and smart agriculture[20], smart energy management system [22]. Smart city with ITS is increasing since 2014. Smart city is recognised by smart governance, smart mobility, smart learning, smart eco-system and smart livelihood [5].]. IoT based smart city with ITS having different applications is shown in figure 3.

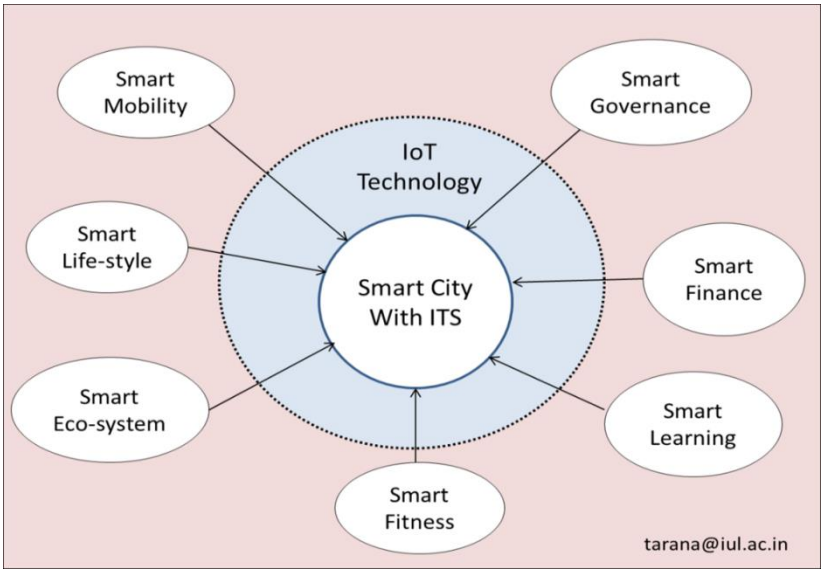

Figure3. IoT based smart city with ITS

2.2 Intelligent transportation system (ITS)

The beginning of ITS programs was initiated in 1960's at United State with the advancement of Electronics Route Guidance System (ERGS) for the drivers for guiding the route information based on real time traffic analysis [25].This research was carried out by Japan' to resolve the problem of heavy traffic congestion. This research period was from 1973 to 1979 as comprehensive automatic traffic control system (CACS) program, testing was done in urban areas as a route guidance system. Japanese stated keeping eye on ITS with better prospective, developing advanced information telecom society globally. This early stage was featured as Japan's CACS and Electronics guidance system in United State during the period, from 1960 to 1970. These systems utilize sensor based hardware, positioned at various locations and square roads, on-board dual way devices in vehicles making a communication hub in-between ERGS and drivers along with a centralized computer system that is processing information's received from far-off distances. Next stage started in beginning of 1970 till 1995 [26], ERGS were programed to provide visual digital map to interact automatically known as Automatic Route control system (ARCS). By the end of 1980, improved condition of ITS was developed with mass memory storage and reduced processor cost. In 1984, a project on road automobile communication system (RACS) was done in Japan, laying the foundation of car navigation system. In parallel, Europe also did research on two projects. First project was a program on traffic system with higher efficiency and unprecedented safety (PROMETHEUS)[26], set up by auto manufacturers for vehicle safety in Europe (DRIVE). The research project in this area was named as Advanced Safety Vehicle (ASV) by the ministry of transportation, super smart vehicle system (SSVS) by the ministry of international Trade and industry, and automated highway system (AHS) by the ministry of construction [26]

Thus, the urban traffic control system was generated interconnecting numerous traffic signals and computer generating fixed timing signals for excellent traffic management. A bill was passes by United State, known as Federal Transportation Bill. This bill was passed to solve the issues related to road accidents, fuel pollution and wastage and enhanced traffic congestion [25]. In 1981, the first commercial was Honda Electro Gyro-Cator, having car navigation system [27] shown in figure 4.

Figure4. Honda Electro Gyro-Cator with car navigation system

In 1986, an intelligent vehicle highway system (IVHS) was framed leading ITS in 3rd stage. An advisory committee was incorporated for IVHS to support the transportation system of US-Department, aiming to upgrade highway operations for both national and global requirements. This became the foundation in establishing an Intelligent Transportation Society of America, fostering a non-profitable organizational in 1991 [25].

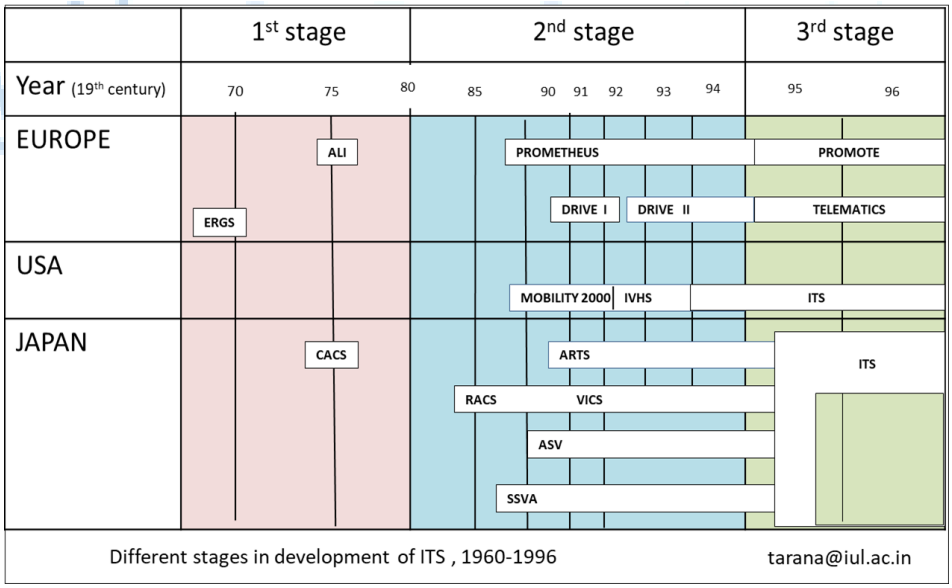

Figure 5. Different stages in development of ITS from 1960-1996

Policy MOBILITY 2000 evolved from the dialogues of group of academicians, stakeholders and UD Department of transportation, representing new technology in framing policy, leading towards ITS for wider transportation community [27].Different stages in

development of ITS in Japan, USA and Europe from 1970 to 1996 [25, 26] is shown in figure5.

It is a newly developed technology providing services to various modes of transportation and traffic management system (TMS). It support the consumers with latest information making safer transport services, good coordination within traffic light system, thus, revolutionizing communication with numerous entities of smart cities. It is a latest approach in developing smart infrastructure with smooth and smart traffic mobility management solutions.

3. Research Methodology

The research methodology involve inductive qualitative study of articles from 2017 to 2023 associated with identification of the challenges with the development of ITS for smart city mobility. The study was conducted from articles published in reputed journal having database on Science Direct, Research Gate, Web of Science, Scopus, Government websites and books, emphasising on quantitative method for data analysis, to identify the present state of art of development. Assessments are done on the collected data, are the basis of research evaluation. This method was adopted in order to identify and clarify the challenges in intelligent transportation system.

Proposed model: The proposed model consists of four stages i.e. key word, data collection, inclusion selection period, data extraction followed by visualization and analysis of the publications and finally the observed challenges as results. The proposed model is shown figure6. “Stage A” involve research keywords such as Information and Communication Technology (ICT), Internet of Things (IoT), Intelligent Transportation System (ITS), Traffic Congestion Condition (TCS), Real-Time Communication (RTC), Security Challenges, Smart City, Sustainability. Stage B consist collection of data from journals, conference proceedings, books and government portal, the data base of these publications are Scopus, Web of Science, MDPI. Stage C involve research duration and stage D involve visualization and analysis of reviewed data and finally observing the challenges as results

4. Intelligent transportation technologies

Intelligent transportation system utilizes different innovation for smooth mobility such as car navigation, traffic signal control system, auto number plate recognition, speed control cameras, accident detection and stop vehicle detection [28]. Furthermore advance

technologies involve integration of current data along with feedback from different sources such as car parking system and weather forecasting system [28].

4.1 Wireless communications

Numerous wireless communication technology are proposed for ITS such as radio modem communication on UHF and VHF. These frequencies are for small and large distance communication. Short distance can be 350 m, accomplished by IEEE802.11 while 802.11bd standards are used by Intelligent Transportation society of America and the United States Department of Transportation. Their range can be extended by mobile ad hoc network and mesh networking. For long distance communication, infrastructure networking is very important and they also utilize similar protocol as short distance communication protocol though they are costly.

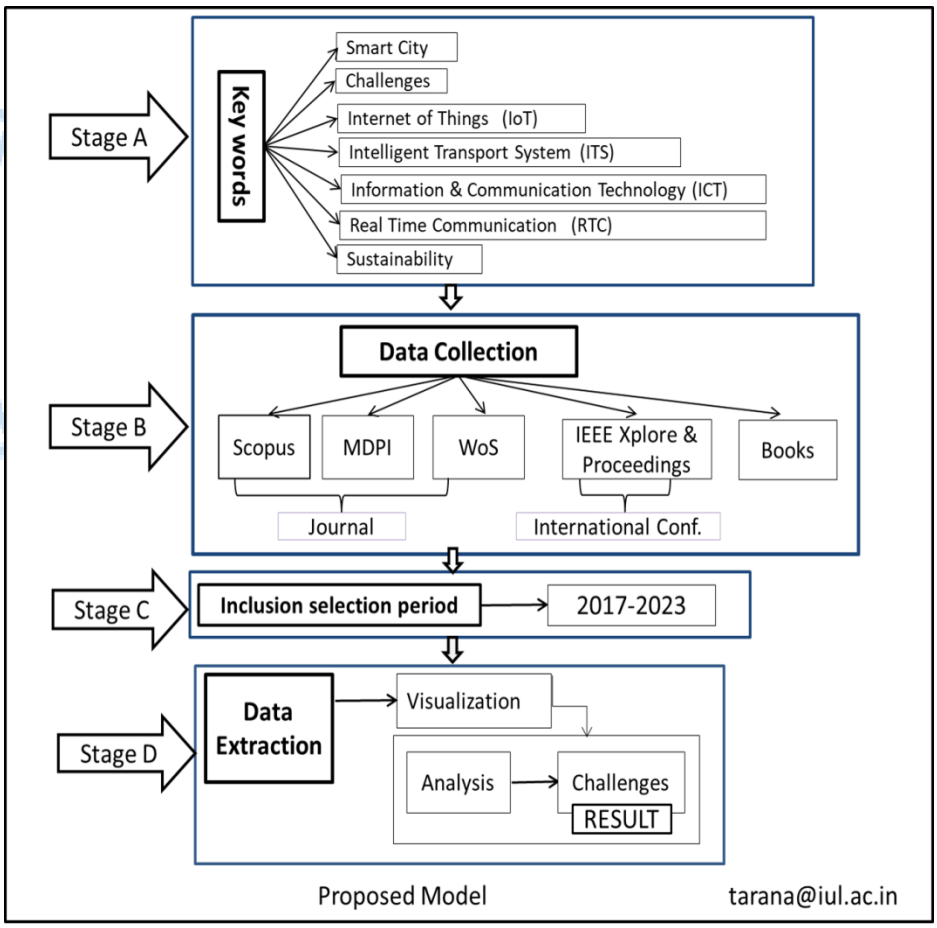

Figure 6. Proposed model

5. Results

At Stage A, survey was done using the keyword mentioned in the proposed model. At stage B data was collected by studying the published articles from the national, international journals

and conference proceeding associated with the database such as Scopus, WoS, MDPI, IEEE Explore, books and also Govt. websites. The publication results for all four data base are shown in figure 7

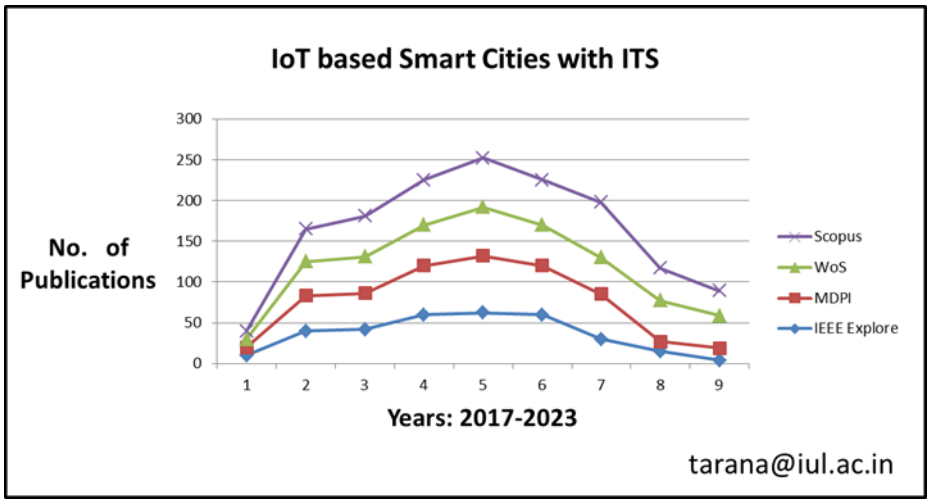

Figure7. No. of publications with years

It shows the change in adaption of technologies with years. No. of articles citation for IEEE Explore, MDPI, WOS and Scopus are 348, 369, 393 and 408 respectively. At stage D, collected data was analysed and challenges were observed.

5.1 Challenges in ITS

Cities/ countries were benefited from information and communication technology (ICT) with the advancement in transport sector. But, these ICT applications were costly [29]. Today, with digital technology and internet, big data analysis has developed effective intelligent transport system with less cost [29]. With these technologies ITS faces challenges. These challenges are infrastructure challenges and technical challenges.

5.1.1 Infrastructure challenges

Constructing new building is very costly and time-consuming. The demanding structure for providing intelligent transport services will be remodelled with in the countries and across it [30]. Making changing in a holistic manner and deploying new infrastructure from present infrastructure itself is a big challenge. Apart of it, with the utility of innovative technologies, it is challenging to reduce traffic congestion and travel times, smart mobility with road safety [31] and reducing greenhouse gas emission.

Smart mobility with road safety: For smart mobility it is essential for users to accept new transport solutions. This may require education to create awareness and encourage everyone to improve their traveling habits and accept new rules and regulation as present rules and regulations are not suited for smart mobility. It is essential to establish new framework with flexible regulations for integrating new technologies. Safety is important in smart mobility to ensure user protection and prevent accidents. According to WHO, approximately 1.35 million people die every year [31] due to accidents on road. Non-fatal injuries lie between 20 to million, many suffering from disability due to injuries [31]. ITS is looking after road safety, with better coordination among traffics and rescue measures. It can alarm drivers about unsmooth road conditions and unprotected road users to prevent accidents. Installing cameras and remotely controlled electronics symbols to avoid violation of traffics rules to decline the rate of road-accidents. A study report on speed camera in 2007 highlights declination rate of accidents from 9% to 41% [32]. This is achieved by analysing the accident data and taking necessary corrective actions, making road safer.

Traffic congestion: Chaotic traffic and congestion is also a challenging issue in all cities. Traffic congestion are time taking, rather than spending time on work or in other way contribute this time to society. Simply constructing new road does not make life simpler and easier [31]. Research study shows that construction of new roads creates more traffics and result is same as previous. With ITS having light box with red, yellow and green colour indicating stop, ready and move, can be installed to avoid traffic congestion and develop better traffic flow. ITS can be utilized to guide the road users from parking to re-route and move with recommended speed. Smooth traffic flow depends on innovative technologies that contribute towards ITS [32]. This system uses sensor based devices, cameras, algorithm for collective real-time traffic data, thus, regulating flow of traffics with optimised traffic lights, providing information's to the drivers to reduce congestion. Real time application such as Google maps provides route plan features, allowing the users to choose their route depending on public/personal transport and traffic conditions. Analysis of real time traffic data is done and transferred to transport management system for improving the traffic services [32].

Greenhouse gas emission:

Transport is the basic source of carbon emission, which directly affects the eco-system. Due to polluted environment approximately thousands of premature children and adults die, which is a burden on society. Above all, transport is the source of fossil fuel carbon dioxide

emission. This is one of the major causes for climatic change. With ITS, better traffic signals coordination take place making less stop on stop stations, making smooth traffic run. An advantage of smooth traffic run is the vehicle consumes less fuel and greenhouse gas emission is reduced by 10% to 20% [31]. It enhances the air quality and transfer data to central transport management system to making better plans and makes corrective actions and decision depending upon the current situation [31]. Electric vehicles, such as buses, scooters and hybrid cars utilize rechargeable batteries for operation. They help reduce greenhouse gas emissions, contributing to cleaner mobile environment [32].

5.1.2 Technical Challenges

While using ITS in the developing nations, faces challenges such as data analysis, interoperability, security of private data. In multiagency projects, it is not necessary to share data and exchange information's according to their regulations and framework designed. In some projects, the raw data are transferred by integrating data system. This raw data can be useful but challenging the capacity of agencies in developing nations.

Conclusion

New intelligent innovative technologies are attracting researcher's attention toward intelligent transport system for sustainable future making smart cities. The research study is focussed on improving energy efficiency, smart mobility to reduce road accidents, infrastructure making smart cities. The study has also highlighted on declination of greenhouse gas emission by incorporating electric vehicle, have chargeable batteries, thus declining fossil fuels. The declination in utility of fossil fuel has great impact on environment and climatic change (SDG-13). This is achieved by regulating emissions and promoting developments in renewable energy i.e. clean and green energy (SDG-7) by using electric vehicle. With the advancement in intelligent transport system, smart-sustainable cities and communities (SDG-11) have been developed, by remodelling the structure and building resilient infrastructure with decent work, thus upgrading industry, technical innovations and infrastructure (SDG-9). Thus, deploying intelligent transportation system, we are fulfilling 2030 Agenda for Sustainable Development, adopted by all United Nations members in 2015 [34]. High quality infrastructure fulfils the sustainability development goals in three aspects i.e. People, Profit, and Planet (3P) [7]. Author observed that intelligent transportation systems utilize different innovative technologies. Changes done in software and hardware of these

systems are often required, thereby changing the functional capabilities. Thus caution is very must while selecting the software and hardware technologies. Thus challenges rely on knowledge, technologies, structures and geographical locations. The impact of technology towards leadership is considerable and beneficial [23].

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References

1. Widner, R. R. Physical renewal of the industrial city. Annals of the American Academy of Political and Social Science 488, 47–57, 1986, (1886)
2. Wikipedia Contributors "Adaptive reuse," Wikipedia, the free encyclopedia. Wikimedia Foundation, Inc. (2012)
3. Kumar, R., Singh, R. C. and Khokher, R. (2022) Framework for modeling, procuring, and building systems for smart city scenarios using blockchain technology and IoT. In The Data-Driven Blockchain Ecosystem (pp 30–50), CRC Press. https://doi.org/10.1201/9781003269281-3
4. Downs, A. Smart growth: Why we discuss it more than we do it. Journal of the American Planning Association 71(4), 367–378, (2005)
5. Chandel, T.A, Reshape the Sustainable State-of-the-Art Development of Smart Cities, for e-book titled Convergence of IoT, Blockchain and Computational Intelligence in Smart Cities, Taylor & Francis DOI: 10.1201/9781003353034-4, pp58-82, E-ISBN 9781003353034, , (2023)
6. Greco, I. and Cresta, A. (2015) A smart planning for smart city: the concept of smart city as an opportunity to re-think the planning models of the contemporary city. Conference: International Conference on Computational Science and Its Applications. https://doi.org/10.1007/978-3-319-21407-8_40
7. Chandel, T.A (2023), Green and Sustainable Infrastructure in India, Achieving the Sustainable Development Goals through Infrastructure Development, ISBN 9781032404240, pp 121-145, DOI: 10.4018/979-8-3693-0794-6.ch006
8. Chandel, T.A (2022), Green Entrepreneurship and Sustainable Development, for the Book, "International Perspectives on Value Creation and Sustainability through Social

Entrepreneurship." Pp.173-208, DOI: 10.4018/978-1-6684-4666-9, ISBN13: 9781668446669

9. Elena Sanchez Arnau et al (2023)Digital technology, GAFA companies and the changing business world: growth trends in the ethereal economy 20 years later, Technium Social Sciences Journal, DOI: 10.47577/tssj.v39i1.7703,
10. Strategy, Smart cities mission, ministry of housing and urban affairs, government of India, 12-04-
11. Keith O'Brien, What is smart transportation? https://www.ibm.com/blog/smart-transportation/ (2023)
12. Sachin Kumar, Prayag Tiwari & Mikhail Zymbler, Internet of Things is a revolutionary approach for future technology enhancement: a review, Journal of Big Data, (2019)
13. Szum, K., IoT-based smart cities: a bibliometric analysis and literature review. Engineering Management in Production and Services, 13(2), 115-136. doi: 10.2478/emj-2021-0017, (2021).
14. Borgia, E. The Internet of Things vision: Key features, applications and open issues. Computer Communications, 54, 1-31. doi: 10.1016/j.comcom.2014.09.008, (2014)
15. Yaqoob, I., Ahmed, E., Hashem, I. A. T., Ahmed, A. I. A.,Gani, A., Imran, M., & Guizani, M. Internet of Things Architecture: Recent Advances, Taxonomy,Requirements, and Open Challenges. IEEE Wireless Communications, 24(3), 10-16. doi: 10.1109/MWC.2017.1600421, (2017).
16. Lynn, T., Endo, P., Ribeiro, A., Barbosa, G., & Rosati, P. The Internet of Things: Definitions, Key Concepts, and Reference Architectures, (2020).
17. Sethi, P., & Sarangi, S. R. Internet of Things: Architectures, Protocols, and Applications. Journal of Electrical and Computer Engineering, 9324035. doi:10.1155/2017/9324035,(2017).
18. In T. Lynn, J. G. Mooney, B. Lee, P. Takako Endo (Eds.), The Cloud-toThing Continuum (pp. 1-22). Cham, Switzerland: Palgrave Macmillan. doi: 10.1007/978-3-030-41110-7_1 (2020)
19. Theodore Gerard Lynn, Patricia Takako Endo, Andrea Maria N. C. Ribeiro, Pierangelo Rosati, Gibson B. N. Barbosa, The Internet of Things: Definitions, Key

Concepts, and Reference Architectures, In book: The Cloud-to-Thing Continuum, DOI: 10.1007/978-3-030-41110-7_1, (2020

20. Katarzyna Szum, IoT-based smart cities: a bibliometric analysis and literature review, Engineering Management in Production and Services, pp: 115-136, volume 13, Issue 2, (2021)
21. Atzori, L., Iera, A., & Morabito, G. The Internet of Things: A survey. Computer Networks, 54(15), 2787-2805. doi: 10.1016/j.comnet.2010.05.010, (2010)
22. Chandel, T.A (2023), Hybrid Energy Storage System for Renewable Energy Integration and Application' chapter 11, book "Artificial Intelligence Applications in Battery Management Systems and Routing Problems in Electric Vehicles" pp:174-188, DOI: 10.4018/978-1-6684-8816-4.ch011
23. Chandel, T.A (2024), Emerging Technology: Present and Future Generation Leadership, e-book Impact of New Technology on Next-Generation Leadership, pp:1-28, DOI: 0.4018/979-8-3693-1946-8.ch001,(2024)
24. Netscribes, How intelligent transport systems help to build smart cities, https://www.netscribes.com/intelligent-transport-systems-power-smart-cities/
25. Lelitha Vanajakshi, Ditakrishnan Ramadurai, Asha Anand, Intelligent transportation system, systhesis report on ITS including issues and challenges in India, Center of Excellence in urban transportation, IIT madras (2010)
26. H. Tokuyama, Intelligent transportation system in Japan, US Department of transportation, public road, vol 60(2), 1996, https://highways.dot.gov/public-roads/fall-1996/intelligent-transportation-systems-japan
27. History Of Intelligent Transportation Systems, U.S. Department of Transportation, publication number: FHWA-JPO-16-329, (2023), www.its.dot.gov/history/pdf/HistoryofITS_book.pdf
28. Intelligent Transportation Systems Joint Program Office. United States Department of Transportation. Retrieved 10 November 2016.
29. Winnie Wang, Raman Krishnan, Adam Dieh, Advances and challenges in 'intelligent transportation' : the evolution of ICT to address transport challenges in developing countries (English). Transport and ICT connections note,no. 26 Washington, D.C. : World Bank Group. (2015) http://documents.worldbank.org/curated/en/434631468186876869/Advances-and-

challenges-in-intelligent-transportation-the-evolution-of-ICT-to-address-transport-challenges-in-developing-countries

30. shareen A. Taie, Ahmad Elazb, Challenge of Intelligent Transport System, InternationalOPEN ACCESS JournalOf Modern Engineering Research,ISSN: 2249–6645, Vol. 6 , Iss. 10, (2016) https://www.researchgate.net/publication/314156806_Challenge_of_Intelligent_Transport_System [accessed Aug 12 2024].
31. SWARCO, 5 challenges that ITS and C-ITS address, (2024), https://www.swarco.com/stories/5-challenges-its-and-c-its-address
32. Nomadia, Advantages and Challenges of Smart Mobility (2023), https://www.nomadia-group.com/en/resources/blog/advantages-and-challenges-of-smart-mobility/
33. Chandel, T.A (2024), Tarana Afrin Chandel, M.A. Mallick, Atif Iqbal, Shirazul Islam, Green and Clean Energy: Current Global Scenario, book titled Renewable Energy and AI for Sustainable Development, DOI: 10.1201/9781003369554-1, (2024)
34. Adis Dzebo,Hannah Janetschek, Clara Brandi, Gabriela Iacobuta, Connections between the Paris Agreement and the 2030 Agenda, Stockholm Environment Institute (2019)