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Sustainable and Progressive Societal Development Asserts Artificial Intelligence Measures in Creating and Restructuring Smart Cities

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Abstract- Smart cities require artificial intelligence (AI) based technologies for planning of land divisions and mapping, sewer and drainage systems, road and traffic management. New York city, USA and Dubai city, UAE; London city, UK and Melbourne city, Australia; Singapore city, Singapore and Tel Aviv, Israel considered and reviewed to understand and analyze these AI based technologies already used in above specified areas. Planning, re-structuring and implementation of AI based technologies for smart cities is inevitable and Indian cities needs implementation of these technologies.

Keywords: Artificial Intelligence, Design Smart Cities, Land Mapping, Sewer and Drainage Systems, Traffic Management.

I. INTRODUCTION

Design, technology, automation and computation are to be incorporated in design and planning stages of smart cities. Design and planning stages for smart cities requires evaluation at each and every stage [1]. Smart cities use, promote and require implementation of automatic systems i.e. in the field of transportation and energy sector with highest efficiency [1]. Artificial intelligence could be useful and productive approach to design and implement planning for smart cities for long period sustainability for smart cities [1]. Artificial Intelligence technologies are growing and effectively used for urban innovation and planning. Such smart cities developed by artificial intelligence supports continuous human growth, enhanced community and proactive governance [2].

The review paper works on sustainable and progressive societal development asserts artificial intelligence measures in creating and restructuring smart cities. Smart cities works on three major areas of mapping and division of land at initial stage, sewer and drainage systems during planning and at working stages, road and traffic management at construction and at working mode. AI based technologies already being used above stated areas in several cities all over the world considered and analyzed. The effectiveness were shown with help of real images of current scenario in these smart cities.

Review, Discussion, Analysis and Current Scenario

Well established examples of world countries i.e. United States America, Japan and Germany implemented designing and planning of cities by AI technologies using data from maps, surveys, aerial pictures, climatic records and physical ground structure data. AI based technologies contribute and support in land mapping and area division, road and traffic management and sewer and drainage systems. These areas being thoroughly reviewed and discussed; further supported by examples of AI technologies and world cities to emphasize to adopt and implement these technologies at several levels to buildup of smart cities.

1. Land Mapping and Division of Area in Smart Cities

Some countries like Germany, Japan and European countries understood the importance and implemented the artificial intelligence based technologies in several areas [3]. Geospatial artificial intelligence emerging as land mapping and areal division technology could be revolutionary [4].

Figure 1: Aerial view of the mapped and planned city of Greater Noida, and on other side unmapped and unplanned city of Dehradun, India.

The pre-planned mapping of cities using technological equipment's provide a stable, efficient and smart cities. The two examples of such deep planning and perfect execution leads in reality a planned city of Greater Noida. The city smartly handles energy distribution, water distribution, water and sewage drainage system, waste management, transportation, market places, educational institutions, medical institution, city governance council and surveillance of the whole city technologically (refer to Figure 1). The Greater Noida, India continuously working on inputs and drawbacks to further improve city as there are lot of space and pre-planned city provides these improvements effectively.

The whole city land rigorously working to plant the trees by road sides, parks and making land holder to plant good number of trees. So a planned smart city looking to handle the global warming issue and at the same time provides excellent working and living space. The comparison of two different cities i.e. Greater Noida and Dehradun, India shows clear differences. The two cities have different development levels and different infrastructures (refer to Figure 1). Dehradun has a population of nearly 2 million while Greater Noida has half of that population nearly less than 1 million according to Indian population census 2011 but serves double in all infrastructure facilities as compared to Dehradun [5].

Esri's ArcGiS Urban is an AI tool utilizes AI and Machine Learning algorithms to analyze spatial data, demographics and zoning regulations to assist urban planners in making informed decisions about use, zoning and development projects [6]. Various cities worldwide including New York City and Dubai adopting such an AI tools to ensure sustainable and stable development of these cities. Other examples sidewalk labs Delve is an AI tool implemented in Toronto city, Canada [7]. It assists city planners in analyzing data and generating insights to optimize land use, infrastructure placement, and urban design decisions.

II. WATER SYSTEMS, SEWER SYSTEMS AND DRAINAGE SYSTEMS

Artificial intelligence based computer models and mapping for water systems, sewer systems and drainage systems certainly helps to build smart cities [8]. One notable example of a city using AI in designing its drainage system is Tokyo, Japan [9]. Tokyo has been incorporating AI and advanced technology into its infrastructure to address various challenges, including managing water and drainage systems [9]. Tokyo's drainage system faces significant challenges due to its dense population, limited space, and frequent occurrences of heavy rainfall and typhoons [9]. To mitigate these challenges, the Tokyo Metropolitan Government has been utilizing AI technologies to enhance the efficiency and effectiveness of its drainage systems [9].

Tokyo's drainage system, bolstered by advanced infrastructure and proactive management, employs AI and Internet of Things technologies for predictive analysis and disaster preparedness. The city's network of underground tunnels, pumping stations, and reservoirs mitigates flooding risks posed by

heavy rainfall and typhoons [9]. In contrast, Delhi faces challenges due to rapid urbanization, inadequate infrastructure, and fragmented governance. With multiple agencies overseeing management, the system often struggles with clogged drains and encroachments. While technology is gradually integrated into urban management, Delhi's drainage system is yet to fully leverage AI for predictive capabilities and resilience against extreme weather events (refer to figure 2).

Figure 2: View of AI designed Tokyo drainage system and un-designed drainage system view in Delhi.

London city, United Kingdom adopted EmaginaAI tool to monitor and analyze sewer network working, find out leaks and schedule maintenance work [10]. EmaginaAI reduces the risk of floods and improve water resource management [10]. Optimatics Optimizer is an AI powered software platform that helps to optimize the design, operations and maintenance of water distribution and sewer systems [11]. Melbourne city, Australia used Optimatics optimizer to improve the efficiency and reliability of sewer and drainage infrastructure [11].

III. ROAD CONNECTIVITY AND TRAFFIC MANAGEMENT

Artificial intelligence technologies implemented in many cities for traffic management and road connectivity to improve efficiency, safety, and sustainability. Let us consider two example where AI being used and effectively implemented to management road and traffic. Barcelona, Spain: Barcelona has embraced AI and Internet of Things technologies to enhance road connectivity and traffic management [12]. The city uses AI algorithms to analyze data from sensors installed on roadways, vehicles, and public transportation systems to optimize traffic signal timings, manage parking spaces, and promote sustainable mobility options such as biking and walking [12].

Dubai, UAE: Dubai has invested in AI and smart technology to transform its transportation infrastructure and improve road connectivity [13]. The city utilizes AI algorithms to manage traffic signals, coordinate public transportation services, and provide real-time traffic information to commuters [14]. Dubai's smart transportation initiatives aim to enhance mobility, reduce carbon emissions, and create a seamless and efficient transportation experience for residents and visitors [13].

Singapore city, Singapore uses IBM’s Watson Internet of Things for Automotive an AI tool is used for better road connectivity and traffic management. This AI tool analyze real time traffic data from vehicles, sensors and road infrastructure. It helps optimize traffic flow predict congestion and improve road connectivity and traffic management in the city. Karamba Security ‘s Carwall an AI powered automotive cyber security solution used in Tel Aviv, Israel to protect from cyber threats and Carwall provides safer and efficient traffic management in the city [14].

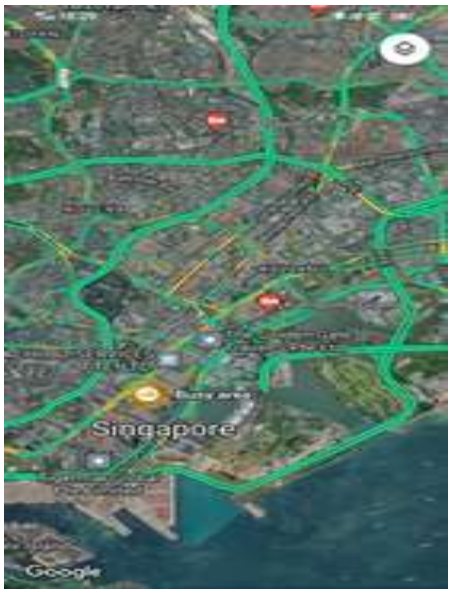

Figure 3: IBM's Watson IoT for automotive is used to monitor road and traffic in Singapore city, Singapore. (source Google maps)

Figure 4: Unplanned road and traffic managemnet in Delhi area. (source google maps)

The comparison of AI based monitoring in Singapore city, Singapore shows smooth flow of traffic. Refer to the figure 3 to verify the statement in real time situations in the city of Singapore. Whereas in Delhi area non AI based monitoring of traffic leads to long jams and congestion in the area. There are other problems of no parallel route of traffic diversion possible because AI technologies are not being used in the road and traffic management. The figure 4 the real time images of Google maps for the Delhi area showing the traffic and congestion problem. The AI based technologies are need of the hour and to be implemented to solve the problems of real world as early as possible.

IV. CONCLUSION

Sustainable and progressive societal development assert humans to adopt the AI based technologies for smart cities. Majorly smart cities would have planned, working and maintained land areas, water systems, sewer systems and drainage systems, road and traffic systems. GeoAI artificial intelligence based systems were used in eastern countries for land mapping and division of area. Greater Noida a pre-planned city using technology provides stable, efficient and smart city environment for living, service and working as compared to unplanned cities like Dehradun. EmaginaAI and Optimatic's Optimiser AI based tools used to design, monitor, analyze, operate and maintain the water, sewer and drainage systems in London city, United Kingdom and Melbourne city, Australia respectively.

Tokyo metropolitan government introduced AI based technologies for water, sewer, flood and drainage systems. Indian cities needs these AI based technologies to implement as these were already successfully executed in other parts of world. IBM's Watson Internet of things for automotive and Karamba Security's Carwall an AI powered tool used for road connectivity, traffic management, and cyber security in Singapore city, Singapore and Tel Aviv, Israel respectively. AI based technologies efficiently and effectively improved the three major areas of smart cities. The paper reviewed and discussed the existing AI based technologies in the planning, design and execution of land, water, drainage and traffic systems for smart cities. The review and analysis suggest societies should adopt and implement these emerging technologies for societal benefits.

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