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# Ingenious Techniques for Creation of Smart Cities by Big Data Technology & Urban Modelling Simulation by Matsim

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***Abstract:Ingenious Techniques for creation of Smart Cities by Big Data Technology & Urban modeling simulation by MATSimas the smart cities are on nascent stage in India. The extension of huge information and the advancement of Internet of Things (IoT) innovations have assumed a significant job in the practicality of keen city activities. Enormous information offer the potential for urban areas to get significant bits of knowledge from a lot of information gathered through different sources, and the IoT permits the joining of sensors, radiofrequency recognizable proof, and Bluetooth in reality condition utilizing exceedingly organized administrations. Thus the job of urban reenactment models and their perception are utilized to help territorial arranging offices assess elective transportation ventures, land use guidelines, and natural insurance arrangements. Typical urban simulations provide spatially distributed data about number of inhabitants, land prices, traffic, and other variables for ex- MATSim is an activity-based transport simulation framework designed to simulate large scale scenarios. Such technologies which have been developed in the past few years have proven to be very effective in smart cities of various countries. This project is an attempt to study the feasibility of such modified system, by understanding the implementation of such technologies to improve the existing smart cities and those which are about to become one. This is done by proposing an idea that is by implementing a big data server in the proposed smart city, the data will be collected through smart sensors which will then be sent to server and the mined data will be converted to simplified data for planners, engineers etc. in order to make a economic, self-sustainable & fully automated smart city.***

## I. INTRODUCTION

A Smart Sustainable city is an innovative city that uses information & communication technologies & other means to improve quality of life, efficiency of urban operations & services wrt. to economic, social, environmental and cultural aspects. Smart city also provides inhabitants a maximum quality of life with insignificant utilization of assets dependent on canny interconnection of framework, for example, transport, vitality, correspondence or distinctive progressive levels, for example, structures, regions and whole city. Intelligent does not necessarily equate IT. Smart city is no new label, but describes a deepening engagement for the expansion of existing activities & projects of an innovative city. [1].

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As India is one of the major developing countrieswhich stands as the 5th largest economy in world, India on its development pathway faces a similar urban challenge. According to the 2011 census, about 32 per cent (377 million) of the country's population lives in urban areas as against 28 per cent in 2001 and 17 per cent in 1991. Projections of Census of India 2011 data suggested that urban population was about to grow at the pace of 2.83 per cent from 340 million in 2008 to 590 million in 2030, living in at least 60 cities with a population of more than one million (Mckinsey, 2010; MoUD, 2011). By 2039,most estimates consider India to be 50 per cent urbanized [2]. The ministry of urban development has launched the first smart city plan in year 2015, with implementation in 100 cities [3]. Various modern techniques, the development of technologies and emergence of new programs enrich the urban planning and design process of smart city. Smart planning in urban planning includes big data analysis, modelling, evaluation, strategic planning, data collection, forecasting & popularization of smart life. [4]

## II. BIG DATA TECHNOLOGY

2.1 Big Data is an expression which defines a monstrous volume of both organized and unstructured information that is so huge it is hard to process utilizing conventional database and programming methods. In most endeavour situations the volume of information is too enormous or it moves excessively quick or it surpasses current preparing limit. Enormous Data can possibly help organizations improve activities and make quicker, increasingly canny choices. The information is gathered from various sources including messages, cell phones, applications, databases, servers and different methods. This information, when caught, arranged, controlled, put away and after that investigated, can assist an organization with gaining valuable understanding to build incomes, get or hold clients and improve tasks [5]

2.2 Big Data informed urban design and governance for smart cities - With the rising complexity of modern cities, traditional urban planning, urban design and urban management methods reach their limits. Life in a city has become increasingly dynamic, whereas urban planning often relies on static and sectorial approaches, involving a very limited number of citizens and stakeholders in relevant decisions.Big Data Informed Urban Design and Governance will develop a framework to support urban planning, urban design, and urban management with five work streams: urban governance, cognitive design computing, urban complexity, citizen design science and evidence informed urban design To turn into a smart city,

urban communities need in any event one thing in like manner. By embedding's sensors crosswise over city frameworks and making new information sources—including residents through their portable devices—Smart City supervisors can apply Big Data examination to screen and foresee urban marvels in new ways. For the most part, smart Cities utilize IoT and AoT gadgets to get information and productively process it for executing it in a specific region. Smart city sensors and associated gadgets gather information from different smart city doors introduced in a city and afterward break down it for better basic leadership. Different Unique highlights by which urban areas can be smart and how might it help the urban/city organizers, as follows:

1. To turn into a smart city, urban areas need at any rate one thing in like manner. By embeddings sensors crosswise over city foundations and making new information sources—including residents through their portable devices—Smart City directors can apply Big Data examination to screen and foresee urban wonders in new ways. Basically, smart Cities utilize IoT and AoT gadgets to bring information and productively process it for executing it in a specific region. Smart city sensors and associated gadgets gather information from different smart city doors introduced in a city and afterward break down it for better basic leadership.
2. Areas to reduce carbon emissions in a particular area. Parking problems can be better managed.
3. Cars will have sensors attached which can guide the car to the nearest available parking lots.
4. The environment will cooler and greener with less energy being consumed.
5. From security point of view, in any case of troubles, predictive analysis helps to handle the situation by recognizing when and where crimes are likely to happen by the study of historical and geographical data.
6. Planning, the sensors installed in the city helps to have a clear picture of what is lacking in the city and how to improve it. A city needs mapping infrastructure to pinpoint where development is needed to become a smart one.
7. Transport, Traffic problems is one of the biggest transportation problem in a city has. This problem can be solved by 'Big Data' i.e. by analyzing data, collected from transport authorities. Big Data tool study about the patterns causing traffic congestion. It helps the transport authorities with an intelligent way of reducing the problem.
8. Future Proofing: Urbanization makes a s city smarter. Automation should be used to handle traffic routines with real time waste management and monitoring. Data collected from various sources should be used with high efficiency and less wastages.

The smart cities depends upon a professional and well planned urban planning which can be done through big data analysis as we have seen above, the quirky features of big data designed urban features. However once the planning for a smart city is done, it needs to be simulated that is by doing doing trial and error runs to check whether the transporation planning and efficient routes are good enough to provides commutes to reach on time under smart city. The planning which is done for the smart city must be providing zero carbon emission based and highly environmental friendly. All the aspects which have been used in planning like transportation, environmental, socio-economic etc. For such aspects thus, a simulation software known as 'MATSim' can provide the simulation analysis and its results whether the smart city made is efficient or it still need changes before its finalised.

## III. MATSIM (MULTI AGENT TRANSPORTATION SIMULATION) –

Proficient and dependable open vehicle is a linchpin for practical urban versatility. Nowadays, present day savvy card-based ticketing frameworks create immense measures of information on open vehicle utilization consistently. While such information is presently for the most part utilized for different ridership investigations, the immense potential to utilize it for reproduction based arranging stayed undiscovered up until now. The Mobility and Transportation Planning module applies different factual models to remove basic social and operational parameters to set up a Multi-Agent Transport Simulation (MATSim) model. What separates the model from existing methodologies is that it represents dynamic marvels, for example, transport clustering, vehicle congestion and clog.MATSim provides a framework to implement large-scale agent-based transport simulations. The framework consists of several modules which can be combined or used stand-alone. At presence , MATSimoffers a structure for interest displaying, operator based portability reproduction (traffic stream recreation), re-arranging, a controller to iteratively run re-enactments just as strategies to dissect the yield produced by the modules. [6]

3.1 Unique features of MATSim :

1. **Agent-Based, Multi-Modal Simulation** of Daily Mobility Behavior.MATSim is equipped for recreating private vehicle traffic and open transport in huge detail, and can bolster extra modes (for example walkers or cyclists) as well.This permits to track single specialists through their entire day, from home to work, to relaxation or shopping and back to home..
2. **Fast, even for Large Scenarios.**MATSim can reproduce situations with a few millions operators on systems with a huge number of street fragments
3. **Versatile Analyses and Simulation Output.**During the reproduction, MATSim gathers a few key qualities from the recreation and yields them to give you a snappy diagram of the present condition of the reenactment. Among different outcomes, it can contrast the recreated traffic with certifiable information from checking stations, showing the outcomes intuitively in Google Earth. Moreover, MATSim gives definite yield from the traffic recreation, which can without much of a stretch be parsed by different applications to make your very own extraordinary investigations.
4. **Modular Approach.**MATSim takes into consideration simple substitution or expansion of usefulness. This enables you to include your very own calculations for specialist conduct and attachment them into MATSim, or utilize your own vehicle re-enactment while utilizing MATSim's preplanning highlights.
5. **Open Source & Multi-Platform.**MATSim can be downloaded by anyone and used by the person. Its free of cost to download the software.

3.2 Major Stages of MATSim –

In a typical MATSim simulation, travel demand data is simulated and optimized on a given transportation network (e.g. a road network, or a multimodal network in the case when public transport is also considered in the simulation). The optimization of the demand data is one of the key features of MATSim, making it suitable to be used for policy studies. In this whole simulation and optimization process, 5 major stages can be identified[7] :

1. Initial demand
2. Execution
3. Scoring
4. Replanning
5. Analysis

**Initial demand**: The initial demand describes the mobility behaviour to be simulated. Plans describe the intentions of agents. If agents calculate too optimistically, get stuck in a traffic jam or miss a bus, it might be that their plan cannot be realized in the simulation as the agents intended to.

**Execution**: Often also called the mobility simulation (or just mobsim), the agents'arrangements get executed along one another in a portrayal of the physical world.This means that the agents and their vehicles are moved around in the network (the infrastructure in the real world). During this execution of the plans, agents can influence each other by taking up space in the virtual world. If too many agents want to travel on the same road at a specific time, they generate a traffic jam in the mobility simulation. This is why the agents' plans only describe their intentions for a day, but do not actually describe their day.

**Scoring**: Once the execution of the plans finished, the agents' plans are evaluated based on their experienced execution.The definite scoring capacity is adjustable, yet for the most part time spent at exercises expands the score, while time spent voyaging diminishes it.Agents stuck in a traffic jam can accordingly free focus, while operators with short and brisk outings can aggregate more score focuses by performing exercises for a more drawn out time span.

**Replanning**: As mentioned in the execution stage, agents can be influenced by others and, for example, vehicles getting stuck in traffic jam. During the replanning stage, agents may modify their plans in order to try to avoid situations in the mobility simulation that lead to bad scores. Typical examples of such modifications are the modification of activity end times, effectively changing the start time of the following trip, changing the mode of transport for a trip, or changing the route for a trip (departure time choice, mode choice, route choice). In MATSim, these modifications are performed by so-called Strategy Modules.

**Analysis:** At the end of a complete simulation, one is often interested in some key performance values of the simulation. Examples could be mode shares, miles travelled in total by all agents, or average trip duration and distance per mode and hour. Such analyses could either be automatically be performed at the end, or in a separate post-processing stepThe three stages Execution, Scoring and Replanning are performed iteratively in order to give the agents multiple opportunities to adapt their plans to the plans and behaviour of the other agents. This is why MATSim typically performs multiple iterations within one simulation run, consisting of multiple mobility simulation, scoring and replanning executions, until the end result is available.

## IV. CASE STUDIES

4.1 Case Studies on How Big Data technology has been used to make cities an archipelago city and smart:

PCMC also known as Pimpri-Chinchwad Municipal Corporation is situated on Mumbai Pune National highway. It was established in 1982 covering an area of about 87 square km. This is the Richest Municipal Corporation - not only in India but the Richest in Asia. And the reason behind it is that, it has an industrial belt of small as well as big National & Multinational Companies.Because of efficient and good planning though it is industrial area the environment is quite pleasant with so many trees around it. The PCMC Smart City was initiated in year 2018 with an investment of 10 billion rupees.At earlier stagesPCMC had currently implemented 40 application modules which provide dashboards for property tax, water supply, sewerage and solid waste management. Further, PCMC has implemented SCADA systems for water supply and sewerage and a vehicle tracking system for SWM. PCMC now intends to develop a command and control centre for advanced data analytics with dashboards for key performance metrics (particularly MoUD prescribed SLBs and WHO prescribed Urban HEART), and live incident management particularly for city traffic and security. Since the smart city is at initial stage herein technologies like 'Big Data' can be implemented in the city planning before finalisation of a smart city. The following steps on how this big data technology can be used are as follows –

1. First collection of data through big data technology that is by launching a large server along with sensors to communicate, in the middle of smart city wherever proposed.
2. Collection of raw data being converted into informational data for Urban Planner, Civil Engineers, Transportation Planners etc. all by engineering perspective.
3. The data collected will be on the basis of existing and previous records of PCMC area which will be including dept. such as: Population, transportation geography, environmental influences, Structural components (Heritage structures as well.)
4. All the system shall be monitored – weekly, monthly, yearly data shall be produced to evaluate and further increase the efficiency of system.
5. After finalised design, the post operation scenario comes where in the local buses such as PMT, Green Energy buses will be coordinated with Big Data Servers which will send all the info. To control room, green house gasses emission, structural monitoring, traffic reports all will be sent to concerned department.
6. After Deep analysis, simulation will be used to run how the city operates on the new proposed designed, if the designed scheme works it, green signal will be given, if it won't; re-planning shall be done.
7. Finally a well planned, eco-friendly, economic, highly sustainable, highly efficient smart city.

There are various software's by which one can make use of Big Data do the city planning, software's such as CitySIM . The software CitySIM is aiming to provide a decision support for urban energy planners and stakeholders to minimize the net use of non-renewable energy sources as well as the associated emissions of greenhouse gases. In developing and testing this software several ambitious aims were reached in order[9]:

To help the product users to depict, in a fitting way, the 3D geometrical structures frames at the size of a urban region (including a few several structures) and to quality these structures thermo-physical properties in a proficient manner utilizing a committed XML file format;

1. To reproduce the vitality request of these structures, regarding the random idea of tenants' essence and conduct and representing a scope of regularly utilized warming, ventilation and cooling frameworks (HVAC systems);
2. To recreate the vitality request of these structures, regarding the stochastic idea of tenants' quality and conduct and representing a scope of usually utilized warming, ventilation and cooling frameworks.
3. To send out standard content records (TSV) to enable the product clients to help the investigation of vitality execution information so as to distinguish scope for enhancing structures' exhibition utilizing their preferred graphical apparatus.
4. The product CitySim includes CitySim Solver, an order line Integrated Solver for mimicking the vitality request and supply of structures for space modelling, together with the detail of the info structures' qualities (in CitySim XML file format) and the climate files (Meteonorm CLI file format).

Now the following images are examples of how big data collection helped in planning in cities and calculating their dimensions in term of environment, transportation, urban stake holders and its management,. Herein we used 'CitySIM' which helped in planning a part of proposed smart city to understand the schematics and plan accordingly in terms of the above mentioned aspects.

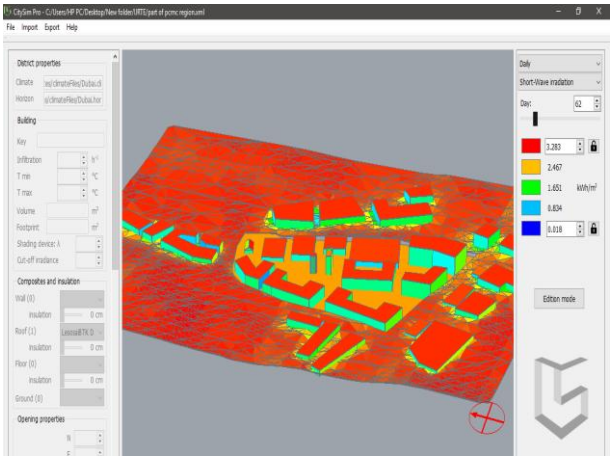

**Fig 1- The above picture shows the CitySIM being used in part of proposed smart city of PCMC wherein we came to know the short wave radiation which is an environmental term i.e the temperature of existing building in month of Feburary.**

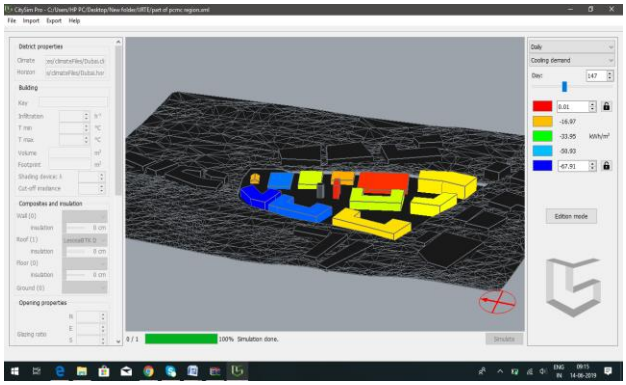

**Fig 2- The above image shows the result of temperature cooling required in the zone. The result shows the cooling required in the month of May.**

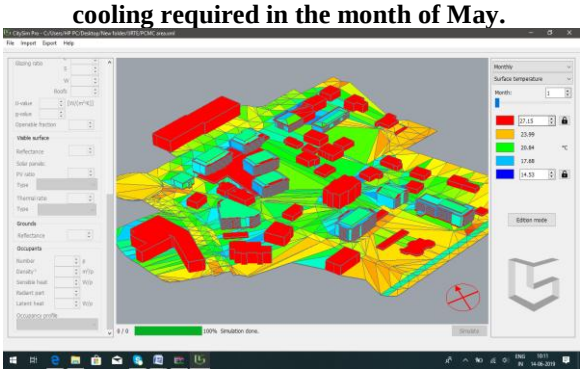

**Fig 3- The above figure shows the surface temperature in the month of jan which gives insight details for construction of infrastructure components like roads, foundation planning etc. which are to be made in smart city.**

After all the planning, designing, implementation aspects are followed the next step is to simulate the planned smart city. In developed countries before finalizing smart city one needs to simulate the aspects so as to know whether the planned city be successful or not, as smart cities are a huge scale investment. If the smart city is successful in simulation the planned smart city will be finalized and if it's not then replanning shall be done. For simulation and visualisation the most well performed software to know the transport simulation, environmental impact etc. 'MATSim' is used. The following results which were obtained are as follows [10] –


Fig 4- The above picture shows the vehicles which are acting as agents in the planned smart city, agents also known as the vehicles which are travelling through the planned routes to not only

simulate also but also calculate the traffic volume count, the congestion occurring on certain routes,junctions etc. this all is done in 'MATSim'.


Fig 5- The MATSim also shows the activity location which means the locations of agents at still positions wherever they are working. The agent's locations are indicated by Blue point. MATSim is overall all in one solution which not only simulates but also helps in planning the Big Data Governed urban smart cities.

The work of Big Data and MATSim is not only till planning aspect, but it also further helps in monitoring, controlling and maintain the smart city components like the infrastructural facilities such as road operations, building management, surveying operations, city security management etc.The basic premise of a smart city is improved delivery of public services, conservation of resources and better citizen-government interaction. It's a no-brainer that smart city projects will focus on exploiting the smartness of things' through a vast and complex network of sensors using IoT technology integrated with the analytics-of-things (AoT). Clearly this will not be achievable by city governments alone and will require the involvement of citizens and partners and will also warrant the seamless collaboration among participating departments and organisations. These proven advantages are as follows [11] –

1. Implementation of smart transportation system, As smart cities incorporate or introduce smart transportation, they will also need to ensure higher levels of efficiency that will incorporate smart management and maintenance programs incorporating data-enabled functionality. So, for example big data, IoT and AoT will come together to ensure a cost-effective, condition-based and predictive maintenance model to ensure higher levels of service – as compared to existing models that involve reactive maintenance.
2. Data enabled systems will therefore help predict when and where a problem is likely to occur, so that it can be addressed before anything unexpected happens. These require civil engineers with a background in traffic & transportation engineering (especially pavement design and maintenance) and geo-technical engineers, along with a team of field engineers.
3. There are software developers involved as well, for handling the IT system deployed for the asset management system, as most of these systems are GIS-based.
4. The Utility needed to improve meter management at the individual level. It had a database of information from all customers, including water consumption, bill control, real state records, revenues and demand on the water meter system and using this they built the profile portfolio of customers and their detailed usage. Each water meter had an average lifetime of five years; if the device was defective or tampered with, the measured consumption read inaccurately low, a result of fraud. ‗Ghost 'bills, or the practice of some consumers was studied and suspected fraud was stymied with action to save money.
5. All these data driven changes will hike the business income, leading to 6 percent revenue growth for the year. Thus, the Utility gained the money for more investments in new meters, resources, equipment, not something easily possible without data analytics.

## V. CONCLUSION -

The significant increase in connected devices in urban cities has led to the rapid growth of data, which has elicited the attention of many researchers in different research domains.Information derived from Big Data will make urban planners and designers more informed and aware, it will also strengthen the role of design as an activity that sets goals beyond past evidence, in the future. Urban simulation such as MATsim will help the planners and civil engineers to apply digital simulations to predict the wind and solar situation, traffic routes, smart statistical locations and visibility situation in the whole area. By which they adjust the architectural aspects, transportation design, smart building design and providing the best result by balancing all aspects. That means the methods of digital urban simulation are step by step used in the design process and quantify the result of design. This will help designers to balance the invest and produce, then make more rational decisions. The PCMC smart city is at nascent stage and if these technologies such as 'Big Data' & 'MATSim' are used not only to improves its efficiency of smart city and well planned city, but also will be the first in India to use these technologies.

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