PUBLIC TRANSPORT OPTIMIZATION

DEFINITION:

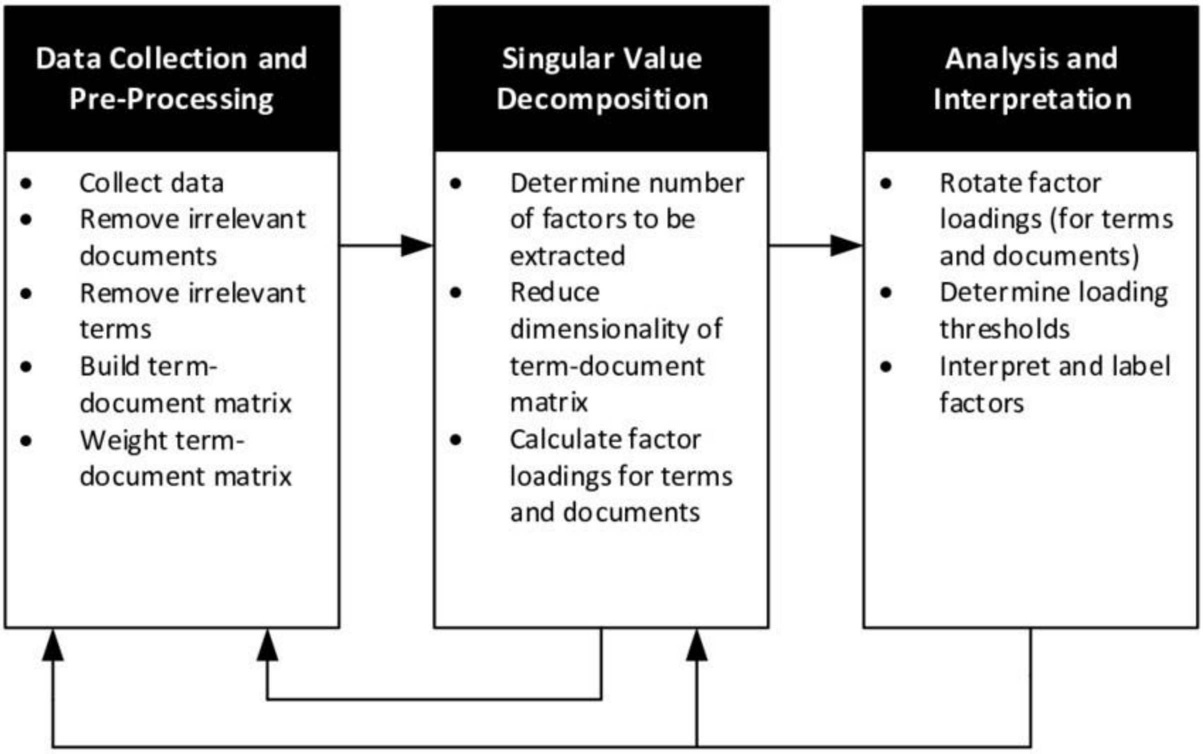
A public transport optimization project aims to enhance the efficiency, accessibility, and sustainability of public transportation systems within a city or region. These projects typically involve a combination of data analysis, technology implementation, infrastructure improvements, and policy changes to achieve their objectives. Below, I've outlined key steps and considerations for such a project.

1. Needs Assessment:

- Identify the current state of the public transport system, including routes, schedules, vehicles, and ridership.

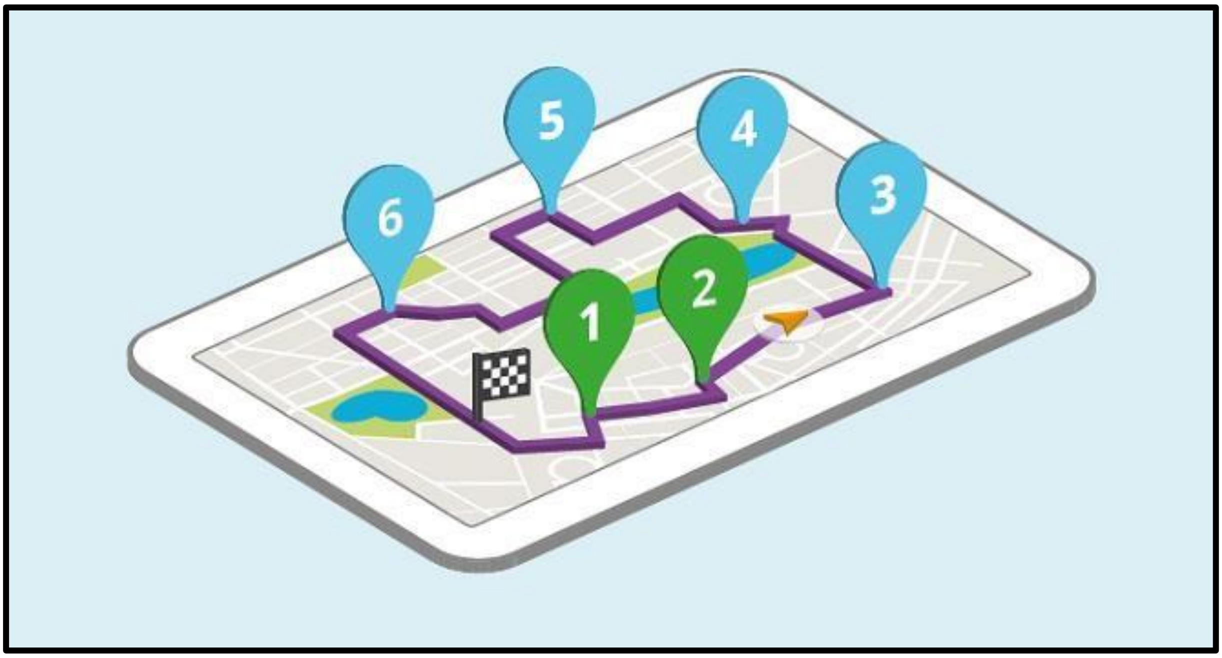
- Conduct surveys and gather feedback from commuters to understand their needs and preferences.
- Analyze existing problems and bottlenecks in the system.

2. Data Collection and Analysis:



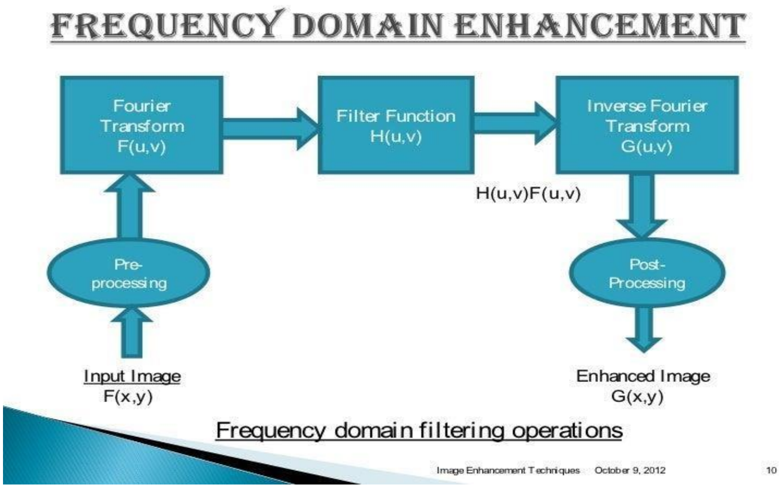
- Gather data on passenger flows, travel patterns, and peak usage times.
- Use GIS (Geographic Information System) technology to map routes and identify congestion points.
- Employ data analytics to identify trends and opportunities for improvement.

3. Route Optimization:



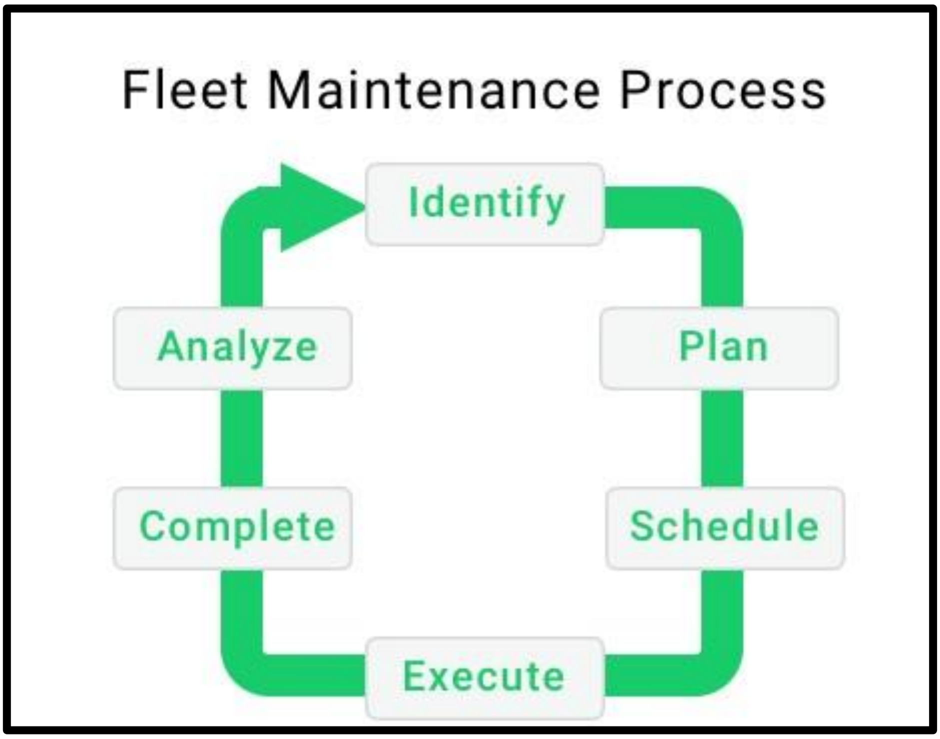
- Use algorithms and modeling tools to optimize public transport routes based on demand and efficiency.
- Consider factors like traffic congestion, population density, and accessibility to key destinations.
- Evaluate the potential for introducing express routes, bus rapid transit (BRT) lanes, or alternative transportation modes like trams or light rail.

4. Scheduling and Frequency Enhancement:



- Adjust schedules to match peak demand times.
- Optimize frequency and service intervals to reduce waiting times for passengers.
- Implement real-time tracking and communication systems to keep passengers informed about arrivals and delays.

5. Fleet Management and Maintenance:



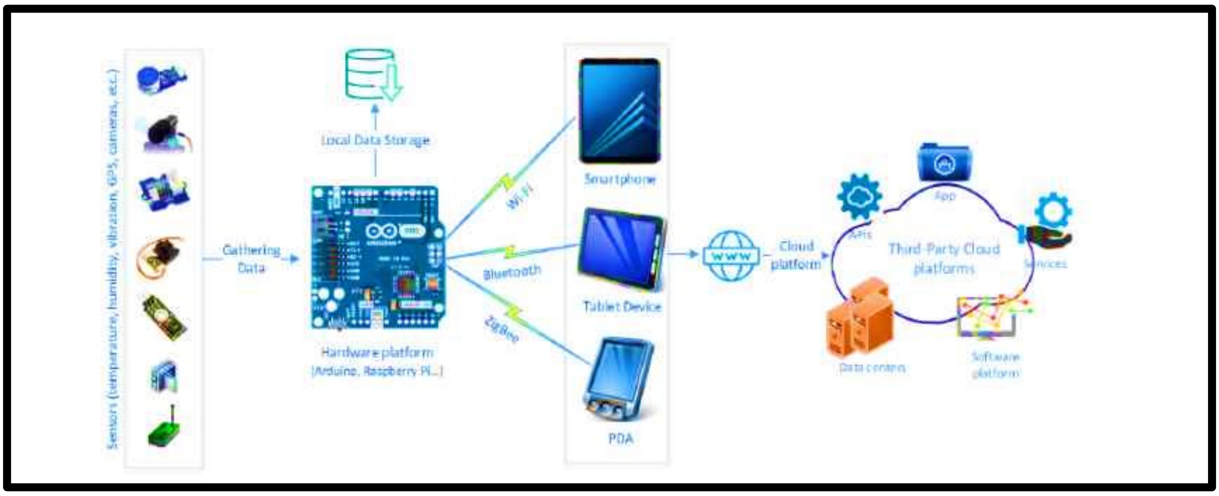
- Upgrade and maintain the public transport fleet to improve fuel efficiency and reduce emissions.
- Implement predictive maintenance systems to minimize downtime.
- Consider transitioning to electric or hybrid vehicles to reduce environmental impact.

  A successful public transport optimization project requires collaboration among various stakeholders, including government agencies, transit operators, urban planners, and the public. It should aim to create a more efficient, accessible, and sustainable transportation network that meets the needs of the community while reducing congestion and environmental impact.

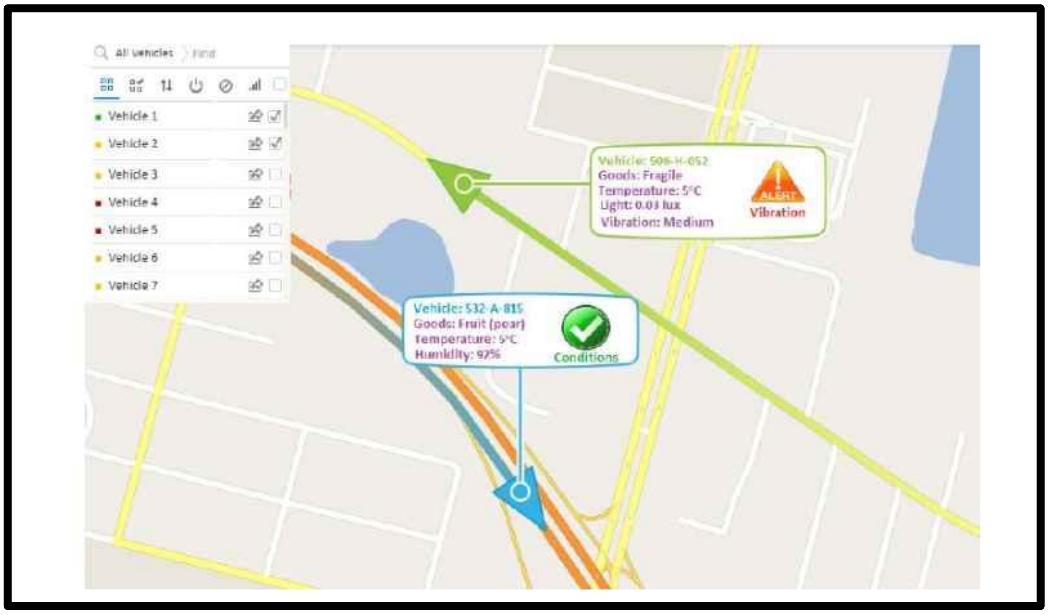
IMPACT AREAS OF THIS PROJECT:

IoT aplication	Enable	Implementation
Traffic and Fleet Management	Efficient public transportation services through managing and gathering information data from streets, buses, taxis, and citizens using GPS devices, loop detectors, road sensors, video, and citizen reports	Automotive manufacturers, transportation operators and transportation information centers
Resource and Energy Monitoring	Tracking all kinds of resources, petroleum, natural gas, electricity and water. Waste reduction, disasters prevention. Strong potential to enable greater environmental sustainability	Utility organizations, municipalities, oil and gas companies, non-governmental organization, individuals
Connecting production environment	Closed form of operational technologies is migrating to open IP standards available information about machine performances, ambient conditions, energy consumption, status of inventory, increased scalability, interoperability, uptime, manageability, security	Factory environment of different purposes
Equipment and Employee Monitoring	Predict equipment failures and reduce risks, employee productivity improvements	Companies of different purposes
Logistics	Item condition and alert in case temperature or humidity of thresholds. Tracking shipments, damage detection, smart-inventory management. Monitor all assets in real time predictive maintenance of the machine systems. Higher level of worker health and safety. Optimization of energy consumption through smart warehouse energy management	Smart warehouse, freight transportation companies, all types of logistics providers

ARCHITECTURE OF IOT BASED TRANSPORT MONITORING SYSTEM:



IoT has a huge potential for developing intelligent applications in almost every vertical market including logistics and transport. For example, there are many IoT applications that have been already successfully implemented for smart traffic systems, fleet tracking solutions, control of logistics chain, collision avoidance systems in cars, etc. In this paper, we describe IoT-based smart monitoring application for monitoring of the conditions in which goods are transported and stored (Figure 1). This solution allows clients, logistics and transportation companies to know where goods are located at all stages of the transportation process and to monitor transport conditions. This information is critical in cases of sensitive goods transportation such as food, dangerous goods, pharmaceuticals, medical equipment, etc. There are three main advantages of using IoT solutions in logistics operations: tracking of transport means and goods throughout the logistic chain, detection of unexpected openings of transportation means (e.g. vehicle or container openings) and monitoring of transport conditions.



For implementing this transport monitoring application based on IoT, delivery vehicles need to be equipped with environmental sensors to monitor temperature, humidity, light, and vibration in real time. Sensor data are gathered by a microcontroller and transmitted wirelessly to a user's device (e.g. smartphone) or to a cloud-based application that continuously analyses alarms and events. Also, IoT-based smart monitoring application requires position, sensing, transmission, and computation capabilities to enable real-time tracking and monitoring conditions of goods being transported. IoT devices can read geo-location coordinates, collect data such as temperature, humidity, or vibration, then send all the information to some computing systems such as user's devices, cloud servers, etc. This Smart Tracking solution can allow data exportation in different formats, such as CSV format for further analysis in the MS Excel or data may be inserted SQL system, etc. For advanced computing processes and storage of huge amount of historical data, this system needs to be able to integrate with Cloud platforms such as Axeda, ThingWorx, etc. IoT based systems are usually complex due to a number of various technologies deployed for a specific solution. The main components of the IoT-based Smart monitoring system are the sensors, GPS, Communication technologies, an Internet gateway, a battery and charger, and application interface. This solution must meet requirements of computation and communication as well as autonomous power. For autonomous power, IoT devices can have an internal battery that allows them to run operations such as data collecting, computation and sending data to other infrastructure. Some computation processes may drain the available battery energy. Therefore, this resource needs to be used in an efficient way or IoT device charges its battery directly from the vehicle battery.

Feature	Infrastructure	Description
Sensing data	Sensors	Sensing data from different kind of sensors (e.g. temperature, humidity, luminosity, CO, CO2, vibration, etc.)
Real-time tracking	GPS and Maps	Tracking geo-location coordinates (longitude/latitude) and transmitting information to the corresponding infrastructure.
Connectivity	Communication technologies	Sending data to storage and computing infrastructure such as Cloud computing or other devices (e.g. mobile phones).
Computing	IoT devices, Cloud technologies	Real-time monitoring, instantaneous control and optimization of transport processes.
Visualization and control	Web and Mobile application	A web interface and mobile application that displays condition information and vehicle locations as well as alerts.

The application interface is used for data visualizations and remote control. It can be implemented as a web interface or mobile application. For example, a driver can receive alerts through Android or iOS application installed on his smartphone while company center and clients can overview the tracked vehicles and goods through the web interface. With the computing systems, WSN, GPS technology and Internet connectivity, the transport conditions (e.g. temperature and position) of each delivery vehicle can be monitored in real time remotely through wearable devices such as a smartphone, laptops, tablets, etc. or through web interfaces.To collect data about transport conditions, it is required to deploy various sensors. For

example, if vehicles carry humidity and temperature sensitive-items adding various sensors to measure these environmental variables, there can be essential to ensuring that goods are managed during transportation and storage processes. If goods are fragile, registering vibration impacts by vibration sensors (e.g. accelerometer) can assist in identifying responsible authorities. A light sensor can beplaced within a vehicle to determine when it has been opened. IoT application can be programmed to check if opening times correspond with scheduled times (estimated times). For this purpose, IoT devices need to incorporate a real-time clock, allowing accurate recording of the date and time of all events that occur. For embedding various sensors (e.g. temperature, luminosity, gas sensors, vibration sensors, etc.) it is required to use some sensor board such as IoT hardware platform (e.g. Arduino, Raspberry Pi, etc.). Implementation of described smart monitoring application requires positioning technology such as GPS or other [8].
Position information is useful for real-time monitoring of shipping vehicles, vehicle fleet tracking, security purposes, etc. It is challenging issue to integrate information gathered from sensors with GIS (Geographic Information Systems) such as Google GIS, Axeda, ESRI or other. A map built with some API (e.g. the Google Maps JavaScript API) provides real-time visibility of vehicles and transport conditions. The combination of location data generated by GPS, time data, and other sensors gathered data, can register each event's location, date and time, and conditions during the transportation processes. If there is no need for real-time tracking, the time between samples can be set to some values, to provide energy efficiency and reduction of data transfer costs.
Cloud computing can be used for processing data and to distribute some resources, processes, and services to data centers which may be located anywhere in the world. Cloud computing provides computation and storage resources by deploying high-performance servers. This infrastructure provides storage for an enormous amount of data, extensive computing analysis, and other functionalities. However, the integration of IoT and Cloud computing is not efficient for many IoT applications due to inherent problems such as unacceptable network delay, lack of mobility support and location-awareness, etc. Therefore, a new computing paradigm is needed to support emerging IoT applications. There are several paradigms proposed to solve these problems such as mobile edge computing, cloudlet, fog computing, etc. The most of these computing systems can be used in cases where the Internet access is unavailable or high costs of data transmission over the network. The key idea of these paradigms is offloading tasks from a mobile device to local computing infrastructure and if there is a need to send data to traditional

cloud servers. These computing systems include local storage and computing capabilities to store data (e.g. coordinates of the route, transport conditions, etc.) which can be used for further analysis.
Wireless communication technologies enable to send alerts and other data such as location and transport conditions to different infrastructure (e.g. smartphones, cloud data centers, etc.). By connecting different components, IoT-based smart monitoring application enables tracking vehicles as well as monitoring transport conditions during the entire transport process. This is one of the major advantages of IoT-based solution over the traditional types of vehicle tracking systems. The most common used in IoT environment are Wi-Fi, ZigBee, 802.15.4, Bluetooth, Bluetooth Smart Low Energy (BLE), GPRS, 3G, 4G, etc. However, it can be used and other communication technologies. Some of these technologies are used for WSN (Wireless Sensor Network) while others are used as RANs (Radio Access Networks) to the Internet.

CONCLUSION:

The implementation of a public transport optimization project is a multifaceted endeavor with the potential to significantly enhance the quality of urban transportation systems. By following the outlined steps and considering the diverse aspects of optimization, cities and regions can achieve several important objectives:

- **Efficiency**: Optimizing routes, schedules, and infrastructure helps reduce congestion, waiting times, and travel durations for passengers. This leads to improved overall efficiency and convenience in public transportation.

- **Accessibility**: Prioritizing inclusivity and accessibility ensures that public transport is available and convenient for people of all ages and abilities, promoting equitable mobility within communities.

- **Sustainability**: The adoption of clean energy sources, reduction of emissions, and the promotion of eco-friendly commuting options contribute to a more sustainable and environmentally friendly transportation system.

- **Technological Advancements**: The integration of technology, including real-time tracking and mobile apps, enhances the passenger experience, making public transport more user-friendly and attractive.

- **Economic Benefits**: A well-optimized public transport system can stimulate economic growth by reducing traffic congestion, lowering transportation costs for individuals, and improving connectivity to job centers and business districts.