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Smart Model Bus Stop for Special Needy Aged Individuals

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Abstract
Countries in the Asia region have hot weather around 2–6 months of the year, which might lead to uncomfortable conditions for elder, physically challenged public commuters. Technical teams have made some major enhancements to existing bus stops as Model bus stop by installing Updated version of smart boards, This paper proposes a smart IoT-based environmentally - friendly enhanced design for existing bus stop services in our cities. The microcontroller transmits the sensor readings to a real-time database hosted in the cloud and incorporates a mobile app that notifies operators or maintenance personnel in the case of abnormal readings or breakdowns. Give systematic information to the bus stop smart display board. The mobile app encompasses a map interface enabling operators to remotely monitor the conditions of bus stops such as the temperature, humidity, estimated occupancy, and space availability. In addition to presenting the system's architecture and detailed design, a system prototype is built to test and validate the proposed solution.
The suggested system uses a mobile app or simply view the smart board that enables users to view current bus stop conditions and related information on Google Map. An added benefit of the proposed system is that by keeping an estimated track of the number of people at the bus stop and other related components will be examined and proposed expert system.

Keywords: Internet of Things; intelligent transportation systems; air pollution; energy efficiency

1. Introduction to IoT concepts:

The concept of IoT technology where citizen related data, processes, communications and things are connected. likewise, our smart system reflects the aspect of 'things' by making use of various types of sensors and actuators. The 'process' aspect of the smart display system is processing the generated and collected data from bus, from various location its other components in order to make appropriate decisions to command actuators accordingly.
The last section concludes the paper and presents ideas for future work.
Generally, minors (below 18 years), the elderly or members of large households (need support), may need support while they go for transport. Collective autonomous info desk might help this situation, e.g. by enhancing standard line-based services or introducing alternative technologies. Nevertheless, the collective usage of AVs in rural transport and their potential impacts on accessibility are still underexplored, with most research focused on the urban context. This study aims to fill this gap by analysing the public transport accessibility impacts that five alternative technology supply scenarios

might generate in the rural areas, Wheel chair access, villages, tribal, braille signage peoples spot, near bus station, audio or screen readers for visually impaired users.

The scientific literature in relation to the technological systems used in the transportation systems and their main elements given scenario. In addition, there is an important volume of scientific literature describing the use of IoT (Internet of Things) technologies for improving the quality of life of citizens in smart cities through measures that lead to a healthy, comfort and sustainable environment.

More than that tourist Language barriers and difficulty understanding local bus schedules or stop names. uncertainty regarding bus timings and unexpected route changes, low-income people area or vulnerable populations limited access to smartphones or technology to track bus time these are the key factors insist us to help and provide unbelievable service to meet their needs by Multilingual bus information available both in digital and physical formats. Language-specific customer service support. Apps with translation features to help navigate, for new riders using smart help desk will make the bus system simple, step-by-step information on how to use bus services.

2. 1 Special coverage peoples:

If people come with special time sensitivity like, sick people, students during exam times, time oriented daily wages, medical appointment for critical patients, teaching faculties and so on. A clear understanding of bus arrival times to ensure timely arrival for work, medical appointments, or other important commitments. Real-time updates to avoid delays or missed buses. This technology provides Priority bus services or dedicated lanes for time-sensitive passengers.

These different groups of people may face unique challenges in our daily life while accessing bus arrival details. Providing tailored updated technology-oriented solutions, such as accessible apps, printed schedules, audio and video notifications, smart help desk, customer service, and multi-language support, can help and ensure that everyone, regardless of their circumstances, easily access essential public transport information. It will be a great help to face their working environment Individual accessibility figures of all the sample members.

S.NO.	Individuals	Gender	Age	House hold size	Employment status	Residential location	Public bus availability	Alternate Economical Private Vehicle availability	Business as usual		Fixed based passenger		Demand based passenger		Mixed in Time		Mixed in space		Mixed in Time and Space	
									STA-Fix	STA-dis	STA-Fix	STA-dis	STA-Fix	STA-dis	STA-Fix	STA-dis	STA-Fix	STA-dis	STA-Fix	STA-dis
1	104	M	A	4	F	A	A	N	0.33	47.48	0.50	45.57	0.63	47.00	0.50	0.50	0.50	21.87	0.75	32.37
2	105	M	A	3	F	H	A	A	0.25	0.36	0.50	2.00	0.33	28.90	0.33	139.00	0.33	6.90	0.67	18.80
3	106	M	A	3	F	A	A	A	0.33	10.49	1.00	31.77	1.00	83.30	1.00	0.33	0.80	33.7	0.50	98.00

																		0		
4	107	M	M	3	S	A	A	A	0.55	0.70	0.30	1.30	0.67	27.80	0.33	0.83	0.33	7.55	0.50	28.00
5	108	F	A	4	F	A	S	A	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.33	0.00	0.00	1.00	0.00
6	109	F	A	3	P	H	A	A	0.25	0.00	0.25	0.00	0.50	27.22	0.00	0.00	0.00	0.00	1.00	11.84
7	110	M	S	2	N	A	N	N	0.25	6.60	1.00	17.80	1.00	63.60	0.75	0.00	1.00	19.40	1.00	62.00
8	111	M	M	2	S	H	N	N	0.00	2.20	0.25	11.30	0.50	25.66	1.00	1.00	0.00	0.00	0.75	32.39
9	112	F	A	4	F	H	A	A	0.33	0.00	0.25	0.00	0.50	25.00	0.50	0.00	0.75	48.00	0.25	4.56
10	113	F	A	4	F	A	N	A	0.45	0.00	0.00	0.00	0.00	24.90	0.50	0.00	0.00	0.00	0.30	39.20
11	114	F	M	3	S	H	N	N	0.00	0.00	0.00	0.00	1.50	51.81	0.00	0.75	0.83	0.00	0.30	0.00
12	115	M	A	5	F	A	A	A	0.25	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	19.30	0.25	55.35
13	116	M	S	2	N	H	N	N	0.33	23.40	0.50	25.50	0.50	28.40	0.25	0.00	0.00	0.00	1.00	34.56
14	117	F	M	3	S	A	A	A	0.00	0.00	0.30	30.00	0.25	59.23	0.00	0.83	0.25	0.00	0.67	37.00
15	118	M	M	3	S	A	A	A	0.00	0.00	0.30	0.00	0.30	0.00	0.67	0.00	0.00	0.25	0.23	22.00
16	119	M	A	4	F	H	N	A	0.45	20.00	0.40	0.00	0.50	0.25	0.50	286.00	0.00	0.25	0.25	23.00
17	120	F	A	5	F	A	A	A	0.50	3.00	0.30	2.30	0.50	0.30	0.00	44.00	0.30	0.00	0.31	35.00

. Gender: M=male, F=female. 2. Age: M=minor (65). 3. Household size: 1=one member, 2=two members, 3=three members, etc. 4. Employment status: F=full-time worker, P=part-time worker, S=school/university student, N=unemployed/retired. 5. Residential location: A=built-up agglomeration, H=dispersed hamlet. 6. Private car availability: A=always available, S=sometimes available depending on household priorities, N=never available.

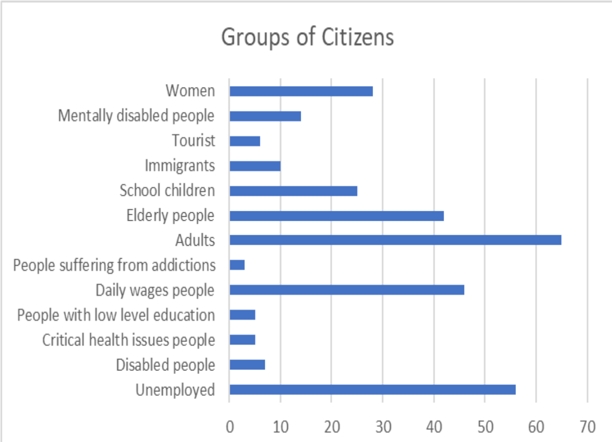

Figure 1:Vulnerable group of citizens

There were 800 million persons aged more than 68 years or over in the world in 2020. The number of older persons is estimated to double to 1.5 billion in 2050, growing from the current 11% to 20% of the current density.

This growth have special needs to maintain a good models and methods. These needs include smart monitoring, helping desk, digital desk, easy access, help to elder people, disabled and ills peoples for the social interaction, mental stimulation and more than that mobility.

2.2 Special people interconnected spot

An interconnected spot is an outdoor space provided with IOT device that can connect only with a similar space in other part of the particular area. That means that an SPA is a node in a network of similar spaces. A Spa node can be established in a bus stop, before government hospitals, schools, in a park or any other outdoor spot in the connected city, in which a group of persons could potentially interact with it. Therefore, spot allow the sharing of collective updated information.

2.3 Smart Bus stop

The upcoming digital concept of the smart bus stop is recently new as part of the developments related to Smart connecting spot. Several Western cities have launched smart bus stop methods. That is the case of Paris (one smart model stop accessible to persons with disabilities, and providing free Wi-Fi and USB charge, bus info, departure and arrival details, among other services), London (100 Clear Channel bus shelters, using Google Outside service to provide information) and Melbourn (around 20 stops, with mobile-based payment system). Other cities have incorporated some smart elements to traditional stops to supply more information to needy people, such as arrival time of buses or other general information, without providing more interactivity. Another example is the smart bus stop prototype which includes ticket vending, parcel delivery, passenger counting, passenger information, wireless, USB charging, bike rental, air conditioning, taxi ordering, tourist information, news, advertisements, weather forecast, reverse vending, surveillance and other services like Solar powered display boards, e-papers, Wi-fi technology, bus time tables, Route changes, traffic, accidents, Unavailability, early departure, special additional buses, other additional information.

Despite the huge potential of smart bus stops, their penetration in many metro cities is very limited and its adaptation to inclusiveness is just starting to be developed.

The main characteristics of smart model bus stop may include the important following points

(a) An interactive bus stop available to the whole population. It is a public access point to a digitized transport system (DTS), which allows access to persons without apps or even without a smart phone.
(b) It can work as a public access point and as a travel assistant for low-income or disadvantaged groups of users.
(c) It can improve the accessibility to DTS through customization of interfaces and reduction of cognitive demand.
(d) It can improve planning in real-time taking into account unexpected events that can improve or disrupt transport operations.
(e) Through an attractive and customized interface, it can foster the penetration of travel planning apps and its use by different user groups (elders, immigrants, etc.).
(f) It can be implemented as a reduced size smart furniture providing a robust, essential electronic equipment that converts traditional stops into accessible smart bus stops, minimizing the modernization cost and having a wide use in the cities and rural areas.
(g) Finally, it can be used for introducing Interconnected Public Space spots of the city.

3. Literature Review

A Modern IoT architecture platform utilizing the IoT concept was proposed to provide neighborhood, elder citizen home, childcare centre watch and medicare as well as some additional features such as smart medication management and patient network applications. Recently, IoT applications have been extended to smart bus stop services, smart kitchen, Smart Medicare, Smart Old age, Smart Park and so on.
Smart Transport management is a crucial phenomenon in smart city applications. In the literature, an IoT-based school bus tracking with arrival time prediction was reported in [6].

4. Proposed System Hardware Architecture:

The microcontroller continuously reads and transmits the most recent sensor values to the remote database. In turn, a remote database pushes the most recent values to a database available to the levels of operators .Time to Time information collected and processed by the system and will be display in the smart model bus stop smart board with all Audio, video display.
For example, If special people waiting for specific bus means they can access the right information from the digital display whether that bus arrived or late, it has adequate capacity or not, If it is filled, What is the next option how time he has to wait. Some time it didn't arrived, provide detail whether can wait some more time or not necessary. So all these basic info related to particular route bus will be displayed using more than three languages visually as well as voice people can get their data without anybody's help and without any device.

GSM/3G/4G Module: To send data via mobile networks. **Wi-Fi/Bluetooth**: If the bus is within the Wi-Fi range of a local network. **NB-IoT or LoRaWAN**: These are low-power wide-area network (LPWAN) technologies that can be used in rural or remote areas. Connect bus with central server or cloud. The IoT device will send data (GPS coordinates, speed, and bus status, images of the capacity) to a central server or a cloud service. The data is processed, and the real-time status of the bus (such as its estimated arrival time, route information, present location, traffic status, estimated arrival time, whether place available or not etc.) is calculated and will be displayed. In smart board On the server, the data is stored and analyzed. This analysis can include, **Current Bus Location**: From GPS coordinates, **Speed and ETA (Estimated Time of Arrival)**: Based on the bus's current location and route.**Route Status**: If there are any delays or traffic-related issues. c**ommunication Protocol**: The server sends the processed data to the smart digital board using protocols like MQTT, HTTP, or WebSocket. **Data Display on Digital Board**: The digital board at the bus stop receives this information and displays it in a user-friendly format such as, **Real-Time Bus Arrival Time**: Based on the bus's GPS location and traffic conditions. **Bus Route and Next Stop Information**: For passengers to know the bus's path and upcoming stops. **Status Updates**: Such as delays or early arrivals. Real time bus mobility status will be displayed, Architecture set up, **Bus IoT Device**: A GPS module GSM/3G/4G module. **Server or Cloud Platform**: AWS IoT, Google Cloud IoT, or a custom cloud solution for processing data. **Digital Board**: Smart display connected to the internet or a local network with software to display real-time bus information. Smart alert : It produce smart alert via digital board because of special issue bus may crossed platform in advance, any other special additional bus facilities provided means that information, otherwise bad traffic no other way to reach means all these alert may be given.

Bus Stop Side: Smart Digital Board (LED/Display Screen),Communication device for receiving data (Wi-Fi, Ethernet, etc.),Software for managing and displaying information on the board
This IoT-based solution enhances passenger experience by providing accurate, real-time information and improves the efficiency of the public transportation device.
The sensors GPS (Global Positioning System) Sensors, **Cameras (Optical Sensors),** Captures visual data, Provides video surveillance, assists in monitoring traffic, and enhances safety features such as lane-keeping assistance or pedestrian detection. **Weight Sensors** Measures the weight of passengers or the total load on the bus. Helps in managing the bus's capacity, ensuring that weight limits are not exceeded, and enabling fare calculation in some systems. Seat occupancy sensor Provides data for passengers about available seats, aids in monitoring and managing passenger load, and supports fare systems that may involve seat reservation.
The future system will operate as shown in the flowchart below:

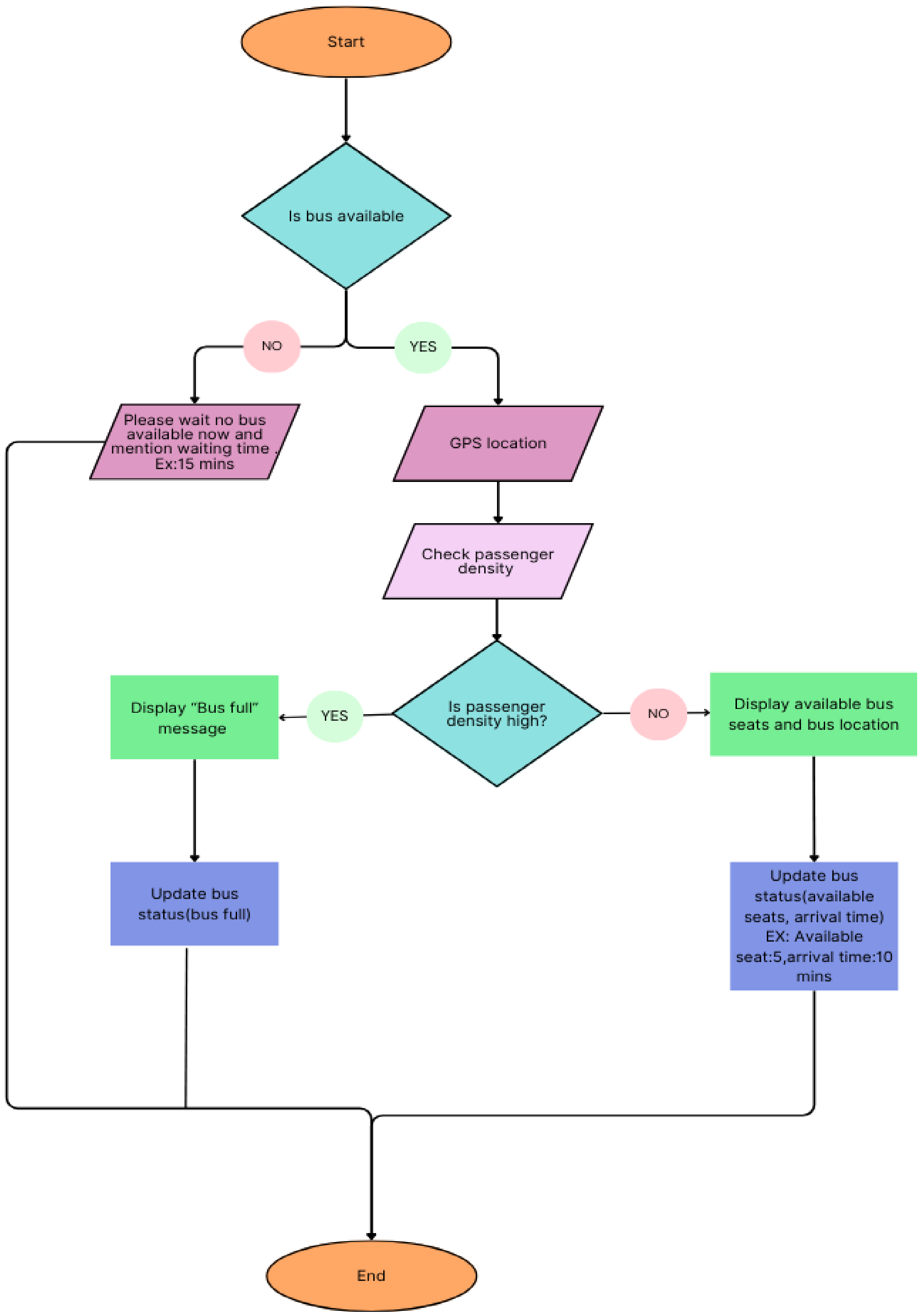

Figure 2:Work flow chart

5. Proposed System software Architecture:

The suggested techniques modern architecture for the Smart model Bus Stop project utilizes a combination of cutting-edge technologies to provide a robust, efficient, and cost-effective solution. At the heart of the system lies the data collection and processing unit, which employs Python as the primary programming language due to its simplicity, flexibility, and extensive libraries. Specifically, the Scikit-learn library is utilized for implementing the Random Forest algorithm, which predicts bus arrival times, passenger demand, and traffic congestion.

To store and manage the vast amounts of data generated by the system, MySQL is employed as the relational database management system. MySQL provides a reliable, scalable, and secure platform for data storage and retrieval. Additionally, its compatibility with Python enables seamless integration with the data processing unit.

To ensure cost-effectiveness and scalability, the unit is deployed on a cloud platform. After careful consideration, Amazon Web Services (AWS) is recommended as the preferred cloud provider. AWS offers a comprehensive range of services, including computing, storage, databases, analytics, machine learning, and more. Specifically, the AWS Lambda function is utilized to run the Python code for data processing and prediction, while Amazon S3 is employed for storing and retrieving data. Furthermore, AWS provides a free tier for new users, making it an attractive option for startups and small-scale projects.

Overall, the proposed system software architecture provides a robust, efficient, and cost-effective solution for the Smart model unit. By leveraging the power of Python, Scikit-learn, MySQL, and AWS, the system can effectively predict bus arrival times, passenger demand, and traffic congestion, ultimately enhancing the overall passenger experience.

Algorithm:

```
Function RandomForest(trainData, numTrees, maxDepth)
  ensemble = []
  For i = 1 to numTrees
    tree = DecisionTree(BootstrapSample(trainData), maxDepth)
    ensemble.Add(tree)
  Return ensemble

Function DecisionTree(data, maxDepth, depth=0)
  If depth >= maxDepth or data is pure
    Return LeafNode(PredictClassLabel(data))
  feature = SelectRandomFeature(data)
  split = FindBestSplit(data, feature)
  left, right = SplitData(data, feature, split)
  Return Node(feature, split, DecisionTree(left, maxDepth, depth+1), DecisionTree(right, maxDepth, depth+1))

Function Predict(dataPoint, ensemble)
  predictions = []
  For tree in ensemble
    predictions.Add(PredictDecisionTree(dataPoint, tree))
  Return MajorityVote(predictions)

Function PredictDecisionTree(dataPoint, tree)
  If tree is LeafNode
    Return tree.classLabel
  If dataPoint[tree.feature] <= tree.split
```

Return PredictDecisionTree(dataPoint, tree.left) turn PredictDecisionTree(dataPoint, tree.right)

6.New Techniques model application and verification.

Relevant details should be stored time to time in main database which could be handled by three more admins to take proper actions same can be displayed on the smart board for special peoples.

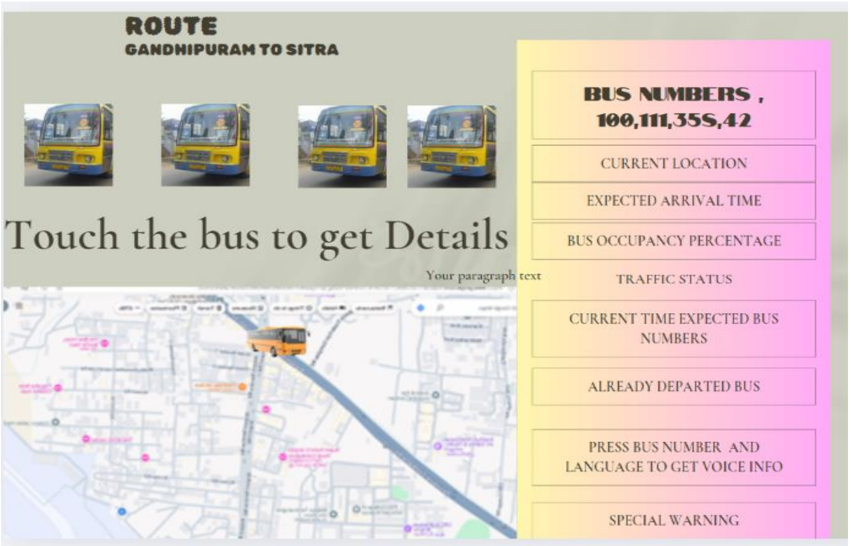

Figure 3.(a) IoT based Smart model Bus Stop (b) System Hardware prototype

The sensors used were **GPS (Global Positioning System) Sensors, Traf-Sys, Amsonic, and SenSource offer affordable solutions that can provide essential passenger traffic data without the high upfront costs of more advanced technologies, sensors from brands like DFRobot, and Honeywell provide an economical way to count passengers, with prices ranging from $10 to $300 depending on the functionality and complexity of the sensor. These sensors are great for small public transport systems, bus fleets, or DIY smart model projects Raspberry Pi camera modules**, **ESP32-CAM**, and **Arducam Mini Modules** are among the best budget options. These cameras are easy to integrate with **IoT systems, . The DFRobot Sound Sensor, KY-038, and Adafruit MAX4466 offer budget-friendly solutions, while the ReSpeaker array offers higher quality sound capture for more advanced applications. These sensors integrate well with microcontrollers like Arduino, Raspberry Pi, or ESP32, and can be used in conjunction with smart board systems, alert systems, or passenger services. proximity sensors such as the HC-SR04 Ultrasonic, JSN-SR04T, and APDS-9960 Gesture Sensor offer a low-cost and reliable solution for detecting the presence of passengers or vehicles. RFID readers such as the HID Global, ThingMagic M6e, and Zebra RFD8500 can be used for various applications, passenger management. Using RFID tags like the MIFARE Classic 1K or Smartrac Frog 3D ensures reliable identification of passengers, improving the efficiency of public transport systems.**

Category	**Passenger Density**	**Location in Km**	**Traffic Intimation**	**Breakdown if Any**
Sensor Name	DFRobot, Honeywell, Traf-Sys, Amsonic, SenSource	GPS Sensors, Arducam, ESP32-CAM	Traf-Sys, Amsonic, SenSource	HC-SR04 Ultrasonic, JSN-SR04T

Operating Range	5-30 passengers for bus occupancy	GPS: ~5 meters accuracy	Traf-Sys: 0-500 meters for counting	HC-SR04: 4m, JSN-SR04T: 10m
Sensor Resolution	Varies based on system: 5-10 passengers	GPS: 1 meter resolution	Moderate, up to 500 meters	HC-SR04: 1 cm, JSN-SR04T: 2 cm

Table 2: System hardware details

Verification of our system

All the sensor data received in a correct proportion and sent to the parent database in a systematic interval for decision making, everything in a correct form to make proper decision to display the result . and the all units are working.

S.No.	**Test Case**	**Expected Condition in the Bus**	**Expected Condition at the Bus Stop**
1	People Density	The bus should have an appropriate number of passengers based on sensor readings (e.g., 5-30 passengers in a 50-seat bus).	The system should display the current density of passengers waiting at the stop (e.g., 5-10).
2	GPS Location	The GPS sensor should provide accurate data within a 5-meter radius.	The model map should display the accurate location of the bus within 5 meters.
3	Availability of Seat	Sensors detect seat occupancy; seat availability data must be within 90-100% accuracy.	Shows available seats at the stop, if applicable (e.g., "5 seats available").
4	Current Position	GPS provides current coordinates of the bus (e.g., 28.7041° N, 77.1025° E).	The map at the bus stop should reflect the bus's current position in real-time.
5	Projected Arrival	Estimated time of arrival (ETA) at the stop should be calculated based on distance and speed. Example: "ETA: 3 minutes."	The bus stop display should show the projected time for the bus arrival (e.g., "Arrival in 3 minutes").
6	Traffic (if any)	Traffic sensors detect heavy traffic conditions (e.g., 10-15 km/h speed).	Traffic conditions should be shown on the map with details like "Heavy traffic ahead."
7	Breakdown (if any)	The system should detect bus malfunctions, triggering alerts for breakdown (e.g., engine failure, sensor malfunction).	The bus stop system should display a warning message like "Bus service delayed due to technical failure."
8	No Space	Occupancy sensors detect full bus capacity (e.g., 50/50 seats occupied).	Displays message: "No space available on the next bus. Please wait for the following bus."
9	Pre-arrival	The system detects the bus approaching (e.g., within 500 meters of the stop).	The bus stop system should alert users with a "Bus arriving soon"

			notification.
10	Post-arrival	Once the bus arrives, all relevant data (e.g., current status, seat availability) should be updated in real-time.	The bus stop system should update with "Bus has arrived" and display the time of arrival.

Table 3. Test cases

The units of the system was tested by receiving data from more than 20 bus stops and adding them to the major database.

7. Discussion :

This work in progress is an experimental platform, which has two main objectives: increasing social inclusiveness and elder people, differently abled persons. First, it addresses the inclusiveness of all kind of people in smart bus stop. Sensor buses to detect or estimate buses' real-time occupancy is crucial for increasing the effectiveness of transport planning, from both users' and transport providers' points of view. Therefore, this work is addressing several issues related to inclusiveness as the lack of information on accessibility of local transport, the lack of information presented in accessible formats or concise and reliable, and the low use of mobile apps and social media in the local transport sector.

Increasing the use of planning apps have the potential to anonymously create mathematical models for planning mobility at city scale and therefore, opens the possibility of new transportation paradigms. In addition, socialization at smart bus stops allows citizens to potentially organize and require new transport options. Finally, this paper introduces the novel concept of Interconnected Public Space or SPA Space and describe its potential for increasing (or at least maintain) quality of life of the elders and differently abled persons. Basic design of SPA-Space is described, as well as how to link it with smart bus stop development, to take advantage of ICT smart bus stop infrastructure. This can be particularly effective in wide outdoor spaces as parks and squares, producing a faster and cheaper deployment of SPA-Spaces.

8. Conclusions

This approach introduced a smart solution IoT-based model bus stop that provided smart monitoring and maintenance solutions and great help to the needy people.

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