**Phase 2: INNOVATION**

**SMART BUS STOPS**

Objective:

To enhance the waiting experience and give passengers useful information, bus stops should be equipped with interactive displays, Wi-Fi, charging points, and real-time arrival information.

Components and Benefits of Smart Bus Stops

1**. Interactive displays**: Touchscreens or QR codes can be used by passengers to access maps, monitor next bus arrivals, and better plan their routes. These displays can also include weather updates and commercials.

2. **Wi-Fi Access**: By providing Wi-Fi access at bus stations, passengers may stay connected as they wait for their buses. To increase productivity and provide take advantage while waiting, passengers can use their smartphones, tablets, or computers to browse the internet, check their emails, or use transportation apps.

3. **Charging Stations**: Passengers who need to charge their personal gadgets can take advantage of charging stations with USB connections or wireless charging capabilities. This helps those with disabilities in particular.

4. **Real-Time Arrival Information:** One essential component of smart bus stops is the display of real-time arrival information for buses. By checking the precise arrival time of their next bus, passengers can lessen uncertainty and more effectively organize their travels.

5. **Security cameras:** Setting up security cameras at bus stations improves traveller security and stops criminal activity. Video can be utilized for incident investigations and security monitoring.

6. **Energy Efficiency:** To lessen their influence on the environment, smart bus stops can be built with energy-efficient lighting and electronics. Incorporating solar panels can eliminate the need for external energy sources by powering lighting and charging stations.

Implementation of IOT Sensors in Smart Bus Stops:

For smart bus stops, popular sensors include:

1. **Passenger Counting Sensors**: sensors can detect how many passengers are waiting at a stop and provide information on how to make routes and schedules more efficient.
2. **Environmental Sensors**: By keeping track on the temperature, humidity and air quality, these sensors can tell you how safe and comfortable the bus stop is.
3. **Occupancy Sensors:** By identifying whether seats is occupied, these sensors can assist control how few resources are utilized.
4. **Security and Vandalism Sensors:** These sensors can spot suspicious activity or tampering and send out signals to the appropriate authorities.
5. **Light and motion sensors**: Depending on occupancy and light conditions, these sensors can regulate lighting and energy use.
6. **Air Quality Sensors**: These sensors can track the amount of air pollution and deliver current information on air quality.

Sensors Placements:

The placement of numerous sensors is essential for a smart bus stop to ensure their efficiency in gathering important data and enhancing the overall experience for passengers. The following are suggestions for where to put each kind of sensor:

1. **Passenger counting sensors**:  The following are examples of usual location choices: - Near to the shelter's entrance or exit or the waiting area.

- Facing the waiting area, on the pole or signage at the bus stop.

- Ensure that the area where people are likely to stand or wait has a clear line of sight for sensors.

- This sensor is used in buses to update information regarding seat availability. If the bus's available seats are all taken, it bypasses the next bus stop and instead arrives at the stop where seats are available.

2. **Environmental sensors:** these sensors ought to be put in a position to record information that is informative of the conditions at the bus stop. To prevent direct sunlight, temperature and humidity sensors can be installed in regions that are shaded.

The height of the air quality sensor installation should correspond to the passengers' breathing zone. To provide reliable readings, sensors should be appropriately protected from rain, wind, and direct sunshine.

3. **Occupancy sensors**: In order to determine whether a shelter or seating area is occupied, occupancy sensors are utilized. They should be positioned appropriately for effective use.

Install them within the shelter structure, generally close to benches or chairs.

To detect movement, install occupancy sensors close to entrance/exit points.

A suitable sensor height should be used to cover the standing and seated regions.

4. **Security sensors and vandalism:** are essential for keeping an eye on and discouraging illegal activity. Install surveillance cameras where they can be spotted vandals, such as at eye level.

Install motion detectors in places where there is a chance of vandalism, such as access points.

5. **Light and Motion Sensors**: Placement of light sensors should allow for reliable measurement of ambient light levels.

Place motion detectors close to the entrance/exit points and in locations where passengers frequently move or wait. Make sure that no things are blocking the sensors' ability to function.

6.**Air quality sensors**: these sensors should be placed so that they can record the air quality that passengers are exposed to:

Install air quality sensors at a level that corresponds to the passengers' breathing area.

Make sure sensors are placed far from any potential pollution sources, such as car exhaust.

Sensor placement should always take into account variables like sensor range, coverage area and environmental conditions.

Conclusion:

It requires meticulous preparation, technical expertise, and collaboration with a range of stakeholders, including transit agencies, local governments, and technology providers, to implement IoT sensors in smart bus stops. Once implemented correctly, it can transform bus stops into convenient, smart, and user-friendly transportation centres.