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Review Article

SECURE DESIGN FOR SMART BUS SHELTER USING RENEWABLE ENERGY

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ABSTRACT

A smart city utilizes Information and Communications Technology (ICT) to upgrade its livability, safety and sustainability. The main objective of this research is to identify and solve the problems in city area applications. The major smart city applications are smart living, smart safety and smart sustainability. Energy management and safety is a major issue in the present city condition. This work will be implementing smart city solar bus shelter using renewable energy for existing areas. The solar and turbine energy bus shelter applies smart solutions to infrastructure and services in rural and urban areas in order to make them better.

Keywords: Solar Energy, Video Surveillance, Wi-Fi, Information Display, Polar Lights, Micro Wind Turbine.

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INTRODUCTION

The Salem city is located in Tamil Nadu state of India. The Salem city's total geographical area is 5205.30 SQ.KM with a total population of 30,16,346. The Salem city is planning a solar energy bus stop and electric busses of its busiest existing route. The solar energy bus shelter configuration centers around transport traveler's needs and inclinations, accessible advancements, and the blend of upgrades that would be most esteemed by travelers, for example, Schedule data, clean environment, solar powered bus shelters, agreeable seats, wellbeing and lightings were seen to be what the best number of people required at transport stops. The city traveler's needs at transport stops are not fundamentally a matter of using the most recent innovation or giving up-to-date stylish shelters, but instead of constant arrangement of precise timetable data, cleaning, repair, and watching that tells travelers that they are esteemed and regarded.

This work distinguishes seven noteworthy objectives in outlining a decent solar powered vitality transport stop: wellbeing, warm solace, vitality comfort, wind security, visual solace, openness, and coordination. The objectives are accomplished by nine strategies: lighting, seating and surfaces, cover, enhancements, data, power plant, movement administration, person on foot framework and vegetation foundation. These nine methods are then connected to nine transport stops in Salem city, going from real trades to remote stops.

This work attempts in an alternate way to relieve the review comes about. In an audit of transport riders and insisted by various diverse examinations, security is reliably situated as one of the most astounding need needs at a transport stop [1]. It is reasonable that individual wellbeing is the commence whereupon each other change can be made. Without an adequate level of clear security, suburbanites will simply pick not to use the bus shelter [2]. Risk of mischances at a bus shelter is generally connected with people on foot being in nearness to overwhelming or quick vehicular movement [3]. Wrongdoing in broad daylight spaces happen for the most part in light of the fact that there exist windows of chance. In this manner, diminishing these open doors is the favored technique for decreasing danger for wrongdoing around bus stops. While expanded reconnaissance by travel police and cameras are alternatives, they may cause extreme target solidifying and prompt a post attitude [4].People will survey the risk of a region in view of their own attributes, for example, age, , gender, and commonality with the zone. Studies show that workers who are senior citizens, female, or new to the region have bring down edges for what is thought to be a protected domain [5].

Reviews of transport stop users exhibit that general solace is settled fundamentally by the warm condition [6]. In regions of extraordinary warmth or extreme cold, it is imperative that the originator construct a level of "radiant " sensitivity [7]. Surrounding temperature is seen to be one of the most grounded factors for the persons strolling when different modes are accessible [8]. A temperature of 24 degree Celsius is most wanted by those holding up outside [9].

The effects of wind can be isolated into two essential classes, mechanical and warm [10]. Twist beneath 5 m/s can be viewed as a light breeze and pleasant. Over 5m/s, mechanical and warm effects can both be felt. At twist speed of 10m/s, strolling ends up upsetting [11]. Wind is a troublesome factor to get ready for as it is welcomed in a couple of conditions and bothersome in others. Wind condition is moreover difficult to envision and control since it is impacted by various worldwide, local and neighborhood factors [12].

Visual solace can be isolated into three components: satisfactory lighting for desired activities, absence of glare or other awkward visual stimuli, and purposes of enthusiasm for the suburbanite to center around. While individuals are exceptionally versatile with regards to the measure of lighting gave, they frequently welcome more light, especially sunlight. Another fundamental estimation is the most extreme separation between users that permits face recognition, which is 24 meters. To ensure a pleasing visual condition in the midst of the day, the sun should reach between 20-80% of the site continually [13].

Accessibility implies the access of the transport stop by all bits of the masses and through all modes. It is discovered that better associations between the area and the environment urge individuals to walk or cycle more [14]. Expecting fundamental availability is met, for instance, minimum widths required for a man on person on foot comfort [3], this

section looks at possible streets of progress of access to grow a transport stop's zone of effect [15]. In particular, the specific needs of the elderly and families must be suited at station passages and stacking focuses [16]. With developing notoriety of dynamic transportation, it is essential to ensure that there is sufficient person on foot and cycling system availability around the transport stop to serve these modes [17].

Like any urban open space, bus shelter can benefit colossally by being facilitated with its surroundings in various angles [18]. The introduction of pleasantries at the stop should be great with the incorporating establishments, paying little mind to whether it's giving extra surfaces to stops near business sectors or legitimately evaluated seats for stops near elementary schools. Planners should similarly realize that the use of the bus shelter may vary between seasons. Accordingly it is essential that pleasantries underused by suburbanites can be repurposed by neighborhood clients [19]. Incorporation isn't only for the benefit of the neighbors. Studies show that being close shops, cooking foundations and organizations added to the drawing in nature of a bus shelter [20].

With the benefit of the above features in [21] should be considered to design the new smart city solar bus stop possible amenities as shown in Fig. 1.

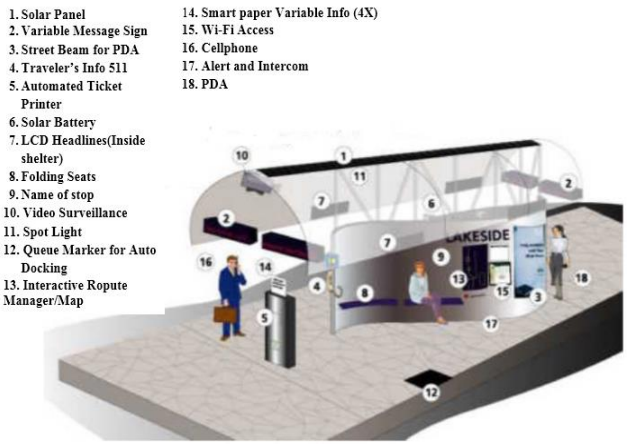

Fig. 1: Possible Smart City Solar Bus Stop Amenities

ANALYSIS

The current problems in Salem city bus stops are,

Fig. 2(a): Salem Nethimedu Bus Stop

Fig. 2(b): Salem Neuro Foundation Bus Stop

Figure 2(c): Salem Shevapet Bus Stop

Figure 2(d): Salem Ammapet Bus Stop

In the above Fig. 2(a), 2(b), 2(c) and 2(d) have the following problems.

(i) No Lighting facilities.
(ii) No security
(iii) Bus route information display is not available
(iv) Rest rooms are not available

Bus Passenger's Surveys:

The problem has been identified by 943bus passenger's surveys which were taken through questionnaires and real time observations such as solar power, information, safety and comfort.

Solar Power:

The wind and sun energy, collected by the solar panels and turbine, turns these bus stops small power plants, generating enough energy for its whole infrastructure. The traveller responses are shown in Table 1. The polar light display and solar & Micro Wind Turbine power was by far Excellent for 80.69% and 84.94% travelers; 19.83% thought that it was Good for utilization of power plant to bus stop remaining all other amenities.

Table 1: How Useful Is Bus Shelter Solar Energy?

Information	Excellent		Good		Average	
	Number	Percentage	Number	Percentage	Number	Percentage
Smart polar light display	761	80.69%	101	10.71%	81	8.58%
Solar and Micro Wind Turbine power plant to recharge with Electric Vehicles batteries	801	84.94%	92	9.75%	50	5.30%
Utilize power to water doctor, mobile/laptop charger, Information display etc.,	695	73.70%	187	19.83%	61	6.46%
Utilize power to Toilet Block	891	94.48%	40	4.24%	12	1.27%

Information

In spite of the way that 78% of those outlined rode the transport at least five or more days a week, despite everything they discovered numerous kinds of data helpful, as appeared in Table 2. Bus Timetable was far the most valuable; 74.43% believed that it was most valuable and right around 25.55% suspected that it was exceptionally or to somewhat helpful. Next most valuable was the time when next transport will arrive. Route maps, interfacing courses and trade centers, and the present time of day were judged particularly most valuable by over 47.93% of riders and to a great degree or to somewhat helpful by around 52.06%. Less valuable, yet to somewhat helpful for a greater part of riders, were benefit updates, passages, and the client benefit phone number. The

study asked with reference to whether people were occupied with a guide of exercises near the transport stop. About half, felt this would be most valuable or to somewhat helpful. More people were keen on data about wellbeing administrations, organizations, and parks and diversion, less in motion pictures and stimulation, family exercises and taxpayer driven organizations.

Table 2: How Useful Is Bus Shelter Information?

Information type	Most Valuable		Somewhat Helpful	
	Number	Percentage	Number	Percentage
Bus Timetable	702	74.43%	241	25.55%
Route map	452	47.93%	491	52.06%
Time when the following transport will arrive	504	53.44%	439	46.55%
Fares	340	36.05%	603	63.94%
Connecting points	396	41.99%	547	58.00%
Customer service helpline number	312	33.08%	631	66.91%
Bus service Updates	315	33.40%	628	66.59%
Date and Time display	367	38.91%	576	61.08%
Map of activities nearby bus stop	275	29.16%	668	70.83%
Government facilities	253	26.82%	690	73.17%
Transport Website	203	21.52%	740	78.47%
Parks and recreation	302	32.02%	641	67.97%
Medical and health services	363	38.49%	580	61.50%
Movies and entertainment	259	27.46%	684	72.53%
Shops and businesses	323	34.25%	620	65.74%

Safety:

People who did not generally feel safe were asked what might influence them to feel more secure. Their reactions are showed up in Table 3. The greater part of the measures recorded, better lighting, surveillance cameras, emergency alarm, emergency telephone and patrols, would make no less than 50% of these people feel in any occasion genuinely more secure. The measures well on the way to influence them to feel considerably more secure were intends to get help in an emergency—an emergency alarm buttons or an emergency telephone. Security watches were next well on the way to influence them to feel much safe generously more secure. Better lighting, knowing when the following transport would arrive, and having a compensation telephone close-by would make over portion of the respondents feel fundamentally more secure. A surveillance camera was broadly less slanted to impact them to feel more secure; not as much as half said it would impact them to feel altogether more secure.

Table 3: Passengers Feel Safe or not at Their Bus shelter

Information	More secure	Somewhat secure	No secure	No response
Better lighting	60%	29%	6%	5%
Emergency alarm	61%	21%	11%	7%
Patrols	59%	31%	5%	5%
Camera	65%	30%	4%	1%
Emergency phone	54%	35%	9%	2%

Comfort:

Travelers were requested about what they liked to do at bus stops. Their responses are appeared in Table 4. Reading and listening to music were the most popular activities followed by talking to fellow passengers and eating or drinking. Somewhat fewer talked on cell phones or pay phones.

Table 4: What Do You do whileWaiting for the Bus?

Information	Number	Percentage
Use a Laptop	85	9.01%
Visit nearby shops	133	14.10%
Reading	261	27.67%
Eating	25	2.65%
Listening to music	264	27.99%
Talk on a cell phone	175	18.55%

Amenities

By then they were asked what may impact their holding up time at the transport stop more charming. Their reactions are appeared in Table 5. The unmistakable most loved was cleaner environment. More people were keen on physical solaces, for example, seats, better light to peruse by, and shield, than in activities while they paused. Most of the individuals addressed the inquiry "Different things that would make holding up time more lovely" Most said the transport benefit itself, data they might want, tidiness, covers, seats, sun oriented transport protect, water specialist, ATM machine, versatile/workstation charger and keeping non-transport riders from congregating or resting at transport stops. A couple specified no smoking; a couple of said automated ticket printer, music, and a restroom. Most of the individuals who addressed the inquiry "Would you take more transport trips if holding up time were more charming?" said yes.

Table 5: How to Make Your Waiting Time at the Bus Stop More Happier?

Information	More happier		Somewhat happier		Not happier	
	Number	Percentage	Number	Percentage	Number	Percentage
Solar bus shelter	695	73.70%	199	21.10%	49	5.19%
Cleaner surroundings	701	74.33%	201	21.31%	41	4.34%
Comfortable seats	669	70.94%	251	26.61%	23	2.43%
Paintings	361	38.28%	481	51.00%	101	10.71%
ATM Machine	643	68.18%	241	25.55%	59	6.25%
Good lighting	624	66.17%	301	31.91%	18	1.90%
Spacious bus shelter	630	66.80%	293	31.07%	20	2.12%
Green surroundings	518	54.93%	356	37.75%	69	7.31%
Automated Ticket Printer	421	44.64%	370	39.23%	152	16.11%
Television stand	471	49.94%	312	33.08%	160	16.96%
RO Water	663	70.30%	211	22.37%	69	7.31%
Mobile charging	675	71.58%	201	21.31%	67	7.10%
Scrolling display announcements	498	52.81%	305	32.34%	140	14.84%
Wi-Fi access	646	68.50%	250	26.51%	47	4.98%
Two Wheeler Parking	351	37.22%	302	32.02%	290	30.75%
Rest Room/Toilet	495	52.49%	320	33.93%	128	13.57%

METHODOLOGY

The objectives of this work as follows:

(i) Create a functional solar and turbine power source within the bus stop.
(ii) To recharge electric vehicle batteries from solar and turbine energy bus stop power source. So maximizing the number of electric vehicles will reduce the city pollution.
(iii) To minimize the city main power consumption with the help of solar and turbine energy.
(iv) To establish a safety with the help of Camera sensor, lighting and emergency alarm.
(v) To display the bus schedule information both in real time (i.e., touch screen display) and Mobile App (Light stop).
(vi) Solar energy bus stop provides several amenities which will help the passengers to spend their waiting time effectively.
(vii) Providing clean, comfortable, and safe bus stops using Restrooms and RO Water.

This work is a conceptual project of a bus station in Salem, bus stop to suggest a solution to solve transit problem. The main problem of the bus station is its own look, bus stops now look unsafe and there is no area to let the people know where they have to stand waiting for their bus. Also, bus stops always have homeless people sleeping in from the company or advertising so the station will be dark to let the advertisement look outstanding, this then causes people to not waiting to stay inside. Because the finances that support the construction of the bus stops is not safe for the people at night. Another significant issue will emerge in the bus shelter is there is no toilet. If the toilet is available the people can't utilize the toilet properly.

Because of these problems people continue to use private cars which can cause traffic jams and more and more pollution is released into the atmosphere.

The solutions for these problems are as follows:

- Looks
- Functions that make people stay in line
- Lights for safety, which in the design I provide two kinds of light. First is the polar lights these will have sensor when someone walks through the light will show up brighter than usual. Second is the lights on the floor, these lights will turn on when someone steps on it, but these light will not be on all the time like the polar one. The polar light will be the light at night and also a fence.
- Construction with a solar and turbine system: The construction will utilize a solar and turbine system to keep supplying power at night in the bus stop, and to recharge electric vehicles, so we don't need the power from main source. These will not waste electricity power like other areas.
- Photosensitive glass: The color of the glass will change to tint during the day and night based on natural brightness.
- Interactive touch screen to show the bus number and route map of each buses destinations.
- Sensor based toilet is designed within the solar bus shelter.

The Fig. 3 and 4. describes the following features,

The design: Because almost all bus stations in Salem stay on the footpath the shape that comes out is rectangular to match the environment and surroundings. Also, it solves the space problem.

The card: will make their life easy because this card can be used at all public transportation. Also the card will have the small screen to display how long it takes before the bus is coming. It will also notify riders when they are approaching their stop. The card is also used as a payment system and savings will also occur for the bus company because they will not need to have conductors. Another function is before people come inside this station they have to touch their card and click the bus number. Before the bus is coming, around 10 meters, it will connect to a sensor in the card to let people prepare before the bus arrives.

Sign (interactive touch screen): the screen will show the bus's number and the route of the bus. People can play on or touch the screen while there is no one using this screen and it will show the news, stock market or other current event information that is necessary for people. The above screen will show the news all day and switch to the name of the bus stop so people will know exactly which step they are at, which is not like current time where the conductor will call the stops name. This should help stop confusion and unsure people to get off the bus at the correct stop.

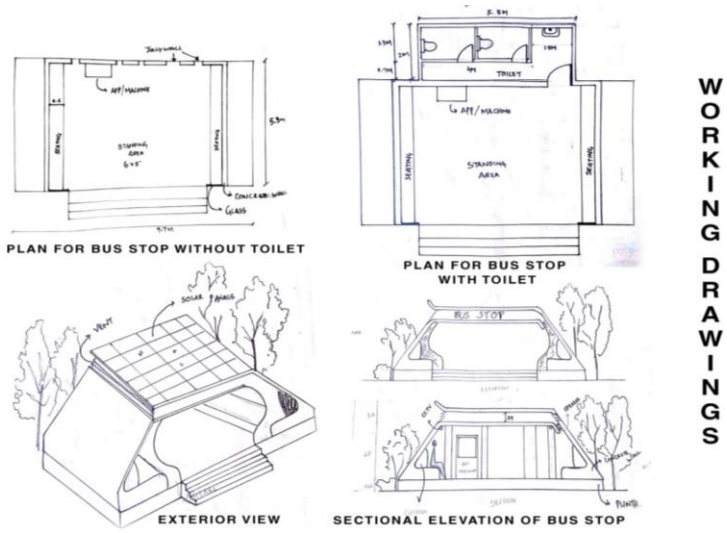

Fig. 3: Work Plan for Solar and Turbine Energy Bus Stop with & without Toilet

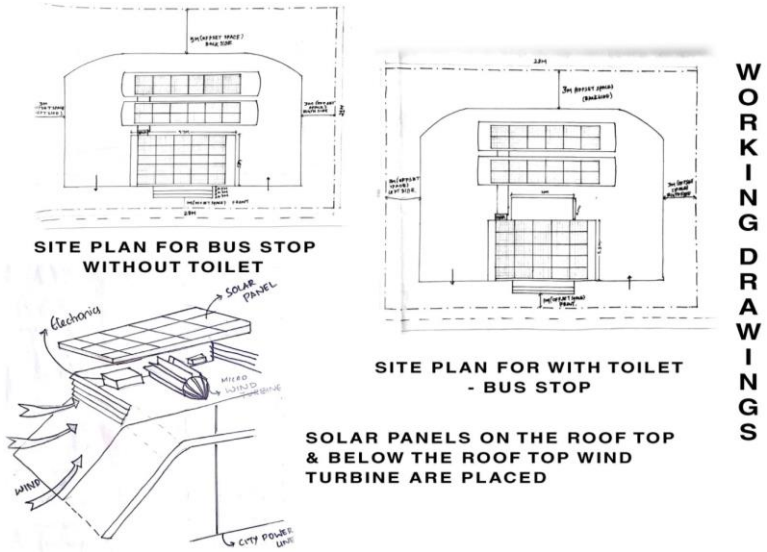

Fig. 4. Site Plan for Solar and Turbine Energy Bus stop with & without Toilet

Sensor based Toilet: The primary aim of this toilet is to assure the cleanliness. At the point when the individual utilize the toilet, the sensor will perceive whether the individual will flush the water or not. On the off chance that the individual is unflushed the water, at that point the sensor won't permit to open the entryway. In the event that the individual is flush the water, at that point sensor will enable the individual to open the entryway.

RESULTS AND DISCUSSION

People they can feel safe when they use the bus station and they know the time of bus arrival. The most important is all the designs will combine with the architecture and interactive plan to solve existing problems. People who don't use the bus stop can play with the space and screen to get information and familiarize themselves with public transports. Also this will be the landmark for meeting or will be a small community to meet other people.

The solar and wind energy, collected by the solar panels and micro wind turbine, turn these bus stops small power plants, generating enough energy for its whole infrastructure. Surplus energy will be directed to the city's electrical network, and returns in benefit of the bus shelter as receivable. Finally, Smart Bus Shelter using renewable energy has following features;

- Through the sensors (Camera) the solar and turbine energy bus stop is monitored by city officials.
- Solar and turbine energy to produce more power to recharge the electric vehicles. Electric vehicles to reduce pollution because people will use more public transportation.
- Interactive touch screen to show the bus number and route map of each buses destinations.
- This proposal will help both the travellers as well as electric vehicles to utilize the solar and turbine energy bus stop effectively.
- Finally the individuals will feel the light of safety when they use the bus station.

Fig. 5: Solar and Turbine Energy Bus Stop with Toilet

This design transforms a simple bus stop into meeting point and pleasant place to be. The final secure design for smart bus shelter using solar energy is as shown in the Fig. 5 and 6.

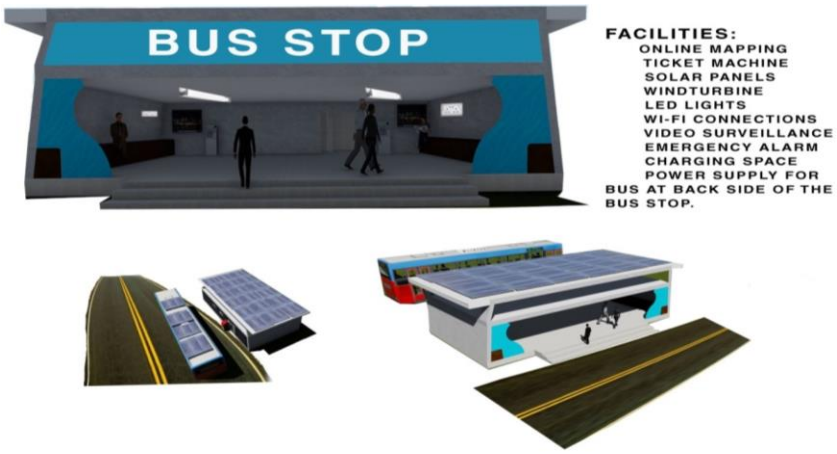

Fig. 6: Solar and Turbine Energy Bus Stop without Toilet

CONCLUSION

This work is helpful for the bus travelers to utilize all the amenities within the bus stop. The solar and turbine energy bus stop is monitored by city officials through camera sensors. Solar and turbine energy to produce better lighting features within the bus shelter and to recharge electric vehicles. Interactive touch screen to show the bus number and route map of each buses destinations. Sensor based toilet provides comfortable and cleanliness environment within the bus shelter. This work will be implemented in Salem metropolitan area bus stops. In future, this work will act as a power house to recharge the electric vehicles everywhere else.

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