

Innovation in designing BUS STOPS as a Modern Requirement

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ملخص البحث:

محطات النقل العام أو المعروفة باسم محطات الحافلات هي عناصر وظيفية في نظام النقل، حيث يعتمد الركاب بشكل كبير على توافر محطات الحافلات ويفضل أن تكون المفروشة منها. يعتمد تصميمها على المعايير الفنية والتوحيد القياسي الذي تحدده السلطات الحكومية والهيئات التنظيمية. ومع ذلك، يمكن أن تلعب محطات النقل العام دورًا مهمًا في البيئة الحضرية. في الواقع، إنها أيضًا فرصة لإنشاء المساحات العامة وتحسينها. تنتشر محطات النقل العام العادية على نطاق واسع في جميع أنحاء المدن ويتم تجاهلها من قبل المصممين الحضريين والنقاش العلمي (Brovarone, 2021). هذه الدراسة البحثية حول استكشاف كيفية التعامل مع الدور المحتمل لمحطات الحافلات كميزات تشكيل البيئة الحضرية في النقاش العلمي، وتقديم بعض الأمثلة التي تعبر عن هذه الإمكانية وتقتراح مبادئ تصميم مختلفة. يمكن بلا شك أن تتفق محطات النقل العام على تشكيل الفضاء العام الحضري، ولكنها تحتاج أيضًا إلى التحول من أجل المصداقية العامة والاجتماع. تهدف محطات الحافلات إلى تلبية مجموعة كاملة من المتطلبات الوظيفية والتشغيلية. بهذا المعنى، يجب أن يستجيب التعبير المعماري ونوع الهيكل، إلى جانب المواد المختارة، لهذه المتطلبات. من المعتقد أن الهياكل الفولاذية محددة سلفًا لتوفير هذه الآلية ولا بد أن تكون صلبة بما يكفي لتحملها لفترة طويلة.

Abstract

Public transport stops or commonly known as bus stops are functional elements of the transport system. The passengers highly rely on the availability of bus stops and most preferably the furnished ones. Their design is based on technical parameters and standardization that are set by the governmental authorities and regulatory bodies. Nevertheless, public transport stops can play an important role in the urban environment. Indeed, they are also an opportunity to generate and enhance public spaces. Ordinary public transport stops are widely spread throughout the cities and are neglected by urban designers and by the scientific debate. (Brovarone, 2021)

This research study is all about exploring how the potential role of bus stops as shaping features of the urban environment is dealt with in the scientific debate, presenting some examples that express this potential and proposes various design principles. Public transport stops can undoubtedly concur to shape the urban public space but also need to be transformed for public authenticity and meeting. Bus stations are meant to fulfill a complete set of functional and operational requirements. In this sense, the architectural expression and type of structure, together with the selected materials, should respond to these requirements. It is most believed that steel structures are predetermined to provide this mechanism and are bound to be hard enough to sustain for a long time.

Introduction

Most of those who do not have cars spend a lot of time in bus stops waiting for them to arrive to take them to their destination (Figure 1). Therefore,

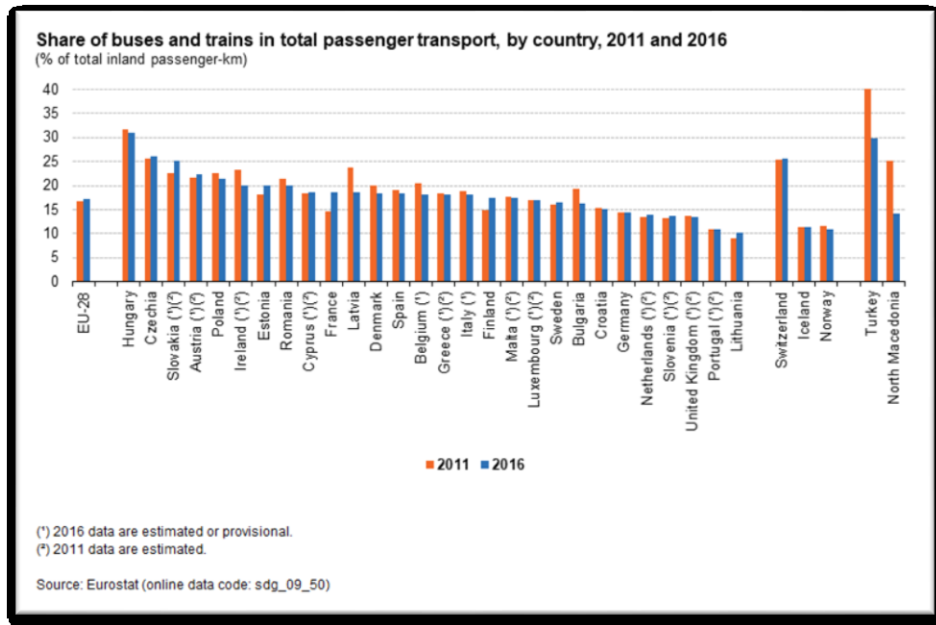


Figure (1) a diagram shows of the number of passengers around the world using buses and trains.

some countries are keen on making bus stops elegant, comfortable, and safe for their users on the one hand, and for the sake of the city's general appearance on the other hand. Recently, many countries have become aware of the importance of the appearance of these stations and have renewed their forms in an attempt by the governments of these countries to encourage the public to use buses instead of private cars to reduce road congestion and reduce pollution.

Transportation architecture is mostly constructed with concrete and steel. What is most probably the necessary thing for the stations and other transportation facilities are specific spans necessary for the vehicle approaches and open space architecture for the buildings. The selection of material is conditioned mostly by the required spans and aesthetical approach of the designer. Every transportation facility has two structural parts that are most often independently built. One is a station building and the other is a canopy for the platforms.

Depending on the architectural design, the use of material for that structure may vary. Lately, the bus station canopies are built separately from the building. During the mid-20th century, the canopies were not an essential element as it is as of today. Platforms were sheltered by overhanging beams that were forming kind of balconies or terraces over the platforms. Those bus stops were built as reinforced concrete structures, those canopies were sheltering only the front entrance to the bus station.

Today, bus shelters are often designed as canopies separate from the building. For that purpose, a variety of materials with different formations is used. Thus, having different varying types of platforms and distance between two parked busses. They can be short being the same width of the bus, which might just give way to the passengers approaching the buses from every side up to a span that corresponds to the whole platform area. The choice depends on the design adopted and on the architectural requirements. This research study will demonstrate how different materials can be used both as structural material and aesthetical value.

The bus stations in Europe run with an Innovation Action co-funded by the European Union within the Horizon 2020 Research and Innovation Programme and coordinated by UITP – the International Association of Public Transport. This project is meant to capitalize on the findings of the previous EBSF project and serves the aim of developing a new generation of urban bus systems with new technologies and infrastructures in combination with operational best practices and testing them to prove the intrinsic needs of modern bus stops. The distinctive factor of modernizing bus stops is a solution for increased efficiency of the system, providing the solution for the energy consumption and operational costs, as required by today's economic situation.

Need for profitable and energy-efficient bus stops has led to technological innovations and strategies together with the strong potential to optimize energy and thermal management regarding bus stops together with climate hereditary, green driver assistance systems, intelligent garage, and maintenance processes, as well as, providing IT standard equipment and services. Moreover, to effectively address the need for innovation regarding the bus stops and bus fleets operation and required technologies need to be tested to provide technological maturity to ensure a short step for commercialization. This must provide a preliminary step for the validation of the innovations in real operational scenarios, performed throughout the innovation project, and carrying out necessary tasks to prove the potential of more futuristic solutions currently employed at an early stage of development.

Modern and innovative bus stop design offers passengers a place to get out of their routine and enjoy the environment around them while they wait, as well as seating, places for bicycles, advertising, or simply a clean, modern structure that enhances the posture of the city. Bus stop design could carry as many styles as it could be, several material parameters, locations, and purposes. Some cities need bus stops that can accommodate large numbers of people, while others may need smaller bus stops with mere people attending them, or there might need a surety that the structure can withstand the elements and offer protection to waiting passengers. Paying attention to these considerations when designing any bus stop architecture to ensure you meet your city's needs. This would be the best way to go through and formulate a bus stop that could be feasible and efficient for the public of any city.

Let's learn about some innovatively designed bus stops across the globe and see what we can learn from them.

Aims and objective

This research study is aimed at testing, evaluating, and validating innovative technological solutions or strategies for urban and suburban bus systems and bus stations through demonstrations of the real service and real value given to the passengers. The goal of this research study is to improve the efficiency of the operation mainly in terms of costs and energy consumption but also to increase the serviceability of the bus stations by improving the image and

look of the stations for the users. To produce breakthrough changes in the existing bus station designs and innovate them with technology, this study has identified six research areas with the highest potential to impact improvement as well as users' acceptance of bus stations. These six improvement areas are as under:

- Energy Strategy and innovative energy resources
- Green Driver Assistance Systems that make them certain about the locations and work through easily for the passengers
- IT Standards introduction within the existing stations and their designs
- Overall station design in terms of Capacity, Accessibility, and Modularity
- Intelligent Garage and predictive maintenance purpose within that station premises
- The interface between Bus station and Urban infrastructure

Materials and Methods

The researcher used in this study analyzing cases of bus stop of some countries. Also apply a survey to identify opinions of different samples of the society.

Previous research

A study been made in China by Jian Zhang and others to evaluate how different bus stop designs affect the operations of vehicles, bicycles, and buses that pass by. The results in the study showed that different bus stop designs had quite different impacts on traffic flow. The study also has several limitations. First, the study only considered the street segments with free flow traffic conditions and low bus volumes. Traffic operations could be very different in the congested traffic situation or with bus spillover from stops. The delay model needs to be modified to accommodate busy traffic conditions. In addition, due to the availability of data, the vehicle and bicycle traffic flow are not controlled when analyzing the bus delay at different stops.

Another study been made by Maria Vittoria Corazza. The paper describes a multi-step methodology to evaluate bus stops' accessibility starting from a cluster of seven indicators describing

objective and subjective features influencing passengers' choice toward a given bus stop. y. Results shows the relevance of the urban network and environment in evaluating the accessibility and in promoting more sustainable mobility patterns. Research innovation relies on the possibility to merge data from different fields into a specific GIS map and easily highlight for each bus stop the relationships between built environment, passengers' comfort, and accessibility, with the concluding goal to provide advanced knowledge for further applications.

Those two studies discuss bus stops in different cases, the first one about the impact of bus stop design on operations of road users, and the second one about evaluating accessibility to bus stop to improve sustainability. Both were had discussed different cases in their countries only(China & Italy), and each of them discuss the problem in different way, which make the study more valuable being its not been discussed before.

1. Examples of Bus stops:

1.1 Casar De Caceres Bus Station

This is a bus station located in western Spain, in a small city Casar de Caceres with almost 5000 citizens, just about 10 km from Caceres. The station creates a metaphorical bridge within Spain with Caceres and with other larger towns. The station has two platforms located in front of the entrance to the station building. Both these platforms are used for arrival and departure due to the small number of operating buses.

The building shape of this bus stop looks like a whirling ribbon of concrete (Figure 2) that is curving in and over itself to create an enclosed waiting room and a place for platforms. It is often described as a concrete ribbon with a building inside.



Resembling local vernacular architecture, building together with its aesthetically extraordinary shape is working as funneling exhaust fumes from buses away from neighboring schools and nursery, thus providing an environmental benefit. Caceres area has characteristic architecture created from a single material. Justo Garcia revived brutalism by using only reinforced concrete for the Casar de Caceres Bus Station. (Snegar, Dzidic, 2019) The specialty is not only in using one material, but the designer Justo Garcia made a step forward by making a “one move structure”. This is meant to not only provide transportation facilities but also aesthetically define the society, provide shelter, and modernize facilities for the passengers waiting for their bus.



Figure (2) Casar De Caceres Bus Station -

1.2 Dual Sided designs

Depending on the way your roads are configured, you might go on to make a bus pulling up on either side of the shelter (Figure 3). This is an innovative design that has a bench at the center facing both sides as well as shade for either side. The result is plenty of seating and space no matter which direction you're going. This is great in terms of openness and providing shelter, basic resting area and might lack in providing space for a cafe, or other activities.

1.3 Minimal designs bus stop

This type of bus stops mimics the color and lines of the building just behind it. So that it might look like it is a of it. Its simple design offers a chance to get out of the elements, might have a single bench for seating, and an easy-to-access advertisement display to help generate income for the bus route and give waiting for passengers something to look at during their stay. This is a flashy idea with minimal access and



Figure (3) Two-sided Bus stop - Czech Republic

minimal presentation, yet lacks in options but provides shelter, security, and it generate its own energy (Figure 4).

1.4 Bold color designs

Bus stop that focusses on colorful design is meant to pop against the greenery by making use of powder-coated aluminum in a bright color thus are generally closer to parks. The red helps it stand out visually so that it is easier to find. This helps create a dynamic design without the need for a lot of detail. These designs are far less detailed and usually have lesser space to work with, might not be used in more congested areas. As these provide less



Figure (4) Tilburg Bus Station -

accommodation of passengers with fewer facilities.

1.5 Crystal clear design

This type of bus stop or shelter blends right into its surroundings by using a crystal-clear surface material on all sides. This might be vulnerable to damages, but its sleek design has a slightly industrial vibe to it that complements the area it is situated in. So, this provides shelter, space, and much needed bus enclosure. These designs might vary concerning their size, space, and accommodation of passengers, as these could be large enough to accommodate thousands of passengers as well, depending on how much the population of that area is. These are enclosed on three sides, being characterized as an ideal space for keeping waiting passengers out of the elements.

1.6 Playful designs

Bus stops do not need to be hard, modern, or utilitarian to be functional. These might be operational but with lesser design and lesser enclosing. At times this can incorporate a more playful and fun design. These designs utilize shades in primary

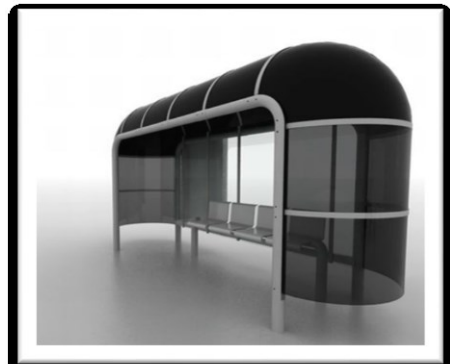


Figure (5) Fruit shapes Bus Station - Japan

colors and whimsical shapes to offer shade from the sun and possess an eye-catching design as shown in (Figure 5).

1.7 Black and White design

The design doesn't need a lot of colors to make a bold statement. Black and white colors may offer a simple look, but it is in fact elegant as shown in (Figure 6). They also offer a way to get out of the sun and rain and might also include a bulletin board for local advertising. The sleek material of the benches helps ensure that they'll be easy to clean and maintain to keep their crisp white surfaces pristine.

1.8 High tech designs

Technology is constantly changing—including bus stops. Our research study is also dealing with the technology innovation of bus stops. These designs are just serving that purposes. Such type of design could carry any luxury or elegant design and offers everything related to technology nowadays (Figure 7). This unique, shelter incorporates a central pole with a screen in the middle. These screens are becoming increasingly popular to communicate with passengers about bus arrivals, route changes, or advertisements. This provides passengers with a lot of information to inform them of the bus before its arrival and could also be informed if the bus has just left the station.

1.9 Exploiting bus stops for advertising

As statistics have shown that the effectiveness of bus advertising includes the great visibility provided by public bus



Figure (6) Bus stop shelter by Spanish designer Feline Martínez Quiroz.



Figure (7) Bus stop shelter in Paris



Figure (8) Bus stop shelter in New York (above) and Port Aventura Park – Spain (below)

advertising costs are low, which leads to displaying the bus advertisement both outside and inside - to generate high exposure at a low cost per thousand ads, making it a great way to increase the exposure of an advertising campaign (Figure 8).

Advertisements at bus stops are available 24 hours a day, and they come with always-on lights, so their visibility is never compromised (in fact, many ads are designed with nighttime in mind therefore their displays appear clearer at night more so than during the day) and in general, this translates into a non-stop ad.

1.10 Azalea Eco-Bus Stop

This beautifully designed bus stop draws its inspiration from flowers and nature which creates a nice balance of nature and urban living and at the same time it is in a very consolidated urban space. The seating features flowerpots within the floorplan, the design itself has taken inspiration from its surrounds and has been inspired by nature, it is designed as bending flower stems that people can sit on (Figure 9).

1.11 Industrial designs

Industrial and rustic-modern designs are extremely popular right now in nearly all areas of the world. These stops are used to define industrial trends and might also give information about the industry with that premises.

This bus stop architecture uses an industrial outlook by combining an industrial style for the supports, with a sleek, plexiglass-style seating and surround. The color of the supports contrasts with the rivets, making them pop and bringing more attention to space. These are attentive and eye-catching designs that are equipped with technological facilities and offer comfort and shelter as well.



Figure (9) Zhejiang Province - China

1.12 Barely there Bus Stop

For very busy bus routes where passengers won't be staying for long, sometimes the best designs are the most simplistic. These provide shelter and comfort for a little period as the passengers are not going to stay here for long. These very modern stops offer a simple gathering place that provide shelter, perfect for passengers who just need to stop and wait for a few minutes while the bus pulls up. Without benches or other objects taking up space, the stop can also accommodate a larger number of people. These are bench-free most of the time.

2. Examples of Bus stops in the countries of the Gulf Cooperation Council (GCC)

2.1 State of Kuwait

Despite the attempts of the government to encourage the public to use public transportation, many people refrain from using buses, which are the only means of mass transportation available in Kuwait, after a study group that asked a group of individuals the reason behind this, they unanimously agreed on several reasons, the most important being that the stations are inconvenient to use and do not meet the needs of users of this service, and



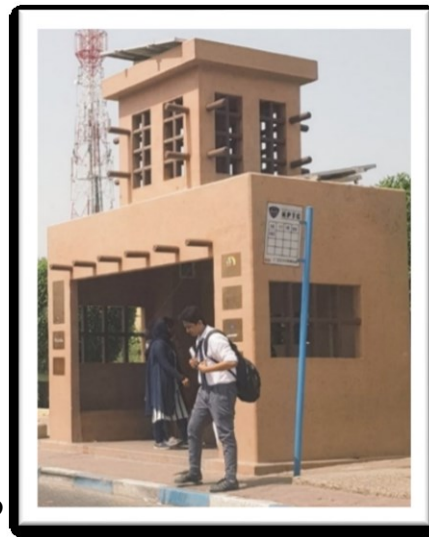
Figure (10) Two traditional Bus Stop Shelter - Kuwait

the view of the bus stops suggests a lack of interest by the organizer of this service, and therefore those who see it are reluctant to use it. Therefore, the cooperative societies for each region set up waiting stations for buses instead, but these stations were not kept up with continuous maintenance, so they were severely affected by the harsh weather factors of the State of Kuwait, as well as being subjected to sabotage by some individuals. In some cases they are sometimes found without umbrellas that protect users from heat and direct sunlight, some of them lack chairs, which makes it difficult for elderly or sick users and other groups that have special needs. In addition, the design of these stations is open from all sides, exposing users to hot air during

summer and freezing cold during winter (Figure 10). Few years later, Hawalli Governorate launched an initiative to develop 100 environmentally friendly bus stops in various regions and parts of the governorate due to the importance of public transport and its benefits to the environment and society, as it was implemented in accordance with environmental standards and international standards, using renewable energy derived from solar energy, in cooperation with the National Technology Enterprises Company and the Kuwait Public Transport Company, an innovative, sustainable and modern model for public bus stations was launched in 2018.

This design is a comprehensive national project that includes the expansion of the infrastructure of an integrated public transport network all regions of the country, as the design is inspired by the Kuwaiti heritage to preserve it from extinction, which is the Al-Bakdir Tower, and this element was chosen to implement environmental standards and international standards, using renewable energy (Figure 11).

Technological innovation was also employed to serve the community, announcing that the company would provide a free Wi-Fi network inside.



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to

Figure (11) The sustainable model developed in Hawalli - Kuwait

However, the design used remains open from several sides and from the top, which introduces hot air during the summer and cold air during the winter, making it an unsuitable design for the climatic environment in Kuwait.

These observations were taken into consideration a year later when a closed design was made from all sides and placed in the Al-Rawda area, and it was provided with

an air conditioning unit to be the first air-conditioned and environmentally friendly bus station with free Wi-Fi, and an electrical socket to

charge phones (Figure 12).



Figure (12) Waiting station in Al-Rawda area - Kuwait

Although this station is better than the one before it, it has waste of electrical energy and pressure on the cooling unit, as it will work around the clock, which will expose it to damage after a long period of continuous use, so it is better to replace the electricity



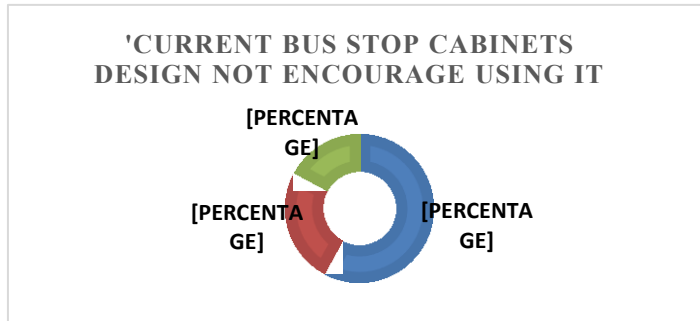
Figure (13) Two waiting stations in Mishref area - Kuwait

with a solar one, and by having the cooling design only to turn on if there are people inside, this can be done by having sensors if someone uses the seat the air conditioning can switch on.

In June 2019, work began to provide all regions of Kuwait with bus stops incorporating modern and sustainable design to keep pace with the future of public transport and its counterparts in the Gulf countries, the focus was on the architectural aesthetic character and it was provided with a lock to prevent tampering, which conforms to modern international specifications. Dozens of waiting stations designed as rooms began to spread throughout the regions of Kuwait after they proved their effectiveness in the harsh climate of Kuwait in summer and winter (Figure 13).

A survey was done on 607 people, 402 male, and 205 females randomly selected from different areas of Kuwait (Figure 14). The question that was asked was if the current cabinets design has encouraged them to use it or not.

The result was 58% were not attracted by the current bus stops cabinets. 25% were satisfied with the current design, and 17% didn't notice the shape of the bus stops cabinets.



2.2 United Arab Emirates

The Sharjah Urban Planning Council has begun work on a project to develop 28 bus stops in the city of Sharjah, to encourage the use of public transportation in the area and to provide a sustainable environment and an integrated infrastructure. The designs of these stations are characterized by simplicity in architectural terms, but they will be highly efficient and flexible in terms of use. Designed according to the capacity and needs of each site, all stations will be equipped with solar panels to provide these stations with the necessary electrical energy in line with environmental sustainability standards (Figure 15).

The stations will be air-conditioned and equipped with all amenities, in addition to providing them with electronic boards that provide the user with all information related to

trips in terms of dates,



Figure (15) Bus Station - Sharjah

destinations and time periods.

In the Emirate of Dubai, there are air-conditioned bus stops in 131 locations in various regions of Dubai to implement this vital project, which is the first of its kind in the world, as these are air-conditioned stations with the electric power needed to operate them, and this step falls within the comprehensive bus development plan (Bus Master Plan). It is



Figure (16) Bus Station – Dubai

one of the strategic initiatives of the Roads and Transport Authority to provide the best services and amenities for passengers, especially in the extremely hot summer, as these stations are equipped with the best air-conditioning technology, which will encourage the public from different segments of society.

Public transport buses contribute to reducing traffic jams caused by the large number of private cars, as well as reducing the percentage of environmental pollution, As for the design of the stations, it will be inspired by the shape of the crescent and will be painted in a contemporary metallic color, in addition to providing them with advanced air conditioning systems, the first of their kind at the global level (Figure 16). providing it with special designs for advertising and spaces for information, a technology used for the first time in the region, and an integrated set of public service facilities that include ATMs, vending machines, garbage recycling containers and other facilities

2.3 Kingdom of Bahrain

As for the Kingdom of Bahrain, and through its knowledge of the experiences of many countries, the desired goal of developing public transport buses was to encourage people to reduce dependence on private vehicles and use public transportation, and despite all efforts, huge sums of money were spent, the output and return were unfortunately weak.

Four public transport stations have been developed in Bahrain with solar energy (Figure 18), in a project that

aims to measure the extent to which alternative energies are used in reducing the cost of lighting stations. The possibility of

providing additional services, including surveillance cameras, and a system for tracking public transport vehicles via satellites, is being studied so that passengers know the arrival time of the buses, and it is also possible to access a special technology to adapt the stations with the testing of air conditioning systems that can be linked to solar energy in the future.



Figure (18) Bus Station - Bahrain

2.4 State of Qatar

In Qatar, despite the huge budget allocated to the operation of public transport buses, by providing the latest fleet of buses, drivers, maintenance, operation and attention to the appearance of public stations, where new air-conditioned stations were developed with a screen and modern design (Figure 19), which led to a qualitative leap in the form and capabilities of these stations, knowing that it is equipped with a space for advertising, according to the latest designs and equipment, the buses remain empty of passengers.



Figure (19) Bus stop - Qatar

2.5 Kingdom of Saudi Arabia

As for the Kingdom Saudi Arabia, the installation of bus stations in the Riyadh region has begun in their locations in preparation for the launch of the operational tests for them. It includes a fully enclosed waiting area, air-conditioned to suit the weather (Figure 20), and self-services for purchasing tickets are available. The bus network is the main tributary to the rail network in Riyadh and is part of the King Abdulaziz Public Transport Project.



Figure (20) Bus stops - Saudi Arabia

2.6 Sultanate of Oman

The Sultanate of Oman, of the six GCC countries, has less exposure to the different modes and services of public transport. It occupies a total area of 310 thousand square km with harsh terrain in some areas.

When analyzing the current reality of public transport here, it becomes clear that there is a weakness in the infrastructure necessary to operate buses due to the lack of preparation of main and secondary roads, including the presence of bus lanes or the lack of bus stops. In some areas it began to use basic bus stops that took inspiration from the traditional heritage of Oman (Figure 21).



Figure (21) Bus stops – Muscat - Oman

Recently, Oman's public transport has been through a significant update. By the 22nd of November 2015, a new company (Mwasalat) was underway, replacing the



Figure (22) Bus stops – Muscat - Oman

Oman National Transport Company, and totally rebranding the company by starting to use three new air conditioning bus stop in Muscat (Figure 22).

Conclusion

It is of the general opinion that steel-based structures and construction provide freedom of form and there are very good examples of how steel structure directly impacts the overall design, while concrete-oriented building seems quite challenging for achieving a similar outcome. However, there are designs of bus stations that show how creative yet simple the concrete design can be.

A similar pattern could be adopted with other stations where there is a concrete structure where the only difference is using straight lines instead of curved as observed across the globe. Various Bus Stations are built with concrete this provided a very good example of how the use of concrete structure does not need to be visually appealing, but it can be very meaningful in sense of architecture that it is providing. Underground bus stations are a way to enhance the use of public space above the station, parks and ease the communication with the acquaintances next to it. However, unlike concrete-made bus stations in the last century, which mainly belonged to various and supportive architecture, the modern concrete bus stations presented through this research study are an example of insights in recently built concrete bus stations or even metal of interesting appearance and structure, including fully efficient functionality and operability.

Bus stations have gone through significant changes over the years and as a result are changing with the changes of the world around us, we are constantly evolving and revolutionizing and thus we should keep in mind that our facilities also need to keep up and evolve alongside us.

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