# PROPOSAL FOR AN EFFECTIVE BUS STOP DESIGN AT HENTIAN BANDAR OF RAPID KUANTAN

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## ABSTRACT

A bus stop serves as an interchange area where a bus picks passengers who wait to go places from different places. At Hentian Bandar Rapid Kuantan, the bus stop has been a facility; where at present 44 busses are plying 13 routes daily back and forth to the bus stop. However, this bus stop was not sufficient to support the increased number of users as compared to the times before Rapid Kuantan buses were introduced. Through observation, the existing condition of the bus stop was investigated. Readings on manuals and checking on documents were done. This was to rationale in revising the bus stop design. Bus stop designs are elaborated in terms of the walkway width, capacity and the facilities. The walkway width was measured and the effective width of the walkway was calculated. Using the traffic counting method, the pedestrian volume was tabulated. The Level of Service of the walkway was identified to be at a very poor level. The same method was also done to the waiting area. Besides that, the facilities were improper to serve the public and the operation officer. A better design was proposed to improve the bus stop with an adequate width of walkway and better serving facilities.

Keywords: Bus Stop Design, Walkway, Effective Width, Pedestrian Volume, Level of Service

## ABSTRAK

Hentian bas berfungsi sebagai kawasan persimpangan di mana bas pilihan penumpang yang menunggu untuk pergi ke sesebuah destinasi dari tempat yang berbeza. Pada masa sekarang, di Hentian Bandar Rapid Kuantan, 44 bas yang beroperasi akan menggunakan 13 laluan setiap hari, pergi dan balik ke perhentian bas tersebut. Walau bagaimanapun, perhentian bas ini tidak mencukupi untuk menyokong peningkatan bilangan pengguna berbanding masa sebelum bas Rapid Kuantan telah diperkenalkan. Melalui pemerhatian, keadaan sedia ada perhentian bas telah disiasat. Bacaan pada manual dan semakan pada dokumen telah dilakukan. Ini adalah dalam rational mengkaji reka bentuk perhentian bas. Reka bentuk perhentian bas akan dihuraikan dari segi kelebaran laluan pejalan kaki, kapasiti dan kemudahan. Kelebaran laluan pejalan kaki telah diukur dan kelebaran effektif laluan pejalan kaki telah dikenalpasti dan dikira. Jumlah pejalan kaki telah diperoleh dengan mengunakan kaedah pengiraan lalu lintas. Tahap perkhidmatan atau *Level of Service* juga telah dikenalpasti berada pada tahap yang sangat lemah. Kaedah yang sama telah digunakan untuk kawasan menunggu. Selain itu, kemudahan yang sedia ada tidak sesuai untuk pengunaan orang awam dan pegawai operasi. Reka bentuk telah dicadangkan untuk meningkatkan keberkesanan perhentian bas dengan kelebaran yang mencukupi untuk laluan pejalan kaki dan kemudahan yang lebih mantap.

Kata Kunci: Reka Bentuk Hentian Bas, Laluan Pejalan Kaki, Kelebaran Effektif, Jumlah Pejalan Kaki, Tahap Perkhidmatan.

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## LIST OF SYMBOLS

| | |
|---|---|
| v | Pedestrian flow per unit width (p/m/min) |
| S | Pedestrian speed (m/min) |
| D | Pedestrian density ($p/m^2$) |
| M | Pedestrian space ( $m^2/p$) |
| $W_E$ | Effective walkway width (m) |
| $W_T$ | Total walkway width (m), and |
| $W_O$ | Sum of widths and shy distances from obstructions on the walkway (m). |
| $V_{15}$ | Volume of pedestrian at 15 minutes interval |
| $V_{p,hour}$ | Volume of pedestrian for 1 hour |

## LIST OF ABBREVIATIONS

| | |
|---|---|
| LOS | Level of Service |
| HCM | Highway Capacity Manual |
| TCQSM | Transit Capacity and Quality Of Service Manual |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background of Study

As population in the country increases and demand for transportation increases, a proper management of transportation is required. In conjunction with this, an effective system of public transportation have been introduced everywhere in urban areas to ease the travelling of the public. Many steps have been taken to improve and promote the public transportation service all around the countries in the world and this includes Malaysia as it is one of the developing countries. In Malaysia, one of the most widely used public transportation is the bus. It is the most convenient mode of public transports in most the states in Malaysia. This is because bus routes cover a wide range of places. Inter city buses are most used by the public to travel around the city.

A fully accessible bus service is a critical element in delivering a fully inclusive society. And bus stops are a vital link in this vision. It is important to view the bus stop as an interchange, rather than simply a location along a bus route where buses stop, comprising only a post with a flag, and a cage laid on the road surface. Bus stop design is recognized as a crucial element in the drive to improve the quality of bus services ("Accessible Bus Stop Design Guidance", 2006).

In accordance to the public need of transport and realizing the importance of public transportation, recently Rapid Kuantan bus service was introduced and launched at around the city of Kuantan. Before the Rapid Kuantan, there was no proper inter-city bus service at

Kuantan. A few private bus company operators were running their buses around Kuantan which includes the Seng Heng Sdn Bhd, Bee Huat Sdn Bhd and Rahmat Alam Sdn Bhd. These buses operated at random times and were not punctual and ineffective at its service. Very less public were using these bus service and the related facilities as their choice of transport.

Rapid Kuantan officially started its operation on 1st December 2012. Since the date of start operation to this date, the performance of the Rapid Kuantan service has been very well welcomed and appreciated by the public. At present, 44 Rapid Kuantan buses are plying 13 routes daily. Bus service would run at a frequency of 15 minutes during peak hours and some 30 minutes during non-peak hours. Many people are being benefited by this service and the number of people using the public transportation in Kuantan has tremendously increased.

Statistics have shown that more than three million passengers have used the services of Rapid Kuantan to date (Iskandar, T., 2013). However, the main bus stop or better to be called as the interchange terminal, of this bus system has been a letdown. The main bus stop of Rapid Kuantan is the Hentian Bandar, which was once used to be known as Hentian Bas Pasar, is the interchange for all the routes of Rapid Kuantan as shown in the Table 1.1. It has not been upgraded after the Rapid Kuantan was launched. The existing bus stop was used to support the very less amount public using the bus service, where the bus stop condition did not matter much. But now, as the number of Rapid Kuantan users is increasing, the Hentian Bandar bus stop has been experiencing severe congestion during peak hours which causes inconvenience compared to the before condition (Refer Appendix A). This study will be carried out as a part of the rationale in revising the bus stop design.

**Table 1.1:** Routes of Rapid Kuantan

| ROUTE NO | ROUTE NAME |
|---|---|
| 100 | Hentian Bandar - Bkt Gambang Resort |
| 101 | Hentian Bandar - Indera Sempurna |
| 102 | Hentian Bandar - Permatang Badak |
| 200 | Hentian Bandar - Teluk Cempedak |
| 201 | Hentian Bandar - Taman Gelora |
| 300 | Hentian Bandar - Taman Impian |
| 301 | Hentian Bandar - Bkt Sagu |
| 302 | Hentian Bandar - Indera Mahkota 1 |
| 400 | Hentian Bandar - Pekan |
| 401 | Hentian Bandar - Kg.Ubai |
| 500 | Hentian Bandar - Sg.Lembing |
| 601 | Hentian Bandar - Polisas |

*Source: Retrieved from https://www.facebook.com/RapidKuantan*

## 1.2 Problem Statement

The public transportation service has been prioritized for the development of the country, yet the transit centres and the facilities related to it are being neglected and not maintained properly to serve the users well. This situation can clearly be seen at Hentian Bandar of Rapid Kuantan, where the public transportation service of Rapid Kuantan has been introduced to serve the public, but the main transit terminal, the Hentian Bandar, has been a let down to the users. The bus stop is not adequate enough to support the increased number of public transportation users, after the Rapid Kuantan was launched. It also lacks of certain facilities for the passengers and operation officers of Rapid Kuantan.

## 1.3 Objectives of The Study

The objectives for this project are:-

- ✓ To investigate how is the existing condition of the bus stop.
- ✓ To propose a suitable design that improves the bus stop condition according to the users' demand.

## 1.4 Scope of Study

The scopes of study for this research are as follows:-

i) Location: Hentian Bandar Rapid Kuantan, Jalan Stadium, 25000 Kuantan, Pahang as shown below in Figure 1.1.

ii) This study will be focusing on certain aspects of the bus stop which is very prominent in contributing to the effectiveness of the bus stop, which are:-

- User demand and capacity
- Walkway condition
- Facility adequacy

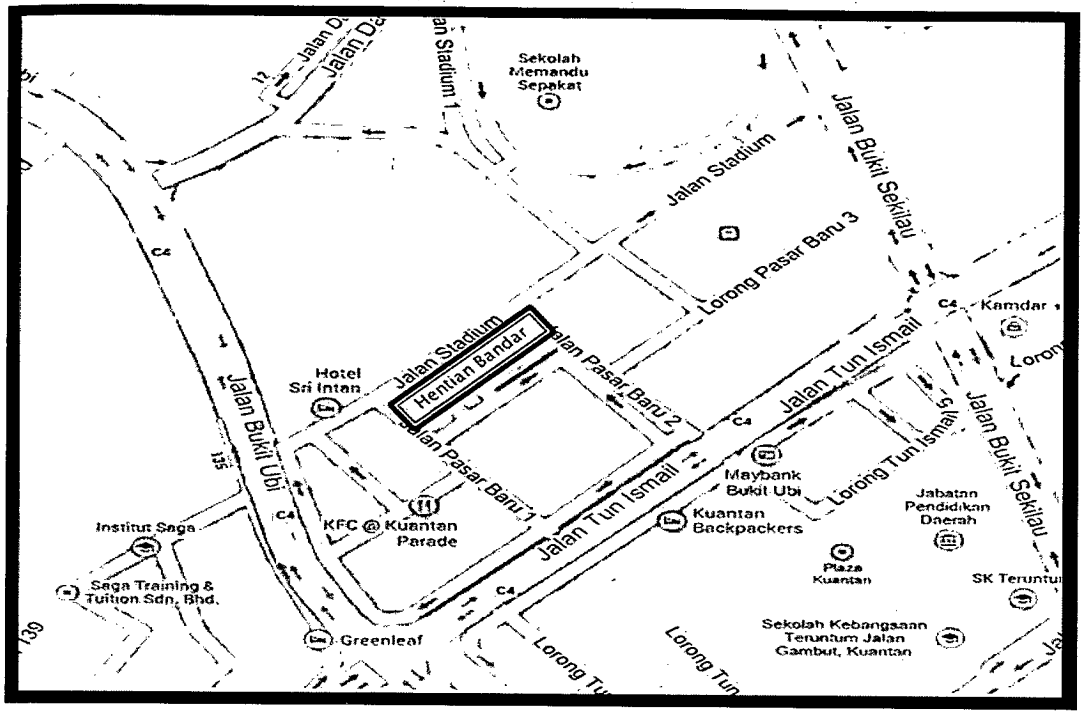


**Figure 1.1:** Location Map of the Hentian Bandar

*Source: Retrieved from https://maps.google.com*

## 1.5 Significance of Study

This research is important because the study will be very beneficial in improving the condition of the bus stop. Besides that, it will very be useful to know the real condition of the existing bus stop. The improvement of the existing bus stop will definitely ensure user satisfaction towards public transportation system. Moreover, this will even increase the usage of public transportation service, which is one of the important moves towards a well-developed country.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Bus stops are an important interface between buses and passengers. They provide facilities for waiting passengers and facilities for the bus. Appropriate traffic management issues also need to be addressed to allow the bus to enter and leave the stop. This approach means that bus stops can be divided into the two distinct components of passenger waiting area and bus stopping area ("Bus Stop Guidelines", 2006).

Bus stop design and location is recognized as a crucial element in the drive to improve the quality of bus services. The concept of 'Total Journey Quality' recognizes that bus passengers are also pedestrians at each end of the bus trip and requires that all aspects of the journey are considered. The convenience and comfort of bus stops must not be overlooked. It is important to view the bus stop as an interchange, rather than simply a location along a bus route where buses stop, comprising only a post with a flag, and a cage laid on the road surface ("Accessible Bus Stop Design Guidance", 2006).

## 2.2 Station Types

Terminals are end stations of one or more bus routes often used for any large station with facilities, such as waiting rooms, ticket offices and so on. Bus terminal, on the other hand are off-street areas or buildings with stops point for several bus routes. The

arrangement of the spaces provided at the terminal must also take into consideration which will determine the accessibility of the bus terminal (Siti Syamimi, 2004).

Station can be classified into several categories according to its function, capacity and layout. The following are the classification of different types of stations: - ("Transit Quality and Service Manual", 2003)

### 2.2.1 Bus Stops

Most bus stops are located along streets and consist of a waiting area integrated with the public sidewalk, signage to mark the bus stop, and, in some cases, a bench or small shelter. Other bus stops are located on- or off-street in conjunction with transit centers, rail transit stations, or intermodal terminals.

On-street bus stops may be located on the near side of an intersection, the far side after the bus has passed through the intersection, or at a mid-block location. The choice of location is primarily related to the operational performance of the bus route and traffic, but can also be influenced by adjacent land uses and opportunities for easy transfers to crossing bus routes.

### 2.2.2 Transit Centers

The term transit center is normally applied to facilities where multiple bus routes converge, offering transfers between lines. The term can also apply to intermodal stations that may combine local bus services with other transit services, intercity bus or rail, and associated services such as taxi stands, concessions, and ticket sales. Both types of facilities are normally located wholly or partially off-street and frequently include a more elaborate and extensive shelter and more passenger amenities than ordinary bus stops.

### 2.2.3 Bus Way Stations

Bus way stations are located along roadways dedicated for buses and are frequently larger and more elaborate than typical bus stops, but are shorter than most light rail stations. Like the bus ways they serve, these stations may be either off-street or on-street. The length of a bus way station is generally 40 to 100 ft (12 to 30 m) but some extend to 400 ft (120 m) to serve multiple routes and services. Amenities may be very limited, consisting of just a paved area and sign, or much more elaborate, with shelters, seating, ticket machines, and other amenities.

Bus way stations usually consist of side platforms boarded from the right side of the bus, but some center platform stations are used with boarding from either the left or right side of the bus (this requires buses designed with doors on both sides). Center platforms can also be used when the bus lanes operate contraflow. Bus way stations may have a single lane in each direction, or a passing lane can be provided at stations to increase operational capacity and allow for multiple services that skip some stations.

### 2.2.4 Light Rail Stations

Light rail stations are typically 180 to 400 ft (55 to 120 m) long. Various platform configurations are possible, including center, side, or split on opposite sides of an intersection. Stations may be on-street, off-street, along a railroad right-of-way, or on a transit mall. High and low platforms have been used, although the trend in recent years has been the increasing use of an intermediate height for platforms that is approximately 14 in. (0.35 m) above the top of the rail to match the floor height of low-floor light rail vehicles. Light rail stations usually include canopies over part of the platform, limited seating, and ticket vending machines. Fare collection on light rail systems is typically by the proof-of-payment system, so stations do not have fare gates or barriers.

### 2.2.5 Heavy Rail Stations

Stations on heavy rail, rapid transit, or metro systems are usually more elaborate than light rail or many commuter rail stations. Due to the presence of third-rail power in many of these systems, and to prevent passengers from entering the track way, these stations always have high-level platforms. Stations are most often located underground or elevated, and frequently have intermediate mezzanine levels between the street and platform levels. Both center or side platform configurations are used, and some stations have more than two tracks. Special configurations allow cross-platform transfers or reflect location-specific conditions. Heavy rail stations are generally 600 to 800 ft (180 to 240 m) long. Most heavy rail stations have fare control arrays and enclosed paid zones, although some European systems use proof-of-payment systems.

### 2.2.6 Commuter Rail Stations

Commuter rail stations range from suburban locations with one or two platforms, limited service, and relatively small passenger volumes to major urban terminals with many tracks and platforms offering a variety of local and express services to various destinations. These stations may use either center or side platforms or a combination of both in larger terminals. Higher-volume systems tend to use high platforms, while lower-volume systems tend to use low or intermediate height platforms. In some cases, passenger and freight trains share the same tracks. Horizontal clearance requirements for freight cars may be greater than for passenger equipment and thus can impact the placement of platform features such as wheelchair ramps. Platforms in these stations can range from 300 to more than 1,000 ft (90 to over 300 m) long.

Passenger flow on commuter rail platforms can be more complex if multiple routes and services share the same platform and waiting areas. Where that is the case, not all passengers waiting on platforms will board a train when it arrives, leaving residual passenger volumes on platforms. Commuter rail cars typically have fewer doors than heavy

rail cars and may fully load or unload at a single major terminal, increasing their boarding, alighting, and dwell times at those stations.

### 2.2.7 Ferry Docks and Terminals

Ferry docks and terminals can vary from simple waterside facilities with limited shelters and relatively small passenger flow volumes to major terminals with multiple ferries receiving and discharging large numbers of passengers and vehicles. Since waterside locations are particularly exposed to the weather, protection from the climate can be an important factor in providing a good quality of travel. The effect of tides, changing river levels, and waves must be adequately addressed and poses unique challenges for passenger access, especially where extreme height changes are experienced, potentially requiring long or steep ramps to reach the vessel.

### 2.2.8 Intermodal Terminals

The term "intermodal terminals" refers to a variety of stations and terminals that provide key transfers between transit modes. Combinations may include local bus, bus rapid transit, intercity bus, light rail, heavy rail, commuter rail, intercity passenger rail, ferry, or automated guide way transit. Such facilities may have a variety of other services and connections, including parking, drop-off, ticket vending, and information booths, and may be integrated with retail shopping, services, and entertainment.

### 2.2.9 Off-Street Bus Stops

Larger bus stops, serving multiple bus routes, are often located off-street. They may be part of an all-bus transit center or may be provided in conjunction with a rail transit station, providing transfer to and from the rail service. For small transit stations, the number

of loading areas (berths) is small, with a fairly simple access and layout configuration. For larger terminals, numerous berths and more sophisticated designs are applied. Figure 2.1 illustrates various loading area arrangements. Four types of bus berths are typically applied: linear, saw tooth, angled, and drive-through.

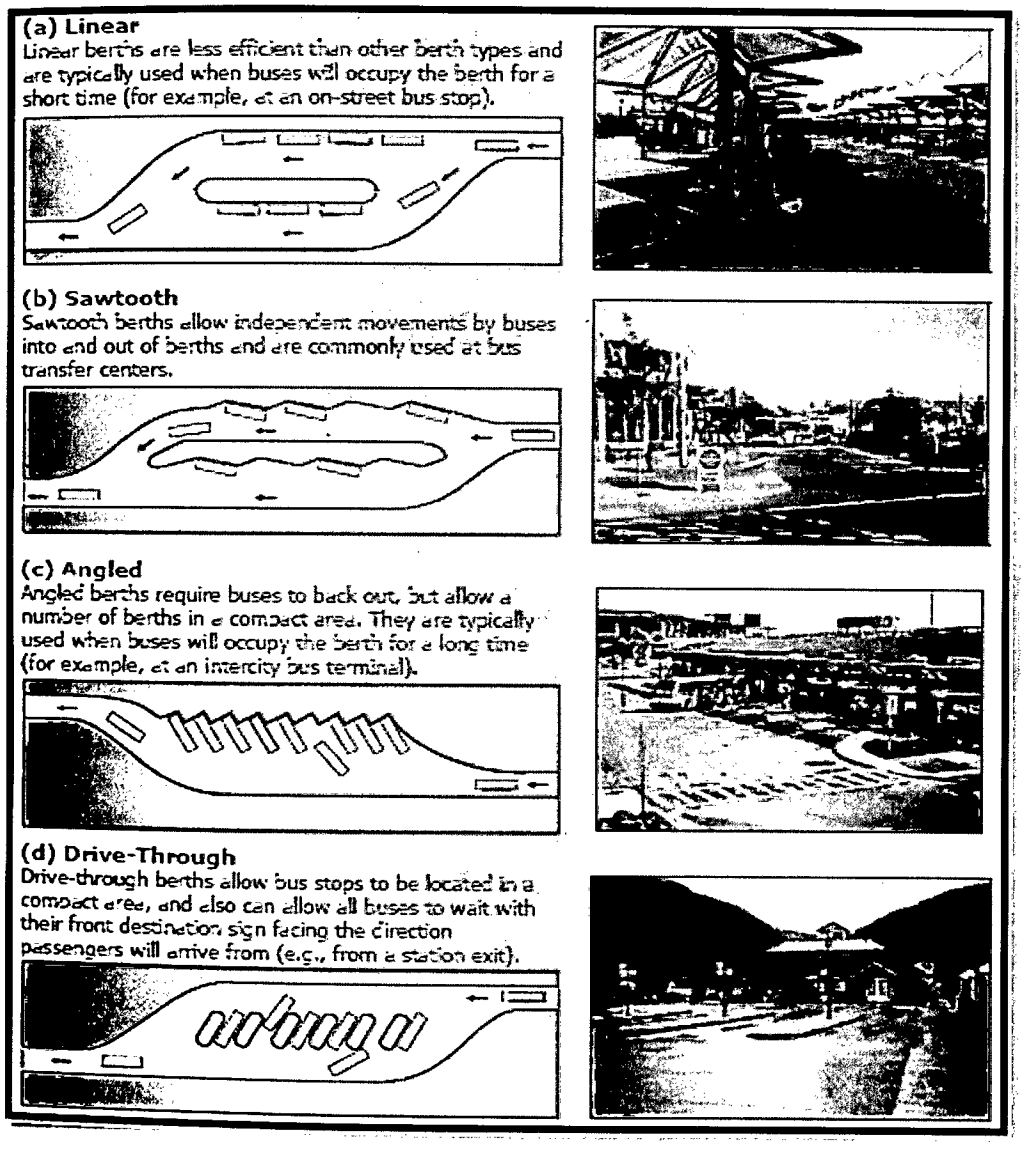


**Figure 2.1**: Types of Bus Berths

*Source: Transit Quality and Service Manual, 2003*

## 2.3 Design Factors

The bus stop environment contains a number of features that need to be considered, as illustrated in Figure 2.2.

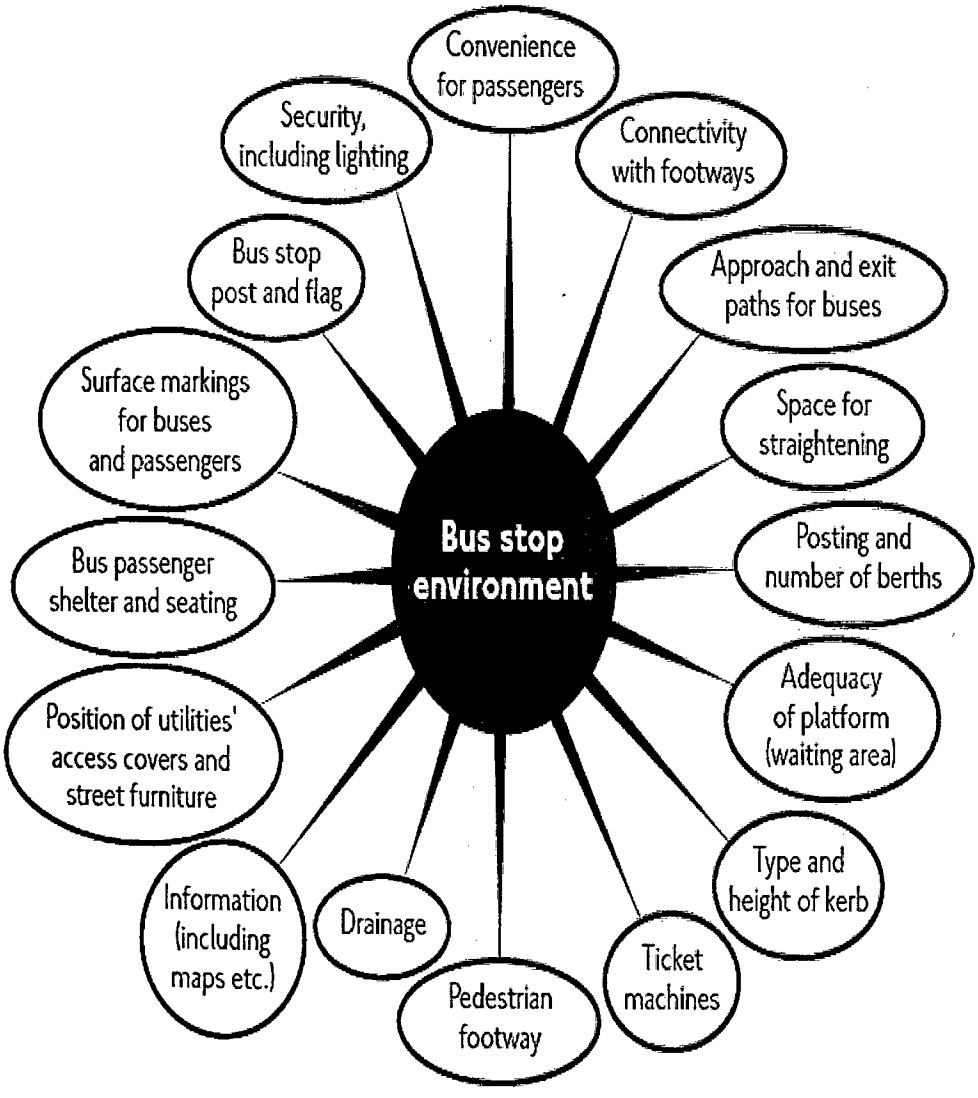


**Figure 2.2**: Features of the Bus Stop Environment

*Source: Accessible Bus Stop Design Guidance, 2006*

A bus stop is intended to be universally accessible should incorporate a number of essential features to accommodate all passengers. Universally accessible for bus stops refers to the qualities of the process of finding, boarding and alighting a bus at a stop that considers collective needs of the entire community, including persons with any form of disability or special need ("Universally Accessible Bus Stop Design Guidelines",2007).

While station locations vary by the origin-destination patterns to be served and local context, fundamental pedestrian factors remain constant. To evaluate the quality of pedestrian access to public transport, an evaluation framework has been devised (Table 2.1). Specifically, effective public transport access is achieved with infrastructure that is affordable, attractive, comfortable, direct, legible, safe, and secure. If any one of these elements is not adequately addressed, then the entire viability of public transport access can be undermined ("Bus Rapid Transit Planning Guide", 2007).

**Table 2.1**: Evaluation for Public Transport Access

| Category | Description |
|---|---|
| Accessibility | "Accessibility" refers to the viability of individuals with physical disabilities in using the system and reaching destinations. |
| Affordability | The "affordability" of providing public transport access is greatly affected by the need for pedestrian bridges, underpasses, and other significant infrastructure. |
| Aesthetics | The "aesthetics" of the pedestrian access area encompasses the attractiveness of the walkway, the street furniture, and the congruence between street design and local architecture. |
| Directness and connectivity | "Directness" involves a pedestrian path that minimises the distance travelled to access the public transport station. "Connectivity" refers to the ability of pedestrians to readily access a broader network of destinations. |
| Ease of access | "Ease of access" refers to the pedestrian's comfort level in walking along a corridor; this issue encompasses steepness of inclines, weather protection, condition of the walking surface, and protection from noise and air pollution. |
| Legibility | The "legibility" of an area refers to the ease in understanding the street environment. The availability of maps and signage can help legibility. |
| Safety | A "safe" pedestrian pathway implies that pedestrians are well protected from road hazards such as vehicles. |
| Security | "Security" refers to providing an environment where pedestrians are not susceptible to robberies or other crimes. |

*Source: Bus Rapid Transit Planning Guide, 2007*

## 2.4 Pedestrian Circulation Concepts

An important objective of a transit stop or station is to provide adequate space and appropriate facilities to accommodate projected peak pedestrian demands while ensuring pedestrian safety and convenience. Early efforts involved designing transit stations based on maximum pedestrian capacity without consideration of pedestrian comfort and convenience. Research has shown, however, that capacity is reached when there is a dense crowding of pedestrians, causing restricted and uncomfortable movement. The procedures for estimating capacity presented in this section are based on a relative scale of pedestrian comfort and convenience. Procedures for analyzing pedestrian circulation on sidewalks, street corners, and crosswalks are presented in the Highway Capacity Manual (2000).

### 2.4.1 Pedestrian Capacity Terminology

Terms used in this chapter for evaluating pedestrian circulation are defined as follows:

- ***Pedestrian capacity***: the maximum number of people who can occupy or pass through a pedestrian facility or element, expressed as persons per unit of area or as persons per unit of time. Both a maximum capacity reflecting the greatest possible number of persons who can pass through and a "design" capacity representing the maximum desirable number of pedestrians are applied in appropriate ways. Higher "theoretical" capacities are sometimes identified (e.g., for escalators and moving walkways), but are not based on practical experience and are not generally applicable in analysis or design.

- ***Pedestrian speed***: average pedestrian walking speed, generally expressed in units of feet or meters per second.