Mehran University Research Journal of Engineering and Technology

https://doi.org/10.22581/muet1982.2304.2870

2023, 42(4) 93-108

Site suitability for intercity bus terminal at Hyderabad, Pakistan: a citizen's perception

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Received: 14 June 2023, Accepted: 25 September 2023, Published: 01 October 2023

KEYWORDS

Bus Terminal

Suitable Location

GIS-based Maps

Expert Opinion

Questionnaire Survey

Descriptive Statistics

ABSTRACT

The city of Hyderabad, Pakistan has been facing a shortage of bus terminals over the years. The native transportation arrangement already increased traffic jams in the city. Besides, passenger buses that arrived in Hyderabad from other suburban cities had caused chaos and increased traffic management issues. Constructing a new bus terminal for the city in an accessible location is determined in this study. To examine the demand for a bus terminal and to determine a proper location, the data were collected from the 480 sampled respondents with the help of a questionnaire survey. Experts from the Hyderabad Development Authorities were consulted on the availability of land for the proposed development of the terminal. To generate suitable information, descriptive statistics and the correlation approach were employed. GIS-based maps were also produced to define the land uses and routes of the city. This research recommends four standard sites for the terminal, i.e., the Mayani Main Forest (Ayub Hotel), Toll Plaza, Kohsar (Gulshan-e-Sarmast), and Zeal Park. Based on expert opinion, the Ayoub Hotel site was found more suitable for constructing a new bus terminal. In this way, this study contributed to the development of a new bus terminal for the city, which has been the demand of the citizens for quite some time.

1. Introduction

One of the most crucial elements of communication between locations, visiting purposes, or tourism is transportation [1]. Road transportation has always played a significant part in the growth of innovation, and it is anticipated that it will continue to do so in the future [2]. The road structure is rapidly degrading as a result of traffic congestion, and an unacceptable number of incidents are being blamed on heavy-duty trucks [3]. Demand for urban transportation facilities and services in the cities is raised by increasing population growth and spatial enlargement. The Bus Terminal (BT), which designates the starting or ending point of the transportation system, is a crucial component of intercity Transferring Services (TS). A well-managed or planned BT catalyzes the societal and economic growth of the surrounding areas [4]. Bus terminal capacity is one of the prerequisites for the optimal functioning of a bus terminal [5]. The bus terminal's capacity features can be attained with the aid of good design and planning. The design of the local traffic system, bus characteristics, size, position, and design of the available space, as well as the surrounding environment, should all be taken into account. The architecture and geographic aspects of the terminal

frequently determine the connectivity options with the road and pedestrian networks [6, 7]. It often requires a sizable plot of land in an estimated portion of a built-up region [8].

Considering Table 1, it can be said that a huge number of vehicles registered in a city created the traffic congestion problem. The intercity buses also entered in city due to the absence of terminal facilities. These inter and intra-transport vehicles put immense pressure on the city's traffic resulting in traffic jams and travel delays.

Hyderabad has been facing acute traffic and transportation problems over the years [14, 15]. The city is also lacking a planned bus terminal facility. Therefore, the purpose of this research is to conduct a site appropriateness analysis and identify potential bus terminal locations. This study clarified people's perceptions about the current issues with intercity bus terminals. At the same time, recommendations were also put forward for the construction of an ideal bus terminal in Hyderabad with all the necessary amenities. The study's findings may contribute to the development of a new planned bus terminal for Hyderabad City. This study only focuses on the suitable site selection of the bus terminal for the commuters of Hyderabad. Hence, other factors, for example, bus route cycle, location of buses, frequency and driver exchange, time scheduling, terminal type, existing terminal design, function of the bus stop, interference due to traffic congestion and other traffic, etc. may be considered for future research.

Hyderabad has a significant dearth of transportation hubs [9]. Transport vehicles on an intercity or intracity route park beside the road because of this situation. Due to a lack of amenities, commuters suffer as a result Coaches, mini buses, taxis, and other modes of transportation are available in Hyderabad City [10]. Even though the majority of this population travels by bus from the suburbs into the town center [11]. Approximately, 7.7 million people are living in Hyderabad city as of 2023, and 20–30% of them use native conveyance [12]. However, Hyderabad's transportation facilities are not well supervised. According to the theory, the organization of buses is the key transportation strategy. Buses are the primary means of mass transit and are used for this purpose [13]. Additionally, these trains and aviation play a crucial role in moving people from one location to another. Despite coming from the outlying areas, most of the population travels by bus to the town center. To validate the traffic congestion causes, the registered vehicle's information is collected from the traffic department of Hyderabad. Table 1 shows clearly the huge number of registered vehicles in a city that create traffic havoc in a city.

Table 1

Total Registered Vehicle-2022

	Cars, Jeeps and Vagons	Motor Bikes	Taxies	Rickshaws	Buses	Tractors	Pickups
Hyderabad	32, 335	95, 740	12, 520	55, 751	12, 763	7, 423	13, 520

2. Literature Review

In the present, the specific investigation is developed to control automobile ability and constancy using a variety of approaches, including bus station relocation, on-time schedule methods, coach expansion or suggestion, automobile setup eras or procedures through difference, and overwork to originate tick. Additionally, a lot of security has been placed on the factors generating facility constancy. Local transportation has been an abject failure. to manage and enhance the standard of transportation. The Transit Oriented Development (TOD) [16, 17] idea addresses urban expansion in peripheral areas. As shown in Fig. 1, prominent zones of the city are numbered as four, i.e., Latifabad, Qasimabad, Hyderabad City, and Cantonment. The passenger buses are only meant to travel on the National and Superhighways; however, they are allowed to go through busy areas. like Risala Road, Qasim Chowk, and Station Road. Pick-up and drop-off caused traffic congestion. Coaches are parked on the street next to residences because none of these have an acceptable space, which adds to the town's noise and obstruction issues.

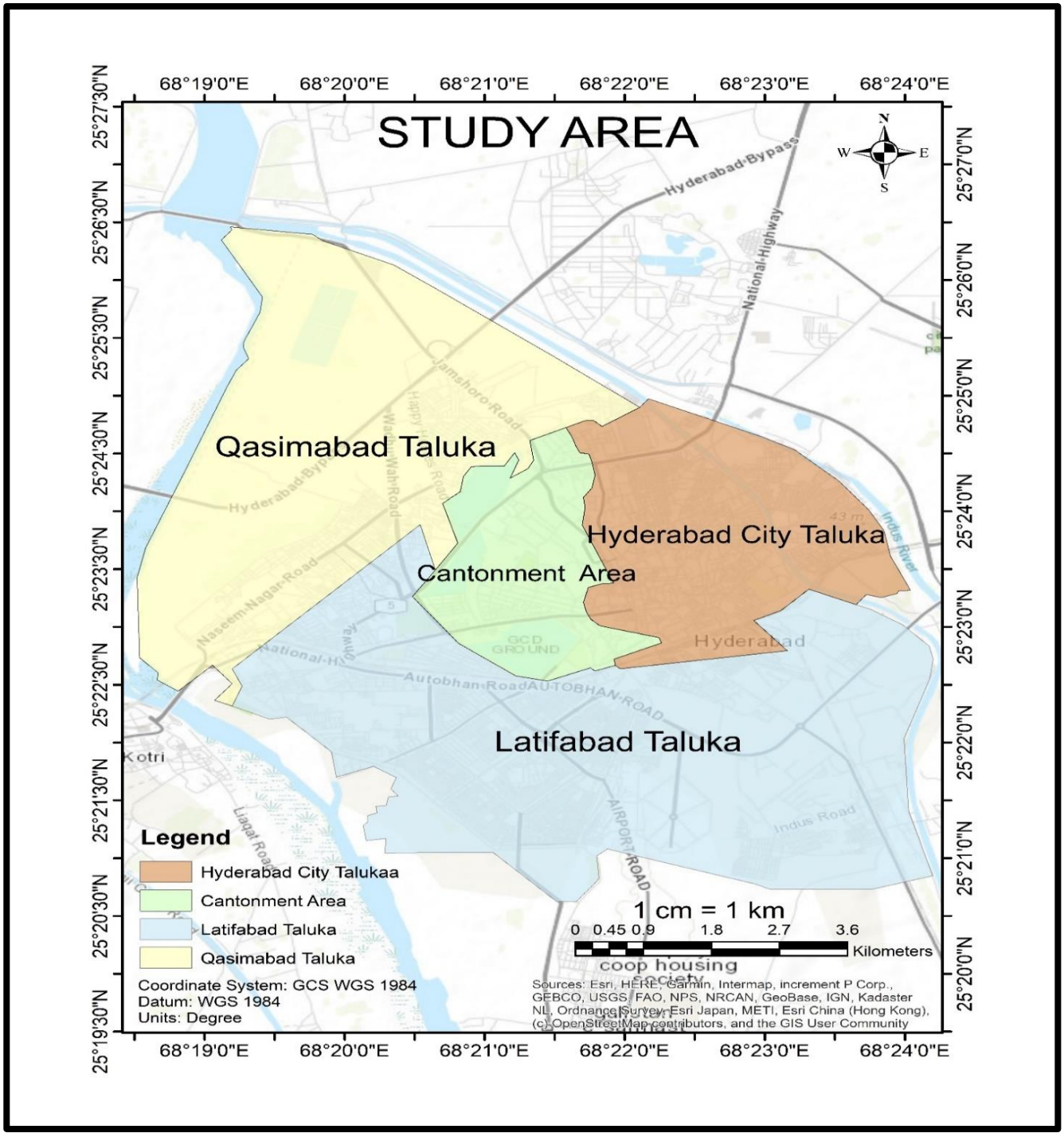

Fig. 1. Main intercity bus stations/ terminals in hyderabad (GIS mapping)

As depicted in Fig. 1, Hyderabad's current bus terminals are located in these busier zones. These installations lacked services that were categorized as ideal for both travelers and workers [18]. The major cause of the worsening road conditions, especially in Hyderabad, is the presence of buses and coaches, which enter the city center and cause traffic congestion. Traffic congestion has been caused by improper and inappropriate location, a lack of a proper bus bay, and the position of bus terminals in the city. Generally, the formation of bus choices to the circumstances represents the existence of the bus structure and its devotion to the organization. The bus route-merger technique may be employed as an unusual occasion of practical challenges linked to the scheme. Bin (1997) [19] developed a method for catching direct bus routes. According to Pattnaik et al., (1998) [20], a heritable approach should be used to control the optimal town bus connectivity project.

Traffic congestion has been caused by improper and inappropriate parking locations, a lack of a proper bus bay, and the position of bus terminals in the city [21]. Generally, the formation of bus choices to the circumstances represents the existence of the bus structure and its devotion to the organization. The bus route-merger technique may be employed as an unusual occasion of practical challenges linked to the scheme [22]. Jing Li et al., (2019) developed a method for catching direct bus routes [23]. The difficulties of the feeder automobile project were

revised by Martins and Patoin. According to Hernández et al., (2020), a heritable approach should be used to control the optimal town bus connectivity project [24]. The primary role of a transportation system is to provide accessibility to people and businesses [25, 26]. As a result, residents can physically engage in spatially and temporally distributed activities of all kinds (social, economic, etc.) [27]. Given this fundamental relationship between transportation and accessibility, it is surprising that accessibility remains a rather elusive concept in transportation planning and modeling. Several transportation issues still exist concerning its definition, measurement, and usage in practical applications [28].

According to Fernandez et al., (2002) [29], the performance of a bus stop in terms of capacity and delays experienced upon entering or leaving the stop depends on multiple factors, including the amount and composition of traffic circulating on the road, the proximity to traffic lights, and the road grade. These factors are typically not taken into account in economic models of bus operation. Bus stop sites in metropolitan networks are often divided into three categories: (i) nearside (before an intersection); (ii) far side (after an intersection); and (iii) midblock (separated from junctions). Every location has advantages and disadvantages that make it impossible to make general recommendations without taking into account a wide range of local considerations, including traffic safety and pedestrian interference with bus movements at bus stops and with intersections, the programming of signalized intersections, the number of vehicles turning left or right at intersections, the geometry of bus access to the curb, the size of the BS, and the distance between the BS and the nearest intersection [30].

Tirachini (2014) [31] defined the importance of vehicular selection that may remain alongside city roads, which was projected by the possibility of ending in low-demand markets. In another study, the relationship between vehicle stop mass, vehicle organization speed, space, and blocking in exceptionally high-demand markets was considered to mitigate traffic management issues [32]. Ibeas (2010) [33] suggested that bi-level optimization is frequently used to locate parking spots for cars, which may reduce the cost of the inclusive transportation program. The job is being done at various car stop locations, and it involves blocking cars, communication with isolated circulation, working factors (task force, occurrence, worker finances), and socio-demographic characteristics of every area in the town section. The methodologies are then used in a real-world situation, and a detailed analysis is done to see how the several factors evaluated influenced the model's output [34, 35].

The intelligent design of stop locations is one approach to enhance the efficiency of public transportation and hence increase usage through the clever planning of stop positions. The decision to locate a bus stop includes a trade-off between two opposing objectives: accessibility and operation [36]. Mathematical modeling is taken into account in three ways when developing a bus stop placement method: (i) Its impact on walking speed; (ii) Its impact on the appeal of an access path to a transit service; and (iii) Its impact on acceleration rates at stops. However, in 2015, heuristic evolutionary methods [37] were used to estimate an optimal model solution due to the complexity of the production model. A classical modeling approach to access nearby bus stops can be seen in Fig. 2.

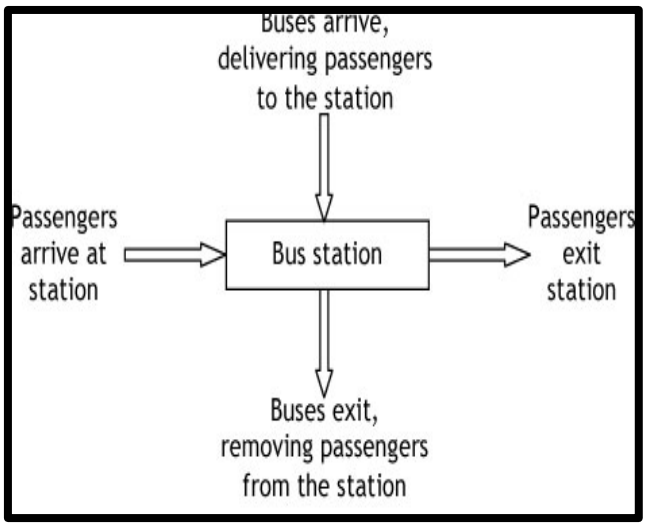

Fig. 2. Modeling techniques to access bus stops [38]

There are two inputs to the bus station as seen in Fig. 2, i.e., the passenger arrives at the station and the bus arrives delivering passengers to the station. In the same way, two outputs are visible, i.e., bus exit carrying passengers from the station and exit of the passengers. The concept of demand and future growth related to intercity passengers are discussed hereafter.

2.1 Intercity Passenger Travel Demand and Future Growth

Intercity passenger travel demand is aimed at the socio-economic characteristics of the travelers and the technical characteristics of the transportation system [39]. One way to attract the general public towards public transport is to improve the service quality of public facilities. There is a need to evaluate public transport based on different parameters [40].

In this way, poor areas will be highlighted, and after improving them, public transport will be able to obtain new users [41]. New transport terminals tend to be located outside central areas to avoid high land costs and congestion and should not be located close to other intercity bus terminals [42-44].

Site selection or suitability is a crucial component of complex projects. Potential locations for bus stops may include the location of new sites, supply facilities, or conservatories, among other developments [45]. When concerned authorities design a master plan or land use plan, they also monitor land usage and make adjustments to convert unused land or the natural environment into a built environment [46]. The site will be allocated to civic organizations and other local management to provide real estate and other necessary substructures, like other utilities like water, gas, and electricity. Intercity bus stations may be built on plots of land measuring 5 to 10 acres (depending on suitability) and improvements need to be at appropriate locations close to the entry/leaving area of the intercity highway, for example, sites nearer to the Super Highway or National Highway in Hyderabad [47, 48]. This study also aids the relevant authorities in reducing the worst traffic and congestion issues that could be caused by local transportation.

2.2 Role of Regional Transport Authority

The Regional Transport Authority (RTA) plays a crucial role in managing traffic chaos, motor vehicle administration, or regulation at the regional and local levels [49]. The RTA formulates and executes policies to manage traffic-related issues. The implementation of regional transportation policies helps reduce the urbanization process in the developing world by strengthening the basic infrastructure [50]. The conceptual basis of this study also touches on the role and responsibility of RTA. The study findings also may assist RTA in selecting the best option for the newly built bus terminal for the city of Hyderabad. The RTA can also plan well for terminal accessibility issues, as local inhabitants can get easy access at a lower cost. Hence, RTA may start intracity public travel services to connect different parts of the city with a terminal. It is also proposed that newly built bus terminals should also be well connected with the existing railway station and airport of the city. A new dedicated ring road may be proposed by the concerned RTA, which may connect all three major terminals of the city, i.e., the new bus terminal, airport, and railway station. It is expected that personal vehicle ownership would be decreased, as public transport facilities induced in the city. As a result, the traffic problems of the city of Hyderabad may be reduced to some extent.

3. Material and Methods

Hyderabad City was selected as the study area for this research. Hyderabad is the second largest city of Sindh Province which ranked seventh in the overall city ranking of Pakistan. The prominent land uses of the city can be seen in Fig. 3. The prominent locations and land -uses were designed using GIS [51, 52].

As shown in Fig. 3, the city is administratively divided into three Talukas, namely, Hyderabad City, Qasimabad, and Latifabad. One can also depict the major arteries of the city in Fig. 3. Fig. 4 can be referred to further to know about the different major arteries of the city.

Major arteries of the city can be seen in Fig. 4. The city of Hyderabad is split into various prominent zones: Hyderabad Rural (72%), Hyderabad City (2%), and Qasimabad (5%). In this regard, further information can be seen in Fig. 5.

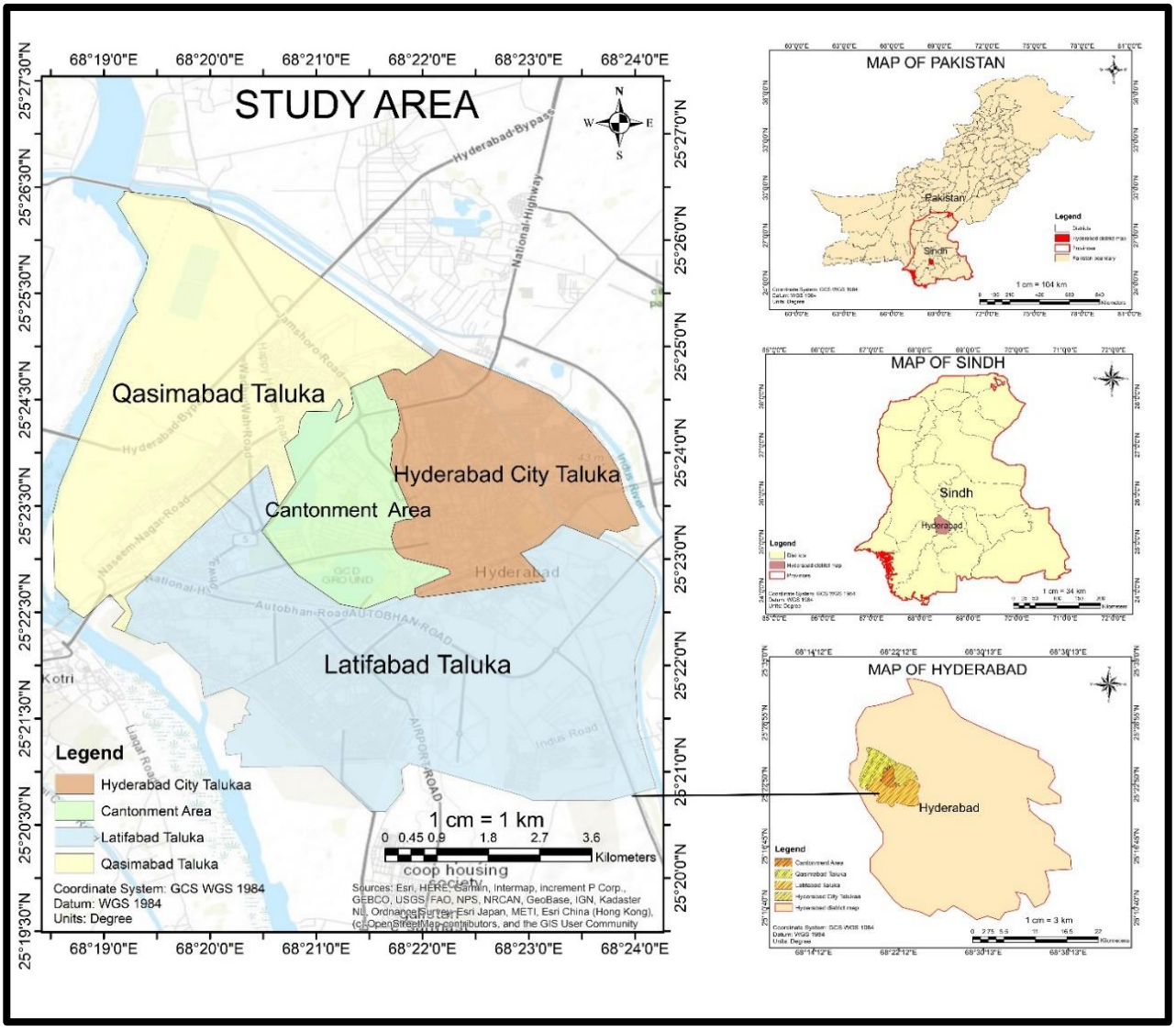

Fig. 3. Gis-based map – hyderabad, sindh, pakistan

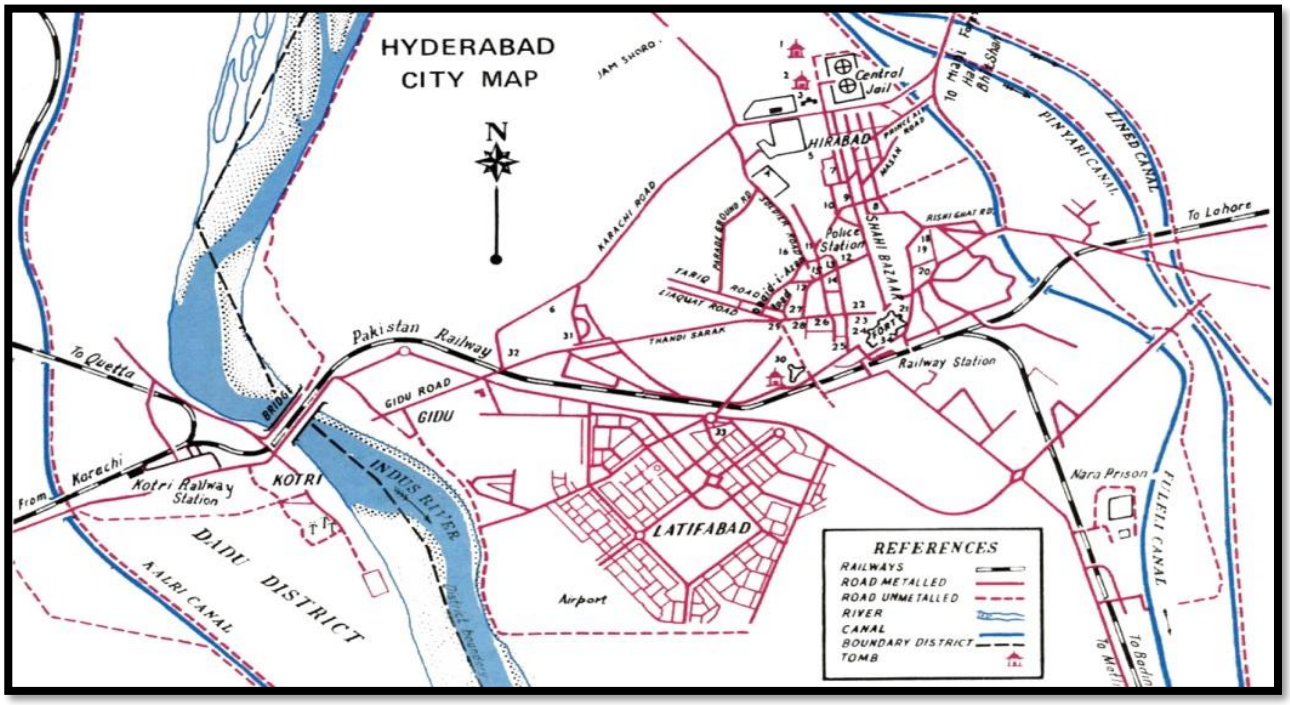

Fig. 4. Route map of hyderabad city [53]

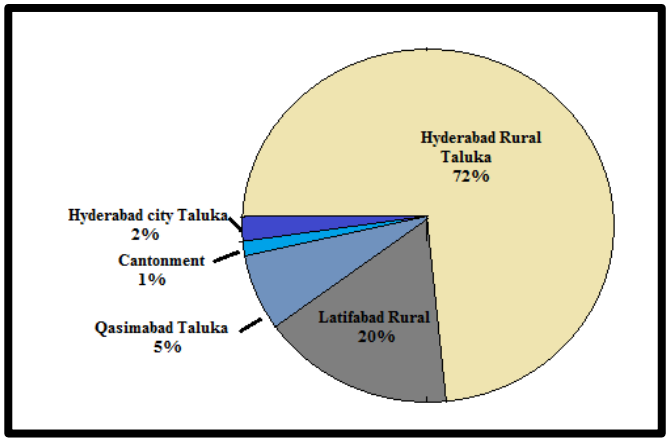

Fig. 5. Administrative area distribution - hyderabad district

The city of Hyderabad has been suffering from traffic and transportation issues including the absence of a bus terminal over the years [44]. Because of the absence of a bus terminal, long vehicles entering the city during the busy schedule of the day, create traffic jams and delayed issues [54]. Hence, this study seeks to understand the proper site selection of the terminal as per people's choice. The information needed for the study was gathered from commuters to analyze the issue with buses and their location, from respondents to a survey in the city of Hyderabad, and from land availability experts employed by the Hyderabad development authority.

The population of Hyderabad has increased with a massive growth rate over the years. The demographic details of the study area can be found in Table 2.

Table 2.

Demographic characteristics of hyderabad, pakistan [55]

Name	Status	Population
Hyderabad	District	2,199,928
Hyderabad City	Taluka	725,153
Latifabad	Taluka	703,690
Hyderabad	Taluka	466,306
Qasimabad	Taluka	304,779

It can be apprehended from Table 2 that Hyderabad is a thickly populated city. With the help of this analysis, decisions may be taken to select the possible site for Hyderabad's bus terminal with all necessary amenities and wider bus stops. The best position must be right on the highway because Hyderabad is well connected to many other places in Sindh, either directly or through intermediary locations. The motorway system connects Hyderabad to different regions of the nation. Inquiries about site suitability and the availability of land were directed to authorities and specialists. In total, 480 questionnaire forms were completed from the study area. Exactly, 240 questionnaires were completed by commuters at existing bus stops and the rest were completed by motorists. SPSS-23.0 was used to analyze data. SPSS-23.0 was used to analyze data as shown in Fig. 6.

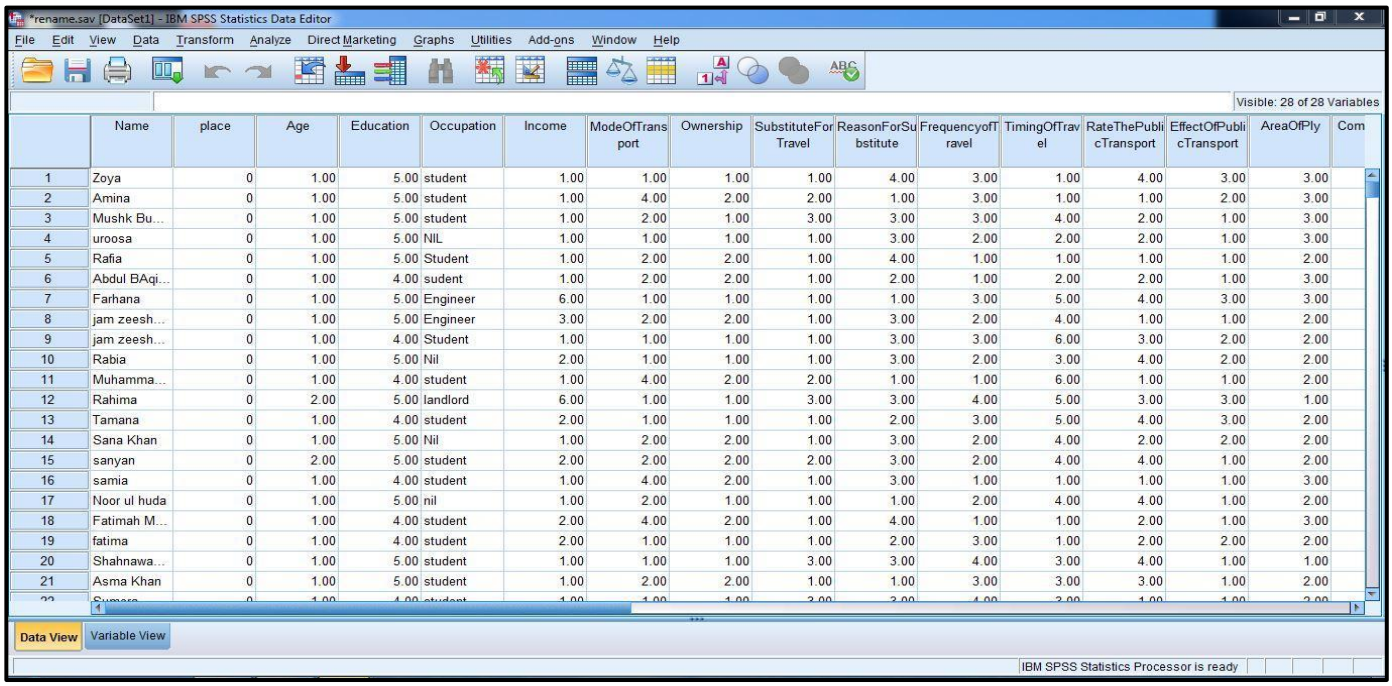

Fig. 6. Representing variables and questionnaire data

Descriptive statistics and the correlation approach were exercised to generate information on the subject matter. Various statistical tests, such as frequency, correlation, and standard deviation (SD) were executed to generate reliable information. Standard deviation may be found with the frequencies command, which can then be used to compute a specified percentile.

4. Results And Discussion

GIS-based locations of existing bus stops were determined as depicted in Fig. 7. The central inter-city key bus standpoints in Hyderabad are Hali Road (Badin Stop), Daewoo (Latifabad # 7), Bakra Mandi (Hallanaka), and Qasim Chowk bus stops, etc. Buses are only meant to travel on the National and Superhighways; however, they are allowed to go through busy areas. like Risala Road, Qasim Chowk, and Station Road. Pick-up and drop-off caused traffic congestion. Coaches are parked on the street next to residences because none of these have an acceptable space, which adds to the town's noise and obstruction issues. However, Hyderabad's transfer facilities are not well supervised as a whole.

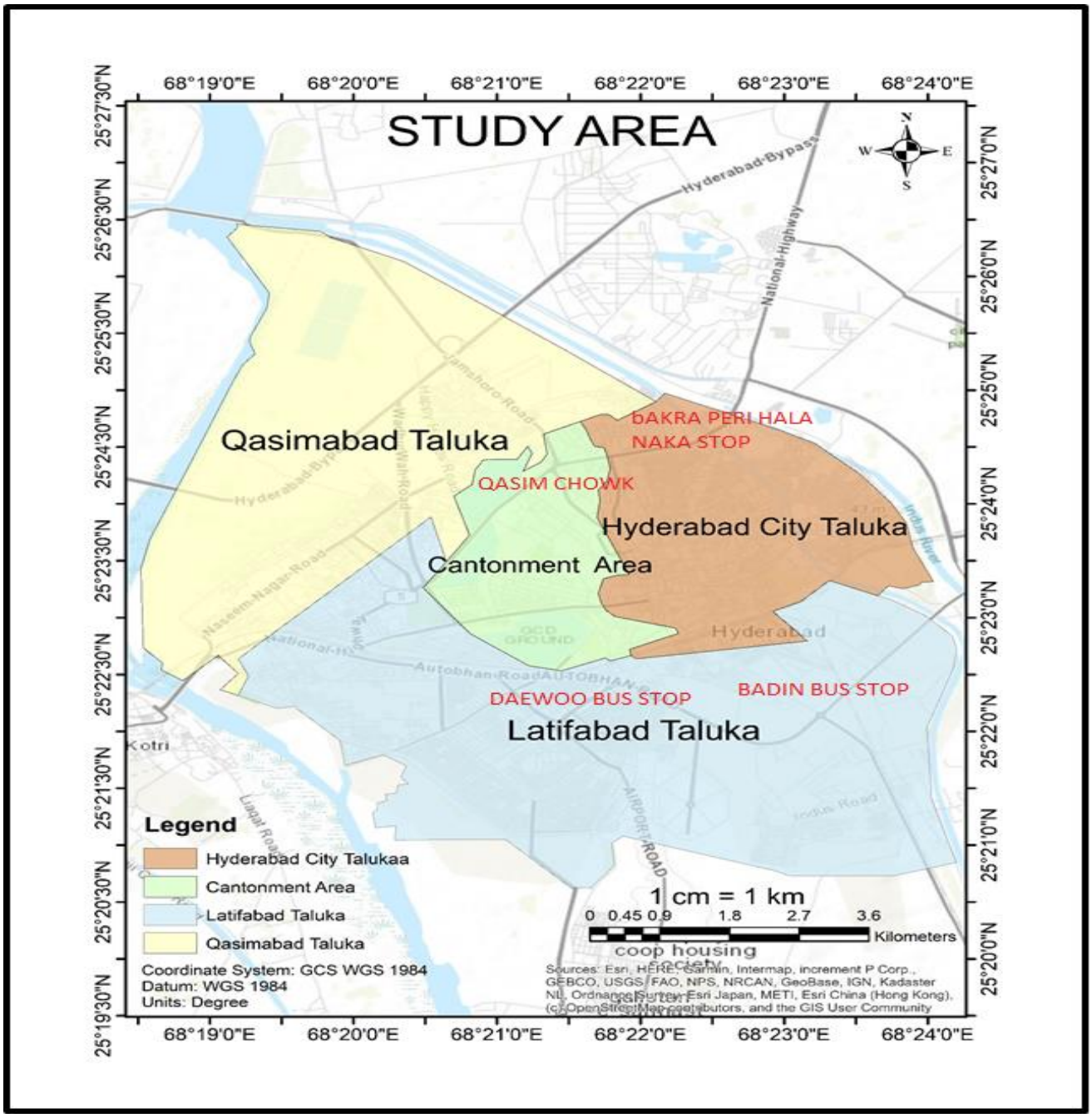

Fig. 7. Main intercity bus stations/ terminals in hyderabad (gis mapping)

As depicted in Fig. 7, Hyderabad's current bus terminals are located in busier districts of the city. These installations lacked services that were categorized as ideal for both travelers and workers [37]. The major cause of the worsening road conditions, especially in Hyderabad, is the presence of buses and coaches, which enter the city center and cause traffic congestion.

The data were analyzed to generate the results. The study's motive was to determine suitable locations for the bus terminal based on experts' and users' perceptions. As clarified in Table 3, standard deviation shows the unit of measurement, along with an estimated SD for the difference.

Table 3

Standard deviation of variables

S. No.	Important Study Variables	Standard Deviation (SD)
1	Education	1.23958
2	Age	1.34570
3	Income	1.74532
4	Mode of Transport	.96138
5	Ownership	.49396
6	Other options for travel	.77987
7	Motive for Substitution	1.23124
8	Amount of travel	.94984
9	When to travel	1.49196
10	Assess the public transit	1.14512
11	Effect of public transport	1.49196
12	Area of ply	.76268
13	Comfort level	1.51946
14	Accessibility	2.33020
15	Condition of buses	.92937
16	Period of departure	1.39280
17	frequency of mode switching	1.43262
18	The accessibility of buses	.49939
19	impacts of the environment	.43470
20	Comfortably	.49874
21	Relocation	.45641
22	Site suitability	1.01404
23	Comfort level	1.40081
24	Service satisfaction	1.51370

The data variables with SD values can be seen in Table 3. Poor data quality is exhibited by the variance from the total closed average for fasting. The values of variables travel time and accessibility were noted as comparatively higher. These values further clarified the traffic issues in a city. The deviation is of good quality, proving that the distribution contains a wide range of data. To clarify the education and income profiles of the respondents, Fig. 8 was generated.

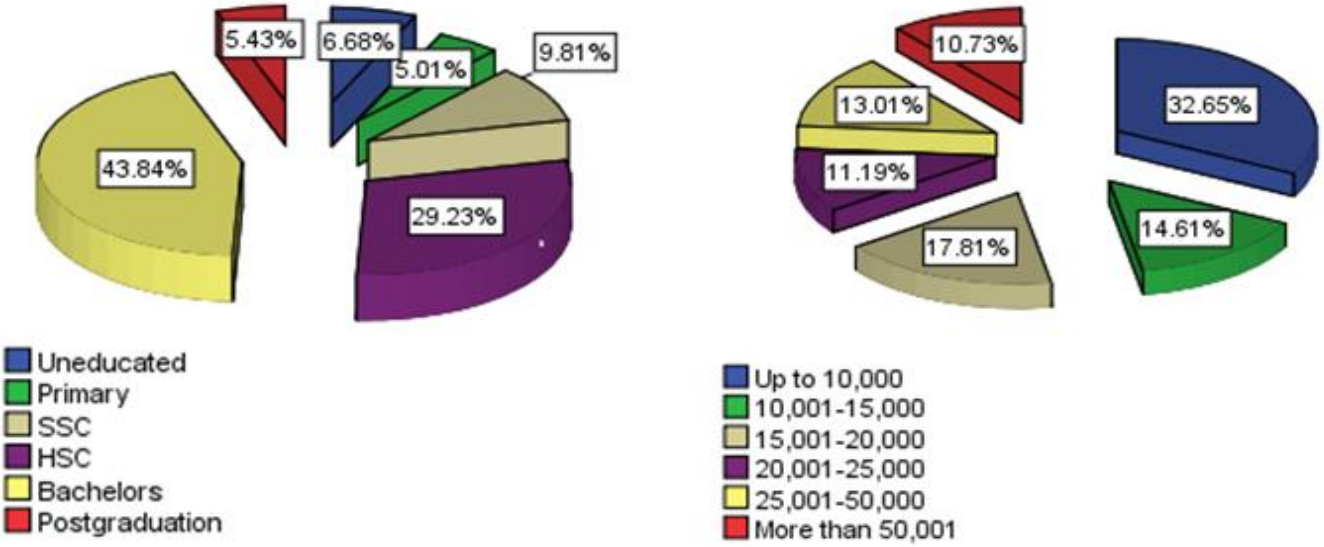

Fig. 8. Literacy level and monthly income of respondents in hyderabad

As illustrated in Fig. 8, the majority of individuals travel for work and school. The results indicated that most of the commuters were educated but only 6.68%. The highest proportion of the users found graduated (43.84%). Only 5.43% of postgraduates and 5.01% of primary passed commuters were notified in this study. The majority of the commuters were found using buses as compared to other travel options. In total, 10.73% of the commuters found earnings of PRs.50,000 and above, who didn't frequently use bus services. 32.65% of individuals were found low-income which made up to PRs.10,000 per month. As a result, they frequently traveled by bus to reach their destinations. The information about the travel timings of the commuters and the frequency of using the bus service can be seen in Fig.s 9 and 10 respectively.

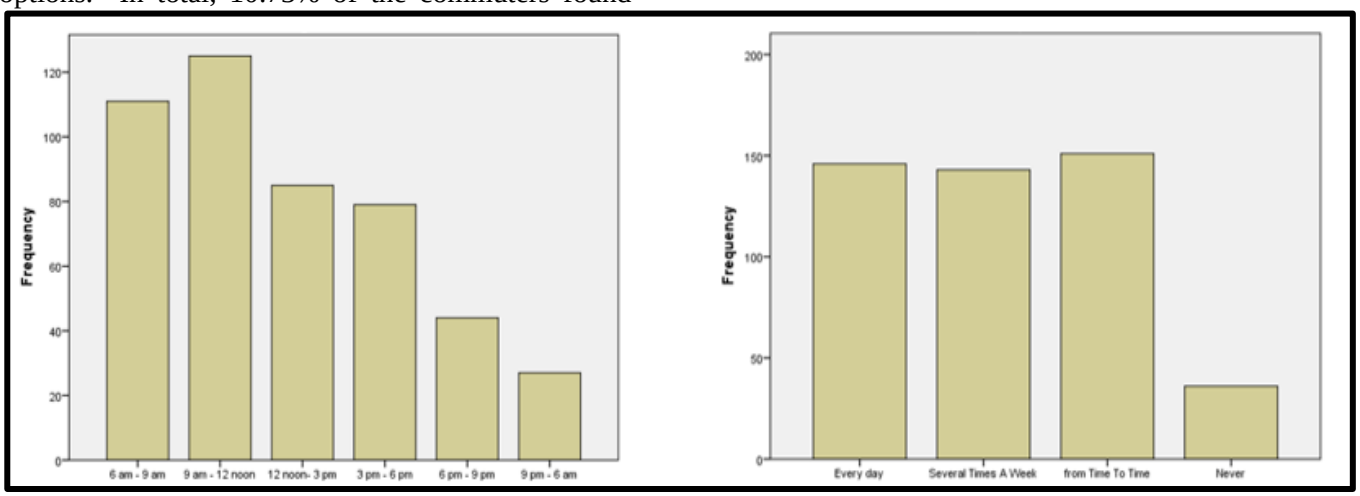

Fig. 9. Traveling timing

Fig. 10. Frequency of using buse service

As shown in Fig. 9, the majority of respondents commute between the hours of 9 a.m. and 12 p.m., which is regarded as the peak travel period, when traffic congestion is at its worst. Concerning Fig. 10, we can simplify that the majority of the commuters opt for bus service every day (145), several times a week (140), and from time to time (150). Consequently, the information on the bus plying area and suitable sites can be seen in Fig.s 11 and 12 respectively.

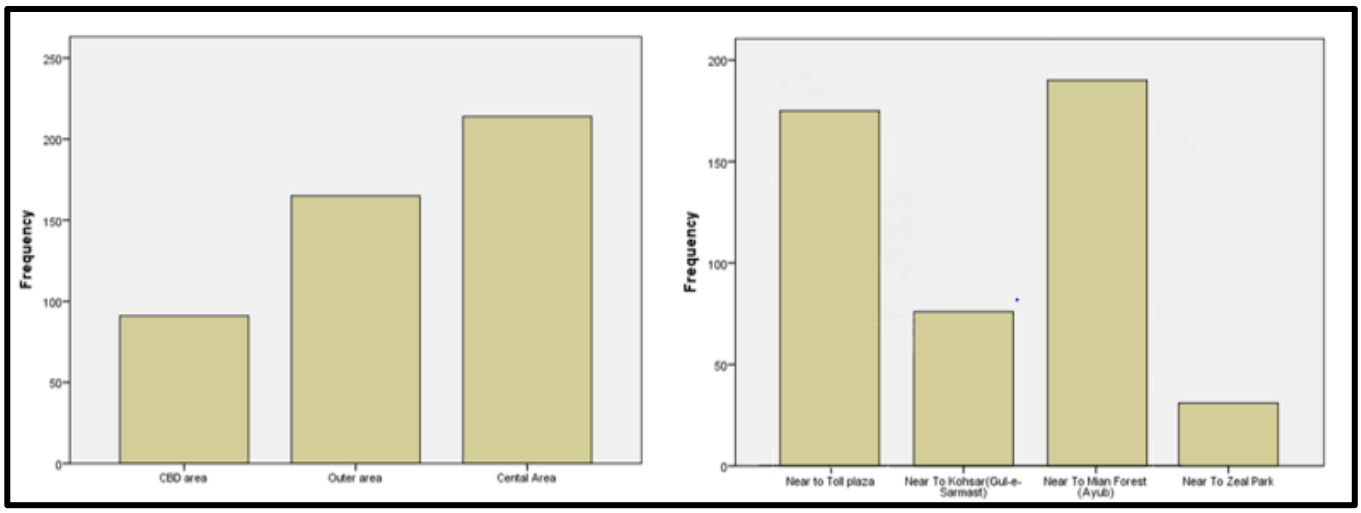

Fig. 11. Plying area of bus

Fig. 12. Suitable sites

Buses often pick up and drop off passengers in congested locations with high traffic and other large vehicles in most urban regions. Near Main Forest (Ayub Hotel), where local transportation is easily accessible for travel to the station. This site is immediately connected to the highway or Super Highway and most of the respondents were found in favor of this location for the proposed planned bus terminal. The information about the commuters' origin can be seen in Table 4.

Table 4

Cross tabulation of area of living-site suitability

Places	Near Mian Forest (Ayub)	Near Kohsar (Gul-2-Sarmast)	Near Toll Plaza	Near Zeal Park	Total
Other places	03	8	34	02	047
Hyderabad Rural	52	16	28	16	112
Hyderabad Urban	52	12	38	03	105
Latifabad	34	23	41	11	109
Qasimabad	32	16	49	10	109
Total	173	75	190	42	480

Table 4 shows a cross-tabulation of the respondents' suggested new locations for the BT and their current residences. In Table 4, we can see that 52 out of 480 residents of Hyderabad's rural and urban areas suggested "Near to Mian Forest," along with "Near to Toll Plaza" suggestions from residents of Latifabad and Qasimabad. To validate the responses, the correlation test was performed to judge the relationship between accessibility and place of origin (please see Table 5).

Table 5

Correlations between place and accessibility

Model	Place	Accessibility
Place		-0.374
Pearson Correlation Sig.(2-tailed) N		007
	480	480
Accessibility	-0.374	
Pearson Correlation Sig.(2-tailed) N	0.000	
	480	480

Table 5 reveals a negative connection between the variables, which indicates that it is difficult to go from people's homes to bus terminals or existing bus stations. The graphical explanation of Table 6 can be seen in Fig. 13.

One can perceive a negative correlation ship between the place and accessibility as depicted in Fig. 13. Further, the relationship between the place and the proposed sites can be shown in Table 6.

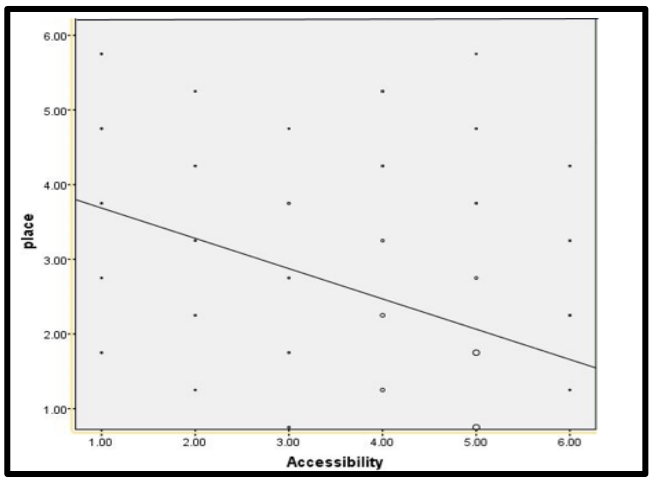

Fig. 13. Relationship between place and accessibility

Table 6

Correlation between place and proposed sites

Model	Place	Site Suitability
Place		-.256
Pearson Correlation		.000
sig. (2-tailed) N	480	480
Site Suitability	-.256	
Pearson Correlation	.000	
sig. (2-tailed) N	480	480

It is explained in Table 6 that there is a statistically significant positive link found between Hyderabad's population density and the locations of bus terminals. The graphical representation can be seen in Fig. 14.

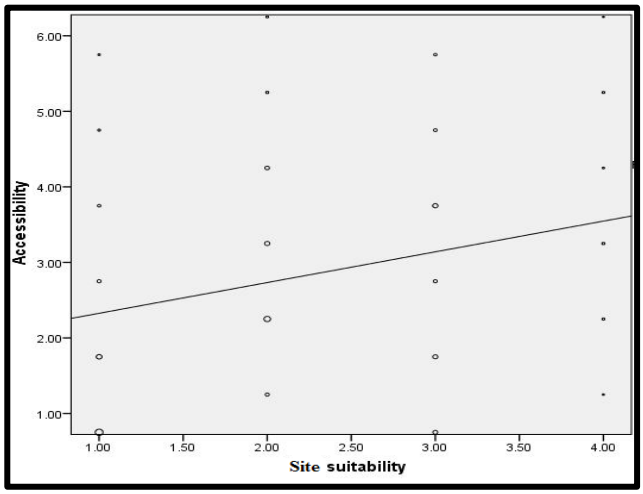

Fig. 14. Relationship between accessibility and site suitability

In the light of results, the following locations were found suitable for the construction of a bus terminal:

i. Towards the Main forest (Ayub Restaurant)

ii. Towards Toll plaza

iii.Towards Kohsar (Gulshan-e-Sarmast)

iv.Towards Zeal Park

The information about vacant land for proposed sites of bus terminals, existing routes, and new proposed routes can be seen in Fig. 15.

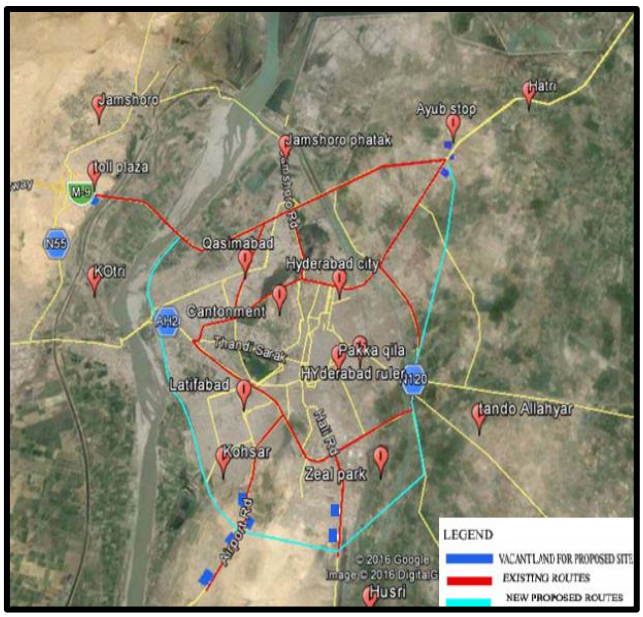

Fig. 15. Bus terminal proposed sites and routes

As shown in Fig. 15, the proposed route, as highlighted with a light blue color, looks suitable and congested-free. This proposed route is circular which may further improve the accessibility standards of the commuters of Hyderabad. At the same time, this route efficiently connected with the proposed sites highlighted with dark blue squares. For the comfort of travelers and to ease traffic congestion, off-road bus terminal facilities had to be provided due to the enormous number of vehicles arriving and departing.

5. Conclusion

Through information and discussion, we learned that Hyderabad is experiencing significant troubles and problems across all regions.. No matter what are the causes, However, in order to overcome it, the government must act honestly the issues of traffic congestion, and the absence of passenger bus terminals for urban commuters. There is a dire need for transportation policies to mitigate the issues of traffic and transportation in a country. Also, planners should be appointed at the local level to formulate and execute relevant policies considering all the main stakeholders of the society. Besides. This study can also be considered a step further in this regard to mitigate the site selection issue of the passenger bus terminal in the city of Hyderabad, Pakistan. This may give us a better idea of the SSA and provide precise forecasts about the suitability and advantages of BT in Hyderabad. According to this study finding a good location for BT is helpful that should be distant from the city center, and at the same time, this should be well connected and accessible to the local commuters

in every aspect. Thus, this study opts for users' perception to better select the best site for the passenger bus terminal. After collecting the data through a questionnaire survey and analyzing it, this study found four appropriate sites, i.e., Mayani Main Forest (Ayub Hotel), Toll Plaza, Kohsar (Gulshan-e-Sarmast), and Zeal Park. The most appropriate site for a passenger bus terminal is proposed near Mian Forest (Ayub Hotel). The site is also directly connected to the National Highway, and easily accessible to the citizens of Hyderabad through various passenger services, including Red and Pink Passenger Bus Services. It should be noted that the Pink Bus Sevice was recently inaugurated by the Sindh Government only for female passengers. The Ayoub Hotel Site is also accessible to every part of the city as both the public transport services directly connect with the proposed location. The earnings are valued not just by civilisation but also by bus drivers and passengers.The small inconveniences caused by the relocation of bus stops and alterations to bus routes can be offset for passengers by an increase in frequency and a decrease in travel time due to less traffic congestion. The development of a new planned bus terminal, in the optimum accessible location, is the genuine demand of the residents of Hyderabad. Therefore, this research may be considered a first step to building a newly planned bus terminal for the people of Hyderabad, Pakistan.

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