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The Impact of Urbanization on the Flow of Traffic in Faisalabad City Pakistan

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ABSTRACT

It is estimated that 50% of the world's population is living on only 2% of land area. Population scientists also believe that the urban population will increase from 80% to 90% by 2030 which is why urban growth is a significant problem in the developing world. Rapid urbanization has created many problems like haphazard development, disturbance in the ecological system, shortage of shelter and food polluted environment, lack of basic facilities, and traffic congestion. Besides traffic jams, traffic flow is also the major reason for different types of pollution like noise pollution and air pollution, which is a cause of health problems. Pakistan being a developing country experiences the same problems because of rapid urbanization. Faisalabad is the third largest city (according to the rank-size rule) and is famous for the agro cottage and textile industry. It covered the 313.21km2 area. Traffic congestion is a significant problem in Pakistan's cities because of their unplanned infrastructure and explosive population growth. Faisalabad is the first planned city of the subcontinent. With time, Faisalabad's infrastructure faced many changes due to uncontrolled urbanization. Road transport increased by 3% yearly due to the usage of personal automobiles. In the usage of personal vehicles, the share of motorcycles is 89 % while the share of cars is 50 %. Rapid urbanization is a severe threat to the city environment. Traffic congestion has become the problem of the day. This menace increased over time due to the slow development of roads and insufficient infrastructure as compared to rapid urbanization.

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1. Introduction

Out of the world's land cover, only 2% is urban area and 98% is rural. This 2% area seems pretty small, but it covers more than 50% of the population in the world's urban areas (Cengiz, Görmüş, & Oğuz, 2022). Population congestion is very high. Long travel times, choking air pollution, deadly traffic accidents, and inadequate public transport are the norm (Dudeja & Singh, 2022). Billions of dollars in economic productivity are lost due to traffic congestion, the poor lack affordable or comfortable mobility (Cervero, Guerra, & Al, 2017; Khan, Jamil, & Malik, 2022). The world's 50% of population is already living in cities. By 2030 this population percentage will change to 80%-90% in Asia and Africa, In 2030 mega cities will convert into meta cities (Girardet, 2004; McGrath & Pickett, 2011). The already overwhelmed transport systems in these crowded centers had to adapt to the massive population influxes and increased personal vehicle use (Ali, Mehraj, Mahmood, Mirza, & Tahir, 2010). The most obvious and dominant trend in urban transportation is the increase in personal vehicle use. More people are buying cars and motorcycles and doing so in large numbers. The prospect of owning a car or a motorcycle represents access, mobility, comfort, status, and an additional measure of safety from fatal traffic accidents and freedom from the drudgery of woefully inadequate public

transportation(Ali et al., 2010). The fast growth of industrial centers and the growth of urban areas play a significant role in changing the world; the markets are attracting people toward the centers and increasing the population pressure and getting congested(S. Wang, 2007; Xin, Shaw, & Lin, 2003). Today, the congestion is an essential part of present life in megacities. It is measured that 33% of all vehicular travel happens under congested conditions, in which speed midpoints a large portion of the free stream esteems (Karimi, Ghadirifaraz, Shetab Boushehri, Hosseininasab, & Rafiei, 2021).

The traffic jams when transport request surpasses transport supply in a particular area of the vehicle framework (Y. Wang, Wu, & Li, 2022). The land use pattern was changed due to the expansion of commercial and industrial development, reform to manage urban growth, and protection of open space areas. The policies of smart growth prevailed in cluster policy that fulfilled the requirement of the development and attached open space area. The parcel hazard was exchanged that affected the neighboring parcels through the development(Gupta, Jain, Sikdar, & Kumar, 2009). The clustering policy was applied, and many sprawls pattern was used the spatial inspiration. Urban communities suppose an indispensable part in advancing economic development and success. To a great extent, urban communities' improvement relies on their physical, social, and institutional framework. In that specific circumstances, the significance of inter-urban transportation is central. Initially surveys the patterns of vehicular development and accessibility of transport framework in Indian urban areas. That was trailed by a talk on the nature and size of urban transport issues(Singh, 2005). Urban transportation problems in Pakistan are managed by constructing the larger and better roads (Imran, 2009a). Point out the main problem of the long-term failure of Pakistani cities to enlarge and handle their public transport systems in mobility, equity, and environmental sustainability. Observe a few elements like urban planning in providing reasonable, professional, and adequate public transport in Pakistan. Transport issues are significant problems for the government in developing countries like Pakistan(Imran, 2009b).

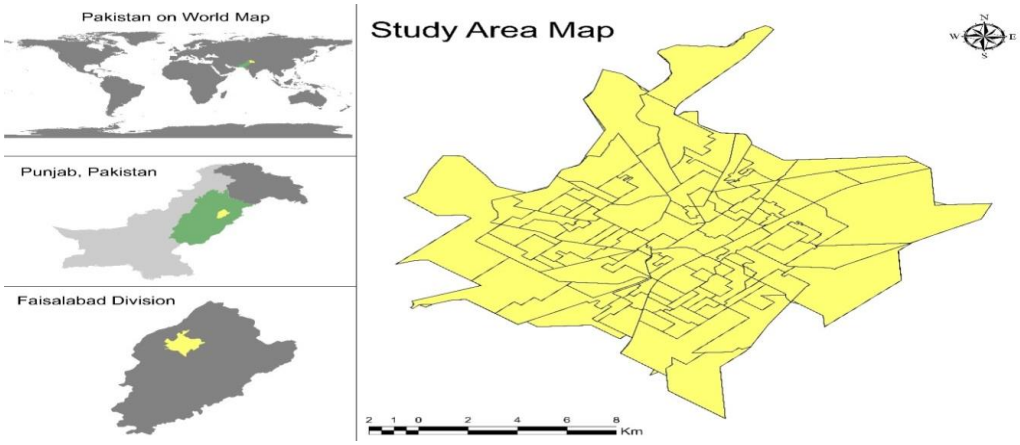
Constructing roads mostly manage urban transport problems in Pakistan, but constricting roads is not the only solution. Road planning needs to be part of a general transportation plan that includes traffic management and developed transport system and public transport. The basis of sustainable transport supports the development of low cost public transport capable of performing well in mixed land use and densely populated Pakistani cities. Research examine the center issue of long haul disappointment by Pakistani government to create and deal with their open transport frameworks to give an abnormal state of versatility, value, and ecological supportability (Muhammad Tahir Masood PhD, 2011). Now a day’s traffic congestion is becoming a more serious issue day by day. Use age of high volume of transportation insufficient infrastructure and irrational distribution of the development which make main reasons for increasing traffic jam. Major cause of traffic congestion is the high number of vehicles due to the population growth and preference of personal transport. Faisalabad is basically an industrial city. It is known as the Manchester of Pakistan. Due to industries, population conjunction increase day by day, that’s why transportation problems are highly increased. Due to high population, now road intensity is lesser than as compare to past. The Faisalabad city is facing the worst situation regarding traffic congestion and traffic flow not all but in some of the busy areas of this city. It is observed that every junction or confluence point is bearing high traffic jams; this condition causes several other problems, as well as health problems, and constructing the sites, submit to road traffic problems. There is a strong need for immediate steps to deal with this situation and prevent its consequences. The primary cause of traffic problems in Faisalabad is the bulk use of personal and heavy-load transport.

1.1. Study Area

Faisalabad is another city recognized toward the last of the eighteenth century in 1895. Its past name was Lyallpur. This channel was opened in 1892, and Faisalabad, named Lyallpur in Sir James Lyall's respect, was built up as Market Town in 1895. It was laid out sanely on 110 sections of land with 8 Bazaars on streets emanating like spokes on a wheel from a focal clock tower. It demonstrates that the yearly increment of urban population is double that of the expansion in urban regions (Naqvi et al., 2021). The investigations demonstrate that the urban developed region in 1980 was only 26 for every penny, which expanded to 44 for every penny in 2010 (Bhalli, Ghaffar, Shirazi, Parveen, & Anwar, 2012)**.** Faisalabad is a plain area of upper east Punjab, between longitudes 73°74' East, latitude 30°31.5' North, and having a height of 184 meters (604 ft.) above sea level. This has a gentle slope from North-East to South-West with a

normal of around 0.2 to 0.3-meter drop for every kilometer or around 1 to 1.5 feet for each mile. The topography is still apart by valleys, local depression, and relatively high ground(Bhalli et al., 2012). While in the winter, the temperature range is 24^{O} and 8^{O} C. The most astounding temperature in summer may be hot 50^{O}C, and the least in winter may fall underneath the point of solidification. The average rainfall in the District is around 27.5 centimeters/Year.

Figure 1: Study Area Map of Faisalabad City



Source: Author 2022

1.2. Objective

- To observe the expansion of traffic flow in Faisalabad city.
- To examine the transport type; which is more used in Faisalabad city.

2. Methodology

This research is based on both primary and secondary data. Primary data had been collected through a designed questionnaire as well as personal observation while secondary data had been collected from relevant departments that are mentioned below. The population of this research paper is 75 which is selected through different sampling methods. Both qualitative and quantitative techniques had applied in this research. Convenience sampling (Volunteer sampling, Snowball sampling, and nonrandom sampling) techniques had been applied in this research. Satellite images had been downloaded from USGS and maps had been developed through Arc GIS pro.

2.1. Preliminary Information from the Relevant Departments

The Preliminary information was collected from relevant departments to understand the current condition of traffic and infrastructure of Faisalabad city. Traffic evaluation data collected from the Transport engineering planning agency (TEPA) provided 1996 to 2014. Before 2007 transportation systems and urban infrastructure were under the supervision of the Faisalabad Development Authority (FDA) and now deal with TEPA. Faisalabad urban transport society (FUTS) provided information public transport system. The High way department provided the current traffic volume and capacity. Analysis of previous and current traffic flow, traffic congestion, and hotspots and determine the primary cause of the traffic congestion—data of the registered vehicle data collected from the Excise and Taxation Department. Examine the type of vehicles which make cause the generation of traffic congestion. The city boundary was obtained from the FDA.

3. Results and Discussion

3.1. Timeline of traffic flow from 1996-2022

Urban growth is highly affecting the transportation of the city in the whole world. Many techniques, methods, and approaches in this research observed the effect of urban growth on infrastructure. The results of this research are categorized into three categories. Firstly, observed temporal changes in infrastructure and land use in Faisalabad city, on the other hand, examines the timeline traffic flow of Faisalabad city through secondary data. The results of the previous changes in the study area view the current infrastructure and traffic flow circumstances after analysis of the previous and current conditions of the case study area. Highlight the strategies for a better transport system in Faisalabad.

The traffic flow data were collected from 32 different points. Those are the most crucial road points in Faisalabad city. Data was collected from the TEPA department and the Highway Department. According to the department, Faisalabad is, by birth, an industrial and agricultural city. It has fertile land so, in the past d, most people were interested in agriculture. The end of twentieth century is known as the industrial era of Faisalabad. Faisalabad is an industrial district city. That is the first planned city of the subcontinent. It has a radical infrastructure. It is connected to more than five cities through 12 different main routes. These (32 points), were divided into three categories and observed traffic flow and a major cause of traffic increase on roads connected with the CBD[1]. It consists of 8 bazaars that connect the CBD with the whole city. Four of their eight bazaars are wide or large, and four are small.

On the other hand, Bawana bazaar, Chinot Bazaar, Rail Bazaar, and Montgomery bazaar are considered the smallest bazaars. Primary roads were traffic in and out of the city—local secondary roads connected the secondary and primary roads. They observed the traffic flow of the cardinal points[2] where traffic was in and out on the road. The critical path of the road was easily observed in the calculation of traffic flow. In 1996 the traffic flow rapidly increased from 3% to 9%. It is still constant in 2002. That period is known as the industrial era of Faisalabad. People first moved towards the rural and other areas. That is the major cause of increased traffic flow in Faisalabad city. From 2008-2014 the traffic flow quickly increased, and across the 12%, that period is known as the residential era. People converted the agricultural land to build up (colonies) areas. These points were divided into three significant categories. Main roads, and commercial areas, were connected with CBD, then traffic flow data was collected. 7 points connected with CBD 6 points selected from primary roads. Eighteen points from local secondary roads.6cordenal points but calculated a single point. CBD consists of eight bazaars. These eight bazaars are divided into two categories .4 Bazaars are small, and four bazaars are enormous Bazaars in length or width. The activities of those bazaars are high compared to others.

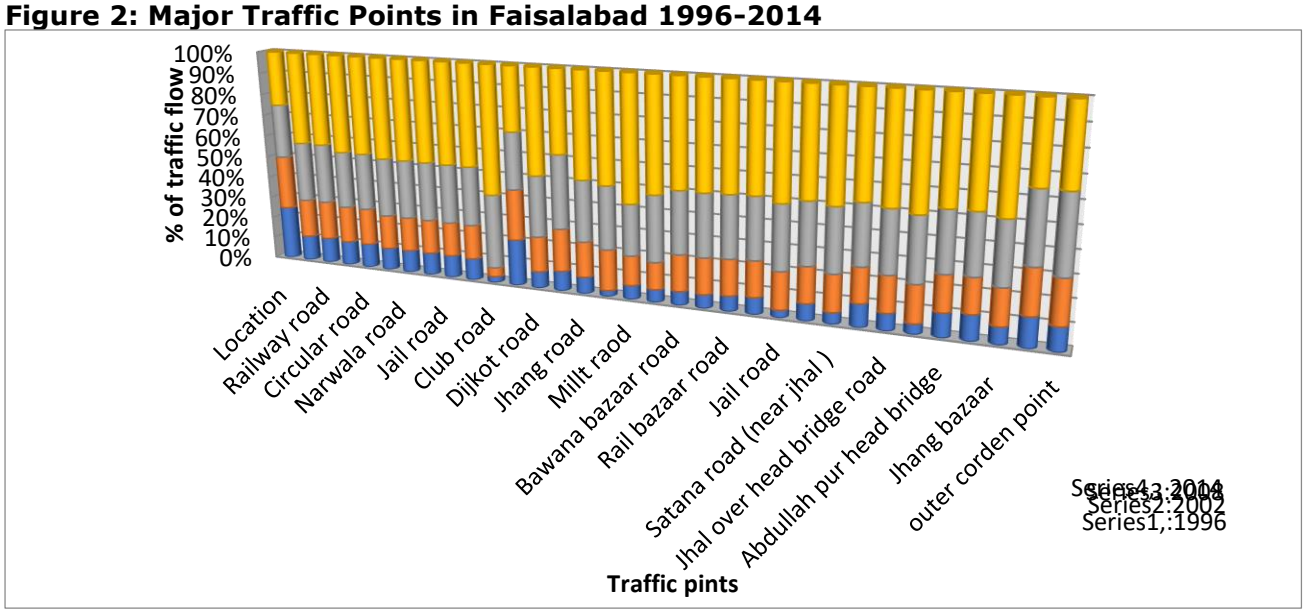
Table 1: Time Line of Traffic Flow (1996- 2014)

Location	1996	2002	2008	2014
Sumandri road	739	1141	1759	2707
Railway road	681	1047	1611	2481
GBS road	1582	2434	3748	6448
Circular Road	833	1283	1973	3395
Allamaiqbal road	1683	2589	4449	7647
Narwala road	673	1033	1771	3043
Police line road	1708	2626	4516	7762
Jail road	1175	1810	3130	5386
Bilal road	616	976	1678	2884
Club road	498	768	6294	10824
Stadium road	2673	2938	3290	3690
Dijkot road	2009	4355	7487	12875
Bakarmandi road	1871	4067	6995	7835
Jhang road	3158	6860	11798	20288
Sargodha road	1299	9334	14374	24718
Milltraod	1513	3277	5635	13747
Regal Road	962	2090	5090	8750
Bawana bazaar road	235	632	1082	1856
Chinot bazaar road	916	2506	4306	7402
Rail bazaar road	746	1796	3086	5306
Jinnah colony road	1522	3304	5680	9766
Jail road	1079	5629	9697	16663
Canal Road (near Jhaal)	1084	2356	4048	6958
Satana road (near jhal)	1710	5698	9796	16846
Sumandri road (near jhal	1785	2745	4719	8115
Jhalover head bridge road	1270	2758	4738	8146
Canal Road near Abdullah pur	1008	3850	6622	11386
Abdullah pur head bridge	1279	1969	3274	5626
Jarawanwala road	3360	4670	8036	13820
Jhang bazaar	803	1733	2975	5117
Toward college road	1278	1968	3030	3393
outer corden point	28434	54024	92916	95210

Source: TEPA, FDA, high way department 2022

[1] CBD Central Business District
[2]Cardenpoints edge of the road. Simple point where started any road.

Figure 2: Major Traffic Points in Faisalabad 1996-2014



Source: Author 2022

3.2. TimeLine of Traffic Flow

These (32 points) were divided into three categories and observed as the primary cause of traffic increase on such roads.

- Main Roads These roads are connected to other cities. So these roads are vital. There is the annual average flow of traffic on some main roads.
- Jhang Road is the oldest joining route of Lyallpur city to the Jhang district. So the traffic flow of Jhang road is under observation by started domestic government. If we take an overview of the past, the average per-hour traffic flow of the Jhang road was 1114 PCU in 1984. According to traffic flow, this road is always essential for Faisalabad city. It takes 3% traffic growth from 1996 to 2008. This road covered the two major types of land use agriculture and somehow residential areas. After 1996 it changed significantly and became a small textile industry (power looms). After 2008 the traffic flow was rapidly high its traffic volume was 20288 PCU.
- Summndari Roadisan primary road in 1996 its traffic volume was 739 it's more turned high, and 3% increase, and turned 1141PCU in 2002. After six years, it became 1759PCU, and in 2014, it across the 2000 and calculated value was 2707.
- Sargodha Road is a primary road. The traffic volume was 1299 in 1996. It rapidly increased in 2002 to 9334 PCU. In 2008 it turned 14374PCU. In 2014 it was across 20 thousand. Its annual flow was 24718 PCU. It is a major Road in Faisalabad city. All important textile industries are located on this road.
- Dijkot Road is the busiest road. It crosses the Novelty pull and Marge on Rajba road. The traffic flow in 1996 was 2009, in 2002 was 4335, and the 12% increase in 2014 to 12875.
- JaranwalaRoad its traffic flow calculated in 1996 was 3360 with annual traffic growth. 1n 2002. It was a 3% increase in 4670 flow. Traffic from 2008 to 2014 increased by 12%. It turned 8036 in 2008 and 13820PCU in 2014.
- CBD: These roads are connected with other parts of the city. So these roads are very important.
- Narwala Road It is connected by Jhang road and Allama Iqbal road. In 1996 the traffic flow was very light. The only annual average rate was 673PCU, and in 2002 1033PCU it was not more than the difference in 2008; it suddenly increased and turned to 1771PCU, and in 2014, it was 3043PCU.
- Circular road It is a crucial road because it is connected to the roads with CBD. In 1996 average annual traffic flow rate was 833 PCU. It was more increased within six years and turned 1238PCU. The increasing ratio continued with the same ratio in 2008; it turned 1973PCU, and in 2014, it crossed 3395. It is a one-way road, so traffic congestion is high.
- Jhang Bazar Road is an essential road because it is connected to Big Road with CBD. It is a two-way road so traffic congestion is high. It is connected with CBD. On the other hand, it is connected with Rajaba road and Narwala road. In 1996 average annual traffic flow

rate was 803PCU; it increased within six years and turned 1733 PCU. The increasing ratio continued with the same ratio in 2008; it turned 2975, and in 2014 it crossed the 5117 PCU.

- Bawana Bazar Road It is important commercial Road connected with CBD and Narwala road. In 1996 average annual traffic flow rate was 235 PCU which is very light but increased within six years and turned 632PCU. The increasing ratio was very high, so in 2008 it turned 1082 PCU, and in 2014 it was across the 1856 PCU. Now It is a one-way road, so traffic congestion is high. It is a one-way traffic route but is used as a two-way road.
- Chinot Bazaar Road is an essential commercial road connected with CBD and Narwala. In 1996 average annual traffic flow rate was 235 which is very light but increased within six years and turned to 632. The increasing ratio was very high, so in 2008, it turned 1082, and in 2014 it was across 1856. Now It is a one-way road, so traffic congestion is high.
- Regal Road It is a commercial road connected with CBD, Jhang road, and Narwala road. In 1996 average annual traffic flow rate was 962PCU which was very light but highly increased within six years and turned 2090 PCU. The increasing ratio was very high, so in 2008, it turned 5090 PCU, and in 2014 it was across 8750. Now it is a one-way road, so traffic congestion is high. It is a two-way road.
- Rail Bazaar Road It is a commercial road connected with CBD. In 1996 average annual traffic flow rate was 746 PCU which was very light but was highly increased within six years and turned 1796 PCU. The increasing ratio was very high, so in 2008 it turned 3086 PCU, and in 2014 it was across the 5306 PCU. Now it is a one-way road, so traffic congestion is high. It is a two-way road.

3.3. Local Secondary Road

- GBS[3] stands for General Bus stand. It is always under high traffic volume because every person who comes out of the city comes here rather than move to their destination. In 1996 that traffic flow was 1582, and it increased and turned in 2434 PCU; in 2014, it crossed 6000PCU, and the average traffic flow was 6448PCU.
- Allama Iqbal road It is connected to narwala Road. In 1996 the average flow was 1683. In 2002 it increased by 2589 PCU. In 2008 was 4449 PCU, and in 2014, it was 7647 PCU. The main reason highly flows of traffic was the educational institutions and worship place of the Muslims.
- Jinnah colony road is connected to Bakarmandi Link Road and Gulbarga road. In 1996 the average flow was 1522 PCU[4]. In 2002 it increased by 3304 PCU. In 2008 was 5680 PCU and in 2014 it is now 9766 PCU. The main reason highly flows of traffic was the hospital and commercial areas.
- Canal road In 1996, the average flow was 1084 PCU. In 2002 it's more increased by 2356PCU. In 2008 were 2 PCU and in 4048 across the 6958 PCU. The main reason highly flow of traffic was a hospital and commercial area
- Club road is considered a private road so its traffic flow was very less in 1996 was 498 PCU, in 2002 was 768PCU
- Corden points out It is the edge of any road. Through this point, traffic entered and out of the road. In 1996 its traffic volume was 28434, and it increased by 95210 on average per year.

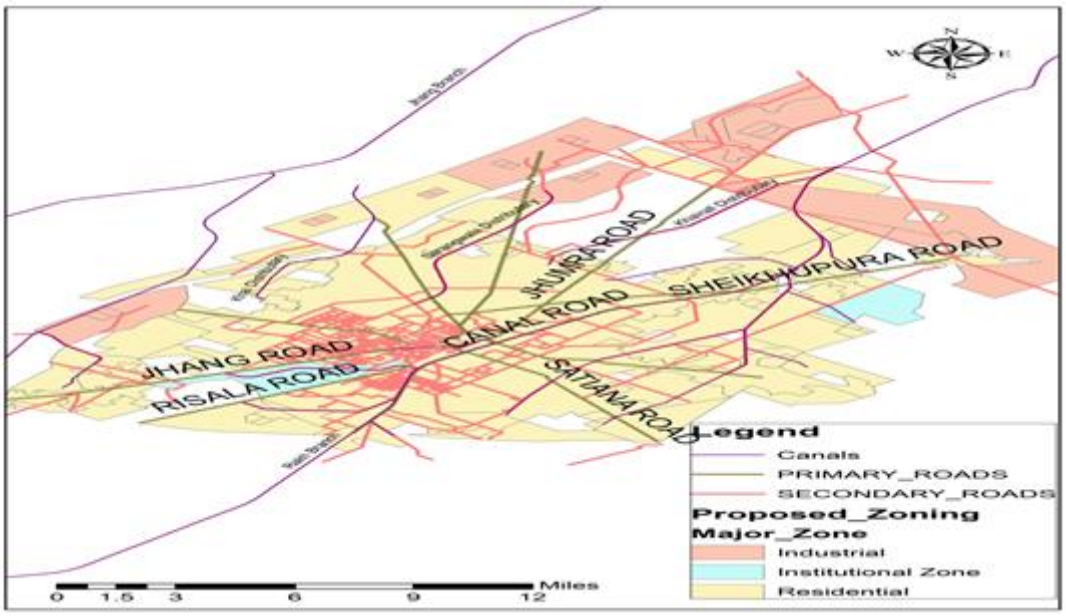
3.4. Registered Vehicles in Faisalabad (1947- 2016)

Excise & Taxation department, which registers all types of properties. Included everything which has value is known as property. The excise and taxation department is divided into many branches according to property demand like property (immovable), professional tax (factories), vehicle tax, and registration. A motor branch special department deals with just all types of vehicles (public or personal). In 1994, a new department was established with the collaboration of private and government departments named FUTS. FUTS deals with only public transport issues. The enlisted 2-wheel engine transport in Pakistan has encountered an expanding pattern. From 2000 to 2003, there was an irrelevant increment of 1% to 3%, after which the number expanded by 10% in 2004. In 2005, the number expanded at a diminishing rate of 2% contrasted with 2004. In the vicinity of 2006 and 2009, the number increased from 4% to 6%. The hugest increment in the number was off 34% in 2010 and 2011, besides 30% by 2012. The yearly

[3] GBD: General bus stand
[4] Passenger car unit calculated the per person at per seconds

increment dropped to 21%, 14% after 2013, and in 2015 expanded to an 18% ratio. In Faisalabad13 types of vehicle articles are registered transport is divided into two categories personal transpiration and public transportation. Personal transport; It covers motorcycles, cars, and jeeps. Such transport for personal use does not provide any type of profit except easy movement. Mainly bikes are used by large populations. Public transport: station buses, Rickshaws, taxi trucks. In Public transport, Rickshaws are used mainly.

Figure 3: Road Network of Faisalabad City



Source: Author 2022

Table 2: Total Registered Vehicles in Faisalabad (1947- 2016)

Types of vehicles	Petrol	diesel	Total	%
Motor cycle	1184861	0	1184841	89.5
Motor car	78265	788	79053	5.97
Jeeps	0	6	6	4.5
Station wagon	72	172	244	1.8
Buses	52	9136	9188	6.9
Mini Buses	1	0	1	7.5
Rickshaw	25667	182	25849	0.0195
cab taxi	4634	0	4634	3.5
Trucks	0	4745	4745	3.585
Delivery van	32	921	953	7.2
Ambulances	29	78	107	8.08
Pickups	3950	9953	13903	0.011
Cranes	0	13	13	9.82
Others	11	9	20	1.5
Total	1297574	26003	1184841	

Source: Excise Department Fsd. 2022

4. Conclusion

Faisalabad is considered the third large city in Pakistan. It is the first well-planned city on the sub-continent. That is connected with more than one alternative road. At the establishment of Pakistan, it has only four industries, and more area depended on agricultural land. Due to agricultural land, textile industries developed here. It is known as the industrial hub of textile industries. Its infrastructure is Radical. In 2008 agricultural land and build up area covered almost same ratio. In 2010 build-up area was exceeded. In 2017 the open land and agricultural land are very less. According to the FDA department, the housing scheme (colony) on Sargodha road is the last developed area. It exceeds the city boundary line. Due to the high population, road infrastructure has been facing many problems. By now, the traffic flow is 16% in Faisalabad city. Especially less parking area, fly-over and underpasses, and proper signals working. At now, Faisalabad city has around 29, 30 signal pints. Some are not in working condition. According to primary data collection, the infrastructure changes over time its future shape will be trapeze.

- Unavailability of latest secondary data.
- There is no planning for future saving.
- Relevant department management has not proper idea for latest work.
- There are some problems related to data collection from the field.
- Any one department have not proper and managed record for their relevant data.

References

Ali, A., Mehraj, J., Mahmood, S., Mirza, Z., & Tahir, M. (2010). Frequency ofRisk Factors Associated with Road Traffic Accidents of Motorbike in a Big City of a Developing Country. *Journal of the Dow University of Health Sciences (JDUHS), 4*(2), 68-72.

Bhalli, M., Ghaffar, A., Shirazi, S., Parveen, N., & Anwar, M. (2012). Change detection analysis of land use by using geospatial techniques: a case study of Faisalabad-Pakistan. *Science International (Lahore), 24*(4), 539-546.

Cengiz, S., Görmüş, S., & Oğuz, D. (2022). Analysis of the urban growth pattern through spatial metrics; Ankara City. *Land Use Policy, 112*, 105812. doi:https://doi.org/10.1016/j.landusepol.2021.105812

Cervero, R., Guerra, E., & Al, S. (2017). *Beyond mobility: Planning cities for people and places*: Island Press.

Dudeja, D., & Singh, H. (2022). *A unified framework for vehicle rerouting and travel behavior models.* Paper presented at the AIP Conference Proceedings.

Girardet, H. (2004). *Cities people planet: liveable cities for a sustainable world*: Academy Press.

Gupta, P., Jain, N., Sikdar, P., & Kumar, K. (2009). Geographical Information System in Transportation Planning, Geospatial World. In.

Imran, M. (2009a). Public transport in Pakistan: a critical overview. *Journal of Public Transportation, 12*(2), 53-83. doi:https://doi.org/10.5038/2375-0901.12.2.4

Imran, M. (2009b). Public transport in Pakistan: a critical overview. *Journal of public transportation, 12*(2), 4.

Karimi, H., Ghadirifaraz, B., Shetab Boushehri, S. N., Hosseininasab, S.-M., & Rafiei, N. (2021). Reducing traffic congestion and increasing sustainability in special urban areas through one-way traffic reconfiguration. *Transportation*, 1-24. doi:https://doi.org/10.1007/s11116-020-10162-4

Khan, M. S., Jamil, K., & Malik, A. A. (2022). Delivering Urban Mass Transit—the Case of Lahore, Pakistan.

McGrath, B., & Pickett, S. T. (2011). The metacity: A conceptual framework for integrating ecology and urban design. *Challenges, 2*(4), 55-72. doi:https://doi.org/10.3390/challe2040055

Muhammad Tahir Masood PhD, P. (2011). Transportation problems in developing countries Pakistan: a case-in-point. *International Journal of Business and management, 6*(11), 256. doi:http://dx.doi.org/10.5539/ijbm.v6n11p256

Naqvi, S. A. A., Sajjad, M., Waseem, L. A., Khalid, S., Shaikh, S., & Kazmi, S. J. H. (2021). Integrating Spatial Modelling and Space–Time Pattern Mining Analytics for Vector Disease-Related Health Perspectives: A Case of Dengue Fever in Pakistan. *International Journal of Environmental Research and Public Health, 18*(22), 12018. doi:https://doi.org/10.3390/ijerph182212018

Singh, S. K. (2005). Review of urban transportation in India. *Journal of public transportation, 8*(1), 5.

Wang, S. (2007). Research of Spatiotemporal Data Model for GIS.

Wang, Y., Wu, B., & Li, L. (2022). Traffic Congestion Management and Control Strategy for Land Redevelopment. In *Urban Redevelopment and Traffic Congestion Management Strategies* (pp. 115-145): Springer.

Xin, X., Shaw, S.-L., & Lin, H. (2003). *DEVLEOPING A SPATIO-TEMPORAL DATA MODEL FOR AN EXPLORATORY STUDY ON THE LAND USE-TRANSPORTATION INTERACTION: A TEMPORAL GIS ATTEMP.* Paper presented at the Proceedings of Asia GIS Conference 2003.