International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 06 | June 2019 www.irjet.net p-ISSN: 2395-0072

ANALYSIS OF PASSENGER FLOW PARAMETERS OF RAIL TRANSPORTATION IN KERALA

Maria Francis[1], Archana S.[2]

[1]*Maria Francis, PG Scholar, Dept. of Civil Engineering, Jyothi Engineering College, Kerala, India*
[2]*Archana S., Assistant Professor, Dept. of Civil Engineering, Jyothi Engineering College, Kerala, India*

Abstract - *Travel by rail transit has become more favorable and has increased in popularity and reputation. One of the identified factors with respect to quality attributes of public transport and to attract as many commuters as possible is by the improvement of rail transit. The overall efficiency of transit operation depends on effective operation of various facilities like transit units, transfer stations and access infrastructure. Access infrastructure includes many facilities that's helps in getting access to railway station, among this the Entrance and Exit width provided by the railway stations is an important factor for the easy and convenient movement of passengers towards and outside the railway station, this is selected as the study area for this study. Fluctuations in passenger flow according to the arrival and departure schedule of train, especially during the peak hours affect the smooth flow of passengers. Present study is carried out in three A1 category railway stations namely, Trivandrum Central, Ernakulam Junction and Kozhikode which has the highest annual passenger income in Kerarla. In order to understand the effect of available width of entrance and exit on the passengers, passenger flow characteristics such as speed, density and flow is analyzed. Video graphic technique is used to collect the data and using this data fundamental relationship of passenger flow is studied. Flow model of speed-density is developed and correspondingly relationship between passenger flow parameters is studied.*

Key Words: **Railway Station, Passenger Flow Characteristics, Speed, Density, Pedestrian Flow**

1. INTRODUCTION

In recent years, the use of rail transit system as a dependable and convenient way of travel has gained increasing popularity in urban cities around the world. Rail transit services receive positive support due to its high capacity, comfort, safety, and reliability. One of the identified factors with respect to quality attributes of public transport and to attract as many commuters as possible is by the improvement of facilities provided by rail transit. In India, railway stations are classified based on the annual passenger income. Among all the categories A1 category railway stations has the highest annual passenger income and hence the passenger flow is greater compared to the other categories. Passengers face a lot of issues due to insufficient facilities provided by railways especially by railways having high passenger flow.

This study focuses on three A1 category railway stations in Kerala namely Trivandrum Central, Ernakulam Junction and Kozhikode. Passenger flow parameters such as speed, density, flow and space is studied for the entrance and exit area. Finally the relationship between speed – flow – density is developed and the space provided for the entry and exit movement is evaluated.

1.1 Objectives

- To analyze the passenger flow on entrance and exit of the A1 category railway stations in Kerala
- To develop fundamental relationships between density, speed and flow
- To develop speed – density model

2. BACKGROUND

In order to carry out the study, more information regarding the passenger flow parameters was required. For this, different journals were referred and the information gathered was used for the successful execution of the study.

Shaha.J et.al [ ] This study is targeted on pedestrian flow This study is targeted on pedestrian flow behavior at Vadodara terminal within the state of Gujarat, India. Four completely different stairways with different physical dimension connecting to the platform and FOB were thought of for the study. For various sizes of steps, flow speed- space and density plots show totally different trends however with general similar pattern. Result shows that pedestrian walk quicker throughout the afternoon or day time compared to evening and conjointly presence of the pedestrian with baggage has potential result on reduction within the average walking speed of pedestrian. For lower flow, large variation in speed; within the vary of 18-48 m/min is determined.

Olander et. al [ ] This study investigated the impact of elevator handiness. Stair and elevator choices were monitored by automatic counters every weekday during two phases. During a natural experiment days with four accessible elevators were compared with days once 3 elevators were accessible. Increasing building occupancy was related to exaggerated step use, while increasing passenger

traffic and time of day was related to reduced step use. A follow-up study disclosed complimentary effects of building occupancy and time of day on elevator waiting times, indicating that exaggerated step use by discourse factors reflects exaggerated elevator waiting times.

Dass.S et. al [ ] The study was a shot to assemble information regarding the means the individual s assume for the pedestrian's facilities they're victimizing day to day. It'll give an insight into the people's mind what they accept the facilities and what square measure the mind blocks for them to discard those facilities resulting in accidents. This study was drained Ambala, Kurukshetra and Chandigarh. There have been chiefly 3 strategies adopted for information assortment. (i) Interview survey (ii) inventory survey and (iii) speed study. This study was closing result for foot over bridge and underneath bridge.

3. DATA COLLECTION

In order to observe the passenger flow parameters, videographic survey data is the most appropriate one, therefore CCTV footage data of the entrance and exit area was collected from Trivandrum Central, Ernakulam Junction and Kozhikode railway Stations. Data was collected for the time duration according to the schedule of arrival and departure of trains. Number of passengers observed from the respective railway stations is tabulated in Table 1

Table -1: Observed Number of Passengers

Railway Stations	Time Duration	No.of Passengers Observed
Trivandrum Central	Morning: 6:30 to 9:30 am Evening : 4:30 to 6:30 pm	5521 4129
Ernakulam Junction	Morning: 7:40 to 10:40am Evening : 4:00 to 7:00 pm	4118 4723
Kozhikode	Morning : 6:30 to 9:30 am Evening : 3:00 to 6:30 pm	5835 4715

3. DATA ANALYSIS

Passenger flow parameters such as flow, speed, density and space is retrieved from the video graphic data collected from the entry/exit of respective A 1 railway stations which is selected as the study area. From data collected the peak hour was estimated for the three railway stations. For both Trivandrum Central and Kozhikode the peak hour is estimated in the morning duration and it is during 7:30 am to 8:30 am for Trivandrum and 8:30 am to 9:30 am for Kozhikode. In Ernakulum highest passenger flow is obtained between 4:40 pm to 5:40 pm. Kozhikode has the highest number of passengers in the peak hour and that is of 2802. Passenger flow is considered in two directions for all the three study areas. Maximum speed of passenger observed is in Trivandrum Central and that is of 32.98 m/min. Minimum speed of 12.50 m/min is obtained in Kozhikode . Trivandrum Central has the mean speed of 27.93 m/min and the least average speed is observed in Kozhikode is 12.59 m/minute. Passenger data collected from the study area is tabulated in Table.2

Table -2: Passenger Data Collected

RAILWAY STATIONS			
Location	Trivandrum Central	Ernakulam Junction	Kozhikode
Time of Survey	7:30 am to 8:30 am	3:30 pm to 4:30 pm	8:30 am to 9:30am
No. of Samples	2351	1785	2802
Direction	Two	Two	Two
Maximum Speed (m/min)	32.98	32.39	29.81
Minimum Speed (m/min)	21.93	16.57	12.50
Mean	27.93	26.61	23.59
Standard Deviation	2.58	3.48	4.44

3.1 Passenger Flow Analysis

Passenger flow is estimated as the number of pedestrians passing a given point per minute. Based on the passenger flow the peak hour of the study locations were determined. Highest passenger flow is observed in Kozhikode railway station for morning duration. Passenger flow corresponding to different minutes in the peak hour is plotted for different study areas. In Kozhikode between 8:45 am to 8:48 am highest passenger flow is observed and it is of 140 pedestrians per minute. In Trivandrum Central the highest maximum flow is reaching upto 120 pedestrians per minute and it is between 8:21 am to 8:22 am. In Ernakulam Junction the peak hour is estimated in the evening and the highest passenger flow is observed between 4:41pm and 4:43 pm

the passenger flow is reaching 130 passengers per minute. Variation in passenger flow with respect to time is plotted and shown in Chart 1 to Chart 3.

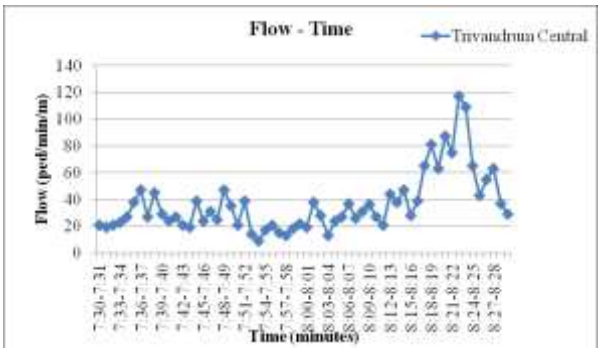

Chart -1: Trivandrum central passenger flow variation

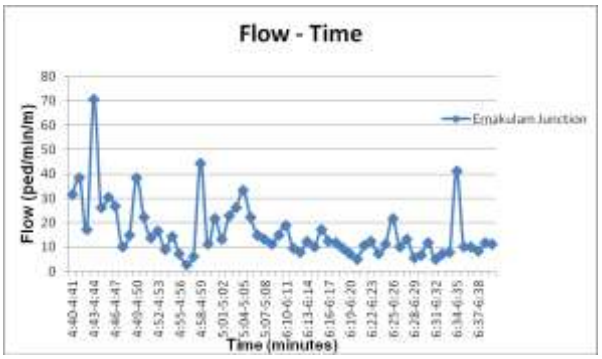

Chart -2: Ernakulam Junction passenger flow variation

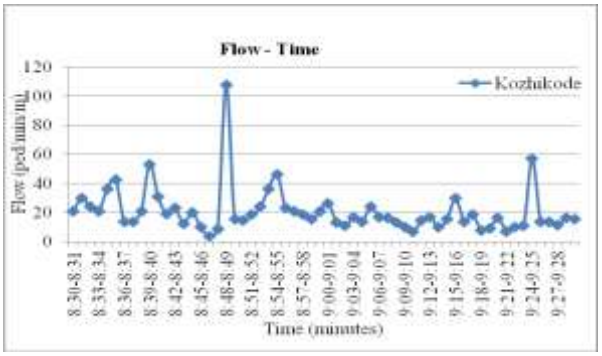

Chart -3: Kozhikode passenger flow variation

3.2 Effect of Entrance and Exit Width on Pedestrian Flow Parameter

This section presents analysis of different characteristics of passenger flow using fundamental relationships. The walking speed of passenger could be a perform of flow, density and available space. Relationship between these passenger parameters helps us to study about the passenger behavior and to understand whether provided width for the entrance and exit is sufficient for serving the peak hour.

3.2.1 Flow-Density Relationship

Density is directly proportional to the flowrate. As the pedestrian arrival rate will increase, the density of pedestrian increases and due to this the available space for the easy movement of passengers at the entrance and exit will be reduced. The observed relationships of density and flow on entrance and exit area at Trivandrum Central, Ernakulam Junction and Kozhikode Railway stations are shown in Chart 4 to Chart 6.

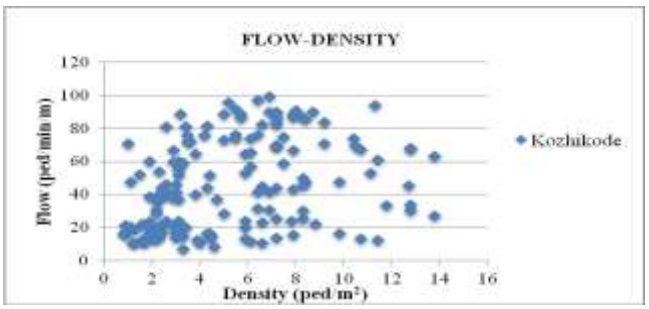

Chart -4: Flow – density variation of Trivandrum central

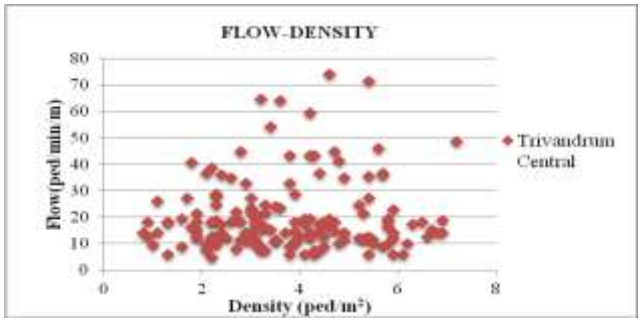

Chart -5: Flow – density variation of Ernakulam Junction

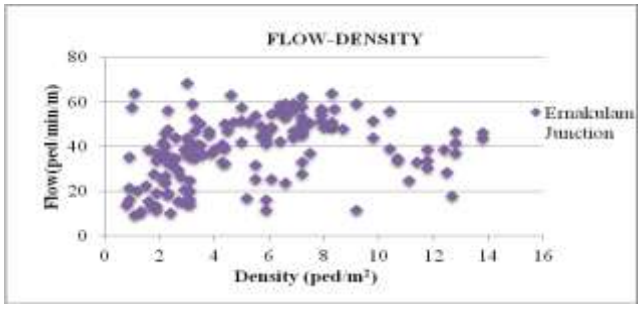

Chart -6: Flow – density variation of Kozhikode

3.2.2 Flow- Space Relationship

Density observed is inversely proportional to space, therefore the available space for passenger also influences the passenger flow rate. As per Indo HCM manual 0.8m^2/ped is considered as the basic space for a standing pedestrian and this is used while designing various pedestrian facilities. The relationship between available space for passenger movement and corresponding flowrate is plotted in Chart 7 to Chart 9.

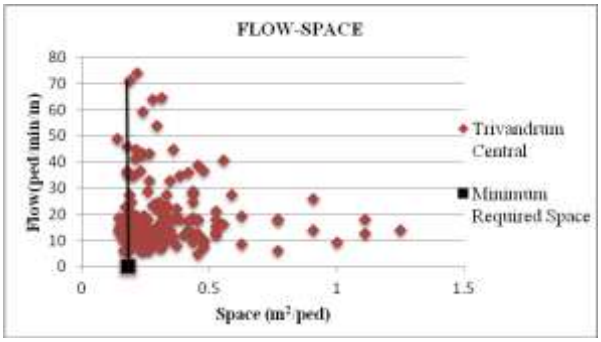

Chart -7: Flow – density variation of Kozhikode

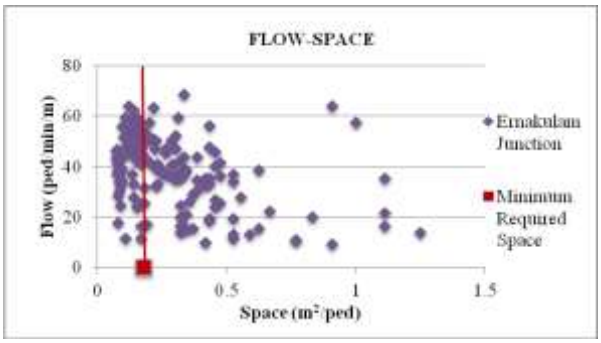

Chart -8: Flow – density variation of Kozhikode

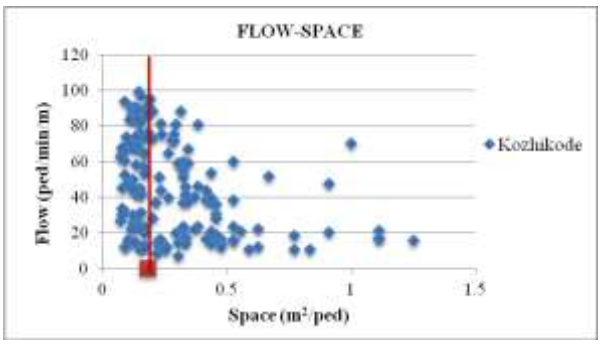

Chart -9: Flow – density variation of Kozhikode

In case of Kozhikode railway station even when the flow is less the available space is less than 0.18m²/ped. In case of Ernakulam, as flow increases the available space decreases for individuals, but at Trivandrum central maximum flow observed is 80 ped/min/m and corresponding space is greater than 0.18m²/ped therefore sufficient space for individual movement is present.

4. SPEED – DENSITY MODEL

The walking speed of pedestrian is a function of flow, density and available space. Relationship between speed and density (measured independently) for different entrance and exit locations is developed using linear function. Speed and density observed from the three railway stations is plotted linearly. It is observed that when the speed is 30 m/min the density of passenger's is very less that is less than 1 ped/m². But as the speed increases and passengers have sufficient space for the movement and density increases. Some passengers wait near the entrance area and this reduces the actual width provided for the passengers. Relationship of speed and density is plotted for the three study areas and the corresponding R^2 is shown in Chart 10.

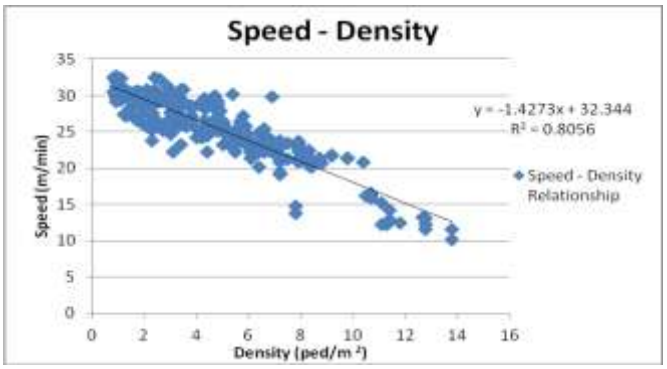

Chart -10: Developed model of speed-density relationship

4.1 Relationship between passenger flow parameters

For the existing conditions of railway station a speed density model is developed. The relationship between passenger flow parameters is developed from the model equation obtained. This is shown in Table 3.

Table -3: Develop Relationship Between Passenger Flow Parameters

Relationship		Equations
Speed- Density	Linear	Q_p=32.344-(1.4273 K_p^2)
Flow - Density	Parabolic	V_p= 32.344 - 1.4273 Q_p
Speed - Flow	Parabolic	Q_p= 32.34V_p - Vp^2/1.4273
Flow - Space	Inverse Parabola	Q_p= 32.344/S – 1.4273/S^2

4.2 Model Validation

Graphical methods readily illustrate a broad range of complex aspects of the relationship between the model and data, this their main advantage over numerical methods. Numerical methods for model validation tend to be narrowly focused on a particular aspect of the relationship between the model and the data and often try to compress that information into a single descriptive number or test result. From the analysis done using the predicted and observed speed data we can see that the existing linear regression model better fit to the given data.

5. CONCLUSION

By analyzing the walking speed of passengers, walking speed depends upon the space provided. If the area is more crowded, passengers have the tendency to alternate their speed according to passenger's walking in front. Comparing the three railway stations, average walking speed of passengers is obtained highest in Trivandrum central and it is of 27.93 m/min. By plotting the speed – density obtained from the three railway stations linear relationship is obtained and this is used for the model development. By using this developed speed-density model, flow-density and speed-flow relationship graphs are derived. The maximum flow obtained is 180 ped/min/m, optimum speed and optimum density obtained is 17 m/min and 11 ped/m^2. In case of space with respect to the passenger flow, at Kozhikode and Ernakulam railway station space is found to be insufficient since the area occupied by single pedestrian is below 0.18 $m^2$and it depicts that smooth flow of passengers is not found at the entrance or exit area.

ACKNOWLEDGEMENT

I am thankful to teaching staffs and Department of Civil Engineering, Jyothi Engineering College, for great support throughout this project. I am deeply indebted to the Divisional Managers of Palakkad Railway Division, Trivandrum Railway Division and also to the RPF police officers of Trivandrum Central, Ernakulam and Kozhikode railway stations for granting me permission and also assisting me during the entire data collection process.

REFERENCES

[1] Brahmbhatt,C, Zala, L, B, Advani, M "Measurement of Pedestrian Flow Parameters – Case Study of Dakor, Gujarat" International Research Journal of Engineering and Technology, vol.02 2018, , pp. 527-532.
[2] C. Holloway and N. Tyler, "A micro-level approach to measuring the accessibility of footways for wheelchair users using the Capability Model" Transportation Planning and Technology, vol. 37, 2016, pp. 636 - 649.
[3] G.R.B, P.Parida, MuktiAdvani and P. Manoranjan, "Pedestrian Level of Service Model for Evaluating and Improving Sidewalks from Various Land Uses", European Transport, vol. 67, 2018, pp. 1-18.
[4] M.Kasundra, and Shinkar,A,P, "Planning of Basic Pedestrian Facilities at Selected Intersection of Rajkot City", Research and Development Journal for Engineering , 2016, pp. 346 - 352.
[5] Olander,E.K and Eves, F.F, "Elevator availability and its impact on stair use in a workplace", Journal of environmental psychology vol.31,(2), 2011, pp. 200-206.
[6] S.Dass, D. Singhal and P. Aggarwal, "Study of Pedestrian Flow/ Behavior on Indian Roads", IOSR Journal of Mechanical and Civil Engineering, 2014, pp. 38 – 42.
[7] T. Muraleedharan, T. Adachi, K. Uchida, T. Hagiwara and S.Kagaya, "A Study on Evaluation of Pedestrian Level of Service Along Sidewalks and at Crosswalks", JStage, 2004, 21.
[8] Guidelines for pedestrian facilities, Indian Road Congress, 103, 2012.
[9] Indo- Highway Capacity Manual – 2014, pp. 9-35