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IMPACT ANALYSIS OF MASS PEDESTRIAN MIGRATION ON URBAN ROAD NETWORK CAPACITY: A STUDY OF PANDHARPUR CITY DURING THE WARI SEASON

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ABSTRACT

The Wari pilgrimage is a major annual religious event in Maharashtra that attracts a large number of pilgrims to Pandharpur. During the Wari season, the sudden increase in pedestrian movement significantly affects the normal functioning and capacity of the urban road network. This study, titled "Impact Analysis of Mass Pedestrian Migration on Urban Road Network Capacity: A Study of Pandharpur City during the Wari Season," focuses on assessing the effect of large-scale pedestrian movement on traffic flow, road capacity, congestion, and overall mobility in Pandharpur city.

Keywords: Wari pilgrimage, Pedestrian migration, Road network capacity, Multinomial logit model, Pandharpur

I. INTRODUCTION

The annual Wari pilgrimage to Pandharpur attracts lakhs of devotees who travel on foot to visit Lord Vitthal. During this period, large groups of pedestrians move along urban roads, especially in and around the city. This sudden increase in pedestrian movement affects the normal flow of traffic and reduces the road network capacity. The study focuses on understanding how this mass pedestrian migration impacts traffic conditions, congestion, and road usage in Pandharpur during the Wari season.

Urban transportation systems are mainly designed to provide safe, efficient, and comfortable movement of people and vehicles. However, during large religious, cultural, and social events, the normal pattern of transportation changes significantly due to the sudden increase in the number of pedestrians. One such major religious event in Maharashtra is the Pandharpur Wari, in which a very large number of devotees travel to Pandharpur to visit the temple of Lord Vitthal and participate in various religious activities. During the Wari season, the population of Pandharpur increases considerably within a short period, resulting in a substantial rise in pedestrian movement on roads and public spaces

II. LITERATURE REVIEW

Gálvez-Pérez, D. et al. 2024 (1) studied Analysis of the elderly pedestrian traffic accidents in urban scenarios: the case of the Spanish municipalities. Results showed that improving road safety for older pedestrians may not necessarily compromise the situation for the rest of population. Hence, policymakers should focus on infrastructure improvements adapted to the needs of elderly pedestrians. Gorrini, A. et al. 2016 (2) studied pedestrian–vehicle interactions at urban intersections. Results showed that pedestrian behavior strongly influences traffic flow and delay, especially at unsignalized crossings. Seyfried, A. et al. 2007 (3) analyzed pedestrian flow through bottlenecks. Results showed that higher pedestrian density leads to congestion and reduces movement efficiency in limited spaces. Lilasathapornkit, T. et al. 2020 (4) studied pedestrian traffic assignment in urban networks. Results showed that pedestrian flow can be modeled similarly to vehicular flow and affects overall network performance. Sadhu, A. M. et al. 2024 (5) reviewed roundabout design considering pedestrian impact. Results showed that pedestrian volume influences intersection efficiency and safety in urban areas. Parkavi, S. P. et al. 2025 (6) studied urban congestion in Chennai city. Results showed that increasing traffic demand, including pedestrian activity, leads to congestion and reduced road efficiency. Gitelman, V. et al. 2020 (7) studied pedestrian signal systems at intersections. Results showed that giving priority to pedestrians improves safety but may affect vehicle delay and road capacity. Golchoubian, M. et al. 2023 (8) reviewed pedestrian movement prediction in mixed traffic. Results showed that pedestrian behavior is complex and directly impacts traffic flow modeling in urban areas. Jancey, J. et al. 2013

III. METHODOLOGY

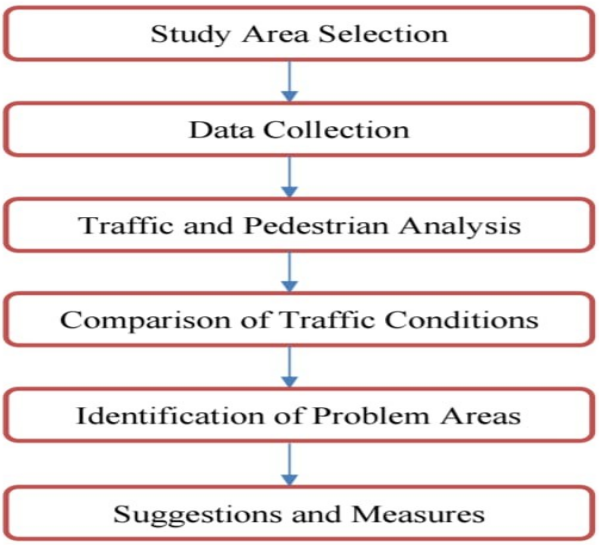


Table 1: Detailed methodology of the study

Table 1 shows detailed methodology of the study area which consists of Introduction, Literature review, data collection, data analysis, model development and finally results and conclusion.

IV. DATA COLLECTION

Primary data will be collected through field surveys in Pandharpur City during the Wari season. Pedestrian and vehicle traffic volumes will be recorded at selected major roads, junctions, temple approach roads, market areas, and other locations having high pedestrian movement. The width of roads and footpaths will also be measured. Pedestrian walking speed, vehicle speed, travel time, traffic congestion, and vehicle–pedestrian interactions will be observed.

Secondary data will be collected from Pandharpur Municipal Council, Traffic Police, PWD, transport authorities, previous Wari studies, research papers, maps, and other available records. Data from normal days will also be collected for comparison with Wari-season conditions. Figure 1 and 2 shows details of data collection.

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PEDESTRIAN DATA TABLE – PAGE 1

Pedestrian Choice	Choice	TT	TC	Age	Gender	Origin	Luggage	Mode	Travel Distance
1	R1	30M		35	M		1	W	300KM
2	R1	1HR		18	M		2	W	325KM
3	R1	1HR		45	M		1	W	90KM
4	R1	1HR		38	F		0	W	105KM
5	R1	30M		31	M		1	W	204KM
6	R1	30M		35	M		1	W	228KM
7	R1	45M		65	M		0	W	115KM
8	R1	45M		59	M		0	W	203KM
9	R1	15M		20	F		3	3W	312KM
10	R1	15M		48	M		2	3W	250KM
11	R1	15M		46	F		1	3W	137KM
12	R1	25M		33	F		2	W	205KM
13	R1	30M		35	F		1	W	72KM
14	R1	25M		31	M		1	W	40KM
15	R1	30M		34	M		1	W	60KM
16	R1	30M		45	F		0	W	78KM
17	R1	25M		57	M		1	W	112KM
18	R1	25M		24	M		1	W	120KM
19	R1	30M		22	M		1	W	141KM
20	R1	30M		39	F		2	W	89KM
21	R1	32M		77	M		1	W	90KM
23	R1	32M		14	M		1	W	116KM
24	R1	25M		20	F		2	W	85KM
25	R1	45M		49	M		0	W	35KM
26	R2	35M		20	M		1	W	105KM
27	R2	40M		60	M		0	W	215KM
28	R2	42M		68	F		2	W	180KM
29	R2	45M		76	M		2	3W	218KM
30	R2	35M		80	M		0	W	310KM
31	R2	55M		45	M		3	W	70KM
32	R2	50M		20	M		1	W	100KM
33	R2	61M		45	F		1	W	150KM
34	R2	20M		15	F		2	W	165KM
35	R2	25M		18	F		0	W	178KM
36	R2	30M		20	M		3	W	250KM
37	R2	33M		25	M		1	W	168KM
38	R2	40M		30	M		3	W	178KM
39	R2	45M		36	M		2	W	220KM
40	R2	20M		60	F		0	W	265KM
41	R2	25M		45	M		0	W	310KM

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Fig. 1: Details of data collection

PEDESTRIAN DATA TABLE – PAGE 2

Pedestrian Choice	Choice	TT	TC	Age	Gender	Origin	Luggage	Mode	Travel Distance
42	R2	35M		25	M		1	W	150KM
43	R2	25M		11	M		3	W	255KM
44	R2	30M		18	M		2	W	225KM
45	R2	20M		10	M		1	W	215KM
46	R2	55M		35	F		3	W	280KM
47	R2	40M		40	F		2	W	250KM
48	R2	65M		55	M		1	W	115KM
49	R2	48M		45	M		3	W	204KM
50	R2	50M		55	M		2	W	210KM
51	R2	55M		57	F		1	W	310KM
52	R3	20M		15	M		1	W	325KM
53	R3	15M		18	M		3	W	255KM
54	R3	10M		10	M		2	W	260KM
55	R3	25M		15	F		1	W	220KM
56	R3	20M		14	F		3	W	215KM
57	R3	18M		30	M		2	W	210KM
58	R3	14M		35	M		2	W	220KM
59	R3	18M		40	F		1	W	255KM
60	R3	20M		25	M		1	W	155KM
61	R3	20M		26	M		1	W	255KM
62	R3	20M		28	M		3	W	115KM
63	R3	17M		29	M		2	W	110KM
64	R3	15M		35	F		1	W	255KM
65	R3	20M		37	F		2	W	265KM
66	R3	17M		40	M		2	W	11KM
67	R3	20M		45	M		1	W	230KM
68	R3	20M		43	F		2	W	115KM
69	R3	18M		30	M		3	W	114KM
70	R3	15M		25	F		1	W	210KM
71	R3	18M		35	M		1	W	230KM
72	R3	20M		35	M		1	W	225KM
73	R3	14M		25	M		2	W	210KM
74	R3	20M		26	M		3	W	80KM
75	R3	20M		35	F		3	W	65KM
76	R3	15M		32	F		1	W	45KM
77	R3	17M		35	F		2	W	115KM
78	R3	20M		15	M		1	W	230KM
79	R3	15M		25	M		2	W	265KM
80	R3	20M		35	M		1	W	30KM

Fig. 2: Details of data collection

V. DATA ANALYSIS

Data analysis involves age –wise analysis, gender analysis and mode of transport analysis. Figure 3 shows age wise analysis. It is found from figure that there is more percentage of people in between 40-50 and 50-60 & there is less percentage of people for age 0-10 and 80-90.

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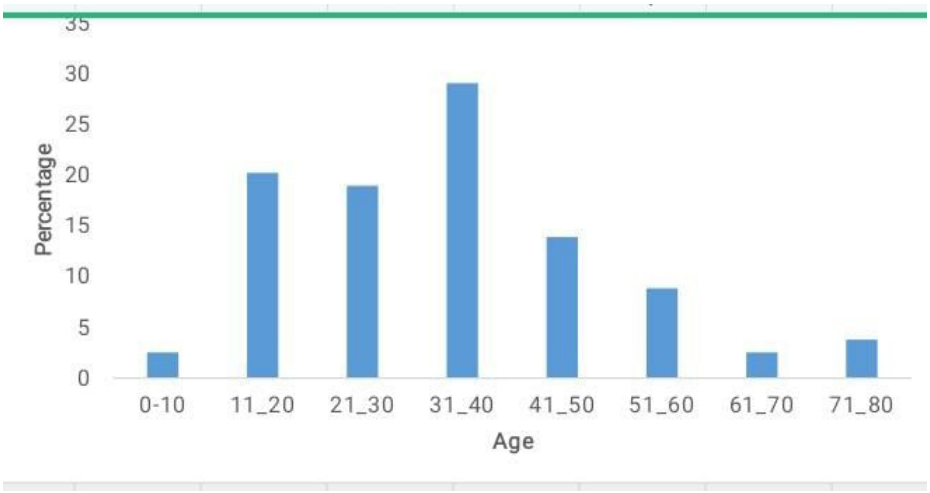


Fig. 3: Age-wise analysis

Age: The largest group is 31–40 years, showing strong participation from middle-aged people.

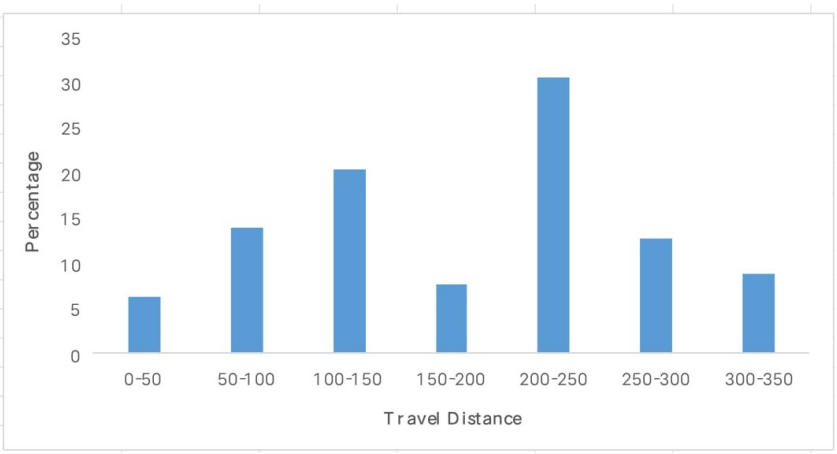


Fig. 4: Details of travel distance

Travel distance: The 200–250 m distance group has the highest share of respondents. Figure 4 shows details of travel distance.

Choice of route : Figure 5 shows choice of route.

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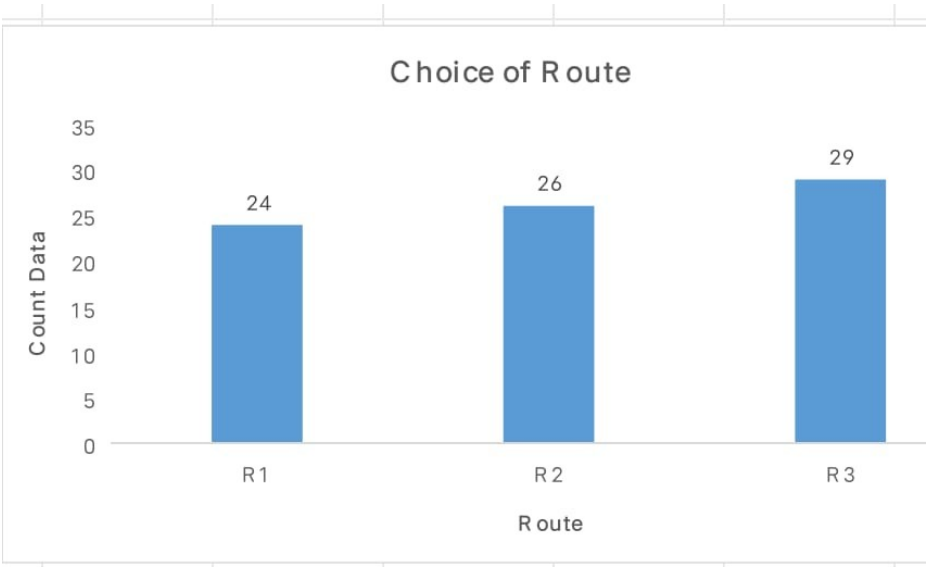


Fig. 5: Choice of route

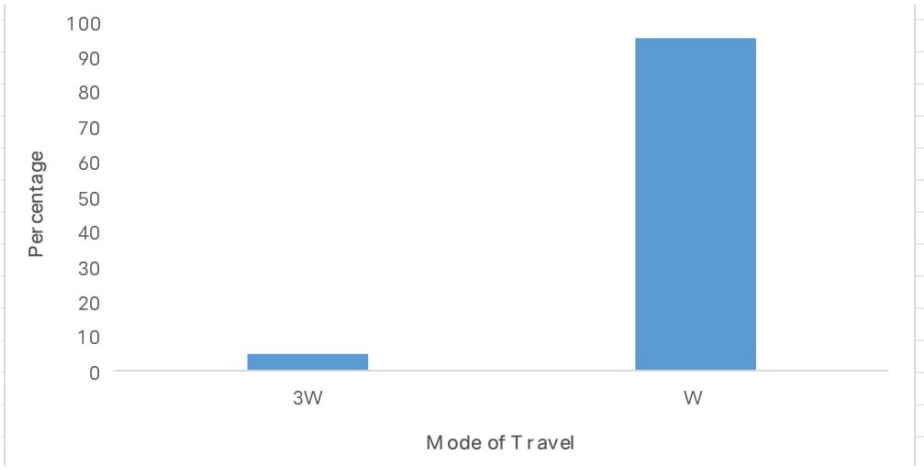


Fig. 6: Mode of travel

Mode of travel: Walking (W) is the dominant mode of travel (≈95%), showing high pedestrian movement. Figure 6 shows mode of travel.



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Fig. 7: Gender

Gender: Males are higher (≈68%) than females (≈33%) in the survey.

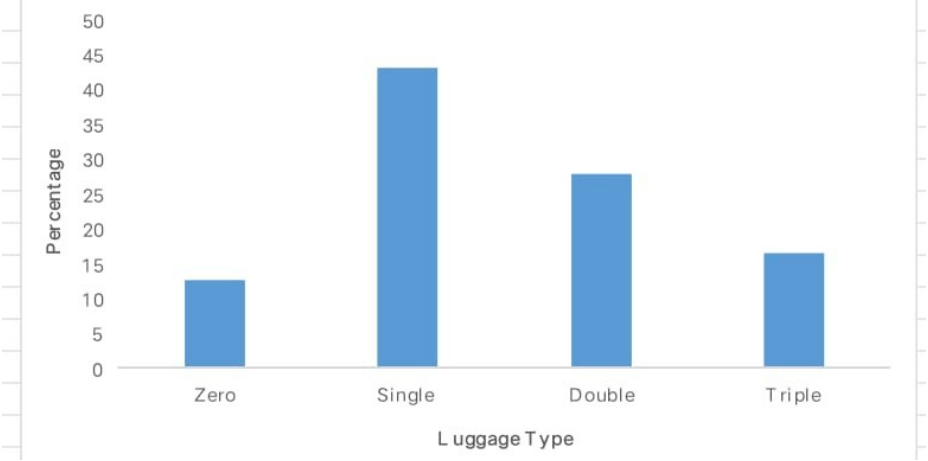


Fig. 8: Type of luggage

Single luggage is the most common type, followed by double and triple luggage.

VI. MODEL DEVELOPMENT

Multinomial Logit Model (MNL) is applied to various trip choices of people. Mode of transport is divided into four types. Walk, Flyover, Shared 3-Wheelers and private 3-wheelers. MNL Equations are framed as shown by equation 1.

$$u(R1)= a0 + a1*(TT) + a2*(TC) + a3*(AGE) + a4*(Luggage) + a5*(mode)$$

$$u(R2) =b0 + b1*(TT) + b2*(TC) + b3*(AGE) + b4*(Luggage) + b5*(mode)$$

$$u(R3)= c0 + c1*(TT) + c2*(TC) + c3*(AGE) + c4*(Luggage) + c5*(mode)\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Calibration of MNL Model is done by using N-Logit software. Table 4 shows Calibration of MNL Model using N-Logit software.

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Table 4: Calibration of MNL models

Constant	Value	Probability (z)
a0	-0.223	0.005
a1	-0.145	0.0012
a2	-3.16	0.0074
a3	1.22	0.0065
a4	0.378	0.012
a5	0.124	0.045
b0	-0.478	0.038
b1	-1.25	0.0098
b2	-2.45	0.0076
b3	-0.114	0.0042
b4	-0.478	0.0018
b5	-0.214	0.034
c0	-0.412	0.0096
c1	-3.29	0.047
c2	-0.248	0.0046
c3	-0.148	0.027
c4	-0.269	0.076
c5	-0.795	0.0021

-

VII. CONCLUSIONS

- It is found from figure that there is more percentage of people in between 40-50 and 50-60 & there is less percentage of people for age 0-10 and 80-90.
- It is found from figures that walk percentage and shared 3-wheelers percentage is more as compared to private 3-wheelers percentage.
- It is found from stated preference survey that flyover is most liked as mode of transport than any other mode of transport. Because of decrease in travel time and travel cost
- It is found that as age of person increases then ability to choose flyovers, shared 3-wheelers and private three-wheelers increases.
- People of Pandharpur city has complex activity patterns
- Multinomial Logit Model (MNL) is best model to capture various activity patterns of the people.
- It is found that trip chaining behaviour of the people increases with increase in travel cost of trips.
- It is found that as age of the people increases then work and shopping trips increases but as age increases then educational trips decrease

VIII. REFERENCES

1. Gálvez-Pérez, D., Guirao, B. and Ortuño, A., 2024. Analysis of the elderly pedestrian traffic accidents in urban scenarios: the case of the Spanish municipalities. International journal of injury control and safety promotion, 31(3), pp.376-395 2.

2. Gorrini, A., Vizzari, G. and Bandini, S., 2016. Towards modelling pedestrian-vehicle interactions: Empirical study on urban unsignalized intersection. arXiv preprint arXiv:1610.07892.
3. Seyfried, A., Passon, O., Steffen, B., Boltes, M., Rupprecht, T. and Klingsch, W., 2009. New insights into pedestrian flow through bottlenecks. Transportation science, 43(3), pp.395-406.
4. Lilasathapornkit, T., 2022. Network Modeling for Walking Infrastructure: Developing Pedestrian Traffic Assignment Methodologies for Large-Scale Footpath Networks (Doctoral dissertation, University of New South Wales (Australia)).
5. Sadhu, A.M. and Patil, A.R., Critical Review of Round About Design Research Approaches and Application to Indian Conditions.
6. Parkavi, S. and Parthiban, A., 2025. Assessing urban traffic congestion for sustainable transportation in Chennai, India: a case study of Kathipara and T. Nagar intersections. Frontiers in Sustainable Cities, 7, p.1684489.
7. Gitelman, V., Carmel, R. and Pesahov, F., 2020. Evaluating impacts of a leading pedestrian signal on pedestrian crossing conditions at signalized urban intersections: a field study. Frontiers in Sustainable Cities, 2, p.45.
8. Jancey, J., Cooper, L., Howat, P., Meuleners, L., Sleet, D. and Baldwin, G., 2013. Pedestrian and motorized mobility scooter safety of older people. Traffic injury prevention, 14(6), pp.647-653.
9. Rao, A.M., Velmurugan, S. and Lakshmi, K.M.V.N., 2017. Evaluation of influence of roadside frictions on the capacity of roads in Delhi, India. Transportation research procedía, 25, pp.4771-4782. 11
10. Zambare, P. and Liu, Y., 2025. Modeling and Simulation of Pedestrian Behavior in Traffic Environment: A Systematic Review of Approaches and Software. IEEE
11. Liu, Y., Ding, X. and Ji, Y., 2023. Enhancing walking accessibility in urban transportation: A comprehensive analysis of influencing factors and mechanisms. Information, 14(11), p.595.
12. Zhu, Z., Cao, Z., He, Y., Guo, H. and Yu, J., 2025. Evaluation of pedestrian networks in urban rail Transit Station catchment areas using entropy weight method and TOPSIS models: empirical evidence from Nanjing, China. Transportation Research Record, 2679(7), pp.317-337
13. Sharma, A., McCloskey, B., Hui, D.S., Rambia, A., Zumla, A., Traore, T., Shafi, S., El-Kafrawy, S.A., Azhar, E.I., Zumla, A. and Rodrigues-Morales, A.J., 2023. Global mass gathering events and deaths due to crowd surge, stampedes, crush and physical injuries-lessons from the Seoul Halloween and other disasters. Travel medicine and infectious disease, 52