COMPARATIVE ANALYSIS OF PEDESTRIAN CROSSING BEHAVIOUR BEFORE AND AFTER THE CONSTRUCTION OF A PEDESTRIAN OVERPASS

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Abstract

This study investigates changes in pedestrian crossing behavior and associated safety outcomes before and after the construction of a pedestrian overpass in İzmir, Turkey. The study area is located along an arterial road with high traffic volumes. Prior to the construction of the pedestrian overpass, pedestrians could cross at an at-grade crosswalk, which was directly connected to the nearby tram station. The combination of high vehicle speeds and pedestrians crossing outside the designated crosswalk showed the need for improved pedestrian safety measures in the area. The second phase of the study was conducted after the overpass started operating. Data were collected through on-site questionnaires and video footage. Before the overpass was built, 54 (44.26%) out of 122 people who participated in the survey perceived their crossing as unsafe or very unsafe. Survey results further showed that 80% of pedestrians (98 respondents) stated they would use an overpass if it were constructed, indicating strong user demand for an overpass. A total of 351 pedestrians were observed through video analysis, categorized by gender, age, group size, and items-carrying condition. Speed observations showed that all pedestrian categories displayed average walking speeds above 2.0 m/s. Raff's method determines the critical gap by plotting the cumulative frequency distributions of accepted and rejected gaps and identifying the intersection point of these two curves. Based on this analysis, the critical gap was calculated as 3.00 s in one direction and 3.30 s in the opposite direction, indicating that pedestrians were willing to accept relatively short gaps before the construction of the overpass.

Keywords: overpass, crossing speed, critical gap, questionnaire survey

1 Introduction

Pedestrians are one of the most vulnerable road users within traffic systems. Direct interaction with motorized vehicles increase the risk of collision severity. In Turkey, a total of 2, 680 fatalities and 162, 295 injuries were recorded among vulnerable road users in 2024, a category comprising pedestrians, motorcyclists, bicyclists, and electric scooter riders. The reported statistics indicate that vulnerable road users accounted for 42.2% of all 6, 351 traffic-related deaths and 42.1% of the 385, 117 injuries reported nationwide during the same year [1]. Such proportions are remarkably high and demonstrate the need for effective safety interventions to protect vulnerable road users. Pedestrian overpasses are traffic facilities designed to enable pedestrians to cross roadways safely by eliminating direct pedestrian–vehicle interactions.

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Räsänen et al. [2] examined pedestrians crossings at five overpasses in Ankara, Turkey and showed that overpass design characteristics significantly influence usage rates, for instance, the overpass equipped with an escalator exhibited the highest usage rate at 62.9%. The authors concluded that the usage rate is expected to increase when pedestrians clearly perceive that the overpass offers safety advantages and convenient crossing conditions without causing significant time loss [2]. A study conducted in Barranquilla, Colombia examined pedestrians who either used a footbridge to cross a high-traffic highway or chose to cross at road level. Survey results showed that although nearly three-quarters of participants perceived the overpass as "safe" or "very safe", this perception did not increase the likelihood of using it [3]. A study conducted in Ipoh, Malaysia found that being in a hurry and fear of heights significantly reduced pedestrians' likelihood of using overpasses. The analysis showed substantial variation in usage rates across locations, ranging from 74% at the highest-compliance site to only 19% at the lowest. The findings further indicated that the presence of an escalator was the most influential factor encouraging footbridge use, while zebra crossings were identified as pedestrians' preferred alternative [4]. Previous studies have shown that pedestrian characteristics play a significant role in crossing speed and gap acceptance. Male pedestrians tend to walk faster and often accept larger gaps than females [5, 6]. Group behavior has also been identified as an important factor influencing crossing decisions. Pedestrians crossing in groups generally accept smaller vehicular gaps, and the reduction in gap acceptance becomes more pronounced as group size increases [7, 8]. Moreover, larger pedestrian groups tend to move more slowly, and drivers are more likely to yield when facing bigger pedestrian platoons [9]. Overall, these studies highlight that both individual attributes and group dynamics significantly shape pedestrian crossing behavior.
The present study investigates pedestrian behavior and crossing safety in İzmir, Turkey, at a location characterized by considerable pedestrian activity and high motorized traffic flow. The study area includes both an at-grade crosswalk and a newly constructed pedestrian overpass, allowing for a comparative assessment of pedestrian decisions before and after the overpass implementation. Within this context, pedestrian speeds, gap acceptance behavior, compliance levels, and crossing preferences were analyzed through field observations, camera-based measurements, and on-site surveys. This combined methodology shows that facility design, pedestrian attributes, and surrounding traffic conditions shape crossing decisions.

2 Method

2.1 Site selection

The study site was strategically selected along an urban corridor characterized by high pedestrian and vehicle traffic. The study was conducted both before and after the construction of the pedestrian overpass, enabling an evaluation of how the new overpass influenced pedestrian behavior. Figure 1 shows the study area which is located in the Karataş neighborhood of the Konak district, situated along Mustafa Kemal Sahil Boulevard (38.4106°N, 27.1188°E). The multi-lane coastal boulevard runs parallel to the Konak Tram line and forms an important transportation corridor along the shoreline of the İzmir Gulf. For the field observations, the cameras were positioned along Mustafa Kemal Sahil Boulevard in a manner that allowed the simultaneous recording of both vehicles and pedestrians.

Figure 1 Study site - Karataş

2.2 Data collection

The before-construction data were collected in November 2024. The pedestrian overpass became operational in May 2025, and the second phase of data collection was conducted in May 2025, immediately after the facility started operating. Pedestrians who crossed the roadway at the study location were surveyed after completing their crossing. The questionnaire collected information on respondents' demographic characteristics (gender and age), the frequency with which they used the crossing, and their perceptions of crossing safety. In the survey conducted before the construction of the pedestrian overpass, participants were also asked whether they would use an overpass if it were provided at the location. In the second phase of the study, conducted after the overpass became operational, additional questions were directed to pedestrians using the overpass. These questions aimed to evaluate the perceived safety of the facility, its ease of use, and whether respondents believed that using the overpass provided time savings. In addition to the survey data, various metrics were obtained from the camera recordings, including pedestrians' crossing speeds, the accepted and rejected temporal gaps that non-compliant pedestrians perceived as sufficiently safe or unsafe to cross. These observations provide a detailed understanding of pedestrian decision-making and risk-taking behavior at the study site.

3 Results

3.1 Descriptive statistics

The numbers of pedestrians observed before and after the construction of the overpass, categorized by gender, age, group size, and item-carrying status, are presented in table 1.

Table 1 Descriptive statistics of pedestrians observed before and after the construction of the pedestrian overpass

		Before the overpass	After the overpass	
		At-road level	**Overpass**	**At-road level**
Gender	Male	78	86	110
	Female	55	132	130
Age	0-18	15	80	50
	19-65	104	115	178
	65+	14	3	12
Group size	Individual	104	128	156
	2+	29	90	84
Items-carrying	Without items	38	56	198
	With items	95	162	42
Total		**133**	**218**	**240**

3.2 Pedestrian crossing speeds

Table 2 presents the average and 15th-percentile pedestrian crossing speeds measured at the road level before and after the construction of the pedestrian overpass. The results indicate a decrease in crossing speeds after the implementation of the overpass. Before the construction, average pedestrian speeds ranged between 2.22 m/s and 2.78 m/s, whereas after the overpass became operational they decreased to a range between 1.32 m/s and 1.54 m/s. Across all demographic categories, younger pedestrians (0–18 years) displayed the highest crossing speeds, while elderly pedestrians (65+) showed the lowest speeds in both observation periods. Differences between male and female pedestrians remained relatively small. Similarly, pedestrians carrying items tended to walk slightly slower than those without items, while group size had only a limited influence on crossing speed.

Table 2 Average and 15th-percentile pedestrian crossing speeds before and after the overpass

		Before the overpass		After the overpass	
		Average crossing speed [m/s]	**15th-percentile crossing speed [m/s]**	**Average crossing speed [m/s]**	**15th-percentile crossing speed [m/s]**
Gender	Male	2.60	2.12	1.53	1.25
	Female	2.64	2.07	1.49	1.25
Age	0-18	2.78	2.25	1.49	1.33
	19-65	2.59	2.12	1.52	1.25
	65+	2.22	1.77	1.32	1.16
Group size	Individual	2.54	2.12	1.54	1.25
	2+	2.59	2.12	1.45	1.22
Items-carrying	Without items	2.68	2.25	1.51	1.25
	With items	2.56	2.01	1.49	1.18

3.3 Critical gap

Studies aimed at defining the concept of critical gap date back to the 1970s, when researchers estimated vehicle and pedestrian capacity at stop-controlled intersections. In this context, the critical gap is commonly defined as the shortest time interval that a pedestrian or driver perceives as acceptable for safely completing a crossing maneuver. However, accurately estimating this value poses statistical challenges, leading to the development of various modelling approaches. Among these approaches, the Raff method has become one of the most widely used techniques due to its computational simplicity and ease of application. The method determines the critical gap by plotting the cumulative frequency distributions of accepted and rejected gaps and identifying the point at which the two curves intersect. This intersection represents the critical gap value derived through the Raff's method [10]. In figure 2, the graph on the left illustrates the critical gap for vehicles traveling eastbound, while the graph on the right presents the corresponding values for westbound traffic. When the accepted and rejected gaps for the eastbound direction were plotted, the critical gap was determined to be 3.30 seconds, whereas the corresponding critical gap for the westbound direction was found to be 3.00 seconds.

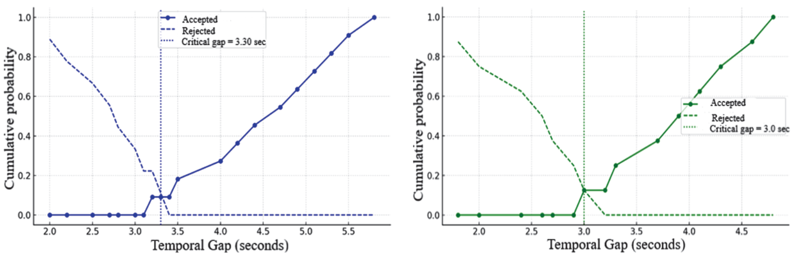

Figure 2 Pedestrian Crossing Dimensions in the Karataş Area

3.4 Questionnaire survey results

A total of 122 participants were surveyed in each phase of the study. The demographic characteristics and responses of the participants before the construction of the overpass are presented in table 3, while the results obtained after the overpass became operational are summarized in table 4. Before the construction of the overpass, the sample consisted mostly of male respondents (66%) and adults aged 19–65 (72%). Many participants (43%) reported using the crossing every day. Approximately 44% of respondents evaluated the crossing as unsafe or very unsafe, while about 30% perceived it as safe or very safe. Despite these mixed safety perceptions, a large majority of respondents (80%) stated that they would use a pedestrian overpass if one were constructed at the location. After the construction of the overpass, 43% of the respondents reported that they always used the overpass. Approximately 89% of respondents rated the overpass crossing as safe or very safe. In addition, about 88% of the respondents indicated that the overpass was easy to use. Similarly, more than 71% of respondents agreed or strongly agreed that using the overpass provided time savings.

Table 3 Respondent characteristics and survey results (before the overpass)

		Count	Percent
Gender	Male	80	65.57%
	Female	42	34.43%
Age	0-18	19	15.57%
	19-65	88	72.13%
	65+	15	12.30%
Frequency of using the pedestrian crossing	First time	12	9.84%
	1-2 times in a month	12	9.84%
	1-2 times in a week	21	17.21%
	3-4 times in a week	21	17.21%
	On weekdays	4	3.28%
	Everyday	52	42.62%
Safety evaluation of crossing at road-level	Very unsafe	28	22.95%
	Unsafe	26	21.31%
	Neutral	32	26.23%
	Safe	31	25.41%
	Very safe	5	4.10%
Potential demand of overpass use	I would use	98	80.33%
	I would not use	19	15.57%
	No idea	5	4.10%

Table 4 Respondent characteristics and survey results (after the overpass)

		Count	Percent
Gender	Male	66	54.10%
	Female	56	45.90%
Age	0-18	29	23.77%
	19-65	83	68.03%
	65+	10	8.20%
Frequency of using the pedestrian overpass	Rarely	27	22.13%
	Occasionally	27	22.13%
	Frequently	15	12.30%
	Always	53	43.44%
Safety evaluation of crossing using the pedestrian overpass	Very unsafe	0	0%
	Unsafe	2	1.64%
	Neutral	12	9.84%
	Safe	47	38.52%
	Very safe	61	50.00%

Table 1 Respondent characteristics and survey results (after the overpass) - continuation

		Count	Percent
Ease of using the pedestrian overpass	Strongly disagree	4	3.28%
	Disagree	3	2.46%
	Neutral	8	6.56%
	Agree	33	27.05%
	Strongly agree	74	60.66%
Perceptions regarding the overpass's ability to provide time savings	Strongly disagree	11	9.02%
	Disagree	11	9.02%
	Neutral	13	10.66%
	Agree	29	23.77%
	Strongly agree	58	47.54%

4 Conclusion

This study investigated pedestrian crossing behavior before and after the construction of a pedestrian overpass in İzmir, Turkey. Prior to the construction, many pedestrians perceived the at-grade crossing as unsafe. Survey results indicated that a large proportion of pedestrians expressed a willingness to use an overpass. After the overpass became operational, safety perceptions improved considerably, and many pedestrians reported using the grade-separated facility. Field observations further showed that pedestrians previously crossed the roadway at relatively high speeds likely due to the direct connection between the at-grade crossing and the tram stop. Overall, the findings suggest that implementing a pedestrian overpass in high-traffic corridors can improve perceived pedestrian safety and encourage the use of safer crossing facilities.

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