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TRANSCOM 2025: 16th International Scientific Conference on Sustainable, Modern and Safe Transport

Politechnika Świętokrzyska
Kielce University of Technology

Analysis of Pedestrian Behavior at Crosswalks in Urban Environments

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INTRODUCTION

Backround information & Market Context

- In 2023, there were 2,684 pedestrian crossing accidents in Poland, a rise compared to the previous year.
- According to the WHO, pedestrians account for 22% of global road traffic fatalities.
- 69.4% of the global population uses smartphones — a major factor contributing to increased pedestrian risk.
- Mobile phone usage while crossing streets has become a significant distraction, leading to higher accident rates.

Problem Statement & Stakeholders

Pedestrian distraction caused by mobile devices leads to traffic violations and increased accident risk, especially at unsignalized crosswalks.

Research Objectives & Expected Impact

- To analyze how mobile device use affects pedestrian behavior at both signalized and unsignalized crosswalks.
- To identify behavioral differences across demographic groups.
- To provide recommendations for pedestrian education, infrastructure design (e.g., sidewalk-integrated traffic lights), and policy improvements.
- The expected impact is to enhance pedestrian safety and reduce the number of road accidents

MATERIALS, METHODS & IMPLEMENTATION

The study was conducted in **Kielce, Poland**, between **2023–2024**, covering both **signalized** and **unsignalized pedestrian crosswalks**. Observations took place at **five major signalized intersections** (e.g., **Warszawska Street & Tysiąclecia Avenue**) and **four unsignalized crosswalks** near the **K. Sabbat Roundabout** and **Radiowa–Polna Street intersection**.
Data collection methods included **direct observation**, **video recordings**, and **standardized observational questionnaires**. The analysis focused on **pedestrian behavior**, such as **mobile device usage** (phone calls, screen use, headphones), **compliance with traffic signals** (green, flashing green, red), and **mode of movement** (on foot, bicycle, scooter).
In total, **1,498 pedestrians** were observed at signalized crossings and **1,179 pedestrians** at unsignalized ones. Collected data was processed using **descriptive statistics** (median, quartiles, mode) and **chi-square tests** (**p = 0.0001**), confirming statistically significant differences in behavior.
The results were visualized through **bar charts and pie graphs**, allowing clear comparisons between locations and identification of patterns. The findings supported **recommendations** for improving **pedestrian safety** through **infrastructure enhancements** (e.g., better crosswalk markings, adjusted signal timing), **educational campaigns**, and the use of **technology** (e.g., warning systems for distracted pedestrians).

RESULTS

Academic Findings & Innovation
The study revealed that **15% of all pedestrians** used mobile phones while crossing the street, and **up to 20%** at certain **unsignalized crosswalks**. A statistically significant relationship (**p = 0.0001**) was found between **intersection type** and **risky pedestrian behavior**.
Key findings:

- **Pedestrians using phones** are more likely to cross on a red light or without checking traffic.
- **Demographic differences**: Women generally follow traffic rules more, while men take more impulsive risks.
- **Environmental factors**, such as poor lighting or weather, increase distractions.
- **Innovation**: Application of behavioral observation combined with **AI-assisted analysis** for pattern recognition opens new directions for research.

Practical Applications

- Implementation of **visual warnings** at crosswalks (e.g., LED strips in sidewalks for phone users).
- Development of **educational campaigns** to raise awareness about distraction-related risks.
- Adaptation of **traffic light timings** to reflect real pedestrian needs.
- Integration of **mobile apps** that alert users when approaching intersections.
- **Infrastructure redesign**: improved marking, signage, and visibility at high-risk crosswalks.

Table 1. Summary of pedestrian behavior at individual intersections studied

Parametr	crossing 1		crossing 2		crossing 3		crossing 4		crossing 5		Sum	
	n	%	n	%	n	%	n	%	n	%	n	%
Pedestrian with phone	51	17	42	15	20	7	37	10	69	26	219	15
Pedestrian with headphones	20	7	32	12	23	8	45	12	24	9	144	10
People with a bicycle, scooter, etc.	4	1	48	17	96	34	60	16	36	13	244	16
Entry with a phone - conversation	8	3	12	4	3	1	19	5	18	7	60	4
Entry with a phone - active use	14	5	7	3	8	3	14	4	15	6	58	4
Pedestrian not using any devices	207	68	135	49	131	47	192	52	108	40	773	52
Sum	304		276		281		367		270		1498	
Chi-square	χ2 = 188,06				df=20						p = 0,0001	

Table 2. Summary of pedestrian behavior at an intersection without traffic lights

No.	Total number of pedestrians	Entry with a phone		People with a bicycle, scooter, etc.		Pedestrian with headphones		Entry with a phone - conversation		Entry with a phone - active use	
		n	%	n	%	n	%	n	%	n	%
1	46	44	9	16	3	29	6	23	5	6	1
2	477	27	6	12	3	9	2	16	3	27	6
3	276	29	11	8	3	7	3	11	4	9	3
4	361	74	20	6	2	40	11	14	4	10	3

CONCLUSION & IMPLEMENTATION PATH

The study demonstrated that **mobile device use** by pedestrians is a significant safety risk, especially at **unsignalized crosswalks**, where the percentage of phone users reached up to **20%**. Despite preventive efforts, public **awareness of these risks remains insufficient**.
Key conclusions:
•**52% of pedestrians** did not use any distracting devices — a positive indicator of growing awareness.
•**Pedestrian behavior varies** depending on location, environmental conditions, and crosswalk type.
•**Education**, **infrastructure upgrades**, and **smart technologies** (e.g., warning apps) can play a major role in enhancing road safety.