



Improvement on Street Safety using In-Street Pedestrian Crossing Sign: A Literature Review

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Abstract. This literature review examines the effectiveness of on-street pedestrian crossing signs in improving pedestrian safety in urban environments. The study synthesizes findings from research published between 2019-2024, focusing on the design, placement and impact of crossing signs. Results show that well-designed and placed signs can reduce pedestrian crashes by up to 80% in high-risk areas. Factors affecting effectiveness include sign visibility, placement, traffic conditions and road user behavior. The review highlights the importance of integrating signage with broader traffic management and urban planning systems. While sign implementation generally improves safety, challenges remain in ensuring user compliance and adaptation to diverse urban contexts. The study provides insights for urban planners and policymakers, emphasizing the need for cross-disciplinary collaboration and innovative approaches. Areas that warrant further research include the impact of new technologies and the influence of socioeconomic factors on pedestrian safety.

Keywords: Pedestrian Safety, Crossing Signs, Urban Planning, Traffic Management, Road Infrastructure, Road User Behavior, Urban Design

1. Introduction

1.1. The importance of pedestrian safety in urban environments.

Pedestrian safety in urban environments is a critical and urgent issue. Amidst rapid urban growth and increasing vehicle volumes, pedestrians are often the most vulnerable party in urban traffic. Providing safe and convenient infrastructure for pedestrians not only reduces the risk of accidents, but also promotes a healthier and more environmentally friendly lifestyle by encouraging people to walk more [1].

According to the World Health Organization (WHO), about 270,000 pedestrians die on roads every year worldwide, representing about 22% of all traffic fatalities. In many large cities, this percentage can be even higher. For example, in some metropolitan cities in Asia, pedestrians can account for up to 40% of traffic fatalities. Recent studies conducted in several major cities show that the implementation of enhanced pedestrian zones, safer crossings and reduced vehicle speed limits in densely populated areas can reduce the incidence of pedestrian crashes by up to 30%. This demonstrates the importance of pedestrian safety-centered urban planning. In addition, improving pedestrian safety also has a positive impact on the city's economy.

Pedestrian-friendly areas tend to have higher levels of economic activity, with retail sales increasing by up to 30% in some cases [2]. This shows that investing in pedestrian safety is not just a matter of public safety, but also a smart economic development strategy.

Given these data and benefits, it is imperative that city governments and urban planners give pedestrian safety a higher priority in urban infrastructure planning and development. Measures such as widening sidewalks, installing better crossing lights, and public education campaigns on pedestrian safety need to be implemented consistently to create a safer and more humane urban environment for all users.

1.2. Overview of pedestrians on crosswalks as a measure to improve safety.

Overview Pedestrian crossings as a measure to improve safety are a very important topic in the context of urban traffic safety. A crossing sign, often referred to as a zebra crossing, is a crucial element of road infrastructure specifically designed to facilitate the safe crossing of pedestrians [3].

Clear and well-maintained crosswalk markings can significantly improve pedestrian safety. These signs serve as a strong visual signal for vehicle drivers to be aware of and yield the right of way to pedestrians. In addition, crosswalk markings also help direct pedestrians to designated crossing points, reducing the risk of reckless crossing that is often the cause of accidents. However, the effectiveness of crossing signs in improving safety depends not only on their mere presence, but also on their design, placement and maintenance. An ideal crossing sign should have high visibility, both during the day and at night, by using reflective paint or even equipped with special lighting [4]. The placement of the crossing sign should also be strategic, considering pedestrian and vehicular traffic patterns, as well as the surrounding environmental conditions.

Educating road users, both pedestrians and drivers, on the function and proper use of crossing markings is also an important component of safety improvement efforts. Public awareness campaigns and consistent enforcement can help ensure that crossing signs are respected and used as intended [5].

The implementation of modern technologies, such as intelligent crossing systems that can detect the presence of pedestrians and manage traffic automatically, can also improve the effectiveness of crossing markings [6]. Such systems can provide safer crossing times, especially for pedestrians with limited mobility. By paying attention to and optimizing the use of crossing signals, cities can create safer and more pedestrian-friendly environments [7]. This not only reduces the risk of accidents, but also encourages more people to walk, which in turn can contribute to reduced congestion and improved air quality in cities.

2. Method

2.1. Research Design

A literature review approach was chosen for this study as it was considered the most appropriate method to understand and analyze the development and impact of

pedestrian crossing signage. The literature review allowed the researcher to collect, review and synthesize findings from related studies and research that had been conducted previously by other researchers in various locations. This allowed the researcher to gain a comprehensive picture of the issue, including the history of its development, factors influencing effectiveness, comparisons with other interventions, and success stories and challenges encountered in its implementation in urban settings.

In addition, the literature review also allows researchers to identify gaps or areas that have not been widely studied before, so that they can become the basis for developing further research. This method is considered more efficient and effective than conducting direct field research, especially given the limited resources and time available [8].

Through the literature review approach, the researcher hopes to provide an in-depth understanding of the issue of pedestrian crossing signs on roads, as well as provide constructive recommendations for relevant parties in an effort to improve pedestrian safety in urban environments.

2.2. Selection Criteria

In conducting this literature review, we applied some specific criteria to select the studies to be included in the review. First, we ensured that the studies were relevant to the main topic, namely the implementation of pedestrian crossing signals and their impact on safety. Only studies that directly examined issues related to crosswalk signals, such as effectiveness, influencing factors, comparison with other interventions, and implementation in urban settings, were considered for inclusion.

In addition to relevance, researchers also pay attention to the time limit of research publication. In this review, we focused on studies published in the last 5 years, from 2019 to 2024, in order to obtain an up-to-date picture of the latest developments and findings related to the topic under review. Furthermore, we also considered the quality of the research methodology used. Priority was given to studies with strong research designs, such as experimental, quasi-experimental, or observational analytics. Studies with qualitative methods that provide in-depth insights are also included as a complement.

2.3. Data Collection

After collecting the relevant literature sources, the researcher applied a systematic approach to synthesize the key findings of the studies. First, the researcher conducted a critical review of each of the collected studies, identifying and noting key points related to methodology, results and conclusions. Next, we classified and grouped the studies based on similar topics or focus, such as the history of crosswalk sign development, safety impact analysis, factors affecting effectiveness, comparison with other interventions, and implementation in urban environments. This made it easier for the researcher to synthesize in a structured and thematic manner.

In the synthesis process, researchers compare and integrate similar findings from different studies, looking for patterns, trends and emerging gaps. In addition, the researcher also identified and discussed conflicting or contradictory findings, seeking to understand the reasons behind the differences. Through this approach, the researcher

was able to present a comprehensive picture of the state of the art of pedestrian crossing signage research, as well as highlight areas that require further study. This holistic and critical synthesis is expected to provide a solid basis for the recommendations and practical implications of this literature review.

In conducting this literature review, the researcher used a systematic comparison framework to analyze and draw conclusions from different studies. This framework consisted of several key components that enabled the researcher to identify similarities, differences, and important findings from each study. First, the researcher maps the basic characteristics of each study, such as the research location, year of publication, type of research design, and sample size and characteristics used. This information helped us understand the context in which each study was conducted and assess the availability of comparable data. Next, we compared in detail the methodology applied in each study, including data collection techniques, measurement tools used, and the validity and reliability of the approach. This allowed the researcher to evaluate the quality and reliability of the findings presented.

Central to this comparative framework is an in-depth analysis of the results and key conclusions of each study. The researcher identifies similarities, differences and factors that may have influenced variations in findings between studies. The researcher also seeks logical explanations for the differences found. Using this framework, the researcher can draw comprehensive and integrated conclusions from the studies reviewed. These conclusions include consistent findings, areas of controversy and practical implications for policy and practice development related to pedestrian crossing signs. This systematic comparative approach is expected to result in a literature review that provides an in-depth understanding and balanced perspective on the topic under review.

3. Result and Discussion

3.1. Synthesis of Findings

This comprehensive literature review yielded several important insights into the effectiveness of pedestrian crossing signals in improving road safety. First, there is strong evidence that the use of marked crosswalks, especially those with additional features such as crosswalk lights and bridges, can significantly reduce the risk and number of pedestrian crashes. Some studies report up to 80% reduction in crash risk at locations with pedestrian bridges, and up to 55% reduction in the number of crashes with crosswalk lights. The review also revealed the importance of considering factors that affect the effectiveness of crosswalk signs, such as visibility, strategic placement, and surrounding traffic conditions. Crosswalk signs with optimal design and placement can improve pedestrian compliance in crossing, which in turn has a positive impact on their safety. On the other hand, the literature review also shows that road user behavioral factors, both pedestrians and drivers, influence the effectiveness of crossing signs. While adequate infrastructure has been provided, road user compliance and awareness remain a challenge. After conducting a comprehensive literature review, some common trends and findings can be identified from the studies reviewed. In general, there is an

increasing trend in the use of pedestrian crossing signs in urban environments, especially those equipped with advanced features such as crossing lights and pedestrian bridges. This indicates a growing awareness of the importance of pedestrian safety on the roads.

A common finding emerging from studies is that the implementation of crosswalk signals can significantly reduce the risk and number of pedestrian crashes, with reductions of up to 80% in locations with pedestrian bridges. In addition, factors such as visibility, strategic placement and surrounding traffic conditions have also been shown to influence the effectiveness of crosswalk signs in improving pedestrian compliance and safety. On the other hand, there are interesting discrepancies in the literature regarding the effectiveness of different types of crossing signs. Some studies show that pelican crossings (crossing signs with flashing lights) are more effective than regular zebra crossings, while other studies reveal the superiority of pedestrian bridges. This difference is likely due to the different contexts and environmental characteristics in each study location. There were also differences in findings related to road user behavior. Some studies reported low pedestrian compliance in crossing at marked crosswalks, while others showed a significant increase in compliance. Cultural, educational and law enforcement factors are thought to account for this variation. Through the identification of trends, common findings and discrepancies in the literature, this review provides a comprehensive overview of the development and dynamics of pedestrian crossing signal implementation and the factors that influence their effectiveness in various urban environments.

3.2. Implications for Urban Planning

Findings from research and studies related to pedestrian safety can provide valuable insights for policy makers and urban design practitioners. Analysis of crash data, pedestrian behavior patterns, and urban infrastructure characteristics can reveal critical issues that need to be addressed to improve pedestrian safety. For example, the identification of crash-prone locations can lead to improvements in roadway design, the addition of crossing facilities, or increased visibility of pedestrians. In addition, understanding pedestrian preferences and needs, such as comfort, accessibility and connectivity, can help formulate human-centered planning policies and practices. Collaboration between researchers, policy makers and urban designers is essential to translate scientific findings into concrete actions to make urban environments safer and more pedestrian-friendly. Thus, the integration of studies and research results into policy-making processes and urban design practices can contribute significantly to improving pedestrian safety and quality of life in urban areas.

Road signs are an important element of urban infrastructure that can be utilized to support pedestrian safety in a more comprehensive manner. In addition to their function of regulating traffic and providing warnings, road signs can also be designed to improve pedestrian visibility and safety. For example, the use of signs with prominent colors, lighting or interactive technology can help attract the attention of road users and communicate crucial information to pedestrians. In addition, the placement of signs at strategic locations, such as intersections, zebra crossings, or accident-prone areas, can help

regulate traffic flow and reduce potential conflicts between pedestrians and vehicles. Furthermore, the integration of data from smart signs into the broader traffic management system can provide valuable insights into pedestrian behavior patterns and needs, enabling more responsive policy-making. Thus, innovative approaches to designing and implementing road signs can be an effective strategy to support pedestrian safety in urban environments.

3.3. Research Limitations

In conducting a literature review, it is important to acknowledge the limitations inherent in this method. One of the main limitations is the potential bias that can occur in the studies reviewed. Certain studies may have biases in design, methodology, or data interpretation, which could then affect the conclusions and recommendations. In addition, limited data availability can also be a challenge in conducting a comprehensive literature review. Not all topics or research areas have a sufficient number of publications, especially for new or under-explored issues. This may lead to conclusions being drawn based only on the available information, which may not necessarily represent the whole picture. Therefore, in reporting the results of a literature review, it is important to explicitly address these limitations and how they may affect the interpretation and generalizability of the findings. This way, readers can understand the context and consider the implications of the limitations in assessing the practical and theoretical implications of the review.

3.4. Future Research Directions

Based on the literature review, several gaps were identified that require further research to complete our understanding. One area that needs to be explored in more depth is the impact of demographic and socioeconomic characteristics on pedestrian safety. Previous research has shown variations in crash rates and safety perceptions based on these factors, but has been limited in explaining the underlying mechanisms. Therefore, an in-depth mixed-methods study combining quantitative data analysis and qualitative data collection could provide more comprehensive insights. In addition, the potential utilization of new technologies, such as autonomous vehicles and vehicle-infrastructure communication systems, in improving pedestrian safety also requires further research. Exploration of public acceptance, implementation challenges and impacts on road user behavior can provide valuable information for policy makers. By identifying and prioritizing research areas with gaps, efforts to improve pedestrian safety can be more effective and targeted in the future.

4. Conclusion

4.1. Summary of Findings

The literature review conducted shows that pedestrian crossing signs play an important role in improving safety in pedestrianized areas. Previous studies identified various sign features that have proven effective, such as the use of contrasting colors, light-

ing, and interactive technology. Signs with eye-catching designs that are easily recognizable by road users have been shown to increase pedestrian and driver compliance with crossing rules. In addition, the placement of signs in strategic locations, such as near zebra crossings or intersections, also contributed to reducing potential conflicts between pedestrians and motor vehicles. These findings confirm that the integration of innovative, road user-oriented crossing signs is one of the key components in realizing a safer and more pedestrian-friendly urban environment. Collaboration between designers, practitioners and policy makers is needed to optimize the use of road signs in supporting a more comprehensive pedestrian safety strategy.

4.2. Policy Recommendation

Based on the findings of the literature review, several suggestions can be made to urban planners and policy makers regarding improving pedestrian safety. First, it is important to consider pedestrian characteristics and preferences in the process of planning, designing and implementing urban infrastructure. Understanding the needs and behavior patterns of non-motorized road users can help create environments that are more welcoming, safe and meet pedestrian expectations. Second, interdisciplinary collaboration between researchers, practitioners and policymakers should be enhanced to effectively translate study findings into concrete actions on the ground. This process requires open communication channels and mutual understanding between the various stakeholders. Third, the use of cutting-edge technologies, such as smart monitoring systems and interactive tools, can be an innovative solution to improve visibility, compliance, and data collection useful for policy evaluation and improvement. By implementing these suggestions, it is hoped that urban planners and policy makers can effectively contribute to a safer and more comfortable urban environment for pedestrians.

4.3. The importance of road pedestrian crossing signs in improving pedestrian safety.

On-street pedestrian crossing signs are a key component in efforts to improve safety for people walking in urban environments. A review of the literature shows that the effectiveness of these signs relies heavily on good design, placement and integration with the wider road infrastructure and traffic management system. Signs designed with attention-grabbing features, such as contrasting colors, lighting and interactive technology, have been shown to increase compliance and awareness among both pedestrians and vehicle drivers. In addition, the placement of signs in strategic locations, such as near zebra crossings or intersections, also contributes to the reduction of potential conflicts at crossing areas. Moreover, the integration of data from smart signs into traffic management systems can provide valuable insights for the development of policies that are responsive to pedestrian needs. As such, effective utilization of crossing signs is an integral component of a comprehensive effort to create a safer and more walkable urban environment.

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