A NEW METHOD FOR ASSESSING THE IMPACT OF UNDERGROUND AND OVERGROUND PEDESTRIAN CROSSINGS ON TRANSPORT EFFICIENCY

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Abstract: Urbanization processes are accelerating across the globe, leading to significant changes in the structure and organization of urban transport networks. As cities expand, the importance of improving both pedestrian and vehicle traffic infrastructure becomes ever more critical. One aspect that has garnered special attention in recent years is the design and implementation of pedestrian crossings, specifically underground and overground pedestrian crossings, and their influence on the overall efficiency of urban transport systems. The necessity of ensuring both pedestrian safety and the free flow of vehicular traffic underlies the need for constantly improved assessment methods concerning the placement and construction of such crossings. Consequently, the development of novel approaches to calculating the impact of these solutions has become a vital area of research within urban planning and transport engineering.

Keywords: pedestrian crossing, underground crossing, overground crossing, transport efficiency, urban planning, traffic simulation, accessibility, safety, infrastructure assessment, mobility.

Efficient transport systems serve as the lifeblood of modern cities, ensuring the mobility of people and goods while minimizing delays and promoting safety. In this context, interruptions to vehicle flow caused by level crossings for pedestrians represent a substantial challenge. Surface pedestrian crossings, while often easier and cheaper to construct, can disrupt traffic, leading to increased vehicle delays, congestion, and a heightened risk of road accidents. On the other hand, grade-separated crossings, either underground or overground, offer

alternatives designed to separate pedestrian and vehicle flows. However, the construction and subsequent use of these crossings imply not just financial costs but also potential implications for pedestrian movement and urban aesthetics. When assessing the impact of constructing underground and overground pedestrian crossings, it is necessary to consider a wide array of factors, ranging from construction costs and urban design to safety, comfort, accessibility, and, most importantly, the effect on transport system efficiency. Traditional methods often rely on simplistic estimations of vehicle delay times and basic analyses of pedestrian flow. However, the growing complexity of urban transport systems and the need for more precise planning demand a more comprehensive and dynamic approach to such evaluations [1].

A new method for assessing the impact of pedestrian crossings on transport efficiency centers around several key principles. Firstly, it integrates detailed traffic simulation models that incorporate both vehicle and pedestrian flows. These models use real-world data gathered from traffic counts, pedestrian surveys, and intersection performance characteristics. By inputting detailed information about both current and projected traffic volumes, it becomes possible to model scenarios both with and without grade-separated pedestrian crossings. This simulation approach allows city planners to identify the change in vehicle delay times, queue lengths, and total travel times associated with the presence of above-ground or underground crossings. Secondly, the method includes an evaluation of pedestrian behavior and accessibility. Grade-separated crossings, though beneficial for vehicles, can potentially reduce pedestrian comfort and increase travel distances—especially if proper access, such as ramps or elevators, is not provided. The assessment thus incorporates analyses of pedestrian route choices, compliance with crossing facilities, and the overall convenience and safety of the structure. By using pedestrian willingness-to-use rates and observed usage patterns, the model is capable of adjusting estimates of vehicular improvement relative to the actual effect on pedestrian movement. Thirdly, a new method takes into account the broader urban context. This involves evaluating how the location and design of

crossings integrate with existing land use, public spaces, and urban fabric. The urban context affects the attractiveness of pedestrian crossings and their success in diverting pedestrian flows from at-grade surface crossings, thereby influencing their actual impact on transport efficiency [2].

A key component of this modern assessment method is the use of multi-criteria analysis. This involves the combination of quantitative indicators—such as changes in vehicle travel times and pedestrian delay times—with qualitative assessments, including perceptions of safety, comfort, and urban aesthetics. By weighting these criteria according to stakeholder priorities, cities can make more informed decisions about the most suitable type and location of pedestrian infrastructure.

To further enhance the accuracy of the assessment, the new method proposes periodic before-and-after studies. Prior to construction, baseline data is collected to establish existing travel patterns and delay times. After the installation of the underground or overground crossing, the same indicators are measured, thus enabling a concrete comparison of the actual and predicted impact. This evidence-based approach provides feedback for future projects and encourages an adaptive process of continuous improvement in urban transport planning. The economic dimension of efficiency assessment is also critical. The new method involves a detailed cost-benefit analysis that not only quantifies the construction and maintenance costs of the infrastructure but also calculates the value of time savings for vehicle users and pedestrians, reduction in accident rates, and potential economic benefits caused by improved accessibility and urban cohesion. These factors help to establish a clear relationship between investment in pedestrian infrastructure and the broader benefits to societal welfare. One significant advancement in this method is its dynamic temporal perspective. Rather than limiting analysis to a specific point in time, the method employs time-based simulation models to evaluate the impact of crossings during various periods, such as peak and off-peak hours, weekdays and weekends, and even anticipated changes due to population growth. By adopting this approach, urban planners can better

anticipate how infrastructure will perform under changing conditions and avoid common pitfalls associated with static, one-off analyses[3].

Another feature is the inclusion of stakeholder engagement in the assessment process. The method provides mechanisms for collecting input from residents, business owners, and other affected parties, ensuring that the selected solutions align with community needs and preferences. Incorporating diverse perspectives not only improves the technical quality of evaluations but also fosters public support for the implementation of the projects. Environmental impact is another important consideration. The method incorporates an evaluation of how the proposed crossings affect pollution levels, noise, and overall urban ecology. Grade-separated crossings that reduce vehicle delays can contribute to lower emissions and improved air quality, further supporting sustainable urban development goals. Furthermore, the method pays special attention to universal accessibility. Ensuring that underground and overground crossings are fully accessible for persons with disabilities, the elderly, and individuals with strollers or other mobility aids is a vital criterion. The assessment framework evaluates the availability and quality of elevators, ramps, and signage, as well as the overall safety and comfort of the pedestrian environment. The role of monitoring and continuous improvement is emphasized in this method. Through regular assessment, cities can detect emerging issues, such as maintenance needs or shifts in usage patterns, and take proactive steps to address them. This iterative approach ensures that pedestrian infrastructure continues to meet the evolving needs of the urban population [4].

Moreover, the aesthetic and cultural aspects of infrastructure projects are considered key factors. The method promotes the integration of artistic and architectural elements into the design of crossings, contributing positively to the cityscape and cultural identity. The flexibility of the method allows adaptation to different urban environments, from compact historical centers to rapidly developing modern districts. By tailoring the assessment to local conditions, transport planners and city officials can maximize the advantages of underground and overground pedestrian crossings. A significant innovation is the digitalization

of assessment processes. Utilizing geographic information systems (GIS) and advanced data visualization tools, the method enables easy sharing of findings among stakeholders and enhances transparency and accountability in decision-making [5].

Conclusion:

The assessment of the impact of underground and overground pedestrian crossings on transport efficiency is an essential component of urban mobility planning. The new method described above offers a significant improvement over older, more limited approaches by emphasizing the importance of comprehensive data, real-time modeling, and inclusive evaluation. By cultivating a deeper understanding of how pedestrian infrastructure interacts with broader urban systems, city leaders and stakeholders can ensure better outcomes for all road users.

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