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Exploring the benefits from 30 km/h speed limit to enhance urban sustainability

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Abstract

Road crashes consist a major societal problem worldwide, with 1.19 million road fatalities per year. Speeding is the number one cause of road crashes worldwide, especially in cities where pedestrians, cyclists and motorcyclists are highly exposed and vulnerable in case of a collision. The aim of this paper was to assess the effectiveness of 30 km/h speed limit reduction. Towards that end, a thorough literature review was conducted followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines and the benefits from 30 km/h speed limits in cities were highlighted. This study described the changes in safety, emissions, energy, traffic, liveability and health before and after the implementation of phased city-wide 30 km/h speed limits. Launching public awareness campaigns and encouraging the use of active mobility, could be proved beneficial for the adoption of 30 km/h speed limits in cities.

Keywords: 30 km/h speed limits, speed limit reduction, road safety, urban mobility, sustainability.

1. Introduction

Road crashes consist a major societal problem worldwide, with 1.19 million road fatalities per year and more than 50 million of road injuries (World Health Organization, 2023). More than 50% of all road crashes, fatalities and injuries involve Vulnerable Road Users (VRUs), such as pedestrians, cyclists and motorcyclists.

The Global Plan for the Decade of Action for Road Safety 2021-2030 sets a target to reduce road traffic deaths and injuries by half by 2030 (World Health Organization, 2021). Achieving this target requires the implementation of evidence-based interventions that are known to reduce road traffic deaths and injuries. Thus, the establishment of 30 km/h speed limit is one such evidence-based intervention.

Vision Zero is a road safety concept aiming to achieve zero fatalities or serious injuries in road traffic (European Parliament Resolution, 2021). The idea is to create a road system that minimizes the impact of human errors

and prioritizes road safety everywhere and for all. The call for a 30 km/h speed limit in built-up areas is based on the understanding that lower speeds can significantly reduce the severity of a crash and increase the chances of survival in case of a collision. This approach aligns with the broader global efforts to improve road safety and reduce the number of road traffic fatalities and injuries. Countries and regions are adopting various measures to create safer road environments, and setting lower speed limits in urban areas is one such strategy.

In the same context, the Safe System approach is a human-centered approach aiming to eliminate fatal and serious injuries for all road users (World Road Association, 2019). It recognizes that humans are prone to errors and that the road transport system should be designed to absorb these errors without resulting in severe consequences. The approach is based on the principles of safe roads, safe vehicles, safe speeds and safe users. In particular, a Safe System approach means any road safety intervention ensured that the impact speed remains below the threshold likely to result in death or serious injury in case of a crash event. Typically, the impact speed should remain below 30 km/h for a pedestrian hit by a vehicle (International Transport Forum, 2008).

In a new road safety strategy for cities, a variety of measures has been identified as essential for the creation of the “Safe System approach”. History shows that countries that have adopted the Safe System approach implement evidence-based interventions, such as 30 km/h speed limits, and tend to have the lowest rate of fatality per population and the fastest rate of reduction in fatality numbers (Welle et al, 2018). The implementation of a 30 km/h speed limit is consistent with one of the key components of the Safe System approach, which emphasizes the importance of managing vehicle speeds to reduce the severity of crashes. Lowering speed limits, particularly in urban areas is a common intervention to improve road safety.

Within the above framework, the aim of the work documented in this paper was to critically review the benefits of 30 km/h speed limit reduction in urban areas in order to enhance urban sustainability. Towards that end, this study described the changes in safety, emissions, energy, traffic and liveability, before and after the implementation of phased city-wide 30 km/h speed limits.

The remainder of the paper is structured as follows: In the beginning, an overview is provided. Subsequently, the theoretical background for the number one cause of road crashes, speeding, and corresponding indicators is given. Then, the methodological approach of the current research is provided. The main part of the paper is covered by an extensive literature review carried out regarding the significant benefits from speed limits reduction measuring road safety, traffic efficiency, environmental impacts, etc. in several cities. Finally, the main findings are highlighted and recommendations for implementation modalities are also discussed.

2. Speeding as a key risk factor

To begin with, speed is a critical factor in preventing life-changing injuries during a road crash, which, by definition, directly affects road transport. It defines the mobility rates and options of persons and goods travelling from one location to another (Aarts and Van Schagen, 2006). In today’s modern life, citizens demand

a high degree of mobility and the possibility to travel fast by air, rail or road has become an integral component of the societies. However, driving speed also has a significant impact on drivers' risk, and it directly influences their involvement in potentially fatal crashes, severe injuries, noise and pollutant emissions (Elvik, 2013).

When driving speed increases, the risk of a crash or the severity of injury increases as well (International Transport Forum, 2008). The effects follow the rules of physics with regards to the change in kinetic energy that is released in a crash. More specifically, the energy released and absorbed in a crash is linked to the impact speed in a crash, and most of the kinetic energy is absorbed by the lighter crash "opponent", e.g. often the VRUs. In addition, the increase in crash risk is usually attributed by the fact that when speed increases, driver' s reaction time is shorter and manoeuvrability of a speeding car is lower.

There is a strong statistical relationship between speed and road crashes, especially for VRUs. For instance, the probability of a pedestrian being killed in a vehicle crash increases with the impact speed. Results from on-the-scene investigation of pedestrians' collisions with vehicles revealed that 90% of pedestrians survive being hit by a car at speeds of 30 km/h; whereas only 20% of them survive at speeds of 50 km/h. It was also demonstrated that the impact speed at which a pedestrian had a 50% chance of surviving a collision was around 40-45 km/h.

All in all, speeding, which encompassed excessive speed or inappropriate speed, is dangerous. As well as being a causation factor in around one third of fatal crashes, speed is an aggravating factor in the severity of all crashes. That is why co-ordinated actions should be taken by the responsible authorities to bring about an immediate and durable response to the problem of speeding.

3. Methodology

The current study endeavours to critically assess the effectiveness of speed limit reduction in cities. Towards that end, a thorough literature review was conducted. This work described the changes in safety, emissions, energy, traffic, liveability and health before and after the implementation of 30 km/h speed limits. Studies fulfilled specific selection criteria to be included in this review. More specifically, the criteria set demands regarding the publication time, study quality and relevance, and the overall validity of the publication source.

3.1 Literature Search

In order to review and assess the significant benefits of 30 km/h speed limit in cities, a systematic search of relevant scientific and grey literature was carried out using the key terms presented in Table 1. Although there was a range of studies and articles investigating the benefits of speed limit reduction in the context of road safety, this literature search and review explicitly focused on research relating to objectively identifying the effectiveness of 30 km/h speed limits in terms of safety, emissions, energy, traffic, liveability and health. Then, the key terms were entered into the relevant databases. The inclusion criteria for selecting relevant studies were as follows:

- Search term included in title, abstract or key words,

- Studies published from 1989 and onwards,
- Studies including information with regards to 30 km/h speed limit in the title or abstract,
- Source: peer-reviewed journals before peer-reviewed conference papers before scientific papers/articles,
- Language: studies published in English.

These criteria were meticulously applied to ensure the selection of studies meeting stringent quality and relevance standards, thereby facilitating a thorough and credible assessment of the effectiveness of 30 km/h speed limits in urban environments.

Table 1: Search terms utilised for the systematic literature review

Key search phrase	Search terms	Screened papers	Included papers
30 km/h speed limit	"30 km/h" OR "20 mph" OR "30 km/h speed limit" OR "speed limit" OR "speed limit reduction" OR "maximum speed" OR "reduced speed" AND "benefits" AND "urban areas" AND "mobility" AND "urban sustainability"	503	38

The search was conducted using the relevant databases: Scopus, ScienceDirect, Google Scholar, ResearchGate and PubMed. Publications were duplicated, screened by title (503 publications) and then by abstract. Relevant literature was documented and synthesised. The limitation was set to publications from 1989 and onwards and publications from peer-reviewed English language scientific journals, conference papers and articles, websites and scientific reports, were considered for inclusion. Additional search terms were also added. Eventually, 38 publications were screened thoroughly and the literature predominantly concerned 30 km/h speed limits.

3.2 The PRISMA Procedure

This review was carried out during January 2024 and adhered to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) steps in order to identify relevant research articles (Moher et al., 2009).

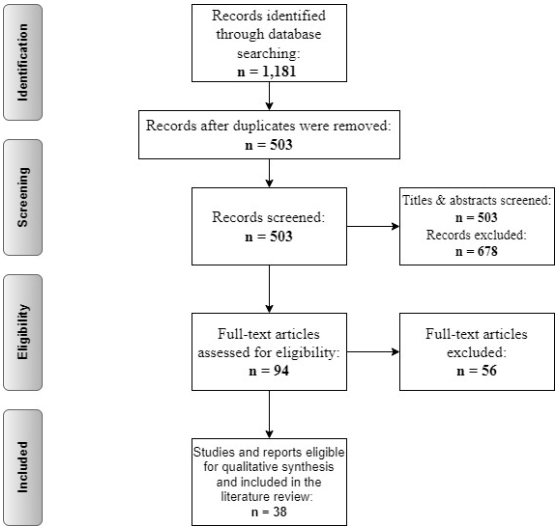

Figure 1: PRISMA flowchart of the systematic literature review

It was recently updated so as to cover more conceptual and practical advances in the methods of selecting, identifying, assessing and synthesizing studies. The initial search was performed in March 2023 and all databases were last accessed in January 2024. The search resulted in a total of 1,181 papers with 503 duplicates. Two reviewers independently screened all papers utilizing a general inclusion/exclusion assessment which was similar to the approach followed by Hawker et al. (2002). A total of 94 articles were selected for full-text review, including full papers and scientific articles suggested from a subject matter expert. After the full paper review, an additional 56 articles and reports were excluded for not meeting the inclusion criteria. In total, 38 scientific papers were included in the final review. An overview of the PRISMA flowchart and the search strategy is presented in Figure 1.

4. Benefits from speed limits reduction

Setting a speed limit of 30 km/h where people and traffic mix, make streets safer, healthier, greener and more liveable. Scientific evidence so far demonstrates more than 40% lives saved with the introduction of 30 km/h speed limit; in parallel to significant environmental, energy and health impacts with less fuel consumption and more walking and cycling. To date, numerous studies have been done in order to investigate the effects of reduced speed limits. A detailed description of the benefits from speed limits reduction is presented below.

4.1 Safety: Road crashes, fatalities and injuries reduction

Reductions in speed limits are intended to improve road safety by decreasing travelling speed and, thus, reducing the risk of crashes occurring and the severity of crashes that do occur. One of the largest effects of reduced speed limits is the reduction in collisions and serious injuries or fatalities. Firstly, an interesting work conducted by Cleland et al. (2020) revealed that in cities where speed limit reduction was applied, the number of collisions decreased between 24% and 45%, the number of injuries decreased between 42% and 49% and the number of serious injuries including fatalities decreased between 24% and 63%. At the same time, collisions in which cyclists were involved reduced by 17%, while the relevant percentage for pedestrians was ranged between 21% and 32%. It should be clarified that the exact reductions are probably depending on how much the actually driven speeds were decreased, how dangerous the street design was in general, as well as the amount of "vulnerable" street users. Uijtdewilligen et al. (2022) indicated that a speed limit of 30km/h reduced the injury risk of bicyclists by 21%. Likewise for car crashes, a majority (75%) of car-to-bicycle crashes occur on roads with a speed limit between 50-70 km/h. Thus, cyclists' safety can be improved by reducing the speed of vehicles.

Moreover, findings from Lindenmann et al. (2005) showed that by changing the speed limit from 50 km/h to 30 km/h, significant reductions in the frequency and severity of crashes on the streets have been identified. After the initial implementation of speed limit reduction, several experimental areas were chosen to determine the effects of enforcing 30km/h in Netherlands. In particular, an experiment was conducted in two cities of Rijswijk and Eindhoven, in which different combinations of measures were implemented in order to enforce a speed limit of 30km/h. Results indicated a decrease in the number of injury crashes by 70% (Janssen & Verhoef, 1989). Another study implemented by Vis et al. (1992) revealed that the implementation of this measure resulted in a

5% and 25% reduction in the total number of crashes and the number of crashes with injuries, respectively.

Lastly, 30 km/h speed limits can save lives and reduce the severity of crash injuries, thereby reducing economic costs and positively contributing to each country's economic growth. An interesting finding from Jones and Brunt (2017) estimated that if all current 30 mph limit roads in Wales became 20 mph limits, 1200-2000 casualties would be avoided and 6-10 lives would be saved each year. Based on the Welsh Government report published by Davis and Jones (2022), the direct estimated cost of introducing the 30 km/h default will be £32.3M. In the first year, it is estimated that the road crash casualty savings of 20mph will be just over £92M; nearly 3 times higher than the costs of implementation.

3.2 Emissions: Air pollution and noise reduction

In addition to road safety considerations, speed has a uniformly negative impact on the environment. In particular, the higher the speed is, the higher the level of noise and exhaust emissions becomes. Streets that promote safe walking and cycling can reduce car dependency and harmful vehicle emissions that contribute to climate change (World Health Organization, 2021). More specifically, 30 km/h speed limits can reduce carbon dioxide and nitrous oxide emissions from diesel cars, and particulate matter emission from both diesel and petrol cars, thus reducing air pollution.

Previous studies have shown that the reduction in noise emissions is dependent on the specific location. Cleland et al. (2020) indicated that after the installation of speed limit of 30 km/h, noise emissions were decreased by a range of 1.5 to 4.8 decibels (dB), with average values reported around 3 dB. This was equivalent to a reduction of about 50% of car traffic volumes. Nevertheless, on roads where the speed limit was not decreased, the noise levels could actually rise as a result of increased car traffic volumes. Similarly, Annecke et al. (2008) found that noise can be reduced by 2.7 dB if the speed is reduced from 40 km/h to 30 km/h. A 30 km/h urban speed limit quickly makes streets quieter, reducing noise by 3 dB. It is estimated to be approximately a halving of the source of traffic noise; ten cars travelling at 30 km/h makes as much noise as only five cars travelling at 50 km/h (Transport & Environment, 2021). Another study showed that substantial noise reduction can be achieved by 30 km/h speed limits reduction, since noise levels can be reduced approximately between 1 and 5 dB, depending on the range of decisive influencing factors (Müller-BBM, 2019).

Regarding air pollution, such as carbon dioxide (CO_2), nitrogen oxide (NO_x) and Particulate Matter (PM), it was demonstrated that reducing maximum speed limit from 50 km/h to 30 km/h could be proved beneficial to the environment. To date, scientific research has revealed that 30 km/h speed limits can result in a remarkable decrease in polluting emissions by 15% in CO_2, 40% in NO_x and 45% in carbon monoxide (CO). The only exception was in hydrocarbons, in which a negligible rise of 4% was observed (Transport & Environment, 2021). According to Panis et al. (2011), the amount of PM emissions significantly decreased when driving 30 km/h instead of 50 km/h and the exact reductions of NO_x strongly depended on the composition of vehicles and their emission characteristics (e.g. motor type). An interesting study conducted by Williams and North (2013)

revealed that 30 km/h zones can reduce NO_x and CO_2 from diesel car and PM from both petrol and diesel cars, thus reducing air pollution. In a residential area case study implemented by Madireddy et al. (2011), it was found that lowering speed limits from 50 km/h to 30 km/h resulted in 25% reductions of CO_2 and NO_x emissions. On the other hand, Tang et al. (2019) examined the impact of reducing speed limit from 50 to 30 km/h. Their results showed that the emission of NO_x and PM increased due to speed limit reduction. However, the extent of the increase depends on the type of network and the traffic characteristics. Moreover, Gressai et al. (2021) provided a more nuanced analysis, arguing that the impact of revealed speed limits on traffic can vary depending on network topology and emphasizing the need for careful planning before implementing speed limit reductions.

3.3 Energy: Fuel consumption reduction

Previous studies have shown the significant benefits in terms of energy and fuel consumption resulting from the introduction of the 30 km/h speed limit. Based on the literature, lower speeds lead to lower fuel consumption while smoother traffic flow leads to additional fuel economy, i.e. eco-driving (Salgueiredo et al., 2017). In a survey implemented by Haworth and Symmons (2001), it was revealed that with speed limit reduction, fuel consumption declined by 11%. However, these effects are rather small and far offset by a more continuous traffic flow (or less accelerations) and less car traffic which may be probably due to less capacity and other modes being more attractive (Jones and Brunt, 2017).

3.4 Traffic: Traffic flow improvement

It is worth mentioning that the establishment of 30 km/h speed limits can be beneficial in improving traffic flow and reducing congestion. Job and Mbugua (2020) found that reductions in speed limits as vehicles reach congested conditions result in a smoother traffic flow with less stop/start traffic movements. Interestingly, at lower speed limits, the following distance between vehicles can be shorter (as cars need less distance to stop than at higher travel speeds), and, thus, there is improved merging of vehicles from the side streets. This allows the road to accommodate a larger number of vehicles travelling at a constant speed, thereby reducing traffic congestion and improving travel times. In this way, Svensson et al. (2014) indicated that reduced speed limits can result in a decline in traffic volumes on the specified roads. Similarly, Vis et al. (1992) demonstrated that the implementation of a 30 km/h speed limit also contributed to a 5-30% decrease in traffic volumes.

It is also important to highlight that crash reduction benefits of lower speed limits also improve traffic congestion by reducing the temporary disruptions in traffic caused by road crashes. Maher (2018) investigated the impact of speed limit reduction with travel times. Results indicated that travel times increased between 3%-5 %. This slight increase on travel time is usually far lower than most people intuitively assume. This is probably due to the fact that in dense urban areas, the proportion of the time that can be driven considerably more than 30 km/h speed limit is quite low, especially during these times of the day at which most car journeys take place. If drivers travel at 65 km/h instead of 60 km/h, the saved time is a maximum of 46 seconds over a 10-km distance. However, the risk of being involved in a crash is double (Transport Roads & Traffic Authority, 2011). Overall, after reducing the speed limits, a remarkable reduction in traffic volumes was identified. Citywide small

reductions can be expected while specific roads have a decrease of up to 30% in traffic volumes. This is caused by changes in decisions of car users, such as changes in mode of transport, routes or trip frequency (Beek, 2022).

3.5 Liveability: Sustainable improvement

Within the above context, motor traffic volumes decrease, since slower speeds encourage active, sustainable and shared travel. More specifically, 30 km/h speed limits facilitate and promote environmentally friendlier and more active transport modes, such as walking, cycling and public transport, freeing up more space for urban recreation, commerce and outdoor activities, improving physical and mental health, and creating vibrant cities with better liveability (Karndacharuk and McTiernan, 2019). According to Pilkington et al. (2018), lower speed limits promote walking and cycling. This is probably due to the fact that VRUs feel safer in the road and; therefore; car usage becomes less attractive.

Concerning different transport modes, the effects of the implementation of 30 km/h speed limits are multiple. Firstly, it is easier for motorists to merge with traffic travelling at 20mph rather than 30mph. At the same time, buses operate more efficiently. The reduced length of traffic queues can reduce bus journey, increase reliability and make buses become more attractive compared to car. Additionally, children are more likely to walk or cycle to school on their own and older people are more confident in venturing outside their homes, trying to cross the street, or of driving their own cars at a more reasonable (i.e. slower) speed, rather than always at 30mph.

3.6 Health: Physical and mental health improvement

Calm driving in lower speeds is a mean of healthier living for the drivers. All road users and, especially, children and the elderly are more likely to walk and are more confident in venturing outside their homes, trying to cross the street. What's more, the implementation of 30 km/h speed limits in urban areas increase opportunities for work and friendship, and reduce health inequalities through improved accessibility for road users with restricted mobility, hearing, vision, or mental health, as well as children, elderly, pedestrians, cyclists, youth and commuters (Pickett et al., 2014).

As already mentioned, the improvements due to reduced noise are probably huge. Findings from an interesting study conducted by Rossi et al. (2020) revealed that noise reduction was far more important for improvements of public health than the number of reduced collisions. This was probably caused by reduced stress levels and better sleep what, among others, had a positive impact on the prevalence of cardiovascular diseases and diabetes. Similarly, the effects of decreased air pollution in case of less car traffic could prevent a large number of years of life lost Cepeda et al. (2017). In addition, Brown et al. (2017) indicated that if active travel modes are increased, a substantial health benefit due to more physical activity will be provided. The overall health effects through the large decrease in road crashes in injuries is probably relatively small when compared to the (possible) extents of increased health due to less noise, less air pollution, and more physical activity.

Taking all the aforementioned aspects into consideration, the implementation of 30 km/h speed limits will not

only improve road safety, but also provide significant cost savings and health benefits delivered by transport noise and air pollution reduction and increased pedestrian and cyclist active mobility (Neki et al., 2021).

5. Discussion

The discussion and introduction of 30 km/h speed limits faces strong reactions and rigid inertia, whereas supporters' voices are weak and inefficient resulting in hesitant politicians and Authorities. Thus, the implementation of a city-wide 30 km/h speed limit requires careful planning and consideration of various modalities. Establishing a legal framework is crucial for implementing a city-wide speed limit. This involves reviewing and updating existing traffic laws and regulations to reflect the new speed limit requirements. This may require coordination with local transportation departments, city councils, and law enforcement agencies.

In order to successfully implement 30 km/h speed limits in cities, it is essential to launch public awareness campaigns that emphasize the safety benefits associated with the reduced speed limit and to elucidate the rationale behind its implementation, with the overarching goal of gaining public support. Efforts should extend beyond citizens to include politicians, fostering a collective understanding and endorsement of large-scale interventions for improved road safety. This comprehensive approach involves the launch of public awareness initiatives through diverse channels, including media campaigns, strategically placed road signage, informational brochures, and community outreach programs. By employing a multifaceted communication strategy, these campaigns aim not only to inform but also to actively engage and unite society in advocating for the adoption of a 30 km/h speed limit, creating safer and more sustainable urban environments.

Simultaneously, promoting public transportation and active mobility options is crucial for reducing reliance on private vehicles. Encouraging citizens to embrace walking, cycling, and utilizing public transit services can contribute to a safer and more sustainable urban environment. Investing in the enhancement of public transit services, developing cycling infrastructure, and creating pedestrian-friendly zones will not only make these alternatives more attractive but also align with broader efforts to address environmental concerns and traffic congestion. In addition, implementing traffic calming measures (e.g. speed bumps, raised crosswalks) is another vital component of creating safer road environments, improving overall safety for pedestrians and cyclists.

The integration of Intelligent Transportation Systems (ITS) could also play a pivotal role in enhancing road safety and traffic management. By synchronizing traffic signals with actual traffic flow, congestion can be minimized, promoting a smoother and more efficient transportation network. Monitoring and evaluation are essential components of any successful transportation initiative. By systematically collecting data on traffic volumes, vehicle speeds and crash statistics can gauge the effectiveness of implemented measures. This approach enables informed decision-making, allowing for adjustments and continuous improvements over time.

6. Conclusions

Speeding is the number one cause of road crashes worldwide, especially in cities where pedestrians, cyclists

and motorcyclists are highly exposed and vulnerable in case of a collision. Road environments designed to reduce vehicle speeds to 30 km/h or lower. This is achieved through 30 km/h speed limits, supported by speed enforcement, traffic calming measures, and pedestrian facilities to ensure safe mobility everywhere and for all. This research paper used an observational study aiming to assess the important benefits from 30 km/h speed limit reduction in order to enhance urban sustainability. To fulfil this object, a thorough literature review was conducted. The work involved a comprehensive speed, collision, emissions, energy, traffic, liveability and health assessment of the roads before and after implementing the new speed limit. Results indicated that as urbanization and motorization continue to grow, a speed limit of 30 km/h should be standard in all places where cars, cyclists, and pedestrians interact.

This study was not limitations. Firstly, there was no data to investigate the quantitative effect caused by the speed limit reduction on liveability and public health. At the same time, based on scientific literature review, mixed results were identified in terms of fuel consumption, energy and speed limit reduction. It was revealed that fuel consumption and CO_2/NO_x emissions might increase with the speed limit reduction. Some opponents have slammed the efficacy of the 30km/h speed limits in urban areas, citing another study by Cerema (2020) which revealed that more CO_2 emissions were generated when travelling at a constant 30km/h than at 50km/h. Nevertheless, these effects were rather small. Also, the exact effects on mental and physical health have not been directly measured. Lastly, it has been proven that the impact of a reduced speed limit on the following aspects remain poorly studied: liveability, significance and usage of public space, social interactions/cohesion, life satisfaction and sense of street ownership.

Overall, the study showed that the new speed limit positively impacted road safety, as evidenced by the significant reductions in speeds and collisions. However, there were still areas where drivers did not slow down, indicating the need for further intervention. The results highlighted the importance of reducing the speed limit to improve road safety and the need for continued monitoring and evaluation of road conditions for better and more optimized decision-making. The framework presented in this work could be further applied to other municipalities and jurisdictions looking to evaluate the effectiveness of their residential speed limit reductions. Future research should also examine the long-term impact of the effectiveness of city-wide 30 km/h speed limit.

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