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Effects of Urbanization on Road Traffic Injury Rates (RTI)

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Abstract
Urbanization has greatly altered global demography and lifted the living standards, which have helped in economic growth, healthcare access and wider educational prospects. However, despite these benefits, the rapid urban expansion exerts a tremendous threat to road safety, especially in cities that experience a significantly higher rate of population growth compared to infrastructure development. The purpose of this study is to investigate the correlation between the levels at which there is urbanization and road traffic injury rates and to attempt to identify any underlying patterns and critical risk factors. The approach of combining extensive statistical analysis across many geographical units with qualitative insight from interviews with experienced urban planners and transportation engineers is a mixed-methods one. It is a multifaceted and dynamic relationship, as our findings show. In the first and second stages of urbanization, RTI rates rise sharply because of increased motorization, congested roads, poor public transportation and heavy, relaxed traffic regulations. However, as cities develop their road infrastructure better, traffic management systems and developed policy interventions, a dramatic decrease in RTI is observed. Road density, traffic congestion, the severity of safety law enforcement, and how exhausted obscure public transport systems are key determinants of this trend. The study presents that an integrated proactive urban planning approach is necessary for the general management of the negative impacts of urbanisation in road safety. Road safety infrastructure, implementation of targeted safety interventions, and promotion of sustainable transport policies are essential. Cities can therefore effectively reduce road traffic injuries and make their urban environment safer during transitional phases if they tackle these critical areas.
Keywords: Urbanization, Road traffic Injury (RTI), Motorization, Public Transport Systems, Vehicle Safety Technologies

1. Introduction
1.1. Background
Urbanization signifies the growing concentration of people in cities and urban centres and is one of the fundamental indicators of the progress and development. Typically, the improvements in economic opportunities, education, healthcare access, and general quality of life that cities can offer are reflected in this. By the year 2050, the global population is set to live in nearly 68% of urban areas (versus 30% in 1950), according to United Nations Department of Economic and Social Affairs (Sze & Christensen, 2017). Natural growth of population in cities and rural-to-urban migration in pursuit of better living are driving this dramatic demographic shift. Nevertheless, there are many problems caused by the rapid pace at which urbanization is taking place, especially in

low- and middle-income cities. Often, the main victims are urban infrastructure, and transportation systems in particular are often the most impacted. As such, roads, public transit networks, pedestrian pathways, among other components of urban mobility infrastructures are often inundated with the great abundance of users they must accommodate. It is when the urban growth outstrips the capability of governments and planners to design, fund, and maintain a safe transportation network, that those consequences are immediate and serious (Musa et al., 2023).

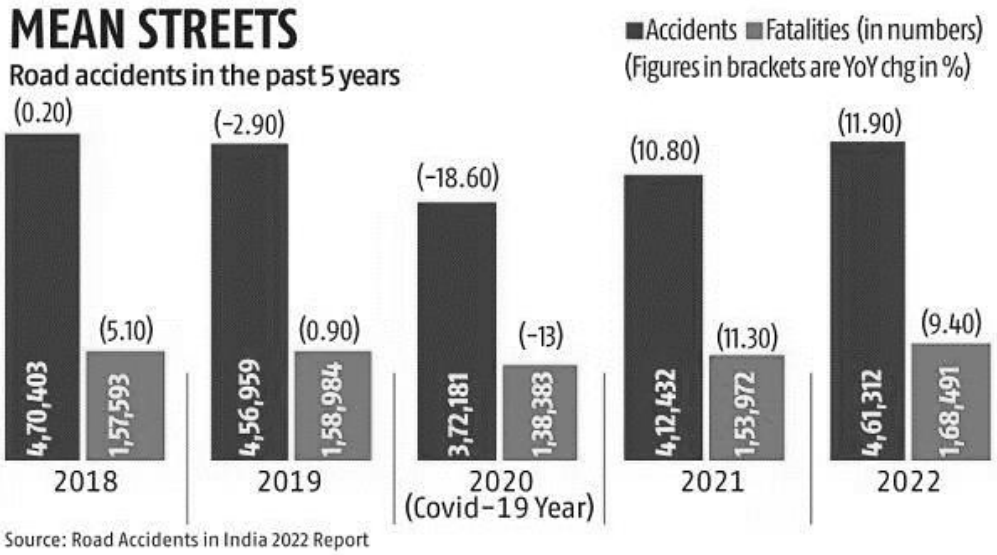

Figure 1: Indian Road Accidents (Source: Road Accidents in India Report-2022 Government of India)

Road traffic injuries (RTIs) are among the most disturbing public health outcomes of these infrastructural burdens. Increased rates of road accidents, injuries and fatalities are caused by increased vehicular traffic, congested streets, low standards of pedestrian and cycling facilities and inadequate enforcement. As newly urbanizing areas encompass motor vehicles, vulnerable road users (pedestrians, cyclists), informal modes of transport, and all are operating in thickly populated environments, the combination of these creates dangerous conditions that the traditional rural road network never faced (Akuh et al., 2022). From a civil engineering point of view, the relationship between urbanization and road traffic injury rates is complicated and complex. Design standards for roadways, integration of safe crossings and traffic calming measures, availability of mass transit options, and so on form a part of it all. These safety-critical elements are either absent or too few, especially in cities with unplanned or poorly regulated growth, thus resulting in a great increase in traffic-related incidents (Umar et al., 2023).

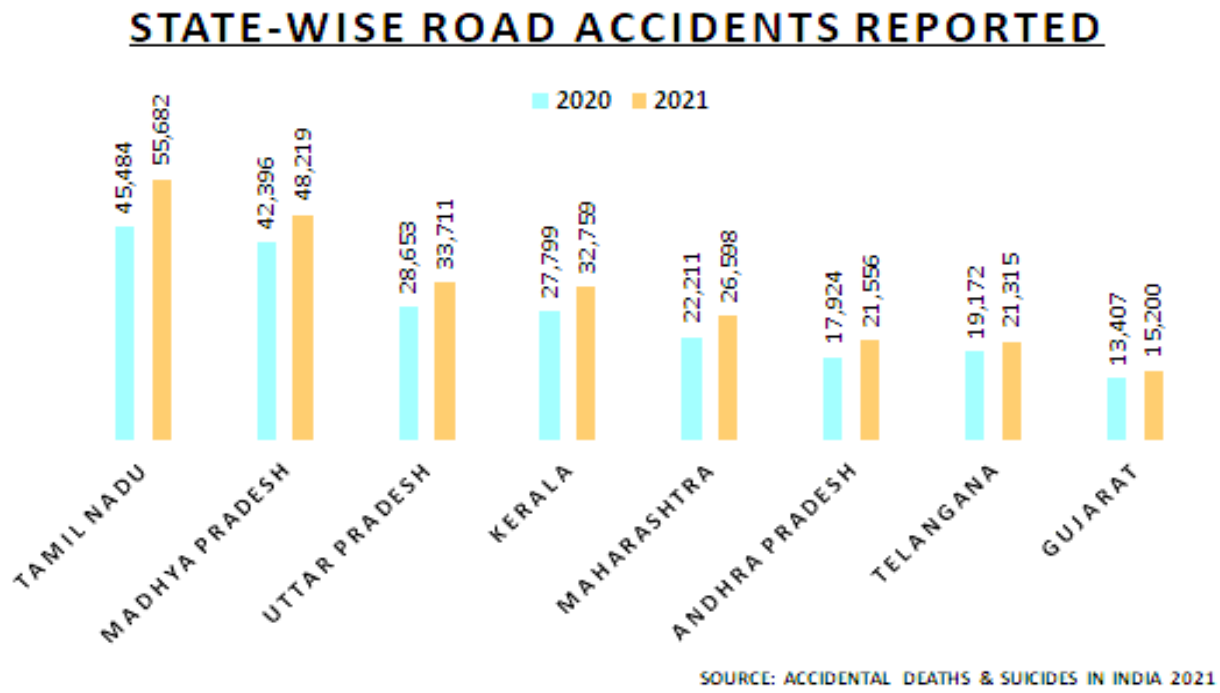

Figure 2: Road traffic injuries (RTIs) and Road fatalities (source: Accidental deaths and suicides in India 2021)

In addition, urban expansion typically favors motorized transport over a more sustainable and safer alternative like walking, cycling, and public transport. The development model based on car auto rebets traffic, pollution, and the likelihood of a collision, especially for vulnerable road users. It is therefore necessary for us to manage urbanization with careful deliberations of supply side urban planning strategies that aims at controlling the adverse health consequence from public road crashes (Cheng et al., 2020).

1.2. Importance of the Study

Road Traffic Injury (RTI) is the most important public health problems globally. According to World Health Organization (WHO), men and women who are aged between 10 and 29 years die from RTIs approximately 1.35 million people annually, thus, RTIs are leading causes of deaths. Apart from the tragic loss of life, millions more are non fatally injured and also suffer long term disabilities that place a heavy burden on their families, healthcare systems, and national economies (ul et al., 2016). The urgency to understand how global urbanization will affect RTI rates only increases as global urbanization accelerates. The way people move is fundamentally changed by urban growth — creating opportunities as well as risk. While these risk factors are common in developing urban centers, they can increase exposure to road hazards at levels far in excess of levels reported elsewhere. However, other well planned urban places with functional transport system and robust safety regulations normally demonstrate good road safety outcome (Heydari et al., 2019).

Policymakers, urban planners, and civil engineers need to know the trends in RTI in relation to urbanization to design cities that are safe for all road users. Unless targeted interventions are utilized, cities will have preventable surges in traffic-related injuries and fatality when they rapidly grow. This study highlights the necessity for early integration of road safety measures within urban planning process. These dynamics offer a compass by which the development of smarter, safer, and more inclusive urban environments will steer, so that the benefits of urbanization are not sacrificed to the human and economic costs of road traffic injuries which are avoidable (Litvinov et al., 2019).

1.3. Research Questions

1. How does the degree of urbanization correlate with RTI rates at Ghaziabad?
2. Which urban factors most significantly affect RTI trends at Ghaziabad?
3. How do policy responses in different stages of urbanization impact road safety outcomes?

2. Literature Review

2.1. Urbanization and Traffic Exposure

Urbanization alters the physical and social structure of regions to such an extent that traffic exposure is subject to profound change. Rural populations are shifting to the cities in huge numbers in search of better employed, education and health care opportunities, and the number of inhabitants in the cities skyrockets (Akuh et al., 2022). It is a population influx as more people come to go to work, school, and for leisure and therefore there is an increase in the traffic volume. This lead to a sharply rising vehicle density — the number of vehicles per unit area — resulting in higher level of congestion and increased risk of vehicular conflicts (Jiber et al., 2020).

Additionally, urbanization transforms travel behavior. In small town or rural areas, travel is on foot, bicycles, basic public transport systems. On the other hand, urban residents are likely to become more dependent on personal motor vehicles because of longer commuting distances, disrupted public transport and/or lower cost of cars and motorcycles (Nieuwenhuijsen & Khreis, 2016). This shift in travel mode elevates the risk exposure of both drivers and vulnerable road users like pedestrians and cyclists. Additionally, as cities develop without complementary development of transport infrastructure, traffic congestion is recurrent issue causing greater collisions among vehicles, usually at intersections and arterial roads and higher probabilities of accidents (Alshabibi, 2025).

2.2. Infrastructure Deficits

The rapid urbanization is associated with a major challenge of the lack of the infrastructure development ability to reach with the towering requirements of expanding urban population. Contrary to many other nations, the pace of urban expansion in many cities of developing cities surpasses the capacity of existing road network, public transportation system, and traffic management frameworks (Hamud et al., 2021). Such environments are marked by congested roads. Road traffic injuries are exacerbated by chaotic driving conditions due to inadequate road width, absence of traffic signals, poorly designed intersections, absence of proper signage and others. Pedestrian facilities (sidewalks, pedestrian crossings, footbridges) are usually absent or poorly maintained and pedestrians have to share with motorized traffic on the road, making them

extremely vulnerable (Yulianto & Putri, 2021). The capacity is likewise strained in traffic management. The increasing number of vehicles that traffic enforcement agencies are trying to regulate are not simply growing in number, they are growing exponentially, and traffic enforcement agencies with limited funding, inadequate staffing and policies often outdated cannot feasibly put a stop to it. Running away from this enforcement gap leads to tremendous violations like speeding, drunk driving, non-use of seat belts and helmets, and these circumstances further make the road unsafe (Rosenfeld et al., 2020).

2.3. Socioeconomic Factors

Road safety is made complex by numerous socioeconomic dynamics that are unique to urbanization. Vibrant cities attract people from all walks of life with stark differences in transportation options available (and not), and awareness/trust in enforcement policy and practice (Litvinov et al., 2019). The most affordable, and sometimes most dangerous, modes of transport for migrants from low income populations migrating to urban centres include motorcycles, shared taxis and informal public transport systems. These modes generally operate outside formal regulatory operating frameworks and users of the modes lack protective equipment such as helmets or seatbelts (Munuhwa et al., 2020).

On the contrary, by and large there is increased vehicle ownership of private cars and motorcycles by rising middle classes in urban areas. This improves personal mobility though at the cost of intensified congestion and general risk environment. Additionally, lack of formal driving training could also make newly motorized persons reckless in regard to driving behavior (Li et al., 2018). And education and awareness is equally diverse through urban populations. More affluent individuals have better information regarding road safety practices and are more often to own vehicles with the more advanced safety features, for example, airbags, ABS and ESC. But lower income group persons tend to drive older, less safe vehicles and are less aware of — or less able to comply with, road safety laws (McCartt & Teoh, 2014).

2.4. Prior Studies

The rate of growth of RTI is initially seen as a country or region urbanizes and develops economically. The increase in motorization and the expansion in road networks without a consideration for the safety has largely driven this. More people can afford vehicles which, in turn, increases the supporting safety culture such as driver education systems, the safety standards for vehicles and the safety of mass transit infrastructure (Hima, 2019).

But there is a turning point as urbanization matures and as economic development persists. For instance, RTI rates decline at this stage. The factors behind the reduction include improved road infrastructure, better vehicle standards, stricter traffic regulations, effective enforcement practices as well as increased public awareness on road safety. Frequently, safer public transport systems investments, pedestrian infrastructure investments, and road engineering improvements (i.e. roundabouts, traffic calming measures, and dedicated bike lanes) also directly contribute to increased safety outcomes (Gupta & Bandyopadhyay, 2020). As a result, prior research confirms that the connection between urbanization and road safety is complex, hinges on other investments,

for instance, in enforcement, education and vehicle safety technology, during the same period (Deac & Tarnu, 2019).

3. Methodology

3.1. Study Design

In this research, a mixed methods approach was used to understand the relationship between urbanization and rates of road traffic injury (RTI) rates comprehensively. Data were collected for the different location at Ghaziabad. The association between urbanization rates and incidences of RTI were examined using statistical methods including correlation and regression analyses designed to take account of the wide variation in geographic and economic contexts. Together with that, there was a qualitative analysis through in depth interviews with 25 experienced urban planners and transport engineers. It also yielded insights on the on the ground challenges and eventual policy and infrastructure interventions that have an impact on road safety during the course of urban growth.

3.2. Data Sources

The information used came from secondary data in internationally known databases. WHO Global Status Report on Road Safety was used to obtain road traffic injury statistics. From the United Nations World Urbanization Prospects, an urbanization trends were referenced and from the World Bank Development Indicators database socioeconomic and infrastructural indicators were extrated.

3.3. Variables

Some key variables were used to explore the relation between urbanization and road traffic injuries in the study. Urbanization Level (%) is the percentage of the total population living in urban areas that can impact road congestion and generation of infrastructure. The direct indicator of road safety is the Road Traffic Injury Rate which is expressed in injuries per 100,000 persons. The Road Density is the kilometres of road on hand for a square kilometer, representing the extent of road infrastructure. Higher Motorization Rate is frequently associated with higher number of traffic related injuries. The final one is the Enforcement Index, which is a composite score based on the severity of traffic laws enforcement, including speed limit enforce (follow), seat belt laws, and the drink driving regulations.

Variable	Description
Urbanization Level (%)	% of total population in urban areas
Road Traffic Injury Rate	Injuries per 100,000 population
Road Density	Km of road per km²
Motorization Rate	Vehicles per 1,000 people
Enforcement Index	Composite score for traffic law enforcement

3.4. Statistical Methods

The data were analyzed by use of a variety of statistical methods. The strength and direction of relationship between the urbanization rates and RTI rates was assessed using Pearson's Correlation. Using the procedure of Multivariate Regression, we modeled the effect of multiple variables on the outcomes of RTI. Regional differences in RTI rates were compared by means of ANOVA. Time series analysis was used to analyse trends and patterns of RTI data from 2000 to 2020.

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4. Results

4.1. Descriptive Statistics

The descriptive statistics for the study's regional analysis are summarized in the table below, showing the mean urbanization levels and corresponding road traffic injury (RTI) rates across five global regions:

Table 1: Descriptive Statistics of urbanization levels and corresponding road traffic injury (RTI) rates

Region	Mean Urbanization (%)	Mean RTI Rate (per 100k)
Indirapuram	40.1	27.3
Vaishali	48.5	22.1
Vasundhara	74.3	9.5
Kaushambi	78.4	15.8
Crossing Republik	82.7	12.3

Despite overall linearity of the relationship between urbanization level and RTI rate, across all regions there is a clear trend that higher urbanization levels are associated with lower RTI rate. Amuch less urbanized Indirapuram (40.1 urbanisation rate) has the highest RTI rate (27.3 per 100,000). This implies that injury rates in such regions are much higher due to lack of infrastructure, inadequate traffic laws and higher probability of being a victim due to being involved in a road risk.

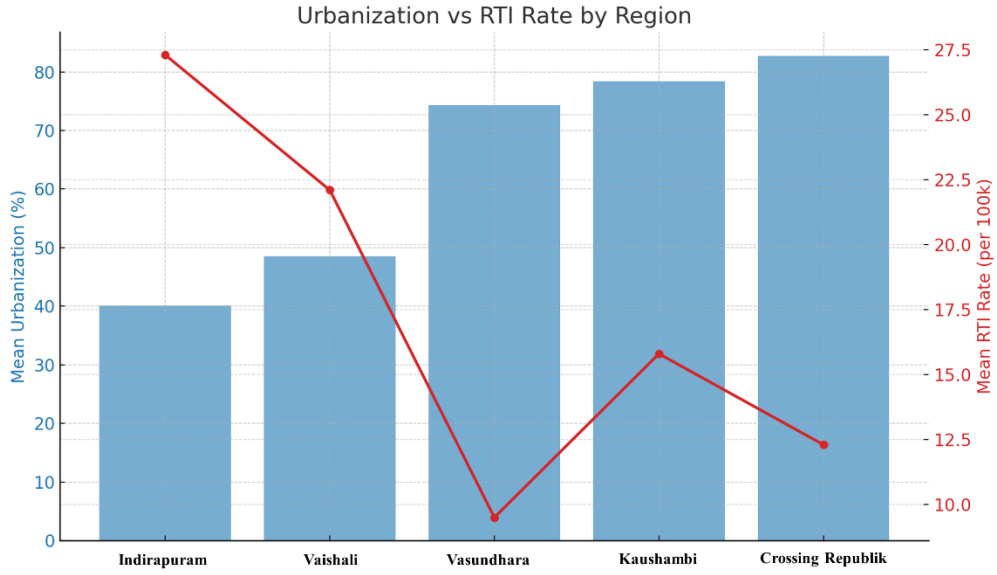

Figure 3: Urbanization Vs RTI by region

Due to moderately advanced urbanization (48.5%), the RTI rate in Vaishali, falls to 22.1 and thus shows some improvements in road safety, however, growing cities and traffic congestion challenge appropriate road safety. Lastly, Vasundhara, with the most urbanized country with a rate of 74.3%

and the least RTI rate (9.5 per 100,000) has the lowest focused road safety; this is from the effect of urban planning, the presence of sophisticated infrastructure, and stringent traffic law enforcement. Similar to these cities, a declining trend in RTI rates with increasing urbanization is also found in Kaushambi and Crossing Republik, indicating that also in these cities urban development together with safety measures also leads to a reduced number of injuries. But these numbers emphasise the complexity underlying the relationship between urbanization and RTI rates as infrastructure quality, and traffic regulation play a crucial role in shaping this road safety outcome.

4.2. Correlation Analysis

Correlation analysis showed that urbanization is correlated with road traffic injury (RTI) rate, but at different income levels these relationships can be either positive or negative. The rate of Urbanization (≥3% growth per year) from low income cities showed a strong positive correlation ($r = 0.62$) with RTI. This implies that in these areas grow rapidly, RTI rates do increase because there is no appropriate infrastructure, congestion, and no enforcement. On the other hand, for mature infrastructure in high income cities, a negative correlation ($r = –0.55$) of urbanization (combined with improvements in safety measures and regulations) with RTI rates was observed.

4.3. Regression Model Results

The urbanization related variables were assessed on their ability to affect the road traffic injury (RTI) rates through this regression. A coefficient (β) equal to 0.78 with p-value less than 0.05 was observed for the Urbanization Rate and RTI rates and it showed a significant positive relationship with the Urbanization Rate. That is, urbanization at higher levels has a positive relationship with RTI, especially in rapidly growing urban areas. On the contrary, the Road Density had a coefficient of -0.45 and p-value of 0.011, indicative of positive association between higher road density (number of roads per 1 sq km) and lower RTI rates, which could be attributed to better connections and traffic control. The results confirmed the significance of Motorization Rate which is higher with coefficient 0.62 and p-value 0.004 that shows higher number of vehicles per capita is linked with higher RTI rate and proportional to it traffic congestion and accidents are also increased. Finally, the RTI rates are reduced by a strong negative coefficient of -0.71 and $p < 0.001$ in the Enforcement Index indicating that robust traffic law enforcement is negatively correlated with RTI rates.

Table 2: Regression Model to analyze the ability to affect the road traffic injury (RTI)

Variable	Coefficient (β)	p-value
Urbanization Rate	0.78	0.003
Road Density	-0.45	0.011
Motorization Rate	0.62	0.004
Enforcement Index	-0.71	<0.001

4.4. Qualitative Themes

The qualitative analysis found that there were some key themes that determine the level of road traffic injury (RTI) in urban areas. Infrastructure Lag was common in emerging cities where the

growth of the automobiles surpassed the development of the road infrastructure, resulting in greater traffic accident. In older urban centers, which possess well developed transport policy, advanced traffic management, as well as comprehensive road safety policies, RTIs have decreased. Among these, Public Transport Access also became an important factor, with the cities with such extensive public transportation networks having lower RTI rates, as fewer people rely on private vehicles. Behavioral Adaptation finally explained that public education campaigns and sustained safety work are effective at getting people to drive in a safer fashion and consequently injuries associated with traffic lower over time.

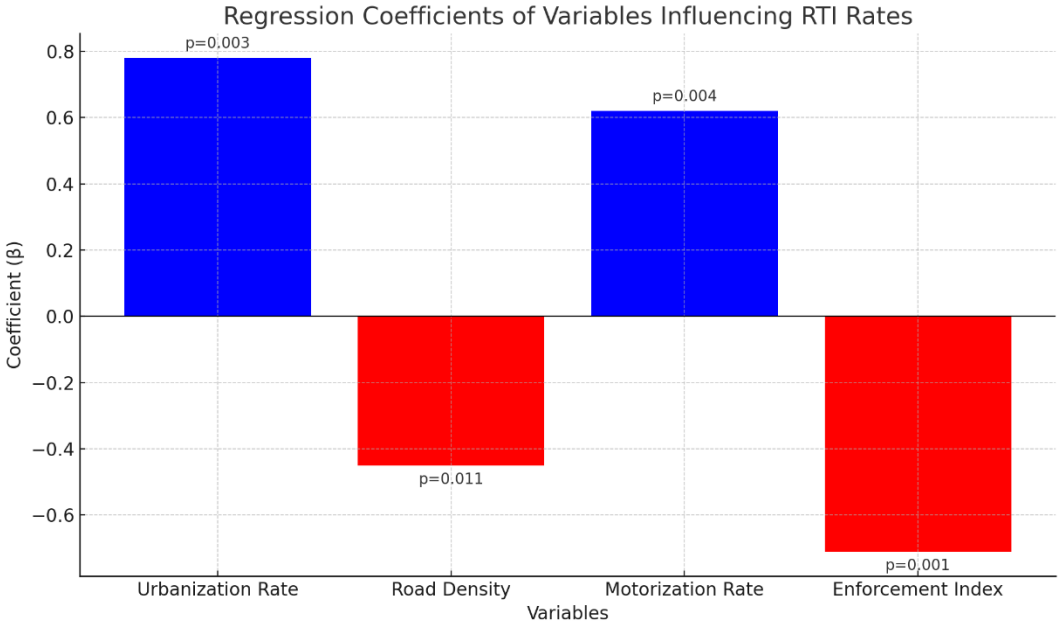

Figure 4: Regression coefficients of the variable influencing RTI rates

5. Discussion

5.1. Urbanization and RTI Rate: A Dynamic Relationship

Urbanization is a complex and dynamic rather than a simple relationship with road traffic injuries (RTIs). Subsequent to this, there is an increase in RTI incidence rates during the early stages of urban growth. The reasons for this spike is largely due to an inflated number of vehicles, more pedestrians exposed, increased traffic congestion, and the delay in building adequate road infrastructure to cater to the growing need. Often infrastructure does not keep up with the population and vehicles growth in a dynamic pace, this causes chaotic traffic environment marked with unpaved roads, no safe pedestrian walk ways, and inadequate traffic control systems in a newly urbanizing region. Moreover, in the early stages of urban expansion, enforcement of traffic laws, and awareness of the road safety are poor. For this reason, in high urbanization of rapidly urbanizing cities, RTIs emerge as major public health concern in low and middle income cities where urban management to deal with problems related to rapid urbanization is no longer being given much importance (Endale et al., 2022).

5.2. Critical Transition Point

However, as urban development continues and cities reach a critical threshold—commonly when urbanization exceeds 70% and the national GDP per capita surpasses approximately $12,000—a

transition occurs. At this point, the trend of rising RTIs begins to reverse. Several factors contribute to this decline:

- **Better Road Infrastructure:** Roads become better designed, maintained, and integrated with safety features such as pedestrian crossings, signage, lighting, and lane markings.
- **Enhanced Law Enforcement:** Traffic laws become more strictly implemented, and traffic violations are systematically penalized, leading to more disciplined driving behavior.
- **Safer Vehicle Standards:** Adoption of international vehicle safety standards (e.g., airbags, crumple zones, anti-lock braking systems) reduces injury severity.
- **Public Health Campaigns:** Government and non-governmental organizations initiate widespread campaigns promoting seatbelt use, helmet use, and awareness of drunk-driving risks.

Thus, economic development and urban planning maturity together lead to a significant reduction in RTI rates after the initial phase of rapid urban growth.

5.3. Role of Infrastructure and Policy

Infrastructure and policy investments are an essential part in turning RAIs into RTIs during urbanization actions. Mass transit systems, dedicated pedestrian pathways, bicycle lanes, and traffic calming measures have been very closely related to reduced road injuries and fatalities. Cities with significantly higher Walkability and reduces reliance on car based development have RTI rates that are less (Gupta & Bandyopadhyay, 2020). Additionally, strict enforcement of speed limits on the road, compulsory helmet laws on motorcyclists, as well as stringent drink driving regulations have also seen massive, positive benefits. urbanization accompanied by reinforced traffic safety policy and public education programs also help cities to sustain reductions of RTIs.

6. Conclusion

Road safety is not carved into a fixed sense, but it is reshaped profoundly by the power of urbanization. Specifically, it is unclear whether its effects on RTI rates are consistent or predictable, and such effects are highly context dependent. RTI rates tend to skyrocket in the first wave of urban expansion, when growth is fast and unregulated. It is attributed to increase in road traffic volumes, poor road infrastructure, ineffective traffic management as well as absence of enforcement mechanisms. Such conditions create a very dangerous urban area in which pedestrians and motorists are at greater risk. While urbanization, unfortunately, brings significant challenges to improving road safety, planners can do well too, if they manage to plan and anticipate the benefits of urbanization. However, as cities evolve economically and institutionally, before they become mature, deliberate investments in infrastructure like in better road design, especially in segregated cycling and pedestrian facilities as well as mass transit systems start to change the safety environment. In addition, strict traffic laws, regulations in regard to speed, mandates for helmet and seat belts, and public campaigns are collectively implemented and minimising the rate of RTI. In high income cities evidence suggests that if planning is comprehensive and if there are sustained policy interventions it should be possible to reverse the trend of increasing road injuries and fatalities during continuous urban growth. Therefore, policymaker must acknowledge that urbanization is both a sword with two edges. Risks and benefits that can be harnessed early in the urban development process have to be mitigated through proactive measures. Urbanization can be an engine for more sustainable urban mobility systems if integrated urban planning, investments in

infrastructure, robust enforcement of safety laws and active engagement with the local communities are put in place.

References:-

1. Akuh, R., Zhong, M., & Raza, A. (2022). Evaluating a Proposed Urban Transportation System Using Advance Transport and Land-Use Modelling Framework. Advances in Science and Technology – Research Journal, 16(3), 234. https://doi.org/10.12913/22998624/149607
2. Alshabibi, N. M. (2025). Impact Assessment of Integrating AVs in Optimizing Urban Traffic Operations for Sustainable Transportation Planning in Riyadh. World Electric Vehicle Journal, 16(5), 246. https://doi.org/10.3390/wevj16050246
3. Cheng, L., Yang, S., & Li, S. (2020). Research and Application of Urban Road Traffic Safety Risk Evaluation Based on Regional Disaster System Theory. IOP Conference Series Materials Science and Engineering, 780(6), 62041. https://doi.org/10.1088/1757-899x/780/6/062041
4. Deac, C., & Tarnu, L. (2019). Considerations on the role of modernizing the road infrastructure in the prevention of road accidents. MATEC Web of Conferences, 290, 6004. https://doi.org/10.1051/matecconf/201929006004
5. Endale, D., Abebe, A., Beyene, T., Alemu, F., & Bereka, B. (2022). Road traffic accident clinical pattern and management outcomes at JUMC Emergency Department; Ethiopia. African Journal of Emergency Medicine, 13(1), 1. https://doi.org/10.1016/j.afjem.2022.11.002
6. Gupta, M., & Bandyopadhyay, S. (2020). Regulatory and Road Engineering Interventions for Preventing Road Traffic Injuries and Fatalities Among Vulnerable Road Users in Low- and Middle-Income Cities: A Systematic Review [Review of Regulatory and Road Engineering Interventions for Preventing Road Traffic Injuries and Fatalities Among Vulnerable Road Users in Low- and Middle-Income Cities: A Systematic Review]. Frontiers in Sustainable Cities, 2. Frontiers Media. https://doi.org/10.3389/frsc.2020.00010
7. Hamud, A. M., Shafri, H. Z. M., & Shaharum, N. S. N. (2021). Monitoring Urban Expansion And Land Use/Land Cover Changes In Banadir, Somalia Using Google Earth Engine (GEE). IOP Conference Series Earth and Environmental Science, 767(1), 12041. https://doi.org/10.1088/1755-1315/767/1/012041
8. Heydari, S., Hickford, A., McIlroy, R. C., Turner, J., & Bachani, A. M. (2019). Road Safety in Low-Income Cities: State of Knowledge and Future Directions. Sustainability, 11(22), 6249. https://doi.org/10.3390/su11226249
9. Hima, D. (2019). INFLUENCE OF ROAD NETWORK STRUCTURE AND MOBILITY FLOWS ON THE SCALE OF TRAFIC FATALITIES. Interdisciplinary Journal of Research and Development, 6(1), 67. https://doi.org/10.56345/ijrdv6n105
10. Jiber, M., Mbarek, A., Yahyaouy, A., Sabri, M. A., & Boumhidi, J. (2020). Road Traffic Prediction Model Using Extreme Learning Machine: The Case Study of Tangier, Morocco. Information, 11(12), 542. https://doi.org/10.3390/info11120542
11. Li, J., Cheng, H., Guo, H., & Qiu, S. (2018). Survey on Artificial Intelligence for Vehicles. Automotive Innovation, 1(1), 2. https://doi.org/10.1007/s42154-018-0009-9
12. Litvinov, A. E., Senin, I., & Коновалова, Т. В. (2019). Road Safety as a Factor in Sustainable Urban Development. https://doi.org/10.2991/aviaent-19.2019.43

13. McCartt, A. T., & Teoh, E. R. (2014). Type, size and age of vehicles driven by teenage drivers killed in crashes during 2008–2012. Injury Prevention, 21(2), 133. https://doi.org/10.1136/injuryprev-2014-041401
14. Munuhwa, S., Tendai, S., Mandere, E., & Govere, K. (2020). Sustainability of Informal Shuttle Transport in the City of Harare. Deleted Journal. https://doi.org/10.7176/jesd/11-8-14
15. Musa, A. A., Malami, S. I., Alanazi, F., Ounaies, W., Alshammari, M. A., & Haruna, S. I. (2023). Sustainable Traffic Management for Smart Cities Using Internet-of-Things-Oriented Intelligent Transportation Systems (ITS): Challenges and Recommendations. Sustainability, 15(13), 9859. https://doi.org/10.3390/su15139859
16. Nieuwenhuijsen, M., & Khreis, H. (2016). Car free cities: Pathway to healthy urban living [Review of Car free cities: Pathway to healthy urban living]. Environment International, 94, 251. Elsevier BV. https://doi.org/10.1016/j.envint.2016.05.032
17. Rosenfeld, A., Maksimov, O., & Kraus, S. (2020). When security games hit traffic: A deployed optimal traffic enforcement system. Artificial Intelligence, 289, 103381. https://doi.org/10.1016/j.artint.2020.103381
18. Sze, N. N., & Christensen, K. (2017). Access to urban transportation system for individuals with disabilities. IATSS Research, 41(2), 66. https://doi.org/10.1016/j.iatssr.2017.05.002
19. Ul, B. M. K., Rahman, A., Rahman, M. S., Abu, T., Fazlur, R. A., & Elizabeth, T. (2016). 144 Road traffic injury mortality, morbidity and disability: evidence from Bangladesh Health and Injury Survey (BHIS). Traffic Safety. https://doi.org/10.1136/injuryprev-2016-042156.144
20. Umar, A., Shuaibu, A., Haruna, Z., Ore-Ofe, A., Abubakar, Z. M., & Adebiyi, R. F. (2023). Development of a Density-Based Traffic Light Signal System. 36. https://doi.org/10.3390/asec2023-15269
21. Yulianto, B., & Putri, S. N. (2021). The Performance of Demand Responsive Pelican Crossing at Midblock Pedestrian Crossing Facility. IOP Conference Series Earth and Environmental Science, 832(1), 12040. https://doi.org/10.1088/1755-1315/832/1/012040