Paving the Way for Tomorrow's Cities through Solving Road Encroachment Dilemmas: A Systematic Review

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ABSTRACT

Globally, countries strive for "Smart City" status by leveraging technology and data-driven solutions to improve urban quality of life, efficiency, and sustainable urban cities. However, developing countries face land-use-induced road encroachment challenges caused by activities such as roadside markets, squatters, street trade, and unlawful parking. This endangers traffic flow, pedestrian safety, residents' health, and the environment. Therefore, this study used Scopus database articles to conduct a systematic literature to reveal the causes, implications, and solutions for land use-induced road encroachment that is hampering Smart City advancement in developing countries. Hence, out of the 399 Scopus publications reviewed, 26 addressed land use-induced road encroachment and related issues, which comprises of 17 from Scopus and 9 from other databases. Thus, according to the findings, uncontrolled urbanization encourages the greatest rates of roadside encroachment in developing countries, resulting in traffic congestion, accidents, pollution, and health issues owing to activities of informal sector operations and illegal parking. The study advocates innovative solutions like Pedestrianization, urban design, roadside vending zones, smart parking solutions, community engagement, economic incentives, enforcement, penalties, traffic management technology, and flexible road use policies. These shall seek to reduce or eliminate road encroachment, resulting in safer, more accessible, and efficient cities for residents and tourists. Consequently, these entail promoting correct road usage through urban planning methods, legislation, and technology in order to discourage encroachment and improve the overall urban experience.

Keywords: Environmental and health challenges, land use, road encroachment, road setback, smart city innovations, street trading

INTRODUCTION

In the coming decades, more than half of the world's population of over six billion people will live in urban areas, a rate of urbanization that may be regarded as unmatched in history. There will undoubtedly be effects on both the health of man and the environment as a result of this and nearly the majority of these population growths will take place in developing countries [1]. In addition, [2] reiterated that slums have proliferated in many Sub-Saharan African cities as a result of rapid urbanization and little development Consequently, according to [3] one of the main concerns in the cities of many emerging countries is traffic. The reasons for these problems are numerous, including poor design of the various road layouts, irregular alimentation of the roadways, noncompliance with traffic laws, heavy traffic, unlawful encroachments on the roads, etc. An effective transportation infrastructure is essential for the expansion of a country's economy and the global economic activities are propelled by urban transportation and many arterial highways in developing countries show decreased performance and capacity [4].

According to [5] road transportation has become the most significant form of communication, therefore all

development efforts are focused on planning, designing, and building a nation's vast network of roads at all levels, in the modern world. Furthermore, major transportation roads have a disproportionate impact on the direction of physical growth in urban areas, which grow centrifugally and strong connections between suburban or rural regions and metropolitan areas encourage the growth along the major roadways [5].

Whereas, travelling (or living close to main roads) may have negative effects on one's health and well-being, which can have a knock-on effect on one's ability to support oneself and engage in related activities. If there are large transportation routes nearby, pollution and stress may also have significant effects [6]. The urban roadway capacity is affected by several variables, including the speed of vehicles on the road, the width of the road, its structure, work being done to build a metro rail system, various land uses that draw motorized and pedestrian traffic to hospitals, institutions, and commercial areas, the width of the roadway and shoulder, access points, terrain, etc. [4].

While according to [3] the most prevalent forms of urban encroachment in cities are hawker operations along pedestrian routes, footpaths, main carriageways, and roadside areas, as well as the unlawful expansion of slums or mushrooming development along diverse patterns of roadways. In the same vein [7] stated that slum expansion and street selling were once considered to be the two most prevalent forms of urban invasion. However, as urbanization has grown, new types of encroachment have emerged, including building ramps in front of houses, building on drains, protruding balconies, illegal mining, illegal sand excavation, utilizing roads for illegal parking, and disposing of rubbish on unused property.

Hence, according to [3] encroachment refers to the holding or occupying of any footpath, two-wheeled moving path, open space/public space, or government land when the illegal land-holder does not have sufficient authorization to use that specific piece of land for their self-interest and self-motive. While [8] said that any object that occupied the part of the roadway closest to the sidewalk was a street encroachment.

However, according to [9] urban regions increasingly look for innovations in a range of scientific disciplines to progress and address the shifting needs and difficulties brought on by urbanization as a result of fast population increase and the antecedent effects of survival by the populace which brings about the encroachment menace and one of such is the evolution of smart cities.

Consequently, according to [9], [10] "Smart City" combines traditional infrastructure with the Internet of Things (IoT) to achieve a sustainable economy, increased quality of life growth, prudent resource management, and participatory government within a City.

Thus, this study through a systematic literature review tends to find the trends of research on land use pattern-induced road encroachment by answering the following research questions:

1. RQ1. What are the human activities that cause road encroachment on urban roads and highways?

2. RQ2. What are the effects of land use-induced road encroachment on dwellers, traffic, pedestrians and the environment?

3. RQ3. What strategies are recommended to address the expansion of road encroachment due to land use and to create the foundation for future Smart Cities in Developing Countries?

4. RQ4. What is the rate of publications on land-use-induced road encroachment among countries?

REVIEW METHODOLOGY

Systematic reviews, which are carried out by review groups with specialized skills, can be broadly described as a type of research synthesis that aims to identify and retrieve international evidence that is pertinent to a specific question or questions and to evaluate and synthesize the results of this search to inform practice, policy, and in some cases, further research [11].

Thus, this study conducted a systematic literature review to establish the concept of road encroachment as it's

related to land use patterns through the usage of the Scopus database by using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) for the selected papers. [12] stated that with the efforts to assist systematic reviewers in clearly describing why the review was conducted, what the authors performed, and what they discovered, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was created and published in 2009. According to [13] 27-item checklist and a four-phase flow diagram make up the PRISMA recommendations.

The flow diagram outlines the selection, eligibility, and inclusion standards for reports falling under the purview of a review. The 27-item recommended list on the checklist covers subjects including the title, abstract, introduction, techniques, results, discussion, and finance. PRISMA elements serve as a roadmap for authors, reviewers, and editors with the help of this flow diagram and checklist. Thus, using the PRISMA principles the reporting methodology format was segregated into four sections: search strategy; selection criteria; quality assessment and data extraction.

Search Strategy

We create a search strategy to find relevant literature for this systematic review. The following search phrases were utilized in this search strategy, which was focused on the database "Scopus":

("Road Encroachment") (road AND encroachment) (roads AND encroachments) ("highway encroachment ") (highway AND encroachment) ("road encroachment" OR "highway encroachment") (setback AND encroachment) ("setback encroachment") (road AND encroachment AND land AND use).

Thus, a total of 399 documents were retrieved using the comprehensive search string (roads AND encroachments), which included all journal articles, review papers, and conference papers in English from 1944 when the first paper was published on the subject matter till 2022.

Selection Criteria

Transport-related concerns are both social and scientific in nature, making them interdisciplinary topics, particularly when it comes to issues with transportation infrastructure, planning and operation of transportation, and traffic externalities. The PRISMA Statement [13] which primarily focused on mapping existing literature on spatial data in the fields of sciences, engineering, environmental science, social science, agriculture and biological sciences, earth and planetary sciences, computer science, and medicine, served as the basis for the selection criteria. The search focused on all countries and spanned from the year 1944 to 2022 while all 2023 publications were excluded from the search. Thus, a total of 11 research articles were excluded at this stage. Their records were extracted at this stage.

Quality Assessment

Only original research publications, review articles, book chapters, and conference papers were used to create the study. All duplications were carefully examined to preserve the review's high standard. To assure the calibre and applicability of academic material included in the review process, the abstracts of the papers were carefully examined for analysis and purification. Each study report underwent a thorough examination at a later time. The second exclusion requirement was to restrict papers to those published in English exclusively and 25 papers were removed based on this criterion. Consequently, 2 more publications were also taken out of the research when duplicate entries were filtered and an additional 3 articles were removed because of lack of authors. After evaluating each item against the aforementioned inclusion and exclusion criteria, we chose 26 papers which were narrowed down to land use pattern-induced road encroachment and related areas. Thus, Figure 2.1 shows the literature inclusion and exclusion at every stage. (PRISMA statement)

Data Extraction

Only 26 articles were chosen for the data extraction phase, and the following attributes were extracted:

1. The article has to be a conference paper, a review paper, and an original work

2. The essay must be written in English and from multi-disciplinary coverage because of the nature of the subject matter which is the land use pattern induced road encroachment.

3. The items that were pulled were published between 1944 and 2022.

4. Extraction papers cover all countries

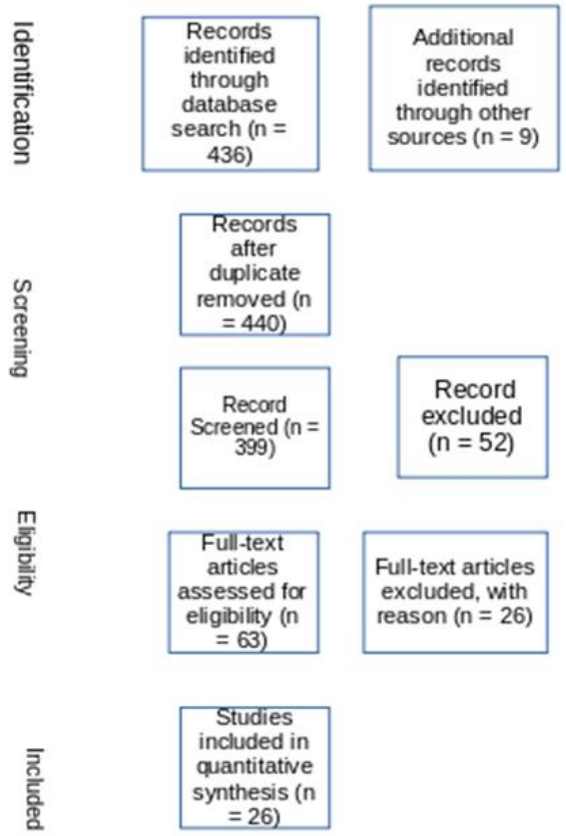

Fig. 1 PRISMA workflow and number of collected papers in each step

RESULTS

The results of the systematic review according to the specific research questions of this study are given below

Human activities that cause road encroachment on urban roads and highways (RQ1)

According to [8] the growing threat of encroachment on streets, sidewalks, and roadside is a serious issue that poses significant safety risks to pedestrians, motorists, and cyclists. This problem is often exacerbated by the lax implementation of road safety requirements and the failure to enforce anti-encroachment laws. Whereas according to [3] traffic issues have emerged as a significant problem in many developing countries' cities, with several factors contributing to the problem, such as inadequate road design, irregular maintenance, lack of adherence to traffic regulations, poor enforcement, heavy traffic, and illegal encroachments.

Urban population growth and urban-rural migration are major forces that spring up unplanned development in many cities in developing countries, [1] stated that the rapid growth in world population, particularly in developing countries, has led to the formation of unplanned and unregulated squatter colonies, open space encroachment, and roadside encroachment in the peripheries and within cities. Also the seemingly irreversible migration of people from rural to urban areas has contributed to this problem of roadside and open space encroachment. Furthermore, [7] reiterated that Slum expansion and street selling were once considered to be the two most prevalent forms of urban invasion. However, as urbanization has grown, new types of encroachment have emerged, including building ramps in front of houses, building on drains, protruding

balconies, illegal mining, illegal sand excavation, utilizing roads for illegal parking, and disposing of rubbish on unused property.

Informal sector activities dominated the human activities on the roadside in urban roads and highways, so according to [3] the unplanned growth of the informal sector and street vendors in emerging nations' cities is a major cause of the encroachment on arterial and sub-arterial roads, collector roads, and local streets. The vendors' activities typically result in the occupation of parking spaces and roadside areas, which contributes significantly to traffic problems. Additionally, the presence of illegal temporary structures on pedestrian paths or walkable areas reduces the space available for pedestrians, exacerbating the situation.

Linear infrastructure such as road and rail attract settlement and this is buttressed by [5] which indicated that the physical expansion of urban areas typically occurs in a centrifugal manner, with the expansion direction often influenced by key transportation lines. The growth along major roadways is supported by robust connections between suburban or rural areas and metropolitan regions, which facilitate commuting and trade activities along the roads.

The effects of road encroachment on dwellers, traffic, pedestrians and the environment (RQ2)

The effects or impacts of land use-induced road encroachment are multi-faceted and these were brought out from the articles after an exhaustive systemic review of the authors' submissions in the articles. Pedestrian traffic challenges happened to be one of the major impacts of road encroachment in cities and this was buttressed by [14] who stated that the obstruction of pathways by shopkeepers, vendors, and hawkers, resulting in the diversion of pedestrian traffic onto small roadways, greatly impedes the smooth and free movement of people, causing significant disruption to foot traffic. Furthermore, [8] reiterated that the encroachment of sidewalks and streets by various structures and objects increases the risk of hazardous behaviour by pedestrians and exposes them to the dangers of road traffic accidents involving pedestrians. In addition, [15] state that studies have found that the inaccessibility or improper positioning of pedestrian crosswalks, as well as encroachment of footpaths, are factors that increase the risk of pedestrian fatalities at intersections. While [7] indicate that pavement encroachment forces pedestrians to use the roads for walking instead of the designated sidewalks, leading to increased pedestrian traffic on the roads. This, in turn, slows down automobile traffic and contributes to congestion in the area according to [16] the effective usage of pathways is hampered by illegally placed fixed or unfixed obstructions that encroach on sidewalks, posing difficulties for people as they cross the street and obstructing the free flow of foot traffic and [15] state that high vehicular volumes, increased pedestrian-vehicle interaction, high approach speeds, vehicle overtaking propensities, specific land uses, encroachment of footpaths, inadequate sight distances, inaccessible pedestrian crosswalks, wider minor carriageways, the absence of a pedestrian signal head, and a lack of enforcement are all linked to pedestrian fatalities at intersections.

Vehicular Traffic accidents are very common or rampant in areas with a high presence of road encroachment induced by the activities of dwellers around the area. [8] in their studies stated that the absence of proper road infrastructure for pedestrians, combined with illegal encroachments on sidewalks and streets, exacerbates the problem of hazardous pedestrian behaviour. In areas with high traffic volume where vehicles and pedestrians converge, it is not surprising to see frequent incidents of injuries and accidents. Consequently, [17] reiterated that encroachment is a widespread issue in developing countries, with roadside activities and objects often diverting drivers' attention, slowing down traffic, and increasing the risk of accidents and injuries.

Traffic congestion is a major impact of roadside activities within urban and along the highways in many developing countries; [18] in his study revealed that unauthorized roadside parking, rude driving behaviour, encroachments, and conducting business on public roads are the main factors contributing to traffic congestion. These bottlenecks impede the smooth movement of traffic, causing inconvenience and stress to locals who depend on efficient transportation systems. Furthermore, [18] state that unchecked land use practices, such as unplanned and haphazard development, often lead to roadside encroachment, which is a primary cause of traffic congestion. Consequently, [14] indicate that informal stops and footpath encroachments can cause congestion on roads, leading to slower vehicle speeds and this decrease in speed can lead to lower crash rates, but it also results in longer travel times for drivers and in addition [3] said that the encroachment on pedestrian

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routes and sidewalks reduces the available space for traffic on the carriageway, leading to traffic congestion and increased conflicts between pedestrians and vehicles and this can be attributed to the decreased mobility of vehicles and the reduced area for pedestrians.

The human activities that result in road encroachment does generate effects that lead to health, housing and environmental challenges. According to [19] cattle herders' encroachment on city roadways poses several socioeconomic concerns, including environmental degradation due to animal waste and air pollution, displacement of urban residents, traffic accidents caused by animals wandering onto the road, and non-violent confrontations between herders and motorists. Furthermore, [5] state that the inadequacy of planning and architectural disciplines has led to ribbon development projects that negatively impact the scenic character along highways and illegal encroachment of small businesses and slum activities further exacerbate the problem, seriously damaging the view along the roadway. Whereas [3] reiterate that encroachment has a particularly negative impact on the green buffer that is present on both sides of arterial and sub-arterial roadways, the trees planted beside them, and the landscape infrastructure and other amenities along the road. Consequently, [20] submit that road encroachments undermine the benefits of housing transformations (such as income from renting out rooms for both residential and commercial activities) and endanger efforts to reduce poverty because some roads are encroached upon to the point where the settlement is inaccessible and the settlement structure is rendered dysfunctional.

The strategies recommended for combating the expansion of road encroachment due to land use and creating the foundation for future Smart Cities in Developing Countries

The systematically reviewed articles raised important ways forward and informed of recommendations to reduce the menace of land use pattern-induced road encroachment.

According to [14] it is necessary for authorities to regularly clear any objects that could obstruct a driver's view, including shrubs, signs, and banners and clearing pathways and roads of encroachments can potentially reduce the risk of accidents. Additionally, steps should be taken to make roads more pedestrian-friendly, and measures such as traffic slowing and preventing encroachments should be implemented. [5] state that in the absence of any measures taken by the national highway's municipal or governmental authority, the pressure of uncontrolled, swift growth along the route cannot be alleviated. It is highly recommended to impose a ban on any development activity within a specified distance from the roadway to mitigate this issue effectively. Such measures can ensure the sustainable and safe development of the region while preserving the integrity of the highway infrastructure. Consequently, [21] suggest that among other proposed solutions, the Town Planning Authority's implementation of setback regulations and public education regarding the dangers of encroaching on the right of way are suggested measures. These actions can help prevent unauthorized development and ensure the safe and sustainable use of the roadway.

Furthermore, [18] said that to alleviate traffic congestion, it is necessary to consider both traffic management and urban land-use policies. Appropriate measures and policies can reduce traffic volume and encourage alternative modes of transportation, leading to a safer and more sustainable urban environment. In addition, [18] state that it is crucial to provide suitable on-street and off-street parking facilities, particularly in central business districts, to discourage road-side parking by motorists and traders. The sale of goods along the road must be prohibited, and strict penalties should be imposed on traffic rule violators. Regular traffic awareness seminars should be held in schools, colleges, and high-traffic areas, emphasizing the negative impacts of traffic congestion [3] said that efficient planning for the informal commercial sector along the roads is crucial to control their activities and reduce interference with traffic flow on different levels of urban roads. Such measures can help ensure smooth mobility and minimize the negative impacts of roadside commerce on the urban environment.

While [22] suggest that a typical features of comprehensive development in Smart Cities through planning for "unplanned areas," providing housing opportunities for everyone, and creating walkable communities that lessen traffic, air pollution, and resource depletion as well as boost the local economy, foster interaction, and ensure security; maintaining and creating public open spaces like parks, playgrounds, and recreational areas to improve residents' quality of life; promoting various forms of transportation, such as public transportation, last-

mile paratransit, and transit-oriented development (TOD); making government more cost- and citizen-efficient; giving the city a distinct character based on its primary economic activity for example, the local gastronomy, health, education, arts and crafts, culture, sporting goods, furniture, hosiery, textiles, dairy products, etc. and implementing smart solutions to infrastructure and services in area-based development in order to make them better should be able to solve the menace of land use induced road encroachment.

The rate of publications on land use-induced road encroachment among countries (RQ4)

The section displays an analysis by Scopus of the countries where the 399 papers on road encroachment in general and the 23 articles chosen for an in-depth systematic review of publications on land use pattern-induced encroachment were published.

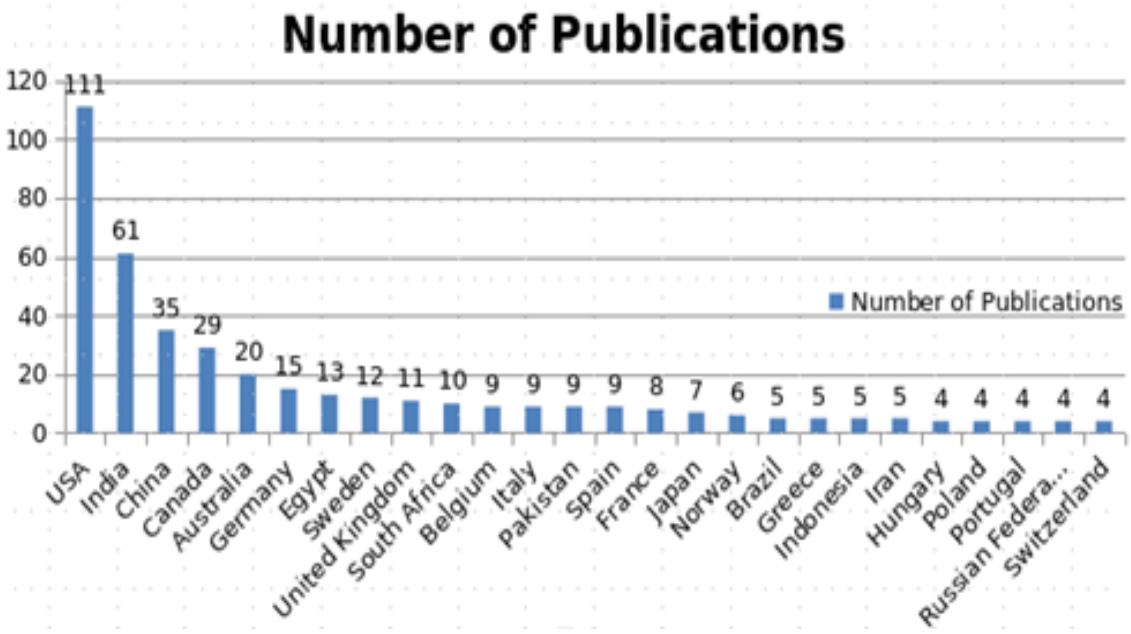

Fig. 2 Scopus analysis of the country of publications of the 399 articles on road encroachments

Figure 2 depicts the rate and trend of country publications on road encroachment as a subject matter from Scopus 399 articles. According to a Scopus analysis of countries of publishing, 77 countries have publications on road encroachment, even though 17 articles countries are undefined. However, among the 77 countries, ten have at least ten articles, accounting for 80% of the total articles (317 out of 399). The United States of America (USA) has the most articles with 111, followed by India with 61, China with 35, Canada with 29, Australia with 20, Germany with 15, Egypt with 13, Sweden with 12, the United Kingdom with 11 and South Africa with 10.

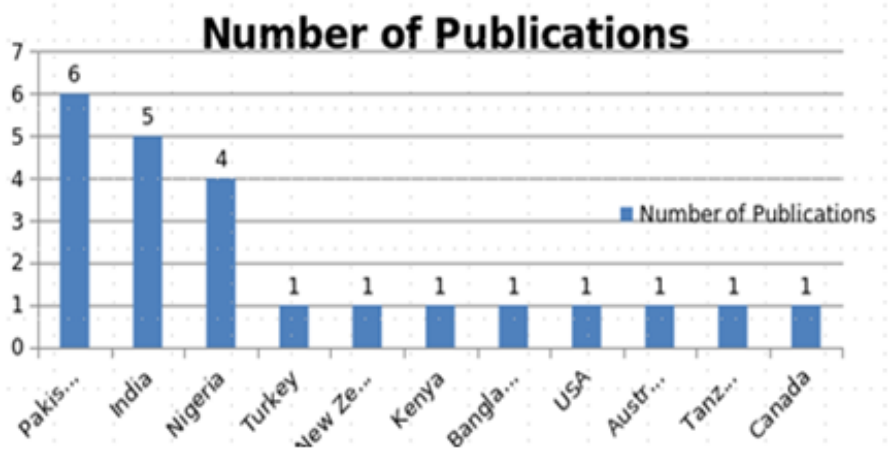

Fig. 3 The country of the spread of 23 screened and used for the Systematic Review of land use-induced road encroachments

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The country distribution of the 23 screened papers utilized for an in-depth systematic analysis of land use-induced road encroachment is depicted in Figure 3. Pakistan has the most with six articles, followed by India with five and Nigeria with four, with the remaining eight nations each having one. However, when the results of Figure 4.2 are compared to the results of Figure 4.1, it is clear that the articles or research on land-induced road encroachment are primarily from developing countries, as depicted in Figure 4.2, whereas developed countries have major publications on general road encroachment concept. Consequently, India has 61 articles on road encroachment-related issues in Figure 2, but only 5 articles on land use-induced road encroachment in Figure 3, and the same is true for the United States, Canada, and Australia which have 1 article each in Figure 3 but have 111, 29 and 20 articles respectively in figure 4.2. Thus, Table 4.1 shows the details of, the author, publication year, country of case study, title and aim of the 23 articles used for the systematic literature review that answered the 4 research questions of this study.

Author	Year	Case study Country	Title	Aim
(Aguda, A.S. et al., 2013)	2013	Nigeria	Spatio-temporal assessment of urban growth of medium-size and nodal towns for sustainable management: using GIS	The paper adopts a Geographical Information System (GIS) in assessing the spatial pattern and the physical planning problems associated with the expansion of Ore township between 1964 and 2002
(Ali et al., 2021)	2021	Pakistan	Understanding traffic congestion from stakeholders' perceptions in the central area of Lahore, Pakistan	The study is aimed at understanding the traffic congestion from the stakeholders' perspective and suggesting congestion mitigation measures
(Badmos et al., 2018)	2018	Nigeria	Urban development in West Africa-monitoring and intensity analysis of slum growth in Lagos: Linking pattern and process	The study aims to contribute by applying object-based image analysis and intensity analysis to map and link patterns and processes of slum growth in Lagos.
(Caputcu et al., 2016)	2016	Turkey	Use of laser measurements and video images to investigate pedestrian movement along non-uniform sidewalks	This paper presents a method as an alternative to conventional data collection methods for traffic analysis and suggests that it can be adapted to investigate micro-interactions and conflicts around locations of aforementioned sidewalk problems.
(Chandra, 2003)	2003	India	Effect of Roadside Obstruction on speed and Placement of vehicles on two-lane roads	The study was undertaken to study the trajectory of a vehicle for different types of obstructions and their distance from the pavement edge.
(Chauhan et al., 2017)	2017	India	Reducing Encroachment Problems on Roads to Reduce Traffic Congestion instead of Widening the Road	The paper studies the ways through which the problem of encroachments on the roads can be reduced.
(Hasan, 2009)	2009	Pakistan	Land, CBOs and the Karachi Circular Railway	The study examines the effects of informal settlements along the railway tracks on the upgrade and expansion of the Karachi circular railway and double-track
(Huisman et al., 2015)	2015	New Zealand	Detecting environmental change within pipeline ROWS using high-resolution	This paper reports on the development of a methodological approach for environmental change analysis using high-resolution satellite

Author	Year	Case study Country	Title	Aim
			satellite imagery	images that can help decision-making in pipeline systems. Analysis
(Iwuoha, 2020)	2020	Nigeria	Cattle droppings litter our city roads: Herders' encroachments, risk factors and roadmap for achieving sustainable development goals	The paper examines herders – urban residents' conflicts
(Khan et al., 1999)	1999	Pakistan	Pedestrian environment and behaviour in Karachi, Pakistan	The study aims to observe the behaviour of Karachi pedestrians which may expose them to an increased risk of RTA and to observe the level of encroachment onto the sidewalks and streets in those city intersections which had the highest reported pedestrian-related RTAs
(Kinyanjui, 2013)	2013	Kenya	Women informal garment traders in Taveta Road, Nairobi: From the margins to the centre	The article investigates the Taveta Road phenomenon, whereby women garment informal traders occupy a whole street in the central business district of Nairobi, Kenya.
(Mahmudul Hasan et al., 2017)	2017	Bangladesh	Impact of Ribbon Development on Land Use along Dhaka Aricha Highway. The Case of Savar Upazila	The study attempts to focus on the trend of ribbon development along the Dhaka-Aricha Highway to show the impact on land use.
(Mukherjee & Mitra, 2020)	2020	India	Modelling risk factors for fatal pedestrian crashes in Kolkata, India	The study analyzes historical crash records obtained from the "Kolkata Police" and identifies the risk factors at the road network level for the hazardous corridors posing a high risk to pedestrians
(Oyinloye et al., 2017)	2017	Nigeria	Pipeline right-of-way encroachment in Arepo, Nigeria	The paper uses remote sensing and geographic information system (GIS) technologies to assess the level of vulnerability of people living along the PROW in Arepo, Ogun State, Nigeria
(Qi et al., 2022)	2022	USA	Empirical Data-Based Condition Prediction for Stormwater Pipelines with Machine Learning	The paper proposes a framework for a novel data-driven model for predicting stormwater infrastructure conditions to identify at-risk pipelines and culverts using existing data inventory
(Rao et al., 2017b)	2017	India	Evaluation of Influence of Roadside Frictions on the Capacity of Roads in Delhi, India	The paper reviews the literature on the impact of different types of fictional roadway capacity and speed
(Schulten & Parnell, 2015)	2015	Australia	Development Around Freight Rail Corridors: Noise Assessment and Mitigation	The paper references a comprehensive noise data set as an evidence base to guide the identification of affectation zones around freight rail corridors and freight rail hubs where

Author	Year	Case study Country	Title	Aim
				the risk of land use conflict is high
(Sheuya, 2009)	2009	Tanzania	Urban poverty and housing transformations in informal settlements: The case of Dar-es-Salaam, Tanzania	This study is on housing transformations in informal settlements, unlike similar earlier research on government-built housing.
(Singh & Punjab, 2018)	2018	India	Factors Affecting The Congestion & Encroachments On Urban Roads (Case Study- Ludhiana City)	The study was made to investigate the factors responsible for the traffic jams, congestion and encroachments by reducing the actual widths of the roads and putting barriers on the flow of traffic smoothly
(Tran et al., 2020)	2020	Pakistan	Pakistan's Urban Transport and Commute Problems (an Empirical Investigation)	The study examines the transport infrastructure in Pakistan and the conditions of traffic and commuting in the country while focusing on its major cities
(Urban Resource Centre, 2001)	2001	Pakistan	Urban poverty and transport: A case study from Karachi	The paper examines the role of transport provision in the lives of low-income groups in Karachi
(Umair et al., 2022)	2022	Pakistan	The impact of urban design and the built environment on road traffic crashes: A case study of Rawalpindi, Pakistan	The study identifies urban design factors that can influence road traffic crashes.
(Wang et al., 2014)	2014	Canada	An Engineering Assessment to Evaluate Integrity Options for Out-of-Class Pipelines	The study examines EA approach has industry-wide applications in providing safer and more optimized solutions

CONCLUSION AND RECOMMENDATIONS FOR THE FUTURE

The study examining road encroachment has several main focuses, such as encroachments onto farmland, effects on flora and wildlife, concerns about road safety, land use-induced road encroachment, and the encroachment of vehicles into highway medians. Among these, road encroachment brought on by land usage stands out as a major issue for developing countries. This issue is a result of the informal economy, the housing challenges encountered by low-income people, and the ineffective implementation of traffic laws and limitations on urban planning and growth.

Furthermore, the study also showed that there are numerous and significant effects of land use-induced road encroachment. They include problems like traffic congestion, a rise in accidents, obstructions to pedestrian movement, environmental degradation, and health difficulties that impact both locals and business people in these locations. These adverse effects underscore the urgency of finding viable solutions to mitigate the problem.

Consequently, the study indicated that addressing land use-induced road encroachment requires a multifaceted approach that includes improving and regulating the informal sector through targeted economic development initiatives, providing designated parking facilities and enforcing measures against unlawful on-street parking, improving housing programs for low-income earners is essential in curbing encroachments, and fostering community engagement.

In addition, the study revealed that the idea of smart cities emerges as a possible solution to the problem of land use-induced road encroachment. Smart cities make use of technology and data-driven solutions to

improve the quality of life for people, streamline city processes, and encourage sustainable growth. Road encroachment in developing nations may be considerably reduced by using smart city concepts.

In conclusion, it is imperative to acknowledge the need for future research on land use-induced road encroachment. Developing nations must fund scholarly studies on the underlying causes and detrimental effects of this problem. It's also important to comprehend how locals perceive and are aware of the issue. These study results help guide successful road encroachment policy and strategy development.

Lastly, By Sustainable Development Goal 3, which aims to guarantee healthy lives and promote well-being for everyone, nations must address the issue of land use-induced road encroachment. Priority should be given to evaluating strategies to stop or lessen road encroachment in both urban and rural regions of developing countries, led by thorough research and a dedication to sustainable urban development.

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