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Pre-feasibility studies of the urban corridor: El Terremoto – La Capilla and El Sabino

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Abstract

This study analyzes the impact of consolidating a road corridor connecting the El Terremoto neighborhood with the ejido communities of La Capilla and El Sabino in Cuautitlán, State of Mexico, to assess its effects on regional mobility and propose integrated solutions. The research is framed by national and local urban planning regulations and examines the municipality's urban, social, and geographic context. A multimodal road configuration model was designed, considering the mobility hierarchy and incorporating traffic counts, user surveys, and demand modeling—including binary choice and induced demand. Simulations were performed using SUMO software to evaluate key mobility indicators such as average speed, travel time, and the number of stopped vehicles. Results show that, during peak hours (6:30–8:30 a.m.), the proposed corridor would increase average speeds to 21.5 km/h and reduce travel time from 29 to 16 minutes—a 45% improvement. These findings suggest that the corridor offers an efficient alternative to current infrastructure. The study highlights the importance of strengthening road networks in suburban areas to reduce territorial inequality and improve connectivity. Its value lies in combining regulatory, technical, and social perspectives, proposing an inclusive, multimodal design, and applying transportation modeling and simulation tools to evaluate non-consolidated urban infrastructure.

Keywords: Urban Corridor, Mobility, Transport Modeling, Cuautitlán, Infrastructure Planning

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1. Introduction

Cities are each organized with a specific structure; however, they all share a fundamental aspect: they are composed of a framework that connects infrastructure, transportation, natural areas, industry, and commerce—urban corridors (Martínez Guevara, 2007).

Optimal mobility and the existence of well-integrated road corridors that ensure safe interaction among various modes of transportation in central urban areas are vital for the development of the urban environment.

Likewise, it is crucial to consider the development of mobility in the outskirts of cities, also known as suburban or conurbated areas. Unlike central urban zones, their road networks are not fully consolidated, presenting a significant opportunity for the development and implementation of mobility projects.

As we move toward consolidating the road network in suburban areas of our cities, various factors must be considered when designing new road corridors and other mobility projects. These include current development plans, public opinion, environmental regulations, legal frameworks, among many others that will determine the success of our projects' implementation.

2. Theoretical framework

The planning and redesign of urban corridors constitute a fundamental element in the sustainable development of cities and communities worldwide. These spaces not only fulfill the function of articulating mobility and transportation, but also influence road safety, social cohesion, economic efficiency, and environmental sustainability. In diverse social, economic, and political contexts, the implementation of urban corridors requires adherence to universal principles that ensure equitable growth and the comprehensive improvement of urban quality of life. Among these principles, the integration of mobility with land use, the promotion of safe environments for pedestrians and non-motorized vehicle users, the reduction of pollutant emissions, and the consolidation of multifunctional spaces capable of responding to the needs of a constantly changing population stand out.

An illustrative case can be found in Oxford Street, London, where the high presence of automobiles, despite the existence of a consolidated public transport network, generates highly vulnerable conditions for pedestrians. In response, planning strategies have been proposed based on the Transit-Oriented Development (TOD) model, aiming to restrict private car use and promote walking as a priority mode of mobility. These measures, in addition to reducing emissions from motorized travel, seek to reconfigure land use and transform this corridor into a safe, diverse, and accessible space for the population. The Oxford Street case reflects the importance of integrating transport with urban planning (LUTI) and of applying models such as the LUTI feedback cycle, the Sustainable Urban Mobility Plan (SUMP) framework, and the 5Es model, in order to promote a more human-centered and sustainable development of urban corridors (Sheikh, n.d.).

Complementarily, in rapidly growing urban contexts such as Chengdu, China, attention has been directed toward ecological corridors as essential components of urban resilience. Accelerated urbanization has resulted in habitat fragmentation, the loss of agricultural and forest areas, and biodiversity degradation. Against this backdrop, the identification, evaluation, and design of ecological corridors are considered key tools for strengthening urban ecological networks and mitigating the negative effects of uncontrolled growth. Using the

Minimum Cumulative Resistance Model (MCRM), recent studies have demonstrated that the construction feasibility of these corridors varies significantly depending on their width, which constitutes a determining criterion for spatial planning and the preservation of urban ecosystems. These findings underscore the need to include ecological criteria in the design of urban corridors, reinforcing the view that such spaces must be conceived not only as axes of mobility but also as infrastructures integrating environmental sustainability and territorial planning (Xie et al., 2023).

Taken together, the cases of London and Chengdu illustrate that the planning of urban corridors, whether from a mobility perspective or from an ecological standpoint, requires comprehensive and contextually adapted approaches. These studies provide insights into how different cities around the world address common challenges and offer valuable frameworks to guide similar projects in other urban environments.

2.1. Urban corridors

In the context of the current regulations in the State of Mexico, the 2019 Urban Development Plan defines three types of urban corridors: regional corridors, metropolitan corridors, and urban corridors.

Regional corridors are defined as:

> *"Those that connect various cities within the State, mainly those with the most dynamic vehicular flows resulting from the intensity of their economic activities. Some of them typically cross these urban areas to continue toward others."* (SEDUM EDOMEX, 2019)

Metropolitan corridors are defined as:

> *"Those located specifically within the metropolitan areas of the State, such as Toluca and Mexico City. Their function is to efficiently connect the urban zones that make up the metropolis."* (SEDUM EDOMEX, 2019)

Urban corridors are defined as:

> *"Those established along the highest-ranking urban roads, such as bypasses, loops, avenues, viaducts, among others, which efficiently connect various areas within cities."* (SEDUM EDOMEX, 2019)

The main differences between these types of corridors lie in their scope: regional corridors have an intermunicipal character and are not necessarily located in the metropolitan core; metropolitan corridors are more critical to the central areas of cities; and urban corridors are more general and diverse, referring to the most important local roads in a specific urban zone.

According to current local regulations, Cuautitlán's 2023 Urban Development Plan defines urban corridors in the municipality as:

> *"Zones that allow for the concentration of economic activities, which not only integrate different localities but also help prevent long commutes by the population to central areas or service hubs.*

These corridors are developed along regional and primary roads, thereby leveraging their infrastructure and installed services." (DDU Cuautitlán, 2023)

2.2. Cuautitlán, State of Mexico

The municipality of Cuautitlán is located in the northeastern part of the State of Mexico and is part of the Mexico City Metropolitan Area, which comprises the 16 boroughs of Mexico City, 45 municipalities from the State of Mexico, and 2 municipalities from the state of Hidalgo. It is the largest metropolitan area in the country, with a population of 21.4 million inhabitants (SEDATU, CONAPO, INEGI, 2020).

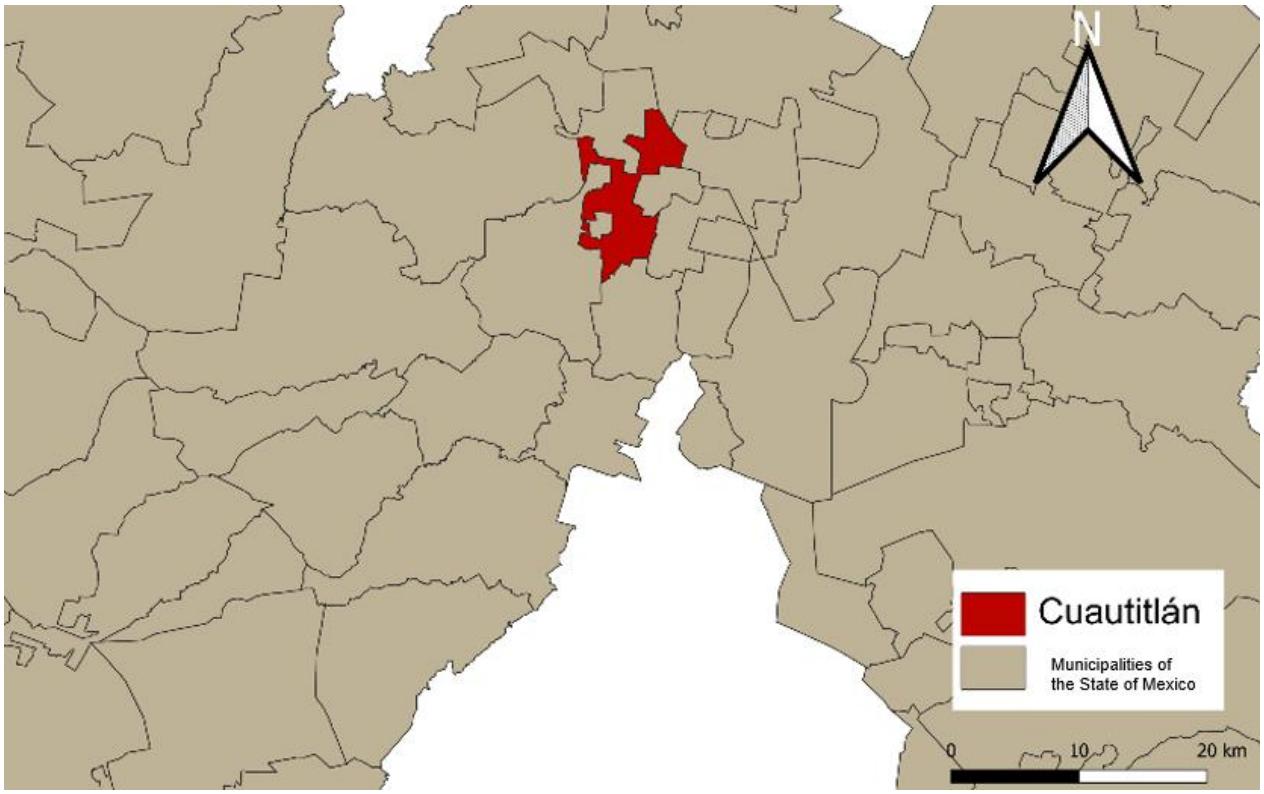


Figure 1. Map of Cuautitlán within the northeastern area of the State of Mexico. (Source: Author's elaboration using data from INEGI.)

According to the current Municipal Development Plan: "Cuautitlán is a metropolitan municipality belonging to the Valley of Mexico, located in the northeastern part of the State of Mexico, in the central region of the country. According to the National Institute of Statistics and Geography (INEGI), the municipality covers an area of 47.535 square kilometers. It borders to the north with the municipalities of Teoloyucan and the southern part of the Zumpango Lagoon; to the east with Nextlalpan, Melchor Ocampo, and Tultepec; to the south with Tultitlán; and to the west with Cuautitlán Izcalli and Tepotzotlán." (Government of Cuautitlán, 2025)

An important aspect to highlight is the recent reincorporation of a portion of territory into Cuautitlán, which took place through a legal process initiated by residents of the town of San Mateo Ixtacalco in July 2021. As a result, the LX Legislature of the State of Mexico approved Decree Number 334, which officially reunified the town and recognized it entirely as part of Cuautitlán. Subsequently, in January 2023, the Supreme Court of Justice of the Nation resolved any remaining legal disputes regarding this matter. (Government of Cuautitlán, 2025)

As shown in Figure 2, the reincorporated territory can be seen in purple on the western edge of the municipality.

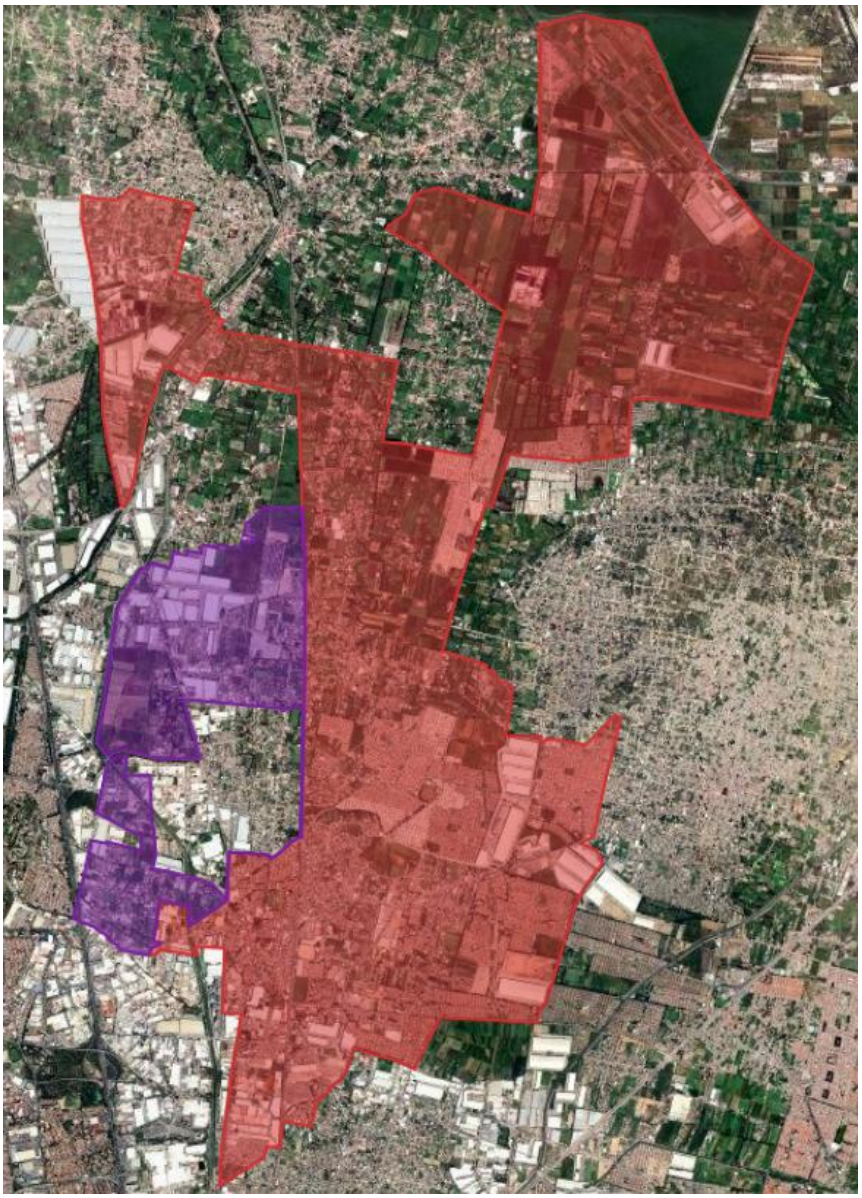


Figure 2. Map of the territory reincorporated into Cuautitlán (Source: Author's elaboration with images from Google Satellite).

2.3. El Terremoto – La Capilla and El Sabino urban corridor project

This corridor project is included in the current Urban Development Plan of the municipality of Cuautitlán. It is defined as a Mixed Urban Corridor with high and medium intensity, depending on the segment of the route. The designated classification is Primary Road with a 21-meter right-of-way restriction (width).

Along the corridor's route, a variety of land uses are permitted, including residential areas, commercial establishments offering specialized goods and services, and almost all types of tertiary activities. In addition, some specific secondary activities are allowed, such as seed mills, corn and wheat product manufacturing, and the production of handicrafts and pottery.

Since, at the time of publication of the current Urban Development Plans for both Cuautitlán and Cuautitlán Izcalli, the town of San Mateo Ixtacalco and its ejido fractions were still split between both municipalities, references are made to the corresponding sections of each plan.

Although they are two separate documents, both consider the proposed urban corridor and assign a 20-meter right-of-way for the primary road along most of its length, except in the central area of Cuautitlán, where a 12-meter restriction is established.

The corridor spans 5.5 kilometers and includes the following east–west roads: Al Tejocote, Ejido de San Mateo, Fresnos, and Río Córdoba.



Figure 3. Excerpt from the urban structure and land use map of Polygon 53 from the Urban Development Plan of Cuautitlán Izcalli (Source: Urban Development Plan of Cuautitlán Izcalli).

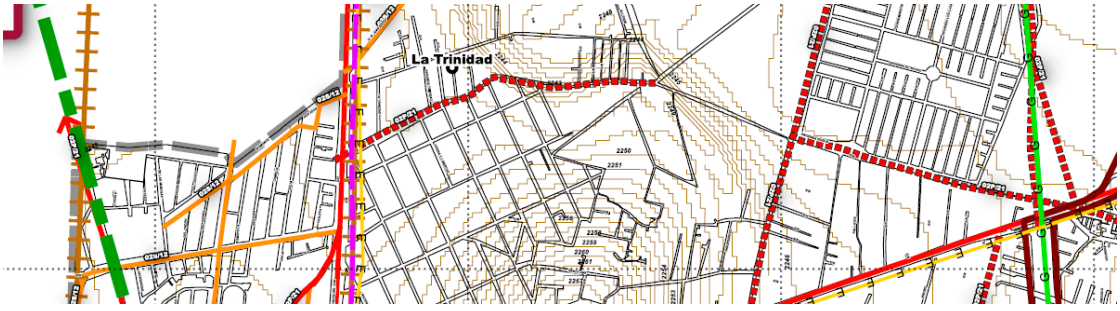


Figure 4. Excerpt from the road and restrictions map from the Urban Development Plan of Cuautitlán (Source: Urban Development Plan of Cuautitlán).

In addition to being supported by the official regulations of both municipalities, this corridor has benefited from the backing and political will of the most recent local and state administrations. In 2021, it received an investment of approximately 118 million pesos from the State of Mexico's Secretariat of Mobility. (MILENIO, 2021)

The project was to include complementary works such as drainage installation, tree planting along medians, and the designation of ecological reserve areas, with a projected completion date in the first quarter of 2023.

However, two years after the projected delivery date, the project remains unfinished. It achieved approximately 60% completion, considering the works carried out by the State of Mexico's Secretariat of Mobility and the segments that had already been developed in previous years. The remaining 40% corresponds to sections where no work has been undertaken, where the roadway consists of dirt roads or narrow paths with one lane in each direction.

One of the main reasons for the project's halt was the failure to deliver indemnity payments to the population of the ejido areas of San Mateo Ixtacalco. Although the payment was issued to the community's representative, it was reportedly not distributed to the affected residents, according to local testimonies and media reports.

As a result, the project entered an indefinite suspension and remains incomplete. The current state of the corridor is shown in Figure 5, where completed segments are marked in green and unfinished segments in red.



Figure 5. Image of the current state of the project (Source: Author's elaboration with images from Google Satellite).

Today, the importance of completing this project is even greater. With the reunification of the town of San Mateo Ixtacalco and the reincorporation of the ejido areas of El Sabino and La Capilla into Cuautitlán, there is a pressing need to address the longstanding demand for reliable and efficient connectivity between these localities and the municipal center.

3. Methodology

To characterize the future behavior of this urban corridor, various indicators were calculated to model travel demand. These included the number of trips the corridor will be capable of redirecting from the existing road network, the induced demand it will generate, expected travel times, among other metrics.

To calculate these indicators, a design projection was developed to consolidate the corridor while considering the different modes of transportation used by the population. This was supported by traffic counts, which were also used for demand modeling and public transportation planning.

Finally, a simulation was performed using specialized software, incorporating the previously gathered results to estimate key indicators such as average travel speed, journey times, and the number of stopped vehicles along the corridor.

3.1. Projected design

A road configuration design was developed for the entire corridor—both for the consolidated sections and those yet to be constructed. The design considers all road users in accordance with the hierarchy of mobility (General Law of Mobility and Road Safety, 2023), which establishes the priority in the use and allocation of road space.

This design includes wide sidewalks for pedestrian use, segregated bike lanes for non-motorized vehicle users, and priority lanes for public transportation—all aimed at protecting the most vulnerable groups and improving the overall efficiency of mobility for the population.

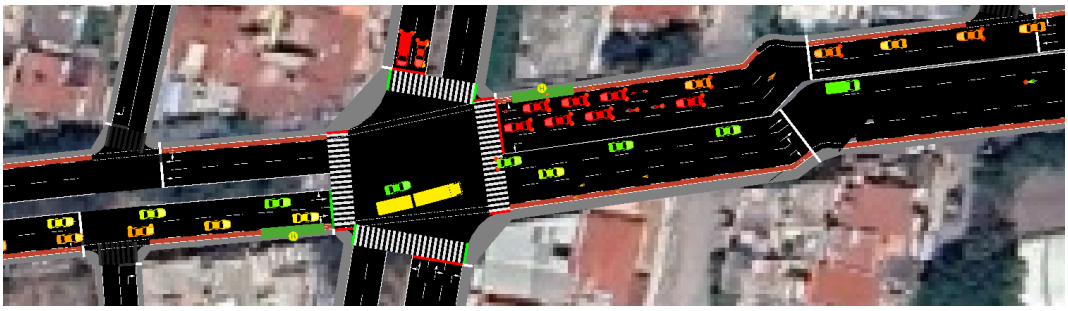


Figure 6. Projected design for the urban corridor (Source: Author's elaboration using SUMO software with images from Google Satellite).

As shown in Figure 6, the projected design includes designated stops for public transportation, wide sidewalks, safe pedestrian crossings, segregated bike lanes, as well as space for afforestation and reforestation.

3.2. Demand modeling

3.2.1. Traffic Counts

Through surveys conducted with the local population, consultations with traffic authorities, and the use of tools such as Google Maps, it was determined that the peak demand period in the corridor area occurs between 7:00 and 9:00 a.m. During this time frame, the highest traffic flow moves from east to west. To project future demand, the first step was to understand the current demand. For this purpose, vehicle counts were carried out at six different points along the corridor during September 2024, specifically during the identified peak demand hours—from 7:00 a.m. to 9:00 a.m. The counts were conducted on weekdays, excluding Tuesdays due

to the presence of a street market in Cuautitlán that significantly alters traffic patterns. Each of the six count stations recorded traffic volumes for a two-hour period. No weather-related disruptions occurred, and the data collection was conducted during a typical season, coinciding with the full return to school activities after the summer break. The sample size was designed to represent approximately 20% of the total traffic in the study area, with a 90% confidence level. The total vehicle count amounted to 16,414.



Figure 7. Locations of traffic count collection points (Source: Author's elaboration with images from Google Satellite).

As shown in Figure 7, traffic counts were carried out at both ends of the corridor, as well as at the four most important road intersections, whose names are indicated in the figure.

During the counting process, vehicles were categorized into bicycles, motorcycles, automobiles, public transportation, single-unit trucks, and tractor-trailers.

3.2.2. Binary choice

A binary choice model based on logit theory was used to estimate the proportion of users who would prefer to use the new road corridor over the existing road network. This type of model represents the probability of choosing between two mutually exclusive alternatives—in this case, using the bypass or remaining on the current infrastructure—based on the generalized costs perceived by users for each option.

The model assumes that users make rational decisions aimed at minimizing "generalized cost," which in this case includes monetary costs such as fuel expenses, traffic congestion, and travel times. The model used is based on the logistic function:

$$P_1 = \frac{1}{1+exp\{-\lambda(C_2+\delta-C_1)\}} \qquad (1)$$

Where:

- P_1= proportion of users choosing option 1 (the new bypass)
- C_1 and C_2= generalized costs associated with each alternative.
- λ= dispersion parameter reflecting user sensitivity to cost differences.
- δ= parameter capturing systematic penalties (e.g., distrust of new infrastructure or preference for a familiar route)

The values considered for each parameter are as follows:

- $\lambda = 0.2$ represents a medium sensitivity to change among road network users. This value reflects that the lack of knowledge regarding road conditions, signage, and other aspects of the new alternative prevents users from making a fully objective decision regarding travel time savings.
- $\delta = -8$ corresponds to a penalty associated with the new bypass, in which users tend to prefer the option they are accustomed to. In this context, they perceive the existing road network as being "eight minutes better" than it actually is.
- C1 = 20 minutes is the estimated travel time on the new bypass.
- C2 = 29 minutes is the average travel time on the existing road network.

Based on these parameters, it is estimated that the probability of adopting the new bypass among current road network users is 55%. However, according to data provided by traffic authorities, as well as from the analysis of the road network and user behavior, it was determined that only 40% of the total traffic at the eastern junction of the bypass has a destination that justifies the use of this new infrastructure. Therefore, by calculating the product of the probability of adopting the new bypass and the proportion of current road users whose trips could be redirected through it, it is concluded that approximately 22% of current road network users will be inclined to use the new bypass upon its opening.

3.2.3. Induced demand

The phenomenon of induced demand occurs when the expansion of a city's road network through construction or widening leads to a behavioral response from users: they begin to take trips they previously avoided due to congestion. Although these projects are expected to reduce traffic, decades of empirical evidence show that congestion typically returns quickly. (Speck, 2018)

In this project's demand modeling, this factor was especially considered for segments where currently only dirt roads exist, used by the local population out of necessity to reach their homes. Consolidating the road corridor will encourage residents to make trips they previously avoided due to poor road conditions.

3.2.4. Public transportation

The implementation of public transportation addresses the population's need to travel in an optimal and efficient manner. High-capacity public transport makes better use of road space. Buses, for example, have a line capacity up to 10 times greater than that of a private car in a city. (Molinero Molinero, 2022)

Therefore, the project's demand modeling considers the establishment of a mixed-traffic bus route with designated stops in the main trip generation and attraction zones along the corridor's route.

In addition to the planning of stops, iconography and the selection of names in public transportation systems are key elements for enhancing the user experience, improving wayfinding, and promoting inclusion. The use of icons—such as in the Mexico City Metro—follows cognitive principles that enable more intuitive and accessible navigation, especially in high-demand contexts. Furthermore, the selection of names with historical and cultural significance, as seen in Trolleybus Line 10 and also considered in the present project, contributes to the recognition and preservation of the identity of Indigenous communities, strengthening the

connection between urban infrastructure and the local populations it serves. For this reason, Figure 9 presents the proposed iconography for the public transportation stops along the corridor.



Figure 8. Projected location of public transportation stops along the corridor. (Source: Author's elaboration with images from Google Satellite).

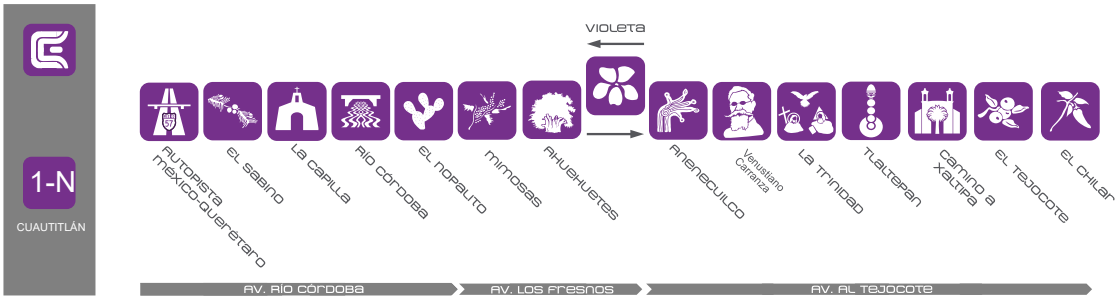


Figure 9. Proposed iconography for the designated public transportation stops along the corridor (Source: Author's elaboration).

3.3. Software simulation

Following the demand modeling, which provided data on trip generation and distribution, mode choice, and route assignment, the traffic behavior along the urban corridor was simulated using specialized software.

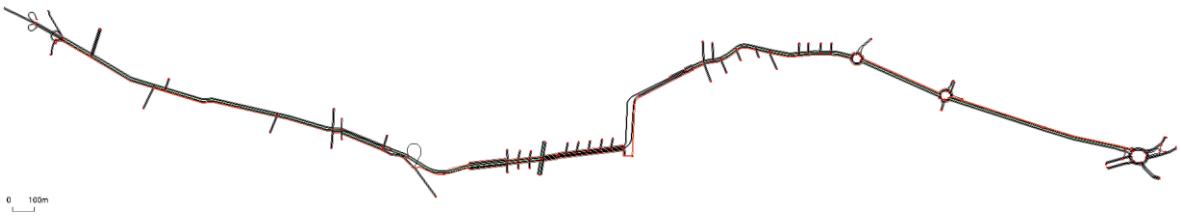


Figure 10. Software-based simulation of the entire length of the urban corridor project (Source: Author's elaboration using SUMO software).

The use of this tool enabled the collection of diverse data such as delay times, average speed, and the average number of stopped vehicles, among others. By analyzing this data and comparing it with the current conditions of the road network in the surrounding area, it was possible to evaluate the expected performance of the corridor once completed.

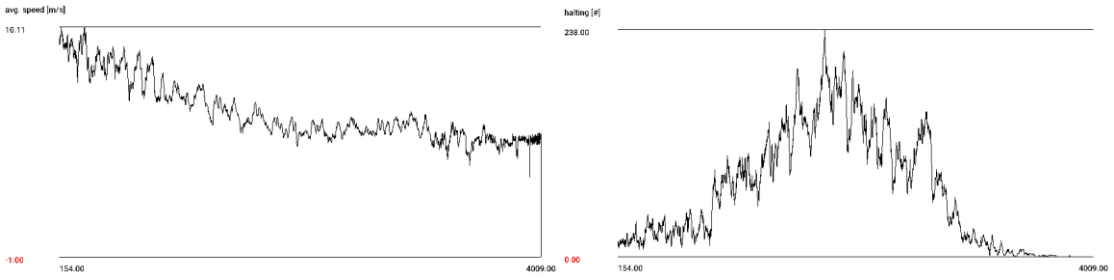


Figure 11. Graphs of average speed (left) and number of stopped vehicles (right) (Source: Author's elaboration using SUMO software).

The main parameters used for model calibration are shown in Table 1.

Table 1. Model calibration parameters.

Parameter	**Value**
Driver reaction time (headway)	1 [s]
Randomness factor in acceleration/braking behavior	0.5
Maximum acceleration	2.6 [m/s^2]
Comfortable maximum deceleration	4.5 [m/s^2]
Maximum emergency deceleration	9 [m/s^2]
Minimum distance between vehicles	1 [m]
Multiplicative factor of individual max speed (to vary drivers)	1
Stochastic variation of the speed factor	.1
Strategic lane changing	1
Level of cooperation in lane changing	1
Level of aggressiveness in lane changing	1
Impatience in lane changing	0
Lane choice at departure	random
Initial vehicle speed	random
Initial position in the lane	random

Source: Author's elaboration based on SUMO software data.

4. Results and discussions

Simulations were conducted under three distinct scenarios by varying the traffic scaling factor to 0.8, 1.0, and 1.2, with the objective of comparing the scenarios and rigorously analyzing their differences. Each simulation was executed over a one-hour period, corresponding to the previously estimated peak demand interval (6:30–7:30 a.m.), and the parameters shown in Tables 2, 3 and 4, were obtained for each scenario.

Table 2. Mean vehicle and road speeds.

Time [min]	Mean Vehicle Speed [km/h]			Mean Road Speed [km/h]		
Traffic Scale	0.8	1	1.2	0.8	1	1.2
5	31.27	29.93	30.51	32.04	31.98	31.95
10	30.7	30.77	30.27	31.74	31.66	31.55
15	29.81	28.64	27.41	31.54	31.36	31.20
20	26.77	25.19	23.71	30.84	30.6	30.44
25	25.85	21.43	19.61	30.6	30.09	29.96
30	23.1	20.06	17.66	30.36	29.95	29.59
35	21.13	17.18	15.65	30.37	29.71	29.46
40	22.27	18.39	15.32	30.66	30.15	29.52
45	21.62	17.81	15.89	30.9	30.35	29.79
50	24.87	19.45	15.06	31.46	31.14	30.44
55	21	17.46	15.19	31.97	31.76	31.30
60	17.36	16.57	20.56	32.26	32.19	31.96
65		17.12	18.96		32.46	32.39

Source: Author's elaboration based on SUMO software data

Table 3. Mean fuel consumption and CO2 emissions.

Time [min]	Mean Fuel Consumption [L/s]			Mean CO_2 Emissions [mg/s]		
Traffic Scale	0.8	1	1.2	0.8	1	1.2
5	1.22	1.16	1.10	3795.8	3596.9	3424.61
10	0.84	0.82	0.78	2612.1	2527.2	2429.85

Time [min]	Mean Fuel Consumption [L/s]			Mean CO_2 Emissions [mg/s]		
15	0.62	0.69	0.69	1907.6	2135.8	2141.41
20	0.84	0.77	0.72	2617.5	2382.1	2236.05
25	0.74	0.66	0.62	2303.9	2056.7	1920.80
30	0.64	0.62	0.60	1981.4	1924.9	1865.25
35	0.67	0.62	0.60	2089.5	1919.3	1850.85
40	0.6	0.59	0.57	1848.4	1830.8	1751.90
45	0.55	0.59	0.59	1694.2	1821.1	1827.19
50	0.47	0.62	0.57	1450.5	1919.6	1754.54
55	0.31	0.6	0.59	960.83	1875.2	1822.91
60	0.1	0.27	0.68	325.41	856.24	2099.14
65		0.14	0.55		429.62	1737.62

Source: Author's elaboration based on SUMO software data.

Table 4. Mean congestion time and social cost.

Time [min]	Mean Congestion Time [%]			Mean Congestion Time [s]			Mean Social Cost [USD]		
Traffic Scale	0.8	1	1.2	0.8	1	1.2	0.8	1	1.2
5	35.2	36.97	36.42	65.16	72.69	66.79	1.71	1.62	1.54
10	37.4	37.63	38.68	58.53	58.31	55.35	1.18	1.14	1.10
15	40.23	41.95	43.27	49.07	55.15	67.40	0.86	0.97	0.97
20	43.48	45.98	47.38	59.26	66.49	76.41	1.19	1.08	1.02
25	45.75	51.27	53.85	59.85	82.76	94.61	1.05	0.94	0.89
30	49.3	54.28	57.39	75.45	99.72	110.71	0.91	0.89	0.87
35	52.05	57.75	60.43	81.95	99.06	121.51	0.96	0.90	0.87
40	53.5	58.77	63.25	77.57	99.56	109.84	0.84	0.84	0.82
45	55.52	60.41	63.41	61.82	143.15	122.69	0.77	0.85	0.85

Time [min]	Mean Congestion Time [%]			Mean Congestion Time [s]			Mean Social Cost [USD]		
50	50.74	60.43	67.74	46.36	74	94.43	0.66	0.87	0.80
55	58.85	65.88	67.67	28.62	54.77	107.11	0.43	0.84	0.83
60	65.99	66.9	57.84	9.83	30.22	57.93	0.15	0.39	0.95
65		68.07	63.50		9.8	17.53		0.19	0.77

Source: Author's elaboration based on SUMO software data

Figures 12, 13 and 14, correspond to the previously presented result tables, providing a visual aid to better understand the behavior of each simulated parameter. Figure 12 depicts the variation in the mean vehicle speed at 5-minute intervals, exhibiting a downward trend as time progresses.

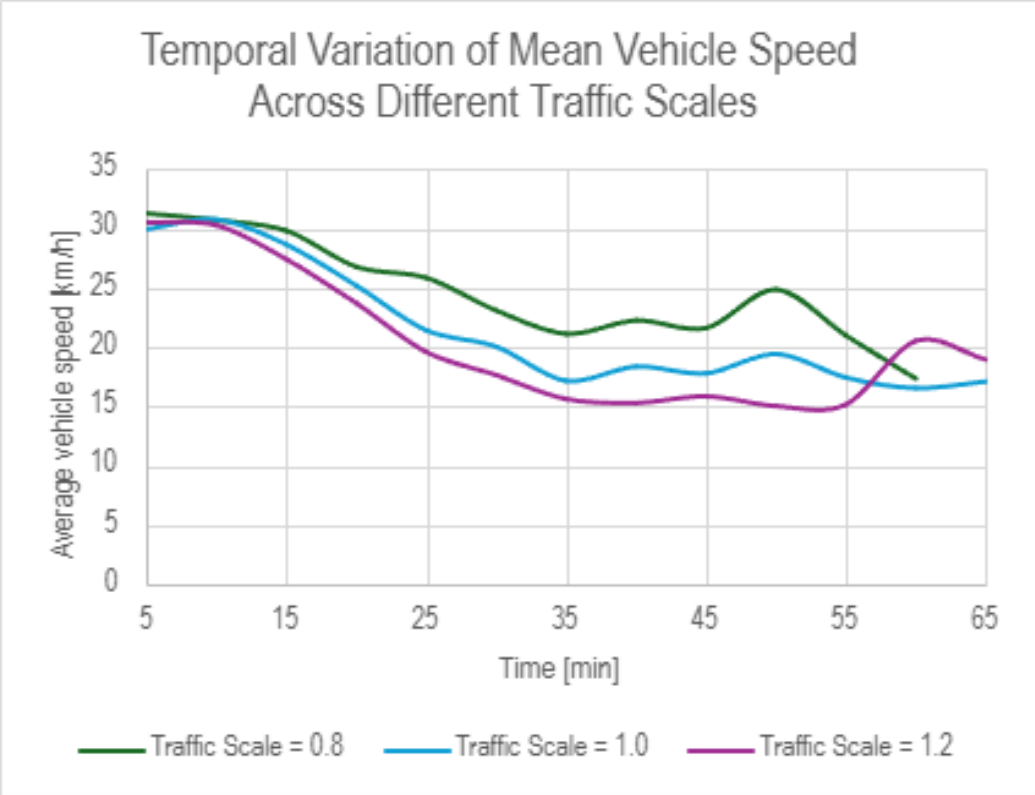


Figure 12. Temporal variation of mean vehicle speed (Source: Author's elaboration based on SUMO software data).

Figure 13 illustrates, at 5-minute intervals, the evolution of the mean congestion level of the simulated vehicles, exhibiting an upward trend as time progresses.

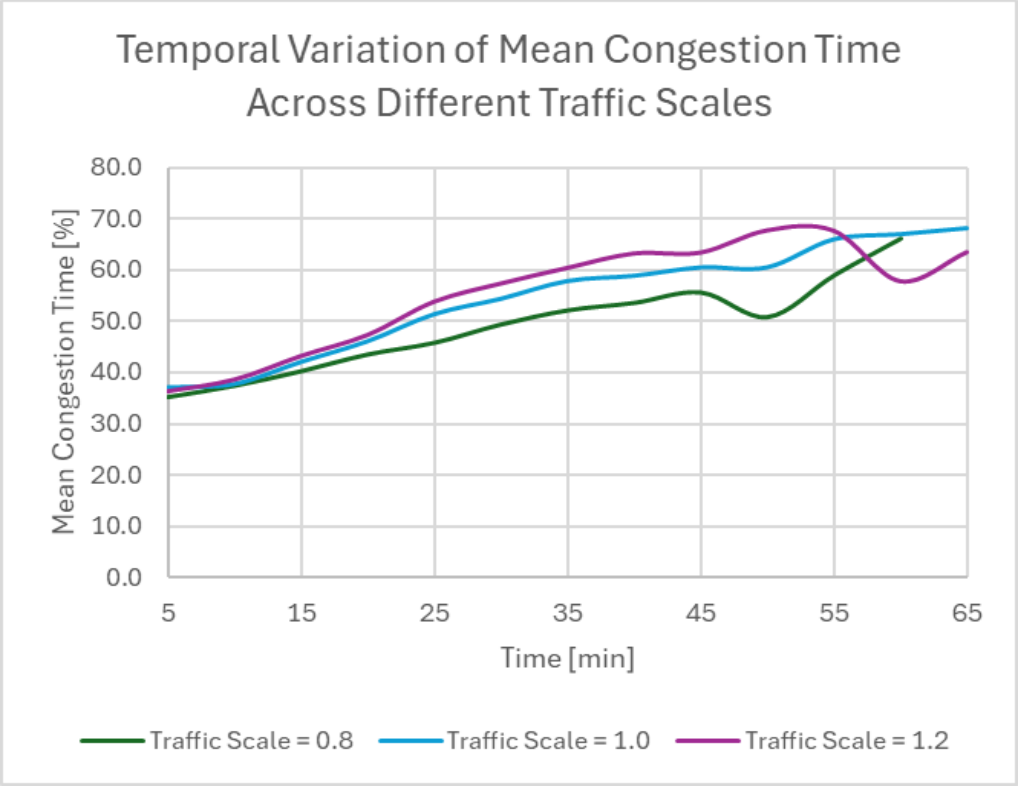


Figure 13. Temporal variation of mean congestion time (Percentage of congestion with respect to total travel time) (Source: Author's elaboration based on SUMO software data).

Finally, Figure 14 present the temporal variation of CO_2 emissions, fuel consumption, and the social cost associated with the use of the new bypass, averaged across all vehicles simulated in SUMO. It can be observed that the three figures exhibit a similar behavior, with variations that can be regarded as negligible.

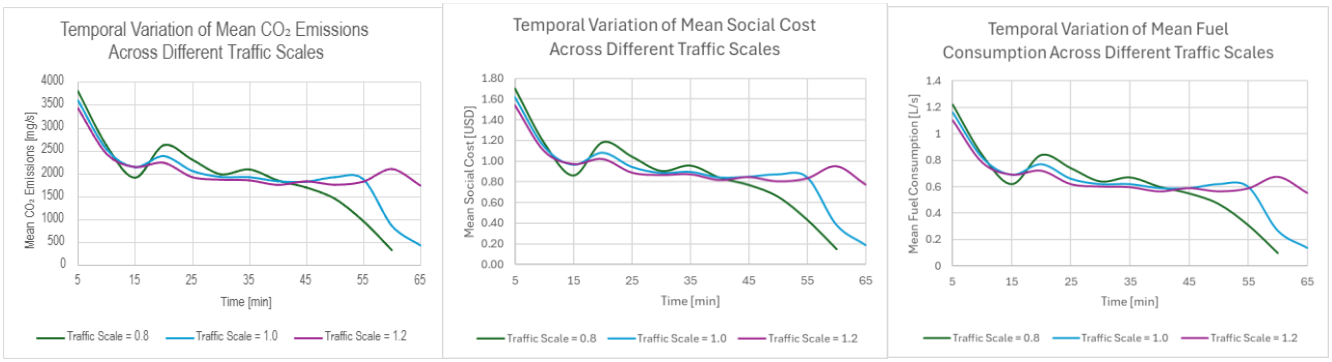


Figure 14. Temporal variation of mean CO_2 emissions, fuel consumption, and social cost (Source: Author's elaboration based on SUMO software data).

From these initial simulations, several relevant parameters and metrics were obtained, enabling both the comparison of the different scenarios defined by the three simulated traffic scaling factors and the examination of specific behaviors of each calculated parameter.

One of the most significant analyses focused on the atypical behaviors observed in most parameters—such as vehicle speed, social cost, and CO_2 emissions—at the beginning and end of the simulation. This effect arises because, at the start, a large number of vehicles are "spawned" simultaneously, while at the end, the entire vehicle fleet "disappears."

As a result, the simulation reports, for instance, peak fuel consumption at the beginning, when nearly all vehicles enter the network and accelerate simultaneously. Similarly, at the end of the simulation, the disappearance of vehicles causes abrupt decreases in parameters such as social cost and CO_2 emissions.

To address this issue, two alternatives were considered: (i) analyzing only the intermediate data of the simulation, excluding the initial and final values; and (ii) extending the simulation by 30 additional minutes—15 minutes before and 15 minutes after the target period—to mitigate these inconsistencies. The second alternative was implemented with a traffic adjustment factor of 0.7, yielding behaviors more consistent with real-world conditions compared to the initial scenario.

In this second scenario, the parameters during the peak demand hour no longer exhibit inconsistent variations, since vehicles are already present in the network both before and after the analysis period. Table 5 presents the parameters obtained for the peak demand hour under this second scenario.

Table 5. Second simulation scenario (two-hour period).

Parameter	**Value**
Mean vehicle speed	21.5 km/h
Mean delay time	6 minutes
End-to-end travel time	16 minutes
Proportion of stopped vehicles	22.34 %

Source: Author's elaboration based on SUMO software data.

During peak demand hour (6:30 to 8:30 a.m.) along the proposed urban corridor, the measured average vehicle speed was 21.5 km/h. The proportion of stopped vehicles reached 22.34%, with an end-to-end travel time of 16 minutes and an average delay time of 6 minutes. These results provide a first approximation of the corridor's performance under current demand conditions.

For comparison, self-conducted travel time studies along the existing road network—currently functioning as the substitute route—showed an average travel time of 29 minutes during the same period. This means that the proposed El Terremoto – La Capilla – El Sabino corridor represents a 13-minute reduction, equivalent to a

44.83% improvement in travel time. Such a difference suggests that the new route has the potential to substantially alleviate congestion and improve accessibility for daily commuters.

4.1. Discussion

The initial analysis, based on traffic scaling factors of 0.8, 1.0, and 1.2, makes it possible to identify how corridor performance responds to variations in demand.

In terms of average vehicle speeds, a decreasing pattern was observed as the traffic scale increased. Between the 0.8 and 1.0 factors, the average reduction in vehicle speed ranged from 3–8%, whereas the change from 1.0 to 1.2 was more pronounced, exceeding 10% during peak load intervals (20–30 minutes). Road average speed, however, remained comparatively stable, with variations below 2–3%, indicating that the differences in performance are more strongly associated with traffic flows than with the structural capacity of the infrastructure.

Fuel consumption and CO_2 emissions exhibited less linear behavior. During the early stages of the simulation (5–15 minutes), increased traffic did not necessarily translate into higher consumption or emissions, due to the rapid dissipation of inefficiencies once the network reached dynamic equilibrium. Nevertheless, from the 20-minute mark onward, the 1.2 scale consistently showed higher consumption and emissions than the 0.8 scenario, with increases of up to 15% in cumulative emissions. This pattern reflects the rise in stops, accelerations, and longer periods spent in congestion.

Regarding average congestion time and social cost, the expected relationship was confirmed: higher traffic scales yielded greater proportions of time lost in congestion and, consequently, higher social costs. The transition from 0.8 to 1.0 implied an approximate 10% increase in accumulated congestion time, while the jump from 1.0 to 1.2 was more severe, exceeding 15%. Social cost followed a similar trend, underscoring the corridor's sensitivity to relatively small demand increases.

A methodological aspect of note was the presence of outliers at the beginning and end of the simulations. These were produced by the simultaneous "spawn" of vehicles at the start and their abrupt disappearance at the end of the period, generating spikes in consumption and artificial drops in indicators such as emissions and social cost. This limitation highlighted the need to refine the methodology in order to obtain more representative results.

To address this issue, a second scenario was simulated, extending the analysis period by 30 minutes and applying a traffic adjustment factor of 0.7. This approach allowed the network to stabilize before and after the critical interval, yielding results that were more consistent with field observations.

The resulting indicators show improved consistency: an average speed of 21.5 km/h and an end-to-end travel time of 16 minutes represent plausible conditions during peak hours. Furthermore, the 22% proportion of stopped vehicles and an average delay time of 6 minutes more accurately reflect operational patterns typically observed in congested urban networks.

When compared to empirical travel time studies along the existing road network, which reported an average of 29 minutes, the proposed corridor achieved a reduction of 13 minutes, equivalent to a 44.8% improvement in travel time. This reinforces the initial hypothesis regarding the bypass's potential to alleviate congestion in the center of Cuautitlán and to enhance accessibility for daily commuters.

The second scenario is methodologically more robust, as it eliminates the biases generated by abrupt simulation starts and terminations. By incorporating stabilized traffic conditions, the results provide a clearer estimate of the net benefits of the infrastructure and offer a stronger foundation for decision-making.

Despite these positive findings, certain limitations must be acknowledged. The analysis focused exclusively on the morning peak hour, without addressing afternoon peaks or off-peak conditions. It primarily assessed private vehicle flows, while excluding freight, public transportation, and active mobility, which are essential components of the metropolitan system. Finally, although induced demand was incorporated into the modeling, uncertainties remain regarding long-term transformations in land use and travel behavior, which could redistribute traffic in complex ways.



Figure 15. Proposed urban corridor (in green) and alternate route in the current road network (in red) (Source: Author's elaboration with images from Google Satellite).

5. Conclusions

The results obtained indicate substantial benefits associated with the implementation of the proposed urban corridor, particularly in terms of travel time reduction and improved network efficiency. When compared with the existing route, the corridor demonstrated a 44.8% decrease in end-to-end travel time, underscoring its potential to serve as a strategic alternative to the saturated central network.

The comparative simulations highlight two important insights. First, the sensitivity analysis with traffic scaling factors (0.8, 1.0, and 1.2) revealed that even small increases in demand can significantly impact vehicle speeds, congestion levels, and social costs, confirming the vulnerability of the corridor to saturation. Second, the extended simulation scenario proved more robust, as it mitigated initialization and termination biases and produced results more consistent with real-world observations. These findings reinforce the methodological value of stabilized simulations for reliable performance assessment.

At a broader level, the study suggests that the corridor not only provides immediate congestion relief but also offers long-term opportunities to reshape the mobility structure of the region. By diversifying connectivity and reducing reliance on centralized urban roadways, such infrastructure can contribute to mitigating spatial inequality, particularly in rapidly expanding suburban municipalities. In this regard, urban corridors represent a more inclusive and effective mobility strategy compared to conventional infrastructure projects, which often reinforce pre-existing development patterns.

Nevertheless, the conclusions presented here remain preliminary. A comprehensive evaluation of the corridor's viability will require further technical, environmental, social, and economic assessments, as well as an explicit consideration of interactions with freight, public transport, and active mobility. Although induced demand was accounted for in the modeling process, long-term shifts in land use and travel behavior introduce uncertainties that must be carefully monitored.

In light of these findings, it is recommended that projects of this nature be incorporated into urban mobility policies as part of an integrated strategy for sustainable growth. When accompanied by complementary measures—such as multimodal integration, demand management at critical intersections, and safeguards for environmental and social sustainability—the corridor can evolve from a congestion relief measure into a cornerstone of a more resilient and equitable metropolitan mobility system.

References

DDU Cuautitlán (2023), "Plan Municipal de Desarrollo Urbano", available at: https://sedui.edomex.gob.mx/sites/sedui.edomex.gob.mx/files/files/planes_municipales/Cuautitlan/PmduCuautitlan_V.pdf (accessed 08 September 2025)

Dirección de Desarrollo Urbano y Medio Ambiente Cuautitlán Izcalli (2013), "Plan Municipal de Desarrollo Urbano", available at: https://sedui.edomex.gob.mx/sites/sedui.edomex.gob.mx/files/files/planes_municipales/Cuautitl%C3%A1n%20Izcalli/Planos%20de%20Estrateg%C3%ADa/Zonificaci%C3%B3n%20Secundaria/53-POLIGONO%20EL%20SABINO%20(EJIDO%20DE%20SAN%20MATEO%20IXTACALCO)%20(1).pdf (accessed 08 September 2025)

Gobierno de Cuautitlán (2025), "Plan de Desarrollo Municipal 2025-2027", available at: https://coplademedomex.gob.mx/sites/coplademedomex.gob.mx/files/files/pdf/Planes%20y%20programas/Mpales-2025-2027/PDM_2025-2027_CUAUTITLAN.pdf (accessed 08 September 2025)

INEGI (2024), "Marco Geoestadístico", available at: https://www.inegi.org.mx/temas/mg/ (accessed 08 September 2025)

Diario Oficial de la Federación (2023), "Ley General de Movilidad y Seguridad Vial", available at: https://www.diputados.gob.mx/LeyesBiblio/pdf/LGMSV.pdf (accessed 08 September 2025)

Martínez Guevara, J. (2007). "Metodología de investigación para la caracterización de corredores urbanos", Psicología para América Latina, available at: https://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S1870-350X2007000200010 (accessed 08 September 2025)

Rodriguez, M. C. (2021). "Cuautitlán y Cuautitlán Izcalli se unirán con la autopista México-Querétaro", MILENIO, 27 October, available at: https://www.milenio.com/politica/comunidad/cuautitlan-y-cuautitlan-izcalli-se-uniran-con-la-mexico-queretaro

Molinero Molinero, A. R. (2022). Conceptos de transporte urbano, AMTM, México.

Ortúzar, J.d. Willumsen, L.G. (2011), Modelling Transport. Wiley, U.S. https://doi.org/10.1002/9781119993308

SEDATU, CONAPO, INEGI (2020), "Metrópolis de México 2020", available at: https://www.gob.mx/cms/uploads/sedatu/MM2020_06022024.pdf (accessed 08 September 2025)

SEDUM EDOMEX (2019), "Plan estatal del Gobierno del Estado de México 2019", available at: https://sedui.edomex.gob.mx/sites/sedui.edomex.gob.mx/files/files/Plan%20Estatal%20de%20DU/PEDU_Extenso_19Dic2019WEB.pdf (accessed 08 September 2025)

Sheikh, N.B. (2021), "Corridor planning: Case of Oxford Street, London", available at: https://favas.net/wp-content/uploads/2019/08/OxfordStreet-CorridorPlanning-NidaBatoolSheikh.pdf (accessed 08 September 2025)

Speck, J. (2018), "Understand Induced Demand", in Walkable City Rules: 101 Steps to Making Better Places, Island Press, Washington, DC, pp. 64-65. https://doi.org/10.5822/978-1-61091-899-2_27

Xie, Y., Wang, Q., Xie, M. and Shibata, S. (2023), "Construction feasibility evaluation for potential ecological corridors under different widths: A case study of Chengdu in China", Landscape and Ecological Engineering, Vol. 19, No 3, pp. 381-399. https://doi.org/10.1007/s11355-023-00547-9