METHODOLOGY TO DEVELOP URBAN FREIGHT REGULATORY PLANS: CIUDAD JUAREZ CASE STUDY

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ABSTRACT
The industrial and economic activity in Mexican cities along the United States (US)–Mexico border increased significantly with the establishment of North American Free Trade Agreement (NAFTA) on January 1, 1994. As a result, these cities experienced accelerated growth in population and economic activity. This has subsequently led to a high demand in freight services for manufacturing plants, local businesses, and international trade necessities resulting in mobility and environmental problems. The objective of this paper is to describe the methodology followed in the development of the Ciudad Juarez Urban Freight Regulatory Plan along with the strategies proposed. The Plan is embraced by agencies and organizations involved and aim to alleviate problems associated with uncontrolled urban freight flows, as well as optimize these flows in harmony with other transportation modes (passenger vehicles, bicycles, and pedestrians). The strategies proposed are based on the best international practices in conjunction with the results of the traffic diagnostic performed and the input of local agencies and organizations. This paper argues that this participatory approach can be successfully used by practitioners developing urban freight improvement plans in developing countries worldwide in general, as well as in other Mexican cities located on the US–Mexico border in particular.

Keywords: urban freight, Mexican border cities, border crossing, freight management, Ciudad Juarez.

1 INTRODUCTION
The industrial and economic activity in Mexican cities along the United States (US)–Mexico border increased significantly with the establishment of North American Free Trade Agreement (NAFTA) on January 1, 1994 [1]. As a result, Mexican border cities such as Ciudad Juarez and Tijuana experienced accelerated growth in population and economic activity fueled by an exponential increase in demand for labor and US supplies. This scenario has led to a surge in freight services for manufacturing plants, local businesses, and international trade necessities resulting in (i) increased congestion levels (ii) accelerated deterioration of transportation infrastructure (iii) reduced air quality, and (iv) increased noise levels. In the case of Ciudad Juarez, the US Department of Transportation estimates that since year 2000, more than 700,000 trucks cross every year from this city to the US using any of its two commercial border crossings [2]. These estimates do not take into account either truck trips crossing from the US to Ciudad Juarez or truck trips generated to satisfy the city’s own internal freight demand.

It is against this backdrop that municipal authorities in Ciudad Juarez have been pursuing the development of an urban freight regulatory plan to help mitigate problems. In 2003, Ciudad Juarez authorities developed a set of policies to regulate freight movements in this city of approximately 1.3 million people [3]. These policies included new regulations and the identification of the specific road corridors within the urban network where freight trucks would be allowed to circulate. However, these policies were not developed with the inputs, much less consensus, from the different freight sector stakeholders or the public. As a result, these policies were neither complied with nor enforced, and the 2003 plan was deemed a failure.

In 2014, as concern remained high, local authorities launched the development of the Ciudad Juarez Comprehensive Urban Freight Regulatory Plan (the Plan). The Plan, funded
by the World Bank, was completed in 2015 and aims to alleviate problems associated with uncontrolled urban freight flows, as well as optimize these flows in harmony with other transportation modes (passenger vehicles, bicycles and, pedestrians). Currently, the Plan is in its final adoption stage for its implementation by the Ciudad Juarez City Council. Once implemented, this plan will be one of the first comprehensive urban freight regulatory plans implemented in a major Latin American city.

The objective of this paper is to describe the methodology followed in the development of the Plan along with the strategies proposed [4]. The authors had the opportunity to work with Ciudad Juarez authorities and freight-sector stakeholders to develop the Plan. The methodology made possible the development of a regulatory plan that was embraced by local freight-sector stakeholders in Ciudad Juarez, including public agencies, shippers, carriers, and academia among others. These strategies were based on the best international practices in conjunction with the results of the traffic diagnostic performed and the input of agencies and organizations involved. This paper argues that this participatory approach can be successfully used by practitioners developing urban freight improvement plans in developing countries worldwide in general, as well as in other Mexican cities located on the US–Mexico border in particular. The paper is organized in five sections. The introduction is followed by the second section that summarizes the methodology used to develop the Plan. The third section describes the specific urban freight problems identified in Ciudad Juarez, while the fourth section describes the strategies developed to address each one of the problems. The final section summarizes the paper’s conclusions.

2 METHODOLOGY

The methodology followed to develop the Plan consists of the five steps described below. The innovation of this methodology resides on the continuous participative process where public authorities and freight stakeholders are involved in every development stage of the Plan. So, the final Plan is embraced by them and adapted to their needs.

1. Analyze current best practices in urban freight at the international level. The researchers reviewed and analyzed literature on current international practices in urban freight implemented around the world and identified those that had been used successfully in urban environments relevant to Ciudad Juarez, or that could be adapted with relatively minor modifications. The main sources of these practices are the World Bank, the European Commission, the Transportation Research Board, and the World Road Association [5]–[12].

2. Analyze local conditions. Researchers reviewed and analyzed five main components of the freight sector and the road network in Ciudad Juarez (a) legal framework (b) institutional framework (c) traffic flows (d) road safety, and (e) pollutants emitted by mobile sources.

3. Use a continuous participative process. Municipal authorities and researchers organized periodic public meetings and workshops with freight-sector stakeholders, public agencies and other organizations with the objective of collectively identifying the most pressing urban freight problems and potential strategies to solve them. The process took place at different stages throughout the project and was facilitated by the researchers to help stakeholders develop consensus. This process ensured that all agencies and organizations involved had the opportunity to participate in the development of the Plan: local authorities, freight carriers, custom brokers, members of the academia, shippers (e.g., manufacturers, retailers), and trade organizations (chambers of commerce and industry, carrier associations).
4. *Identify urban freight problems.* Based on the analysis of local conditions and the inputs obtained by consensus through the participatory process, stakeholders shortlisted the most critical urban freight problems in Ciudad Juarez that the Plan should address.

5. *Define urban freight strategies.* As a final step and based on the international best practices identified and feedback obtained through the participatory process, authorities and researchers identified a set of urban freight management strategies to address the shortlisted problems.

Fig. 1 presents the methodology used to develop the Plan. The Step 3, “continuous participatory process with parties involved” is the core of the methodology and will ensure the acceptation of the Plan by public authorities and freight stakeholders.

3 URBAN FREIGHT PROBLEMS IDENTIFIED IN CIUDAD JUAREZ

Six major problems were identified in Ciudad Juarez based on the results of the analysis of local conditions and the feedback received through the participatory process: (i) road safety (ii) traffic congestion (iii) greenhouse gases/pollutant emissions and noise (iv) premature deterioration of road infrastructure (v) limited enforcement of regulations and prohibitions, and (vi) lack of involvement of freight sector in the decision-making process.

3.1 Road Safety

The road safety problems identified in Ciudad Juarez are associated with the following local conditions. First, there are freight vehicles circulating in the network are already more than 20 years old. Second, minimum freight rates (i.e. tariffs) for certain industries with high competition, such as water tankers and construction materials, are regulated by law. However, according to some carriers, these minimum rates are seldom respected by large
shippers. As a result, carriers overload their vehicles to be more competitive. Additionally, the traffic police do not have adequate equipment to enforce weight regulations, and overladen vehicles circulate without impediment.

Further, the urban freight corridor network connects main freight origins and destinations by means of inadequate road infrastructure. Heavy freight vehicles enter touristic areas where the interaction with pedestrians is frequent.

Finally, the lack of road safety education of the population in general contributes to dangerous interactions between freight vehicles and passenger vehicles. It is common to see freight and passenger vehicles circulating with disregard for safe distance recommendations.

3.2 Traffic congestion

Ciudad Juarez suffers from significant traffic congestion problems that affect road users. However, there are several problems that are more closely related to the freight sector. First, there is a lack of road infrastructure capacity and alternate routes to access main freight origins and destinations. Second, the existing road infrastructure is poorly signalized throughout the city. Third, freight vehicles frequently circulate during peak hours and load and unload on the roadway.

Furthermore, Ciudad Juarez experienced rapid and considerable growth over the last two decades as a result of the expansion of industrial activities (i.e., manufacturing). Consequently, several industrial zones and freight vehicle yards which are important origins and destinations of freight trips are now located well within the urban core. This leads to a freight-related traffic congestion problem. These industrial zones and freight vehicle yards have now limited access to high capacity road infrastructure and are surrounded by commercial and residential areas. Finally, the long waiting times and queues at international port of entries spill over to the road network and produce high traffic congestion levels in their surroundings.

3.3 Greenhouse gases (GHG)/ pollutant emissions and noise

Significant environmental impacts such as GHG/pollutant emissions and noise are produced by the freight sector in Ciudad Juarez. The large proportion of freight vehicles already more than 20 years old represents an important source of GHG/pollutants, as well as noise. This situation is aggravated by the high congestion levels in the city’s main arterials, as well as the fact that many freight carriers do not have access to affordable credit to renew their fleets. Finally, freight vehicles idling and moving slowly for hours while queueing at ports of entry to enter into the US are another significant source of these environmental impacts.

3.4 Premature deterioration of road infrastructure

Premature deterioration of road infrastructure in Mexican cities along the US–Mexico border is mainly caused by three factors: insufficient maintenance to existing infrastructure, lack of infrastructure engineered to carry heavy freight connecting main freight origins and destination; and the lack of equipment and resources to enforce maximum truck weights limits. As a result, overloaded freight vehicles circulate freely throughout city streets that were not built to carry freight, producing premature deterioration.
3.5 Limited enforcement of regulations and prohibitions

The limited enforcement of freight regulations and prohibitions may be attributed to three main reasons. First, there is little awareness of existing freight regulations among traffic police officers. Second, traffic police officers do not have access to equipment and/or training to monitor and enforce freight regulations such as weight limits. Finally, the practice of bribery in exchange for not enforcing current freight prohibitions and regulations is common.

3.6 Lack of involvement of freight sector in the decision-making process

There are no formal procedures in Ciudad Juarez to involve freight-sector stakeholders in the planning and decision-making process of freight transportation planning and road network operations. There is currently no formal or informal forum where freight-related public authorities, carrier associations, manufacturers, and other organizations can discuss urban freight problems and propose solutions. As a result, input from freight-sector stakeholders is not considered when authorities make decisions related to urban freight.

4 URBAN FREIGHT STRATEGIES PROPOSED IN CIUDAD JUAREZ

This section presents the set of fifteen strategies proposed in the Plan. The strategies are grouped into five different categories: 1) regulatory strategies 2) economic strategies 3) planning and land use strategies 4) new technology strategies, and 5) institutional and public outreach strategies. They are detailed in Fig. 2. The paragraphs that follow describe each
strategy proposed. This description is followed by a table that provides specific examples for each strategy proposed (see Table 1).

4.1 Regulatory strategies

Regulatory strategies include regulations and prohibitions that must be adopted by public authorities and enforced by traffic police. The proposed regulatory strategies proposed are described in the paragraphs that follow.

Access restrictions based on time of day. This strategy helps to avoid interaction of freight vehicles with passenger vehicles and pedestrians during peak hours. This strategy may be implemented in areas where streets have limited capacity such as the downtown areas. The positive effects produced by this strategy are reduction in traffic volumes and congestion levels, reduction of GHG/pollutant emissions, and improvement of road safety. However, the implementation of this strategy can lead to increments in transportation costs due to the underutilization of freight vehicles because of schedule restrictions.

Access restrictions based on freight vehicle characteristics. This strategy prohibits access to certain areas for heavy vehicles and/or freight vehicles that exceed certain dimensions. This strategy aims to reduce the premature deterioration of the road infrastructure, and also to avoid an increment in congestion levels due to the limited maneuver capability of these vehicles. The positive effects of this strategy include reduction in traffic volumes and congestion levels, reduction of GHG/pollutant emissions, improvement in road safety, and reduction of road infrastructure maintenance costs. The implementation of this strategy can lead to transportation cost increases due to the underutilization of certain freight vehicles and the overutilization of others.

Extended hours of commercial Ports of Entry. This strategy provides more schedule flexibility to carriers and shippers (mainly manufacturers), so these freight movements could be scheduled after midnight and before 6:00 a.m. The positive effects of this strategy include reductions in congestion levels, travel times, noise, and the number of accidents. Additionally, this strategy produces an improvement in air quality. Alternatively, this strategy may cause an increase of costs associated to the operation of ports of entry for Mexican and US authorities. The implementation of this strategy requires acceptance and coordination of the three levels of government (i.e., federal, state and municipal), as well as the private sector (i.e., carriers and shippers) on both sides of the border.

Designation of an urban freight corridor network. This strategy defines a network that connect main freight origins and destinations by means of a freight-adequate road network, and also to reduce freight movements across residential and commercial areas. Only freight vehicles with two axles can circulate out of the network after implementing it. The positive effects of this strategy include the reduction of congestion levels, premature deterioration of the infrastructure, and travel times. Other positive effects are improved air quality, noise reduction, and road safety. In contrast, the implementation of this strategy would make impossible the access of heavy freight vehicles to certain origins and destinations. This negative effect can be solved with the creation of “extraordinary connectivity permits” that allow heavy freight vehicles (with more than two axles) to, under special circumstances, access origins and/or destinations not connected to the network.

Extraordinary connectivity permits. This strategy provides heavy freight services to public and private entities that are located out of the urban freight network. This strategy guarantees heavy freight service to every origin and destination within the city limits. It is important to establish an efficient and effective system to issue these connectivity permits within 48 hours.
Restrictions of freight load and unload operations to designated areas. This strategy prohibits load and unload operations on inadequate areas for these operations, or directly on the roadway. It significantly decreases interactions among freight vehicles, passenger vehicles and pedestrians while expediting loading and unloading operations. The positive effects of this strategy include reduction of congestion levels and increase in road safety. A deficient distribution of load and unload areas will produce deficiencies in freight services for businesses located relatively far from these areas.

Use and promotion of sustainable supplying practices in public agencies. This strategy promotes sustainable freight movement practices by using them in the public sector. Sustainable freight movement practices include the use of efficient freight vehicles or the application of optimization techniques to reduce the number of empty trips. This strategy will reduce congestion levels, air pollution, and noise. It could be implemented by the private sector at mid-long term, thereby increasing its positive effects. However, the use of this strategy may cause an increase in freight transportation costs.

Easy pay systems for traffic fines. This strategy expedites the process of paying for traffic fines by means of removing inefficient bureaucratic processes which can only be done in person. This strategy includes the option of paying via internet or telephone. This strategy could reduce bribery. On the other hand, it will require significant investments that need to be made by public authorities in charge of processing traffic fine payments.

Definition of competences in road infrastructure. This strategy proposes to request the transfer of road management competencies on urban federal roads to the municipality. Currently, there are sections of important federal roadways already inside the Ciudad Juarez metropolitan area where the municipal traffic police do not have jurisdiction. Once these competencies are transferred, the city will be able to apply municipal traffic regulations on these roadways. This strategy allows enforcing urban freight regulations and prohibitions in all road infrastructure located within the city limits.

4.2 Economic strategies

Economic strategies consist of a set of policies to be implemented by the local governments in conjunction with financial institutions to facilitate freight carrier access to credit lines for renovating their fleets. The economic strategy proposed is described below.

Access to favorable credit lines to renew freight fleets. This strategy facilitates the renovation of the freight fleets in favorable terms, such as low interest rates and long repayment periods. The positive effects of this strategy include a decrease in GHG/pollutant emissions from freight vehicles and the resultant improvement in air quality. Additionally, the renovation of freight fleets will produce an improvement in road safety. This in turn may cause an increase in freight transportation costs due to the investment required from carriers to renovate their freight vehicles.

4.3 Planning and land use strategies

Planning and land use strategies are based on the integration of future freight demands into the land use planning and decision-making process. These strategies must be implemented by municipal planning departments. The planning and land use strategy proposed is described below.

Planning and zoning activities. This strategy allows to concentrate economic activities with the high demand of freight services in the same zone to decrease freight vehicle miles traveled. The positive effects of this strategy include the reduction of road infrastructure
maintenance costs, noise levels, and congestion levels. Additionally, the implementation of this strategy will also produce an improvement in air quality and road safety. These strategies may initially be costly for private companies located within the urban core that would relocate to these new zones with better accesses to freight services and road infrastructure.

4.4 New technologies strategies

New technology strategies consist of a set of initiatives for the implementation of intelligent transportation systems (ITS) and alternative-fuel vehicles in the freight sector. New technology strategies proposed are described below.

*Use of vehicles powered by clean energy fuels.* This strategy improves air quality by reducing the use of freight vehicles powered by fossil fuels. The positive effects of this strategy include reduction of GHG/pollutant emissions and noise. However, the implementation of this strategy may cause an increase in freight transportation costs due to the investment required from carriers. The use of these silent freight vehicles can cause road safety problems because pedestrians are not able to hear them approaching.

*Development of on-line tools to monitor traffic conditions in real time.* This strategy provides the traveling public (including freight carriers and shippers) with real-time decision tools to improve effectiveness and efficiency of freight movement. The positive effects of these strategies include the reduction of congestion levels and noise, as well as improvement of air quality.

4.5 Institutional and public outreach strategies

The institutional strategy consists of establishing a formal group of freight-sector stakeholders, public and private sector agencies and organizations responsible for identifying and solving urban freight related problems. The public outreach strategy consists of the implementation of educational campaigns and capacity building programs to promote road safety among the public and freight professionals. Institutional and public outreach strategies proposed are described below.

*Creation of a Freight Transportation Management Committee.* This committee would be responsible for identifying urban freight transportation problems, establishing goals and objectives, envisioning needed urban freight transportation operations, recommending the best combination of approaches and strategies, and identifying unexpected effects of certain strategies. Committee strategies could be implemented by the municipality as pilot projects for evaluation. Based on the results obtained from these pilots, the committee will decide if the strategies evaluated can be fully implemented.

*Road safety awareness campaigns and capacity building programs.* The main objective of this strategy is to reduce the number of traffic crashes produced by the lack of knowledge regarding road safety and/or traffic regulations. The campaigns and capacity building programs should be specifically designed for being easily understood by all population groups. The positive effects of this strategy include reduction of traffic accidents and an increase in traffic regulations and prohibitions compliance.

4.6 Illustrative examples of proposed urban freight strategies

Table 1 presents specific examples of the fifteen strategies presented in this paper.
Table 1: Examples of the strategies presented in this paper.

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<th>Strategy</th>
<th>Example</th>
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<td>Regulatory Strategies</td>
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<tr>
<td>Access restrictions based on schedule</td>
<td>Access restriction of freight vehicles to downtown area from 6:00 a.m. to 7:00 p.m.</td>
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<tr>
<td>Access restrictions based on freight vehicle</td>
<td>Access restriction of freight vehicles with more than 2 axles to downtown area</td>
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<td>characteristics</td>
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<td>Extended hours of commercial Ports of Entry</td>
<td>Implementation of 24 hours of operation schedule in one of the commercial Ports of Entry located in the urban core.</td>
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<tr>
<td>Development and implementation of urban freight</td>
<td>Implementation of an urban freight network for freight vehicles with more than 2 axles</td>
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<td>networks</td>
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<td>Extraordinary connectivity permits</td>
<td>Protocol to issue extraordinary permits for providing heavy freight services to business located out of the designated urban freight network</td>
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<tr>
<td>Restrictions of freight load and unload operations</td>
<td>Restriction of load and unload activities to designated areas from 7:00 a.m. to 5:00 p.m.</td>
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<td>to designated areas</td>
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<td>Use and promotion of sustainable supplying practices</td>
<td>Include the use of vehicles powered by clean energies by carriers as a scoring component in the bidding process for delivering medical</td>
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<td>in public agencies</td>
<td>supplies to public hospitals</td>
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<td>Easy pay systems for traffic fines</td>
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<td>Definition of competences in road infrastructure</td>
<td>Transfer main freight corridors competence from federal to local government</td>
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<td>Economic strategies</td>
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<tr>
<td>Access to favorable credit lines to renew freight</td>
<td>Creation of agreements between cities and the North American Development Bank to provide access to carriers for renewing their fleets at low interest rates and repayment periods of up to 25 years</td>
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<td>Planning and land use strategies</td>
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<td>Planning and zoning activities</td>
<td>Relocate industrial zones which are inside portions of the urban core and surrounded by commercial and/or residential areas</td>
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<td>New technology strategies</td>
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<td>Use of vehicles powered by clean energy fuels</td>
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<td>Development of on-line tools to monitor traffic</td>
<td>Development of an on-line tool fed in real time with GPS data from freight vehicles to monitor traffic conditions</td>
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<td>conditions in real time</td>
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<td>Institutional and public outreach strategies</td>
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<td>Creation of a Freight Transportation Management</td>
<td>Creation of a Freight Transportation Management Committee for working with municipal departments of transportation in urban freight regulations and enforcement</td>
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<td>Committee</td>
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<td>Road safety awareness campaigns and capacity building</td>
<td>Implementation of 8-hour defensive driving courses for drivers who commit traffic infractions</td>
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5 CONCLUSIONS

The need for urban freight policy and regulations that ensure effective, efficient, and reliable freight movements while minimizing their negative effects has been widely documented. Many cities in the developing world, such as Mexican cities on the US–Mexico border, have experienced explosive growth in a short amount of time, without a commensurate expansion of their transportation networks. This phenomenon has brought significant challenges for all modes of transportation, particularly to the freight sector. The resulting traffic congestion has often made freight movement inefficient and unreliable, and its regulatory framework ineffective.

Ciudad Juárez, a 1.3 million urban manufacturing center on the US–Mexico border, is a prime example of the challenges major developing world cities are experiencing. Attempts made in Ciudad Juárez to rationalize urban freight traffic in the early 2000s failed in part due to a lack of involvement of important freight-sector stakeholders. Efforts relaunched in 2014 by local authorities with funding from the World Bank successfully concluded in 2015 with the development of the Ciudad Juárez Comprehensive Urban Freight Regulatory Plan. As a result of the participatory approach used in its development, this time the plan and strategies proposed were embraced by the city’s urban freight-sector public and private stakeholders. The strategies were developed based on international practices, but adapted to the local conditions and needs of Ciudad Juárez in consensus with all freight-sector stakeholders.

This paper summarizes the steps followed in the development of the plan, describes the main problems that affected Ciudad Juárez, which are common in many cities in developing countries, and presents the strategies proposed to solve them. The participatory approach used in Ciudad Juárez and outlined in this paper can be successfully applied by practitioners working in developing countries in general, as well as in other Mexican cities located on the US–Mexico border in particular.

REFERENCES


