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Asociaciones Público-Privadas
(APP) en la gestión de
infraestructuras. Aplicaciones a
México

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Tesis Doctoral

**ASOCIACIONES PÚBLICO-PRIVADAS (APP) EN LA
GESTIÓN DE INFRAESTRUCTURAS.
APLICACIONES A MÉXICO**

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TESIS DOCTORAL

ASOCIACIONES PÚBLICO-PRIVADAS (APP) EN LA
GESTIÓN DE INFRAESTRUCTURAS.
APLICACIONES A MÉXICO

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A mi familia por la paciencia y comprensión al destinar tiempo para alcanzar esta meta en busca de un mejor mañana.

INTRODUCCIÓN

INTRODUCCIÓN

Los cambiantes y acelerados procesos económicos de las últimas décadas en el mundo, han generado nuevas estructuras políticas, económicas, ideológicas, sociales y geográficas. Las demandas de consumo y servicios a atender en aras al desarrollo y productividad, obligan a los gobiernos a implementar reestructuraciones en todos los niveles, así como la intervención de otros agentes públicos y privados, generando alianzas para garantizar la estabilidad económica en sus territorios.

Estas alianzas han existido desde épocas antiguas y la participación de actores del sector privado y público trabajando de forma conjunta ha sido clave para el éxito económico Cañeque (2007). Encontramos ejemplos en Italia desde antes del siglo XV, con la formación de las ciudades-estado, o en el siglo XIX, en la revolución industrial británica, que facilitó un crecimiento económico destacado y el comercio exterior. Con ello, se gestaron nuevas alianzas entre el sector público y privado, motivadas por un interés comercial y económico.

La alianza contractual de las Asociaciones Público Privadas (APP) es una modalidad de financiamiento y gestión, implementada por los gobiernos para el desarrollo de obras de infraestructura pública, con el objetivo de satisfacer necesidades económicas y sociales, ante la limitada disponibilidad de los recursos públicos. Lozano et al. (2017) resaltan que esta relación colaborativa entre el sector público y privado, en su primera etapa, se utilizó para financiar programas de educación en los Estados Unidos. Ante los interesantes resultados obtenidos, este modelo se extendió en los años cincuenta y se popularizaron en la década de los sesenta para obras de servicio público. España, también fue un país pionero en la década de los sesenta, y se convirtió en un referente mundial, en colaboraciones público-privadas en el sector de las concesionarias de autopistas de peaje. Por ello, actualmente, nueve de las mayores veinticinco concesionarias de infraestructuras de transporte mundiales son españolas (Public Works Financing, 2023).

Posteriormente, la “Private Finance Initiative” (PFI), promovida a principios de los noventa por el gobierno británico acuñó las iniciativas Public-Private Partnerships (PPP) como un referente de financiación en materia de infraestructuras y servicios públicos, no sólo en Europa, sino también en otros países de influencia anglosajona como Canadá, Australia o Sudáfrica. Este modelo de financiamiento actualmente se extiende a todos los

sectores de la economía en el mundo y se justifica por la escasez de recursos públicos destinados a la inversión en obras públicas, integrándose y adaptándose a las diversas legislaciones, características geográficas y necesidades públicas.

En el caso concreto de los países en desarrollo, su sector público se apoya especialmente en la inversión de capitales privados al no tener capacidad de pago suficiente para atender las inversiones millonarias a corto, medio y largo plazo que requieren las infraestructuras. Con ingresos insuficientes en la recaudación de impuestos, ausencia de ahorros programados, inadecuada gestión en ocasiones, falta de transparencia, escasa experiencia y pocas garantías de sostenibilidad, las obras de infraestructura resultan más atractivas realizadas en colaboración, tanto para el sector público como para el capital privado al asegurarse cobros periódicos por los servicios proporcionados.

Así, las obras de infraestructura que impulsan la economía de una región, como es el caso del transporte (carreteras, autopistas, vías férreas, puertos), son gestionadas habitualmente a través de APP entre los gobiernos y el sector privado, al tener éste garantizada la recuperación de la inversión a través del flujo constante de efectivo con el cobro de tarifas y cuotas, y mayores tasas de rentabilidad al estar dirigidas a un sector con capacidad de pago en la utilización de estos servicios. Además de las construcciones de infraestructuras, el sector privado suele atender el mantenimiento, diseño y su explotación. En infraestructuras más de carácter social, como hospitales y escuelas, o plantas de tratamiento de aguas residuales, si los ingresos reales son inferiores a los previstos en el contrato, los compromisos y endeudamientos se trasladan al presupuesto de los gobiernos (Akitoby et al., 2007).

Aunque los gobiernos tienen la responsabilidad de destinar recursos para la inversión en infraestructuras que impulsen la economía y las obras sociales que, por su naturaleza, son competencia del sector público, y la aprobación de esquemas financieros regulados a través de contratos donde interviene el capital privado viene representando cambios relevantes para lograr la reactivación económica y el bienestar de los ciudadanos, la literatura registra casos de fracaso, generalmente por el endeudamiento a largo plazo que generan estas fórmulas, así como casos de corrupción, por monopolio e intereses políticos, que han impedido el cumplimiento de los objetivos propuestos, generando

malestar social. Al respecto, Sandoval (2016) señala que, en estas alianzas, la opacidad está por encima de la transparencia en materia de movimientos bancarios, compromisos fiscales, monopolio, control sobre los activos, no publicidad de los contratos, ... con el argumento de la protección de los secretos comerciales frente a competidores, generando ciertos nichos de corrupción, impunidad y protección para el sector privado.

A pesar de todos estos riesgos, la Comisión Económica para América Latina y el Caribe (CEPAL) destaca la cooperación entre el sector público y privado mediante APP como una alianza habitual en las economías de los países, que asegura su funcionamiento a largo plazo, al determinar objetivos concretos y definidos para su cumplimiento. La CEPAL ha fomentado varios estudios sobre el impacto y experiencias obtenidas al promocionar las APP en México, América Latina y el Caribe, principalmente en el contexto del desarrollo industrial, que altera los recursos naturales en sectores tradicionalmente dedicados a la agricultura (Palacios, 2008).

En México, la Ley de Asociación Público Privada, publicada en el Diario Oficial de la Federación el 16 de enero de 2012, regula y rige este tipo de contratos APP, para atender el desarrollo de infraestructuras y servicios. Así, la Iniciativa de Financiación Privada (IFP), acorde con las leyes vigentes de su jurisdicción gubernamental, se aplica en México aludiendo a los Proyectos de Prestación de Servicios (PPS).

Para el caso de México, este tipo de contratos deben ser filtrados por estudios previos e intervenidos por diferentes actores sociales para garantizar resultados con verdadero impacto social. Además, con ello se pretende evitar la ausencia total de transparencia, la corrupción, el monopolio, el traspaso de los bienes de la nación a particulares y los usos electorales. Así mismo, se pretende equilibrar la responsabilidad ante los riesgos, vigilar que estos contratos no comprometan décadas del Presupuesto de Egresos de la Federación (PEF), ni el de los Estados, ni a las futuras generaciones con compromisos financieros excesivamente costosos, generando así el desplazamiento de rubros vitales para la sociedad mexicana.

El objetivo de esta Tesis Doctoral es estudiar varias iniciativas llevadas a cabo en México, que involucran la participación del capital privado en obras de infraestructuras públicas, como estrategia financiera ante la falta de capacidad económica del gobierno mexicano para abarcarlas. La Tesis, que incluye dos partes, está integrada por cuatro

artículos, algunos de los cuales ya están publicados en revistas indexadas, enmarcados en la línea de investigación “colaboración público-privada y co-producción de servicios públicos”.

Concretamente, nos centraremos en cuatro iniciativas bajo contratos de APP: dos de ellas referidas a plantas de tratamiento de aguas residuales y, otras dos, centradas en el sector de infraestructuras de transporte terrestre. Tres de ellas están ubicadas en el Estado de Jalisco, concretamente, en el Área Metropolitana de Guadalajara, y la cuarta aborda la carretera federal Querétaro- San Luis Potosí, un tramo de la Carretera Federal 57, ubicada entre los Estados de Querétaro, Guanajuato y San Luis Potosí. En todos los casos, junto al estudio bibliográfico, se ha realizado un trabajo de campo para un mejor análisis de los aciertos y desafíos que cada obra pública analizada representa para México. Para ello, nos hemos dirigido a distintas instituciones implicadas en la infraestructura, a personal activo en el servicio público, a expertos, a académicos y a personas clave, que han contribuido al discernimiento de la información oficial y a la aclaración de las negociaciones con los desarrolladores/operadores. Incluso nos prestaron su apoyo para facilitar la visualización y análisis de documentos sin acceso al público.

A continuación, se describen los objetivos de los capítulos que integran esta Tesis Doctoral.

-La **Parte 1** está centrada en iniciativas de APP en Plantas de Tratamiento de Aguas Residuales (PTAR) e incluye dos capítulos que abordan dos de ellas, ubicadas en el Área Metropolitana de Guadalajara (AMG).

El **Capítulo 1**, *“Trajectory of public private associations. Case: wastewater treatment plant “Agua Prieta”, Jalisco”* (Trayectoria de las asociaciones público privadas. Caso: la planta de tratamiento de aguas residuales “Agua Prieta”, en Jalisco) tiene como objetivo analizar los resultados de la financiación y gestión de infraestructuras bajo el esquema de APP, tomando como caso de estudio la planta de tratamiento de aguas residuales “Agua Prieta”. Esta obra está todavía en proceso de operación por lo que es prematuro confirmar su éxito, aunque el trabajo de campo realizado, así como las entrevistas y la información de acceso abierto, evidencian que fue mal planificada, carece de opiniones comunitarias, de participación activa de grupos clave para un mejor diseño y la implicación de la sociedad para garantizar su sostenibilidad y dar una solución a la problemática del

saneamiento de aguas de esta zona. Tampoco parece que se realizó una selección adecuada del inversor.

El **Capítulo 2**, *“Approaches to the financial evaluation of the “El Ahogado” wastewater treatment plant in Jalisco, Mexico”* (Aproximaciones a la evaluación financiera de la planta de tratamiento de aguas residuales “El Ahogado” en Jalisco, México) estudia una infraestructura de gran importancia para el Estado de Jalisco y México, por atender el saneamiento de aguas residuales del área metropolitana de Guadalajara, AMG, y se centra en la búsqueda de indicadores financieros para concluir sobre si esta obra era viable o no financieramente. En la fase de entrevistas y obtención de información, se detectaron varios cambios con respecto al proyecto inicial y una planeación deficiente, de los que se hicieron eco los medios de comunicación y de acceso abierto, confirmando que esta obra desde su inicio no era viable financieramente, dados los altos costos de mantenimiento y operación del inversor. Aunque el enfoque de este estudio es fundamentalmente financiero, se destacan también los efectos que producen a la sociedad y al medio ambiente la aprobación de obras millonarias que no resuelven el problema de la contaminación de las aguas y cuencas naturales.

- La **Parte 2** de la Tesis incluye dos capítulos centrados en el estudio de dos aplicaciones de APP a infraestructuras de transporte terrestre: uno en el tramo carretero federal Querétaro -San Luis Potosí y, otro, en la línea 4 del tren ligero de Guadalajara, L4TLG.

El **Capítulo 3**, Análisis costo-beneficio del tramo carretero federal Querétaro-San Luis Potosí, estudia este tramo carretero de libre acceso de la Carretera Federal 57, columna vertebral del sistema carretero de México, cuyo mantenimiento y operación se encuentran a cargo de un desarrollador privado. El estudio se ha focalizado en la comparación de este tramo con una vía paralela de peaje, la Autopista México-Querétaro 57D, a través del análisis del costo y del beneficio que reciben los usuarios -de forma inconsciente- al transitar por la Federal libre Querétaro-San Luis Potosí, ya que los pagos al desarrollador privado se realizan con cargo al Presupuesto de Egresos de la Federación (PEF). Como el inversor debe elevar a estándares de calidad este tramo estudiado, favorece a los usuarios y comunidades y es un factor relevante para impulsar la economía a nivel nacional y la conexión con países vecinos. La existencia simultánea de alternativas de

tránsito carretero de calidad, con peaje y de tránsito libre, en rutas con la misma conectividad, confirma la aplicabilidad de las APP en tramos de características similares.

El **Capítulo 4**, “*Public Value Determinants in PPP Contracts. Application to Guadalajara Light Rail Line 4*” (Determinantes del Valor Público en los Contratos APP. Aplicación a la Línea 4 del Tren Ligero de Guadalajara) trata de identificar las variables clave que definen el valor público en obras con modelo de financiamiento APP, basándose en el proyecto de la Línea 4 del Tren Ligero de Guadalajara, México, y utilizando una metodología prospectiva, que incluye el punto de vista de expertos, la academia, la comunidad y la administración, entre otros, dentro del desarrollo de un sistema. El trabajo concluye que el *costo-beneficio social* es la variable clave que proporciona mayor valor público a estas obras que deben evaluarse por el servicio que se presta a la sociedad.

En la sección final de “Resumen y Conclusiones” se abordan datos puntuales de cada uno de estos estudios con la finalidad de integrar la información relevante al término de la lectura de esta Tesis Doctoral. Nuestro objetivo es dejar abiertos los diferentes campos que aborda para que puedan proponerse nuevos estudios, profundizar en sus contenidos bajo la misma línea de investigación, o desde el punto de vista de otras disciplinas, y generar nuevas perspectivas enfocadas en la mejora continua de este esquema de financiamiento, con una base científica, que permita impulsar un adecuado desarrollo de infraestructuras dirigidas al beneficio social, en equilibrio con los intereses de los desarrolladores privados.

PARTE 1. Iniciativas de Asociaciones Público Privadas (APP) en Plantas de Tratamiento de Aguas Residuales (PTAR)

Capítulo 1. *Trajectory of public private associations. Case: wastewater treatment plant "Agua Prieta", Jalisco (Trayectoria de las asociaciones público privadas. Caso: planta de tratamiento de aguas residuales "Agua Prieta", Jalisco)*

Trajectory of public private associations. Case: wastewater treatment plant "Agua Prieta" – Jalisco (Trayectoria de las asociaciones público privadas. Caso: planta de tratamiento de aguas residuales “Agua Prieta” – Jalisco)

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Abstract

Objectives: Public-private associations (PPPs), for the government sector, an opportunity to take advantage of the experience and efficiency of the private sector to improve the representation of services and develop the necessary infrastructures for economic and social development. PPPs generally involve large-scale projects, but unfortunately some sectors, such as water management, exclude the opinion of experts, giving rise to monopolies that greatly benefit the private sector, even excluding them from responsibilities by not fully resolving the problem for which they were created. contracted, the costs being absorbed by the public sector.

Methodology: Confirming the success of PPP participation in works still in operation is premature, but an analysis of the current results is made, taking as a case study, the "Agua Prieta" Wastewater Treatment Plant (PTAR).

Contribution: The results show that the collaboration of community groups in carrying out a participatory diagnosis and having follow-up and evaluation mechanisms to monitor the performance of the private partner, are actions that further improve the chances of success of the project; On the other hand, competition and the adequate selection of private partners represent the biggest failure factor in the implementation of PPPs.

Administration of Public Resources, Institutional and regulatory framework, wastewater treatment

Resumen

Objetivos: Las asociaciones público-privadas (APP) representan, para el sector gubernamental, una oportunidad para aprovechar la experiencia y la eficiencia del sector privado para mejorar la prestación de servicios y desarrollar las infraestructuras necesarias para el desarrollo económico y social. Las APP generalmente involucran proyectos de gran envergadura, pero desafortunadamente algunos sectores como la gestión del agua, excluyen la opinión de expertos, gestándose monopolios que benefician ampliamente al sector privado, incluso excluyéndolos de responsabilidades al no resolver en su totalidad la problemática por la que fueron contratados, siendo absorbidos los costos por el sector público.

Metodología: Confirmar el éxito de la participación de las APP en obras aun en operación es prematuro, pero se hace un análisis de los resultados actuales, tomando como caso de estudio, la Planta de Tratamiento de Aguas Residuales (PTAR) de “Agua Prieta”.

Contribución: Los resultados evidencian que la colaboración de los grupos comunitarios en la realización de un diagnóstico participativo y contar con mecanismos de seguimiento y evaluación para monitorear el desempeño del socio privado, son acciones que mejoran en mayor medida las probabilidades de éxito del proyecto; por otra parte, la competencia y la selección adecuada de los socios privados representa el mayor factor de fracaso en la implementación de APP.

Administración de Recursos Públicos, Marco institucional y regulatorio, saneamiento de aguas residuales

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Introduction

The drive for infrastructure development in a country is aimed at activating the domestic economy and projecting new investment expectations from foreign capital. The financial

crisis of governments has led to budget cuts, which has motivated the implementation of new approaches to public services with the participation of the private sector. This has led to infrastructure projects in the transport sector; however, other areas of the economy, due to increased demand, such as healthcare, have pushed for the introduction of private sector participation to manage the delivery of these services (Acerete, Gasca, Stafford, & Stapleton, 2015).

The Program for the Promotion of PPPs in Mexican States (PIAPPEM) clarifies that PPPs do not necessarily focus on the construction and financing of new infrastructure but can include in the same contract the operation/provision of a public service. In this sense, the use of this type of scheme, according to the same PIAPPEM, is used in Mexico for the development of projects in sectors such as roads, health, education, infrastructure, water sanitation, among others (Rebollo Fuente, 2009).

With regard to risk sharing, this is another characteristic of this contractual relationship, where both sectors take part in the event of a claim. Regarding risk-taking, Sresakoolchai and Kaewunruen (2020) consider that one of the most positive aspects of adopting PPPs is the appropriate allocation of risks in order to optimise the benefits for PPPs.

Acerete Gil (2003), for his part, comments that PPPs "bring together a series of structures and concepts that involve collaboration between the public and private sectors in the design and implementation of infrastructure projects and public facilities, for the sharing of risks and responsibilities", since according to De la Fuente (2008), the objectives of PPPs are to address investments in infrastructure and generate profitable businesses, where the interests of the parties combine to achieve their objectives, as well as to supply and guarantee public goods and services.

In this way, it can be seen that the changes and the international vision registered in the 1990s for PPPs, is handled as an innovative strategy, where this interaction between the public private sector is not new and that until 1970 there was no presence of PPPs among international organisations and relations were few between donors and national governments directly (Almeida, 2017). By 1969, the term was coined in the Pearson Commission Report "Partners in Development: Report of the Commission on International Development".

The momentum of PPPs was boosted by the economic crisis of the mid-1970s; to alleviate it, international organisations such as the World Bank (WB) and the International Monetary Fund (IMF) promoted changes in economic structures and public policies. In addition, the increase in poverty and social inequalities in the world strengthened PPPs in the late 1980s and early 1990s, finding a relationship with international development aid and cooperation.

Although there are those who are against this financing scheme due to the results, political management and interests, among other questions, Moore (2006) finds that there is an increase in trust towards the private sector to improve living conditions, economic and technological development within a society, thus assuming a social responsibility.

From this government-private contractual relationship, it should be noted that PPPs serve as a legal tool that regulates the financing of investments from the private sector, and are intended to promote infrastructure to provide public services. Both sectors have different objectives: the public sector guarantees social welfare, public services through infrastructure works, among others, while the private sector generates income for the capital invested, guaranteeing the results agreed in contracts of this alliance. A specific time is stipulated, generally in the long term, to carry out its objectives with the fulfilment of a task, work, improvement, activity, acceptance of specific risks, surveillance, etc., all aspects regulated by the law that each country applies in the matter.

Currently in Mexico there is a lack of information and open access on issues related to impact monitoring and evaluation, application of penalties in response to untimely response and objectives not achieved by the investor, in works under this financing scheme. In countries such as Mexico, this issue is relatively new and is regulated by their respective Public-Private Partnerships Law, both in force since January 2012; in practice, there are different implementation models, from the construction, modernisation, maintenance, conservation and operation of infrastructure works, aspects linked to the development and growth of these Latin American countries.

The objective of this article is to describe the trajectory that PPPs have had internationally and their development in Mexico, through the analysis of governance in water sanitation in the Metropolitan Area of Guadalajara (AMG) with a case study of the Wastewater Treatment Plant (WWTP) of "Agua Prieta", in order to assess the

performance obtained so far with respect to the expected results in the social and environmental sphere, through a review of specialised literature, information from public entities with open access and interviews with key actors.

Concepts of Public-Private Partnerships

The figure of PPPs has crossed borders, as they are currently enjoying acceptance and growth in different countries. The interest of governments, organisations, corporations, transnationals, among other actors, in attending to the welfare of humanity has become relevant in the decisions and regulations on the public function of each country.

Korab-Karpowicz (2020) mentions that for several years, PPPs have been handled internally as a government instrument to operate, but nowadays the intervention of actors as a nation-state takes different actions in the face of the generation of new international relations. The strength of PPPs as a partnership for international relations helps to solve governance problems beyond nation-state actors, leading to the acceptance of more democratic and accountable global governance.

The evolution of the model also generates new concepts that define the relationship. The fact that a new actor or third sector intervenes within a state structure to meet the same need gives rise to the term "Third Way". Patiño (2016) comments that the presence of a new institutional structure, including private parties with the intention of fulfilling the same objectives and activities as the public sector, generates a characteristic feature of this new alliance. The different schemes between the public and private sectors seek first and foremost to achieve an "optimal contract", where the private sector guarantees and ensures maximum efficiency through its experience and knowledge to guarantee social welfare (Barreto Nieto, 2011).

The World Bank Reference Guide (2014) details that the functions that are the responsibility of private parties may vary, and will depend on the type of good and service involved. Among others, contract types include functions such as design, concerning the development of the project from its original concept and requirements to the design specifications of the completed construction. PPPs relating to construction or rehabilitation are developed to create infrastructure that requires private parties to build and equip it. On the other hand, where PPPs involve existing assets, the private party would be responsible for rehabilitating or extending the asset. As for maintenance, PPPs

assign maintenance responsibilities to the private party for the duration of the contract. In terms of financing, a PPP that includes the construction or rehabilitation of the asset requires private initiative to partially or fully finance the capital needed for the works. And with respect to the operation, the private party's responsibility may vary depending on the nature of the asset or service in question, whether it is providing technical support and providing a service to the government. In addition to the technical operation of the asset, the private party may provide services directly to the user, as in the case of public lighting and the water distribution system in several entities of the country.

Table 1 is presented below to illustrate different concepts addressed by different authors when referring to PPPs.

Table 1 Concepts Public-Private Partnerships

Concept	Source
"PPP is a mechanism by which the public sector (government or other state organisations) uses the capacities of private sectors (including cooperatives, private, charitable, non-governmental organisations (NGOs, etc.) such as knowledge, expertise and financial sources to provide infrastructure services (water and wastewater system, transport system, health system, education system, etc.). The private sector, on behalf of the government, plays the service delivery role."	Azami- Aghdash, Sadeghi- Bazargani, Saadati, Mohseni & Gharaee (2020).
"The concept of a PPP refers to a long- term agreement between public and private entities that allows the private sector to provide public services".	(Engel et al., 2014) citado por Liu y Xiongzhi (2019)
"Public-private partnerships can be defined as "the formation of cooperative relationships between government, for- profit businesses and private non-profit organisations to fulfil a policy function".	(Linder y Vaillancourt Rosenau, 2000, p.5) citado por Korab-Karpowicz (2020).
"They are voluntary arrangements between state and non-state actors, are based on a set of norms and rules, and involve the formulation of policy and the delivery of public goods, which distinguishes them from occasional public-private interactions or lobbying.	(Streck, 2002) Citado por Bjärsting (2017).
"Through PPPs, the state can take advantage of the private sector's capacities (financial, technological, administrative) to generate goods and services. Thus, in recent years there has been a trend that reflects a greater interaction between public and private actors to carry out tasks and activities in science and technology".	(Cimoli, 2000) citado por Navarro Arredondo (2013).
"A PPP is an agency relationship in which the government serves as the principal, and the private investor is commissioned to design, execute and manage a long-term investment project, transferring responsibility for the delivery of public goods or services, linking the return and utility of the investment to the sustained, high quality performance of the project".	Polack, Martínez Silva & Ramírez Chaparro (2019).
"The PPP is a form of public service provision that operates by agreement between the public sector and the private sector, whether it is a private or state initiative. Through this modality, part of the services, the implementation and management of which are originally the responsibility of the public sector, are handed over to a private entity for their provision".	Gallo Aponte, Fácio, Rodelo, Brito Jaime & Abcarius Racines (2018).

Source: Own elaboration, based on the above-mentioned authors

Background

As investment models, PPPs originated in 1992 in the United Kingdom; their purpose was to promote the participation of private capital in public sector projects, to develop infrastructure works for sanitation and health services that could not be financed by the sector (Vasallo Magro and Izquierda de Bartolomé, 2010).

For its part, Spain had already developed the figure of concession, today known as PPP, before the United Kingdom implemented it. In this sense, the concession as a legal figure is "the most common contractual manifestation of PPPs in Spain and in other countries with an administrative tradition" (Rebollo, 2009). In addition, in their evolution, PPPs went through "a process developed worldwide as a result of the crisis of the State since the seventies of the last century" (Sada Correa and Sada Correa, 2014), registering a boom at the beginning of the millennium in countries such as Germany, Portugal, Korea and Australia, among others.

The history of PPPs can even be traced back to European countries, where private investment in public infrastructure was already being generated in the 18th century. As a reference, one can mention the concession contract for the supply of drinking water in Paris, the Suez Canal and the Trans- Siberian Railway, already in the 19th century.

Tang, Shen and Cheng (2010) relate three generations as antecedents in the evolution of the model: presence of errors due to lack of experience for both sectors; large companies develop specialised projects in the urban sector, generally hiring PPP project managers who worked for public entities; and finally, in this third generation, social development emerges.

However, for other authors such as Warshawsky (2016), PPPs have been present in one form or another for many centuries, and have gained momentum in the 1990s and 2000s as an alternative or third way of partnership with the aim of changing welfare: private sector participation is sought in the development of projects, mainly in public service.

Internationally, the UK, as mentioned above, has extensive experience in PPPs. Acerete, Shaoul, Stafford and Stapleton (2010) highlight this nation as a global player in the field, where it has implemented the management of different financing schemes involving the private sector, including the construction of crossings and roads, and

subsequently the expansion and maintenance of roads (Design, Build, Finance and Operate - DBFO).

In Spain, Acerete, Stafford and Stapleton (2011) record as a precedent the financing of a hospital with a PPP structure in operation for more than 10 years, carried out solely under this model, where the initial contract was never financially viable (it was very costly for the government) and a second contract improved its viability due to the financial benefits. In the financial sector, on the other hand, the authors highlight that regional non-profit savings banks are socially obliged to invest in the region for their communities.

Background in Mexico

As mentioned above, PPPs are an alternative financial strategy to boost Mexico's economic development through infrastructure development, mainly in the road construction sector.

However, failed results, deficiencies, lack of involvement of society, corruption and the search for profitability, regardless of quality and social benefit on the part of the private sector, have generated a strong controversy for this investment scheme between the public and private sectors (Lozano Montero, Godínez López and Albor Guzmán, 2017). The little regulation of PPPs in Mexico, according to Érick Díaz, generated great benefits "only for the private sector". He adds that there is little literature in Mexico because it is a relatively new topic, but other countries in the 1950s and 1990s developed the concessions that have been part of PPPs since the 19th century, and have been adapting to legal changes.

Prior to the legal recognition of PPPs in Mexico, three participation models or mechanisms can be distinguished as antecedents to PPPs: Productive Investment Projects with Deferred Registration in Public Expenditure (PIDIREGAS), Projects for the Provision of Services (SPSS) and Concession Schemes (Rojas de Paz and Delgadillo Díaz, 2017).

The creation of the Public-Private Partnerships Law came to regulate the implementation of this model in the country; its main objective is to regulate contractual relations between the public and private sector to achieve a social purpose. Thus, Article

2 of this legislation considers that "public-private partnership projects must be fully justified, specify the social benefit sought and demonstrate their financial advantage over other forms of financing".

This law clarifies that long-term contracts must not exceed 40 years of concession, including term extensions, and in the case of contracts that exceed this period, they must be approved by law (articles 87 and 98).

In addition, articles 14, 21, 25, 38 and 59 of this legislation set out the institutional framework, contracting mechanisms, required studies, approval procedures, PPP registration, fiscal management and other issues that make up the country's public-private partnership policy.

This legislation and its regulations set out the institutional responsibilities for conducting a PPP tendering process, and describe the process for evaluating the bids received and selecting the winning bidder.

The Centro de Estudios de las Finanzas Públicas (CEFP) (2016), as a technical collaborating body in legislative matters of Public Finance and Economy, integrates extensive information on the subject, from the background of PPPs, their trajectory, projects, legal framework, modalities, cases, among others.

The description of the background and the most relevant aspects registered in Mexico on the subject are included in Table 2.

Table 2. Background on the legal framework and first PPP projects in Mexico.

PROYECTO	ANTECEDENTES	CONTRATO	CONDICIONES
Productive Infrastructure Investment Projects - PIDIREGAS	Deferred Registration for Public Expenditure. Born in 1995 as a reform in response to the economic crisis of December 1994, scarce public resources and the development of infrastructure projects for PEMEX and CFE.	Procurement through international competitive bidding.	Commitment to build the Projects with own resources or markets. With the start of income generation once the projects were completed, the obligation would be paid.
Concessions	Emerged after PIDIREGAS in the early 1990s. Aimed at road works projects and service provision. Given the economic crisis of 1994, terms of less than 10 years, increasing tariffs and decreasing demand, it was concluded that the projects were not profitable.	Road concession programme (52 concessions) to develop new roads - 5 thousand kilometres.	50% bank loans 20% public subsidies 30% Concessionary company
New Concession Scheme	The SCT and Banobras reorganize the previous scheme. Participation of state, federal and private resources. Maximum term of 30 years to keep the concession.	Public tender	Toll collection, rates regulated by the SCT. Concessionaires are responsible for cost overruns.

Source: Own elaboration with data from CEFP, (2016)

López Toache, Amado and Martínez de Ita (2018) mention that PPPs in Mexico have been favoured by the economic reforms of the 1980s to the present day, taking on greater momentum and momentum to materialise as new privatisation structures in the 21st century that undermine the public sector.

In this sense, Espejel Espinoza and Díaz Sandoval (2015) argue that the reform on PPPs in criminal matters is worrying, because private parties go from being simple contractors to administrators for twenty to thirty years - subject to renewal - responsible for the construction, maintenance and/or management of prisons. With this, they point out, the government commits itself to pay year by year for the use of the facilities and services, but if the private sector does not fulfil its obligations and commitments, the loss will be absorbed by the nation and the private companies involved will not be called to account.

Background of PPPs in Wastewater Treatment Plants in Mexico

Public-Private Partnerships (PPPs) in Mexico have emerged as a strategic tool to encourage investment and the development of infrastructure projects. These partnerships are based on the collaboration between the public and private sectors to carry out projects of public interest, seeking to combine the resources and capacities of both parties to achieve more efficient results. In the PPP approach, a private company is responsible for the financing, construction, operation and maintenance of the facilities, according to agreed quality, service or other standards (Engel, Fischer and Galetovic, 2014).

The development of PPPs in Mexico has had ups and downs over the years. At the federal level, PPP projects in Mexico had their beginnings in the context of major reforms of liberalisation and privatisation of Mexican markets. They can be considered to have started in the late 1990s and early 2000s, as it was during this period that Mexico began to implement the PPP model as a tool to promote private investment in public infrastructure projects. However, it was not until 2012 when the Public-Private Partnerships Law was enacted, which established the legal framework and guidelines for the implementation of PPPs in the country. (Sada Correa and Sada Correa, 2014).

During the first years of implementation, several projects were carried out in sectors such as roads, airports, ports, telecommunications and energy. The federal and state governments started to use PPPs as a tool to boost the modernisation and development of

infrastructure in the country. (López Toache and Chavez Maza, 2020).

Some examples of projects developed under the PPP scheme can be seen in Table 3.

Table 3 Main pioneering projects developed with the Public-Private Partnership model.

Project	*Year	Description
Cancun International Airport	1989	During this period, a PPP was carried out for the construction and operation of Cancun International Airport, one of Mexico's main tourist destinations.
Mexico-Toluca Highway	1994	A PPP was established for the construction and operation of the Mexico-Toluca highway, an important communication route between Mexico City and the city of Toluca.
Container Terminal of the Port of Manzanillo	1994	A PPP was implemented for the construction and operation of the Container Terminal at the Port of Manzanillo, one of Mexico's most important ports for international trade.
México-Puebla highway	1995	This PPP was in charge of the construction and operation of the Mexico-Puebla highway, one of the country's main highways connecting Mexico City to the city of Puebla.
• Year of implementation		

Source: Own adaptation. Ministry of Communications and Transport (SCT) (1996) (1997). Airport and Auxiliary Services (2016)

On the issue of water sanitation in Mexico, PPPs have played an important role. These partnerships have allowed the implementation of infrastructure projects and services to improve water management, wastewater treatment and drinking water supply in different regions of the country.

One of the flagship projects in the field of water sanitation is the PTAR Atotonilco. This PPP was established for the construction and operation of a wastewater treatment plant located in the state of Hidalgo. The plant, inaugurated in 2015, is considered one of the largest in Latin America and has the capacity to treat wastewater from various sources to reduce pollution and improve water quality in the region (Rodríguez, Molina, del Cuvillo Martínez-Ridruejo and Bozzano, 2014).

In the state of Guanajuato, a PPP was carried out for the construction of the Salamanca WWTP. This initiative aimed to improve water management and reduce pollution in the city. The treatment plant, inaugurated in 2017, allows for the proper treatment of wastewater before it is released into the environment (Pantoja-Espinoza, Proal-Nájera, García-Roig, Cháirez-Hernández and Osorio-Revilla, 2015).

In terms of drinking water supply, the city of Puerto Vallarta in the state of Jalisco has experienced significant improvements thanks to a PPP that was established to improve the drinking water supply and sanitation system in the city. Through the expansion and improvement of existing infrastructure, it has been able to provide a more reliable supply of drinking water to the community (Sistema de Agua Potable y Alcantarillado de Puerto Vallarta, 2020).

In recent years, Mexico has experienced a significant increase in the use of PPPs as a mechanism to drive the development of key infrastructure. According to a World Bank report (2019), Mexico is among the Latin American countries with the largest number of PPP projects underway, covering various sectors such as transport, energy, water and sanitation, health, among others.

One of the main benefits of PPPs lies in the ability to attract private investment for projects that otherwise might not have the necessary resources for their implementation. The participation of the private sector makes it possible to diversify the sources of financing and transfer part of the risk to the investor, which reduces the fiscal burden on the government and allows resources to be allocated to other priority sectors.

In addition to investment, PPPs can also generate efficiencies in project management and operation. The experience and expertise of the private sector can improve the quality of services and the timely delivery of projects. In addition, competition among private participants can foster innovation and cost reduction, generating benefits for both government and end-users.

However, it is important to mention that PPPs also pose challenges and risks. These include appropriate project selection, equitable allocation of risks and benefits between parties, transparency in tendering and contracting processes, and protection of public interests. Clear regulatory frameworks and effective oversight mechanisms are essential to ensure the long-term success and sustainability of PPPs. In Mexico, there are institutions in charge of promoting and regulating PPPs, such as the Ministry of Finance and Public Credit (SHCP) and the Investment Unit of the Ministry of Economy (UISE). These entities are in charge of establishing guidelines and criteria for the implementation of PPPs, as well as evaluating and monitoring ongoing projects.

Despite the potential benefits of PPPs, there are also challenges and criticisms

associated with their implementation in Mexico. Some authors (Bracey and Moldovan, 2006; Sanger and Crawley, 2014; Sandoval Ballesteros, 2016) argue that PPPs can lead to further privatisation of public services and generate imbalances in the distribution of benefits. The need for greater transparency and accountability in the process of private partner selection and project management has also been pointed out.

To address these concerns, the Mexican government has implemented measures to strengthen the regulatory framework for PPPs and ensure greater transparency. For example, clear rules have been established for the tendering of projects and mechanisms for monitoring and evaluation of partnerships have been improved.

Involvement of PPPs in Infrastructure Works for WWTPs in the AMG

In Jalisco, the authorities in charge of water issues and hydraulic works are at the federal level the National Water Commission (CONAGUA), at the state level the Jalisco State Water Commission (CEA) and at the municipal level in the AMG the Intermunicipal System of Drinking Water and Sewerage Services (SIAPA) (Flores Elizondo, 2016) (Flores Elizondo, 2016).

According to the 2010 CONAGUA report, Jalisco treats only 3,493.5 litres per second out of a total of 14,144 litres per second, registering a critical situation, as only 24.7% is treated (Villanueva and López, 2014). The wastewater treatment plants for the sanitation of wastewater out of operation in this regard Anda Sánchez (2017) comments that in 2013 in the state of Jalisco there were 273 WWTPs in different municipalities, where 50% were not operating (22 abandoned and 63 about to be decommissioned), due to the high costs of maintenance, operation and electricity according to the report of the State Water Commission of Jalisco (CEA) and an interview with officials of the state water system.

Given the inequality and use of water in Mexico and as an alternative for the sanitation of wastewater or domestic water in an area of Zapopan, Jalisco, Caro, Vizcaíno, Hernández, Reyes and Díaz (2019), comment that there are studies that propose the construction of Treatment Plants with natural, ecological and sustainable processes based on plants, physical, chemical and biological sediments that carry out a purification process. In 2016 in the town of Las Cañadas de San Isidro in the municipality of Zapopan, it promoted the Natural and Sustainable Ecological Systems

to contribute to the discharge of sewage or wastewater, helping 60 families to improve water sanitation in the area, training and awareness to improve the environment. Unfortunately, in Mexico there is an imbalance in the consumption and availability of water, as most of it is used by industry, which contributes a high percentage of the Gross Domestic Product (GDP), but there are other alternatives that can be promoted by governments and communities to contribute to this problem of sanitation for domestic wastewater.

Case study

The different health, environmental and social problems that have been triggered by the contamination of the Santiago River by industrial discharges and the scarce legislation to control these discharges, hinder the operation of the WWTP designed to treat sewage or domestic wastewater from the AMG (McCulligh, 2013). Another problem that exacerbates the pollution of the Santiago River is due to irregular settlements and the lack of planning for an orderly growth of the AMG, giving rise to marginalisation and poverty in certain areas due to lack of infrastructure such as schools, hospitals, roads, among others, but mainly the lack of works such as drainage and sewerage, increasing the risk indices for the population with health, safety, social and environmental problems. Torres-Rodríguez (2018), comments that the metropolisation of this area has transformed soils suitable for agricultural activity into industrial and urban areas, demanding greater natural resources, including water, mainly for industrial and housing processes, causing an imbalance with the environment and social development.

According to data provided by the State Government of Jalisco (2012) in a report issued by the State Water Commission (CEA), the Rio Blanco WWTP served only 3% of sanitation for a population of approximately 3.3 million people in the AMG in 2012. The AMG's wastewater sanitation system is being expanded with the integration of two WWTPs. The first one is El Ahogado, starting operations in 2012 to serve 20% of the wastewater treatment and Agua Prieta to serve 80%, starting operations in 2014. The treated water is used for electricity generation using the biogas produced at the "Valentín Gomez Farias" hydroelectric plant of the Federal Electricity Commission (CFE), registering its final discharge in the Santiago River.

Both WWTPs are located within urbanised areas or regular low-income housing developments and irregular housing units, as well as large industries in the south of the

AMG.

The "Agua Prieta" WWTP is the second largest in the country and the third largest in Latin America, and its construction is being promoted due to the contamination of the Santiago River by discharges generated by the AMG. This initiative is made possible by the support of the three levels of government, federal, state and municipal, through the financing of private capital in the PPP scheme with a period of 20 years, under the Build, Operate and Transfer (BOTT) model, which addresses the design, construction, financing, operation and maintenance. The financial distribution and characteristics of the project are illustrated in Table 4.

Table 4 Project characteristics

“AGUA PRIETA” WASTERWATER TREATMENT PLANT		
INVESTMENT SOURCES (Figures in millions, excluding V.A.T.)	El Ahogado and Agua Prieta Sewerage and collectors WWTPs	Treatment Plants D.B.O.T. Scheme
		Agua Prieta 8,50 m3/s
Federal Expenditure Budget (PEF)	\$1.842,5	
State of Jalisco	1842,5	
Trust Fund. National Infrastructure Fund (FONADIN)		\$948,0
Private Investment		\$1.657,3
Subtotal	\$3.691,0	\$2.605,3
Winning consortia:	Tender No. 43111001-090-08 Trust No. 1004	Controladora de Operaciones de Infraestructura S.A. de C.V. (CONOISA) 50%; Atlatec S.A. de C.V. 34%; Servicios de Agua Trident S.A. de C.V. 16%
Construction start dates	2007 - 2011	Site 36 months Operation 207 months Operation in 2013
*Includes Financial Expenses Note: The Private sector is contracted under the DBOT (design, build, operate and transfer) scheme, with a concession period of 20 years. Typology: Hydraulic Infrastructure.		

Source: CNA (2012) National Infrastructure Programme 2007-2012. De la Peña, Ducci & Zamora - IDB (2013). Ownadaptation

This work was financed with federal non- refundable support from FONADIN with 49% and private investment (51%) recoverable through a service provision contract,

convened by the Ministry of the Interior (2008) in public tender No. 43111001-090-08, for the Agua Prieta WWTP project: "provision of wastewater treatment services at the Agua Prieta WWTP with a capacity of 8,500 lps. which includes the executive project, construction, electromechanical equipment, operation tests, capacity tests, operation, conservation, maintenance, as well as the removal and final disposal of biosolids and solids generated in the monofill, under the lump sum modality with mixed, private, partial and recoverable investment, within 27 months from the date of signing the supervision contract".

Among its objectives is the sanitation of 100% of the wastewater of the AMG, promoting environmental benefits such as improving water quality and reducing diseases, odours, employment generation (1,500 direct and 4,500 indirect), generation of electricity, sludge treatment in compliance with NOM-004-SEMARNAT-2002, which guarantees improvements in soils for agriculture, among others.

The Government of the State of Jalisco, with the support of the State Water and Sanitation Commission (CEAS), the CNA, promotes sustainable alternatives for the environment, environmental protection and economic engine for projects. For this project, the intervention of the private sector in the participation of the corresponding percentage of the State Government through the municipalities of the AMG in the course of the work, allows a financing alternative to the lack of economic resources of any of the parties, to conclude works of relevance for social benefit (National Institute of Sanitary Management (INGESA) (2008).

The results after years of initiating these projects have both positive and discouraging comments, given this investment of millions of dollars by the Mexican government, where investors must guarantee optimum results in response to the government's initiative to include the private sector in the financial model of the Public-Private Partnership in public works that resolve social problems.

Relevant information in interview

As fieldwork, an interview was conducted with a former government official from the state of Jalisco, who is knowledgeable and expert in this wastewater treatment project for the AMG, under the PPP financing scheme. A description of the background and general details of this project were obtained in order to understand the problems and the

final objective of this infrastructure. Given that there are few studies in specialised databases on this specific WWTP, we were guided by the public and private entities involved in this project to search for information.

Among the data to be highlighted are:

- This project is awarded through a tender.
- It will benefit more than 3.5 million inhabitants.
- This project is the third largest in Latin America and the largest plant in Mexico.
- The cost per cubic metre for water treatment is 98 cents, the lowest in the country.
- Capacity of 8,500 litres per second.
- It will cover 80 percent of the wastewater produced by the AMG.
- As an important part of the AMG's wastewater sanitation system, the San Gaspar-Agua Prieta collector has not yet been built, which would go to the edge of the Huentitán ravine in the Atemajac Basin, which would take the sewage from the east of Guadalajara, the San Gaspar, Osorio and San Andrés basins, to the Agua Prieta WWTP, where it would finally be treated and discharged into the Santiago River. It is known that there have been settlements in the area of the Barranca, without any interceptor tunnel, throwing the sewage directly into the river through the ravine.
- This collector would be in charge of CONAGUA and the State Government, as the State Government did not budget for it in the total project.
- The biogas will be used to generate electricity.
- The PTAR Agua Prieta was planned to treat 8,500 litres per second, but in the absence of this collector, it only treats 6,000 litres per second from the San Juan de Dios River, the remaining 2,000 litres of sewage fall directly into the Santiago River without any process. It can be said that this magnificent project is useless.
- The project does not contemplate the treatment or sanitation of industrial or agro-industrial water, only domestic or waste water. This limitation has not allowed the objective of 100% wastewater treatment in the AMG to be achieved. On the other

hand, the permissibility of the authorities and the strictness of the law to oversee and monitor the waste produced by all the companies located in the AMG. It is known that there are permanent and constant discharges of industrial waste, prohibited by national and even international law.

- There were no agreements to buy land for the construction of the WWTP, because it is close to the Federal Electricity Commission (CFE), the "Agua Prieta" WWTP.
- Concrete actions were carried out for the construction of the Agua Prieta and El Ahogado WWTP, by the State Government through the Comisión Estatal del Agua y Saneamiento (CEAS) and in coordination with the Sistema Intermunicipal de Agua Potable y Alcantarillado, (SIAPA) and the Comisión Nacional del Agua, (CNA).
- The resources will come from the following distribution, it is clarified that the difference between the cost of the project and the total amount of investment will be financed by the company with risk capital and / or credit.
 - a) The risk capital, equivalent to 25% of the cost of the project.
 - b) The resources from the credit, equivalent to 28.5% of the cost of the project.
 - c) The support of the fund, equivalent to 49% of the cost of the project with the support of the fund.

The distribution of percentages among the municipalities participating in this AMG project is listed below. See Table 5.

Table 5 Percentage distribution

MUNICIPALITY:	AGUA PRIETA
EL SALTO	-
TLAJOMULCO DE ZUÑIGA	-
SIAPA	100.0%
GUADALAJARA	50%
TLAQUEPAQUE	8%
TONALA	11%
ZAPOPAN	31%
TOTAL	100%

Source: own adaptation based on interview data.

- The reality is that today the results are far from the commitments, objectives and promises that were made before this millionaire investment. The government and the

investors did not diagnose in depth the problem of pollution of the Santiago River, leaving aside the pollution that companies and industries in the AMG produce every day, as the damage is mainly generated by industrial and chemical waste rather than by wastewater and domestic water. Academics, society, experts, local farmers, key actors, among others, were not involved. Finally, the laws are permissive and protect the investor, as the responsibility and risks fall on the public sector.

- The state of Jalisco has several WWTPs that are not functioning, not operating, so it should carry out a technical study with experts and, based on the experience of other WWTPs in Mexico and the world, include local and regional communities and different social and economic sectors to study the possibility of reactivating, adapting and modernising these infrastructures, considering that their presence can avoid further environmental damage and destruction of land and natural resources in the face of new proposals that are millions in the millions since their construction, which in many cases only put the state and the federation in debt.

- Finally, there is a problem that exacerbates the wastewater sanitation situation in the AMG, which is the indiscriminate and unplanned growth of low-cost housing developments allowed by the authorities to real estate companies or developers in the vicinity of the AMG river or basins that do not have adequate infrastructure for the provision of services, including aqueducts and sewage. Likewise, irregular settlements without control by the municipalities and authorities, where they improvise channels or outlets for wastewater into natural basins, giving rise to an area with high levels of pollution, which in turn strengthens the urban stain of marginalisation, insecurity and poverty, generally of immigrants or families with very low incomes.

Analysis of results

Promoting public works that guarantee the development of a country's economy through programmes and projects is an issue that every government handles in different ways, although its applicability defines its level of development. The contractual alliance as a financial strategy between the public and private sector through Public Private Partnerships (PPP) is an alternative to strengthen the different sectors of the economy, where governments adopt, regulate and govern PPPs to promote works that provide

public services for social welfare, when the finances of the state do not allow to provide 100% of the capital. In Mexico it is relatively new and its implementation in some cases has been more of an experiment than a project analysed to solve the real problem.

Unfortunately, in some sectors, such as water management in metropolitan areas, monopolies have been created that largely benefit the private sector, even excluding them from responsibilities by not fully resolving the problem for which they were contracted, with the costs being absorbed by the public sector. The proposals presented by the investor were not always the most suitable for solving the problem of water sanitation.

In Mexico, the impact of PPPs represents a real challenge, given that monitoring initiatives are practically new and there is a lack of official information from the institutions involved.

Unfortunately, in water management in metropolitan areas, monopolies have been created that largely benefit the private sector, even excluding them from responsibilities by not fully resolving the problem for which they were contracted, with the costs being absorbed by the public sector. Furthermore, the proposals put forward by the investor were not always the most suitable for solving the problem of water sanitation.

Infrastructure management activities, traditionally carried out by the public sector, include construction, financing, operation, maintenance, regulation and control. However, the private sector may also be involved in whole or in part under policies established by law.

The changes in the international market economy, globalisation and the different designs and political schemes developed for these associations have allowed the dynamisation of a network of their own aspects and characteristics that today strengthen their legitimacy at a global level. As structured institutions with more grounded objectives, the literature shows diverse antecedents for PPPs with supported data and formalised records.

One of the justifications used to promote the implementation of PPPs in countries such as Mexico is the lack of adequate infrastructure to meet the demand for citizen services, which leads to a reduction in basic rights.

For this financing scheme, in Mexico, the Public-Private Partnerships Law (LAPP)

legally ratified the legality and promotion of this contractual relationship between the public and private sectors, with the signature of Felipe Calderón, then President of the Republic, on 16 January 2012 (Diario Oficial de la Federación. DOF, 2018). Since then, these regulations have generated conflicting opinions, including the generation of corruption, the granting of privileges, public indebtedness, the handing over of control of public sector administration to private entities, among others.

The aim of this legislation is to improve the efficiency and effectiveness of these projects, as previous legal provisions had loopholes that - as in the Mexican case - fostered vices carried over from previous concession models, such as cost overruns, lack of transparency and poor coordination between government entities and private parties.

A review of the Mexican context of PPPs shows that they have made use of concessions that opened the door to private capital to jointly address major infrastructure deficiencies, such as the creation and maintenance of highways and road projects.

It was noted that in the last decade of the last century, in the absence of specific legislation on the subject, Mexico faced difficulties in the application of PPPs such as cost overruns, lack of compliance in delivery, lack of planning and coordination, unforeseen environmental impacts, corruption, and so on.

However, the experience allowed learning from the deficiencies and generating robust regulations that, a little more than a decade after coming into force, have given way to a variety of concession projects in areas as diverse as road infrastructure, health, drinking water supply and sanitation, as well as other public works that have been built thanks to the participation of private capital.

With all of the above, scholars from other disciplines could deepen their analysis of current or completed projects under this scheme with a sharper vision and a focus that measures social welfare, environmental impact and the legality of the contracts signed, as well as their compliance, since it is the taxpayers or users who pay for these million-dollar works that generate debt for the nation.

These results could strengthen or refute opinions in favour or against this form of financing that governments adopt as an alternative to solve social problems through public works.

Conclusions

The concept of Public-Private Partnerships (PPP) arises from the participation of the public and private sector in the construction of works for the development of infrastructure in a country. The intervention of this model in different countries around the world can be justified by the lack of economic capacity of governments to promote infrastructure development that guarantees an improvement in the quality of life of their citizens.

PPPs are alliances or contractual relationships whose intention is to achieve particular objectives for both the state and the investor with its private capital. Arguably, their origins date back several centuries and have evolved to the present day.

Developing countries may find in PPPs a financial strategy to promote economic development and social welfare, especially given their legal regime, regulations, financial models, contractual relationships, geography and the experience of other countries.

As a financing alternative, PPPs are currently being implemented by governments in Latin America, where Mexico is no exception, as they have become a strategy to boost economic development through public works infrastructure in both countries since 2012.

The literature reviewed shows the opinions of experts, scholars, academics and international organisations in favour and against, based on the results, the costs of public works, the political management that has been given to the projects, the fulfilment of objectives safeguarded in promises and hopes to benefit the majority of citizens.

On the other hand, it should be remembered that there are several models that involve the private sector in projects of this nature; as there is a wide range of schemes, the criteria for selecting a particular one should take into account aspects such as the ability to mitigate demand risk and payment risk, as well as the ability to make the projects attractive to all parties, i.e., users/citizens, investors and the public sector.

In Mexico, the impact of PPPs represents a real challenge, given that monitoring initiatives are practically new and there is a lack of official information from the institutions involved.

Finally, it is important to highlight that currently the federal government's major

public works are carried out with mostly public funds managed by the Ministry of National Defence (SEDENA) and Banobras, leaving aside the participation of private capital in projects such as the Felipe Ángeles International Airport, the Mayan Train or the Dos Bocas refinery, despite the technical and financial benefits of PPPs described in this document.

Public-private partnerships in Mexico have been an important tool to promote the development of infrastructure and services in the country. While they have faced criticisms and challenges, the government continues to work on improving its regulatory framework to promote greater transparency and accountability in these partnerships. The effective use of PPPs can contribute significantly to economic growth and social welfare in Mexico through their potential to attract private investment and thus foster collaboration and improve the quality of life of citizens, which makes them an option to consider in the Mexican context.

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Capítulo 2. *Approaches to the financial evaluation of the “El Ahogado” wastewater treatment plant in Jalisco, Mexico (Aproximaciones a la evaluación financiera de la planta de tratamiento de aguas residuales “El Ahogado” en Jalisco, México)*

Approaches to the financial evaluation of the “El Ahogado” wastewater treatment plant in Jalisco, Mexico (Aproximaciones a la evaluación financiera de la planta de tratamiento de aguas residuales “El Ahogado” en Jalisco, México)

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Abstract

Purpose: To generate financial feasibility indicators for the "El Ahogado" wastewater treatment plant project in Jalisco, Mexico, as an integral part of the water sanitation system in the Guadalajara Metropolitan Area (AMG).

Methodology: Model of Public-Private Partnerships (PPP) for the development of social infrastructure works. A research object is adapted to a retrospective case study for its current application in Mexico. The financial feasibility analysis includes an evaluation of the financial costs regarding the revenues and subsidies delivered to the developer periodically and those received for water recovery per month.

Contribution: This study allows us to conclude that for the financial conditions for the development or private capital in the “El Ahogado” treatment plant project, it was not financially viable given the maintenance and operation costs required in this infrastructure.

Wastewater treatment plants, Public-Private partnership, Financial viability

Resumen

Objetivo: Generar indicadores de factibilidad financiera para el proyecto de la planta de tratamiento de aguas residuales “El Ahogado” en Jalisco, México, como parte integral del sistema de agua potable de la Zona Metropolitana de Guadalajara (AMG).

Metodología: Modelo de Asociaciones Público Privadas (APP) para el desarrollo de obras de infraestructura social. Se adapta un objeto de investigación a un estudio de caso retrospectivo para su aplicación actual en México. El análisis de factibilidad financiera

incluye una evaluación de los costos financieros en cuanto a los ingresos y subsidios entregados al desarrollador periódicamente y los recibidos por recuperación de agua por mes.

Contribución: Este estudio permite concluir que por las condiciones financieras para el desarrollo o capital privado en el proyecto de la planta de tratamiento “El Ahogado”, no era viable financieramente dados los costos de mantenimiento y operación que requiere esta infraestructura.

Plantas de tratamiento de aguas residuales, Asociación público-privada, Viabilidad financiera

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Introduction

The conservation of natural water sources is an issue that concerns humanity in general. Rivera, Chávez, and Salinas (2018) point out that natural resources have suffered great impacts; among them water, this liquid has suffered an increase in demand due to population growth, generating pollution due to the discharge of garbage and waste to natural sources such as rivers, lakes, seas, a problem that has been getting worse over the years. In the international sphere, McGillivray (2008) comments that the United Kingdom, through the United Kingdom Department for International Development (DFID), demonstrates its experience in private investment projects for the development of infrastructure, mainly in poor countries. In the case of the Water and Sanitation Program (WSP), electricity, telecommunications, and transport programs in 2003, the Global Association for Results-Based Aid (GPOBA), formed by the World Bank with the support of the United Kingdom United, considers that delegating responsibility for the provision of public services to a private company or Non- Governmental Organization NGO is an effective strategy for financing or if it is justifiable to apply subsidies based on results, especially to low-income users.

Unfortunately, the economic issue is not addressed with much research in this regard since there is no consensus to evaluate the projects, high costs, limitations, and obstacles that they present (Senante, Sancho, and Garrido 2010). The collection of a fee that guarantees the management of wastewater treatment to the users allows the use of public resources for other purposes, guaranteeing optimal service and generating awareness of rational consumption among users (Moral-Pajares, Gallego Valero, and Román-Sánchez 2019). For their part, Lindtner, Schaar, and Kroiss (2008) pointed out that wastewater treatment plants in Australia are publicly owned and operated by the public sector and private companies.

Debaere and Kapral (2021) address the problems that several countries in the world are experiencing due to water scarcity. For countries with strong economies, the participation of private investment in their different financing schemes (Public Private Partnership - PPP) can be a good strategy to solve water problems, taking advantage of their experience, a calculation more in line with user prices to guarantee the works and innovation that they have been developing due to market competition. The United Nations, addressing the challenge of the water problem to guarantee its availability and sanitation, implements it in its agenda as the Sustainable Development Goal 6 (SDG6), focused mainly on low-income and developing countries, since 61% of the world's population does not have sanitation services. Africa is no exception, and the struggle to provide this service. Ghana approved in 2010 under the supervision of the Government; the polluter pays policy, in addition to this, the public sector, to positively improve sanitation services, should review the implementation of PPPs as a financial alternative to this problem (Tanoh, Nikiema, Asiedu, Jayathilake, and Cofie, 2022).

Van Dijk, Etajak, Mwalwega, and Ssempebwa (2014) comment that among some of the obstacles that exist to offer a better sanitation service to the most unprotected communities, a better financing scheme and a mechanism to generate income can be highlighted for the support of the projects undertaken. The industrial sector is the one that pollutes the most and uses the water resource the most. Industrialized countries produce approximately 80% of hazardous substances and 70% in developing countries, which directly dump the waste into their natural water sources (Rodríguez, Letón, Rosal, Dorado, Villar, and Sanz, 2006).

The European Court of Auditors (2018), in a press release, reported that after auditing several PPPs, the deficiencies are notorious as there is no balanced relationship between quality and price with respect to ineffective and unnecessary expenses recorded, lack of transparency in The percentage of risk distribution, which makes some contracts under this PPP scheme a non-viable option to promote public infrastructure works as a response to social problems.

To date, the financial and economic viability of the Wastewater Treatment Plant (WWTP) in Mexico is officially unknown. In this regard, there is no official evidence that shows this situation and reality in the states; Also, there is misinformation transparency and disconnection between studies of financial viability and the social value generated by WWTPs and for which they were promoted and approved in developing countries. Waste is dumped into natural water sources near the urban sprawl, especially rivers, lakes, seas, underground streams, even wasting this resource for drinking water supply, communication as a means of transport, and power generation (Espigares-García, Gálvez, and Lopez, 1986).

The objective of this document was to generate financial viability indicators for the "El Ahogado" WWTP project from the point of view of the developer's investment as an integral part of the water sanitation system in the AMG. Financial viability will be the ratio of financial benefits to financial costs, based on formulas used in a study to analyze financial viability for decentralized sewage treatment plants in Beijing selected because this article focuses on determining whether decision-making for the developer is financially viable and, therefore, its permanence and final results to achieve the objectives proposed by the public sector in the construction, maintenance and operation of the WWTPs object study. Liang and van Dijk (2010) establish that the financial viability of the project will be determined by the relationship between the financial benefits and the financial costs because if the results are less than 1 (one) the investment is not viable, but if on the contrary is greater than one (1), it can be concluded that the work is feasible for its realization and operation.

According to Ordoñez and Losada (2015) point out that water issues have been on the Cooperation for Development Agenda permanently, even several international organizations promote drinking water and sanitation projects from their

conceptualization, financing, processes, collection of documented experiences and publications referring to research and manuals on the subject.

For Lahera-Ramón (2010), developing countries such as Mexico must return the water that is used in optimal conditions and after treatment so as not to stop its hydrological cycle, and even they are issues that have not been resolved in part due to the population size, technology, economy, and regulatory policies that have not allowed these projects to be consolidated.

Mexican legislation and institutional

Article 27 of the Constitution of the United Mexican States states that the waters are national and not of the states or individuals; everything originates there, so for this, they defined the national water law that regulates how to manage water in the country, and Jalisco in congruence with the regulatory framework and to regulate the administration of waters in the jurisdiction of the state of Jalisco, the Water Law for the State of Jalisco and its Municipalities was approved, with decree 21804/LVII/06 and published in the Official Newspaper "El Estado de Jalisco" (Congress of the State of Jalisco 2007). This law establishes the regulations and regulatory bases whose activity is to attend to social welfare in terms of water for all state and municipal entities; construction, conservation, expansion of hydraulic infrastructure; administrative cooperation between entities; the provision of drinking water, sewage, sanitation, and wastewater reuse services in the State of Jalisco, delegating responsibility to the municipalities; fees, among others. Regulation of the Water Law for the State of Jalisco and its Municipalities (2009) (Government of the State of Jalisco 2009).

The State Commission for Water and Sanitation (2003) addressed the situation regarding the contamination of natural water sources located in the AMG, mainly in the "El Ahogado" Basin, the Santiago and Verde Rivers, as a result of untreated water spills, to which the Government of the State of Jalisco, with the support of the State Water and Sanitation Commission (CEAS), the National Water Commission (CNA), they promote sustainable alternatives for the environment, protection of the environment, prevention of public health problems and economic engine for projects.

In the "El Ahogado" and "Agua Prieta" WWTP project, the public sector contemplated the participation of private capital in a financing scheme of a Public-Private Partnership

in which the Federation through the National Infrastructure Fund (FONADIN) contributes a part of the required investment (49%), while the state is responsible for the difference in missing resources to achieve them. Garrick, De Stefano, Turley, Jorgensen, Aguilar-Barajas, Schriener, ... and Horne (2019) mention that some policies maintain that the administration of public services locally is positive, since the needs are adjusted to the interests of the population, in addition, accountability directly to citizens grows (Herrera, 2014). Mexico registered in 1998 the origin of fiscal decentralization, generating in the thirty-two states. In the legal framework of Mexico, water is a resource for all its inhabitants; that is, it is a public resource and is under the direction of the National Water Commission (CONAGUA), and the reuse of water is regulated. The policies that govern the recovery of water to take advantage of it, for example, in irrigation, make the mandatory administrative costs too high for its use (Mendoza-Espinosa, Burgess, Daesslé, and Villada-Canela, 2019).

In 1992, the WWTPs were the first projects to become concessions in Mexico, a project of the Government of the State of Mexico through the Secretariat of Urban Development and Public Works (SEDOP) (World Bank 2006). Municipalities are responsible for providing drinking water, sewage, and sanitation services, according to article 115 of the Mexican Constitution (Bravo, Castro, and Gutiérrez 2011). Regarding the tariff, issue to demonstrate the financial sustainability of the projects. The National Water Commission (CONAGUA, 2007) points out that there are different models for the rate structure with representative models at the international level and in practice at the national level, which seeks to improve the rate- setting for users; and for the calculation of the rate, the total of the costs that integrate it must be considered "technical, financial and social criteria; these are reflected in the fixed and variable costs" (CONAGUA, 2007, p. 7).

For the particular case of the state of Jalisco, it was determined that the state participation would be covered with resources from private participation through the municipalities of the AMG, which are organized in the Intermunicipal Drinking Water and Sewerage System (SIAPA) for the municipalities of Guadalajara, Zapopan, San Pedro Tlaquepaque, and El Salto; Potable Water, Sewerage and Sanitation System (SIAT), for Tlajomulco de Zúñiga; and finally the El Salto Municipal Potable Water and Sewerage System (SIMAPES) for the municipality of El Salto. It has the financial support

of the Government of the State of Jalisco, through the State Water Commission of Jalisco (CEA) in the course of the service operation of the work carried out. This situation allows a financing alternative in the face of the lack of economic resources of some of the parties to conclude works of relevance for social benefit.

The results after years of starting these projects have discouraging comments and results, so this document aims to focus its attention on the “El Ahogado” WWTP and review the financial viability for the developer in the face of this million-dollar investment at the initiative of the Government of Mexico, with the projection of monthly income, subsidies regarding the programmed expenses for its operation agreed in the ruling of the Public Tender No. 43111001-046-08 (CEA, 2008), important in this analysis since these must guarantee and demand an optimal result the developer as a member of the private sector in the financial model of the Public-Private Partnership (PPP).

The guarantee of solving public service problems must be contemplated before the start of the projects since these represent a true social impact and hope for problems that afflict several communities. Throughout the document, both treatment plants will be mentioned because they are complementary, and their entire infrastructure forms the integral system of treated water for the AMG.

Anda-Sánchez (2017) points out that the WWTPs mostly used in the municipalities of Mexico consist of conventional or centralized technologies, which demand large amounts of energy, markedly increasing maintenance and operation costs. Unfortunately, when they present failures, they directly impact the communities with sewage flooding. The investment, maintenance, and operating costs are not viable for low-income sectors of the country, as this becomes an unsustainable long-term financial burden for the users or beneficiaries of these populations. Mexico should consider new technologies as an alternative to this problem, such as decentralized wastewater treatment systems (cost reduction, adaptation to the environment for its construction, etc.). On the other hand, the “El Ahogado” WWTP is projected to serve 20% of the AMG, while the “Agua Prieta” WWTP 80%, in order to integrate the wastewater treatment system of the AMG urban area.

Due to the contamination of the Santiago River by residual discharges from the AMG, the construction of the “Agua Prieta” and “El Ahogado” WWTPs was promoted with the support of federal, state, municipal, and private sector resources. The lack of budget at

the three levels of Government in Mexico (federal, state, municipal) once again allows the participation of the private sector in investments that promote development in different sectors. These two- infrastructure works form the purification or treated water system, with a projection of sewage treatment of 89% in the AMG. For both WWTPs, the financing model is under the PPP scheme and with a DBOT contract (design, construction, operation, and transfer), with the long-term operation. The sources of investment and characteristics of the projects are illustrated in table 1. Regarding the construction of the sewage system and the collectors, they are carried out by the companies with the best economic and technical proposals under the regime of the Public Works Law, absorbed in its entirety with public resources.

Table 1 Characteristics of the Comprehensive Sanitation Project of the AMG

Comprehensive Sanitation Project for the Guadalajara Metropolitan Area			
Details	Public sector	Private sector	
Investment	Sewerage and collectors "Agua Prieta and El Ahogado"	Treatment Plants - PPP Scheme (DBOT) 20 years	
	Construction of sewerage network 615 km collector system 203 km pumping station San Gaspar collector tunnel San Martín collector	"Dark Water" 8.50 m ³ /s 80% treated water	"The Drowned" 2.25 m ³ /s 20% treated water
Tender and Trust		2009– 2012	2008– 2009
Expenditure Budget of the Federation (PEF)	USD 88.61 million		
Jalisco state	USD 88.61 million		
National Infrastructure Fund Trust (FONADIN) non-refundable.		USD 45.52 million	USD 19.71 million
Private investment		USD 79.58 million	USD 21.53 million
Subtotal	\$177.23	USD 125.09 million	USD 41.24 million
Total investment without VAT	USD 343.56 million		

Source: National Water Commission (CONAGUA, 2012) Strategic Projects for drinking water, drainage and sanitation. National Infrastructure Program 2007- 2012. De la Pena et al. (2013). own adaptation

The dollar exchange rate used corresponds to \$20.8266 MN MX on March 15, 2022. <https://www.banxico.org.mx/tipcamb/main.do?page=tip&idioma=s>

The objective of the "Agua Prieta" WWTP project is to provide and take advantage of the reuse of treated water for the generation of electricity for the benefit of the Federal

Electricity Commission (CFE), Valentín Gómez Farías hydroelectric plant. Finally, once the treated water is reused, the discharges will be deposited in the Santiago River. For this work, wastewater discharges from the Atemajac Basin (Osorio, San Andrés, and San Gaspar sub-basins) are contemplated, which pass through the Tunnel - San Gaspar - Atemajac to reach the "Agua Prieta" WWTP, treating 80% of the wastewater from the AMG. (State Water Commission - Jalisco, 2012).

The distribution of capital, according to reports from El Informador (2009), estimates that for the construction of the "El Ahogado" WWTP in Jalisco, Mexico, could have reached a cost of approximately 43.22 million dollars, made up of the participation of FONADIN with capital up to 19.70 million dollars in lost funds (49%), and on the other hand, the participation of private capital, of 25% with risk capital and the rest with a loan at the end of the total project. The recovery of 51% of the developer's investment would be generated at the time of the concession through the payments that the Government of the State of Jalisco would make monthly once this work begins operations.

The financial benefits for the PTAR project will be the monthly payments and subsidies that the CEA makes to the investor or developer agreed upon in the resolution of the public Tender No. 43111001-046-08 (public access at the State Water Commission - Jalisco, 2008). The financial costs will be integrated with the total cost of the investment, maintenance costs, and initial operation. See table 2.

Table 2 Characteristics of the AMG wastewater treatment plants

Operation Period		Monthly payments at constant prices from September 30. from 2008.				
Year	Month	investment fee	Fee for fixed costs of operation and maintenance	Fee for variable costs of operation and maintenance	Consideration per month	Total project payments
		T1=T1C + T1R	T2	T3		
3 to 19	31 to 222	\$248.22 million	\$97.04	\$85.44	\$430.70 million	USD 82.69 million
19 to 20	223 to 240	\$102.20 million	\$97.04	\$85.44	\$284.68 million	USD 5,124.40 MD
Total of the National Public Bidding project 43111001-046-08						\$87,820.55 MD
Data in millions of dollars MDD						

Source: Own elaboration based on the Public Tender ruling and information collected from the State Water Commission - Jalisco (2008); National Water Commission (CONAGUA, 2012). Data obtained in field interviews.

Note: Values are given at current prices. Operation Period Monthly payments at constant prices from September 30. From 2008. Conversion to dollar price.
Projection of monthly payments per rate for the "El Ahogado" treatment plant

Given the results obtained with the data worked, those perceived by the AMG community, it will be supported with references and studies that prove them since this work has been in force for more than ten (10) years. Since the proposal of the project for the PTAR "El Ahogado" to solve the wastewater problem for the benefit of the Metropolitan Area of Guadalajara (ZMG) or also known as the Metropolitan Area of Guadalajara (AMG), several changes have been recorded from its structure of initial financing, as government participation, to finally intervene the private sector in the PPP scheme.

The "Agua Prieta" WWTP was built with federal resources from the National Infrastructure Fund (FONADIN) and private resources. This project is expected to benefit 3.5 million inhabitants; this project is the third- largest in Latin America and the largest plant in Mexico; the cost per cubic meter for water treatment is 98 cents, registering as the lowest in the country, with a capacity of 8,500 liters per second; and the PTAR "El Ahogado" with its 2,200 liters per second, will cover the sanitation of around 98% of the residual or black water produced by the ZMG (Government of the State of Jalisco 2014).

Methodology

From the methodological point of view, the criterion of adapting a research object to a retrospective case study for its current application in Mexico is assumed. In the internal order, the methodology is translated into an analysis of financial viability that includes an evaluation of the financial costs that is integrated with the financial benefits (the initial investment, operation, and maintenance costs) with respect to the financial benefit that would be integrated by the income and possible subsidies delivered to the developer periodically (generated by the payment of the users of the different municipalities that participated in the WWTP project, with the "Contribution of sanitation plants" tax with their respective percentages of participation, subsidies) and that received for water recovery per month. Although the reality is different, since the responsibility is assumed by the SIAPA before the developer, this study will be based on the monthly payments agreed in the public tender, which was published by public sector entities with open access and the one collected in Fieldwork.

The relationship between these two factors will determine the viability (if the ratio is greater than 1, it is viable; otherwise, good financial planning was not done). The

formulas used to obtain the results are referenced from a study in Beijing on decentralized wastewater treatment plants to understand the regular performance obtained with respect to expected expectations. For the evolution of financial analysis, the relationship between financial costs and benefits will be taken into account, which is calculated with next formulas (3 and 5), source: Liag & Dijk (2010).

$$V_I = V_B + V_M + V_P \quad [1]$$

$$V_{O\&M} = \sum_{t=1}^n \frac{V_t}{(1+r)^t} \quad [2]$$

$$FC_{PV} = V_I + V_{O\&M} \quad [3]$$

$$FB_{PV} = \sum_{t=1}^n \frac{FB_{r(t)}}{(1+r)^t} + \sum_{t=1}^n \frac{FB_{s1(t)}}{(1+r)^t} + FB_{s2} \quad [4]$$

$$R_{FB/FC} = \frac{FB_{PV}}{FC_{PV}} \quad [5]$$

Where:

V_I: Initial investment (land, electrical and mechanical material, pipes, building construction material, etc.).

V_{O&M}: initial operation and maintenance costs

t: time in which the investment was developed

r: discount rate o

n: number of years of the concession

V_t= operation and maintenance expenses of year t

FC_{PV}: Financial cost (total investment and maintenance costs and initial operation)

FB_{PV}: Financial benefits

FB_{r(t)}: Income in year t.

FB_{s1(t)}: Subsidies in year t

FBS2: Initial investment subsidies

RFB/FC: Relationship between financial benefit and financial cost.

For this investment, three rates are agreed upon, classified as follows: T1 investment rate, T2 rate for fixed costs of operation and maintenance, and T3 rate for variable costs of operation and maintenance, which make up the total consideration for the project, listed in table 2.

Results

To achieve the collection of this information, officially published sources with free access were sought, mainly issued by the State Water Commission of Jalisco (CEA), the State Government, SIAPA, CONAGUA, newspapers, magazines located in databases and the Internet, government reports, among others, and as fieldwork, an interview was conducted with government officials from the state of Jalisco. The results obtained show that the financial viability for this project is zero (0.00162366).

These reinforce information issued by the CEA itself, institutions, researchers, and even various government entities, where the monthly payments agreed in the Public Tender rose considerably in the face of maintenance and operation costs.

The information was converted to real prices based on the National Consumer Price Index (INPC) (financial costs, income to the developer, and investments) to determine the financial viability of the “El Ahogado” WWTP. As of November 2009, the initial investment, maintenance, and operation costs were deflated. For its part, revenues to the developer were deflated as of 2012, which is when the commitment begins until 2029. However, as of 2022, an increase in inflation (INPC) is projected based on the increase in the average registered year in 2021. The results obtained are generated based on the information listed in table 3.

Table 3 Information for the calculation of formulas

Formulas details	Without vat
V1: Initial investment (land, electrical material, pipes, construction material, etc.)	\$19,350,466.43
VO&M: initial operating and maintenance costs	\$5,477,484.51
t: time in which the investment was developed	2.5
r: discount rate	12
n: number of years of the concession	20 years
V _t : operation and maintenance expenses of year t	\$31,661,176.03
FBr(t): Income in year t.	\$42,128,430.21
FBs1(t): Subsidies in year t	\$0
FBs2: Initial investment subsidies	\$0

Source: State Water Commission - Jalisco (2003). Data obtained in field interviews. Minutes of the Public Tender decision and information collected from the Jalisco State Water Commission – CEA. (2008).

Deflated data (real own prices obtained) based on the National Consumer Price Index INPC. Base = 100 second fortnight of July 2018

The results obtained are the following:

$$FBPV = \text{USD } 1,714.28$$

$$RFB/FC = 0.00162366$$

Given that the final relationship between financial benefits and financial costs is less than one, it is concluded that it is not financially viable from the developer's point of view, which allows reinforcing the results with literature that addresses comments against expectations. Expected before this millionaire infrastructure work in the AMG. Construction of the “El Ahogado” WWTP began in 2012 to complete the sanitation of wastewater from the AMG on a par with the “Agua Prieta” WWTP, but the proposed objectives have not been achieved due to the lack of pipelines to handle the municipal discharges from Tlajomulco since the wastewater from this municipality falls directly into the Santiago River, notoriously affecting this water resource of the state for the development of important economic activities in this region (Government of the State of Jalisco 2019).

Contrary to the amounts reported in the final decision of the Public Tender No. 43111001-046-08 (State Water Commission - Jalisco, 2008), which amount to USD

430,709.09 thousand dollars per month, Anda- Sánchez (2017), addresses the high maintenance and operation costs for the “El Ahogado” WWTP, where monthly it is for USD 1,632 thousand dollars, becoming a long-term and non-viable debt for developing countries.

Some exercises were carried out to understand that in the absence of subsidies from the beginning of the investment and in the years granted to the developer, the relationship becomes negative; On the contrary, if these are present during the initial investment and in the concession years, the relationship is positive, yielding a result greater than 1. But this analysis can be supported if the monthly payments reported and agreed in the accepted public tender have been fulfilled, in contrast, with the results shown in the information collected.

Meléndez (2020) comments that the “El Ahogado” WWTP is overflowing because it is working at 110% of its capacity; it is attributed to the increase in population but adds the same CEA that the “Agua Prieta” WWTP is not working at its capacity maximum after three years of operation since it is only at 56% of its capacity. This confirms that the project of the two largest treatment plants is not complying with the attention to the pollution problem, a statement issued by the Greenpeace organization according to a November 2016 report, since in their studies they found highly toxic, unregulated chemicals by Mexican Law, they also conclude that these plants will not solve the problem, since they only treat domestic water and were not designed for industrial discharges.

Covarrubias and Lozano (2012), in their article "The plant of “El Ahogado”, the last fiasco of Calderón," strongly evidence how political interests are more relevant than social welfare problems. This is demonstrated by the million-dollar approval of the PTAR “El Ahogado” to attend to the sanitation of the Santiago River, where the norms of NOM 001- SEMARNAT-1996 are not fulfilled in 87% to 94% by the industries located mainly in the municipality from El Salto, precisely where the “El Ahogado” dam is. The high levels of substances were found to violate the provisions of the Federal Water Rights Law 2009 (Secretariat of Environment and Natural Resources 2009). Between El Salto and Juanacatlán, the mortality rate from 2007 to 2010 increased due to diarrhea, gastroenteritis, malignant tumors, leukemia, cancer, hypertensive kidney diseases, among others, according to the National Health Information System (Sinais). On the

other hand, the problem is exacerbated by irresponsible administrations such as the PRI and the PAN, where an average of 23 housing developments were authorized a decade ago. In an interview with the Greenpeace organization, the Mexican legislation for the regulation of the environment is obsolete, and they are free for the industry. He concludes that those who pollute are the industries that cause the contamination, such as the case of non-phenol, since there is no technology in the world to clean this substance, so its implementation should be prohibited.

It is concluded that the project was not analyzed from the beginning because these plants were only going to attend to domestic water discharges, so the real beneficiaries are the developers in the face of the millionaire charges, as researchers from the Western Institute of Technology and Higher Studies (ITESO) (Covarrubias and Lozano, 2012), they already knew that these WWTPs were not going to solve the problem because they did not address the real problem by applying the technology required to attend to the water discharged by the industries.

In more recent information, Beret (2020) reports that the “Agua Prieta” WWTP is underutilized according to the report of the 2014-2018 Institutional Plan of SIAPA (National Water Commission (CONAGUA, 2016), in the absence of collectors, highlighting that the capacity of the project proposal of 8.5 m³/s, only 5.4 m³/s are working on average. The promise of the state government to treat up to 89% of the AMG has not been fulfilled because the results in 2019 are 51%. Given this situation, SIAPA, from the Tariff Commission, published that, for the wastewater treatment activity, the monthly fee will be between USD 0.03 cents and up to USD 0.50 dollars.

Meléndez (2020), according to reports requested for transparency, the CEA informs that due to the new investment in the infrastructure of another 13 treatment plants within the state with an estimated USD 28.81 million dollars will partially solve the contamination problem by managing to go from 65% to 70% of sanitation of the domestic waters that fall into the Santiago River. The questioning that is made in this report to the Government is towards the wrong solutions that are being implemented to this problem; according to Cindy McCulligh, a scientist from the University of Zacatecas, points out that the eastern interceptor collector or tunnel that conducts wastewater from the AMG should be built to the “Agua Prieta” WWTP, which has been contemplated since 2013. The tunnel project has not even been put out to tender to date, but it is contemplated from

the projection of the wastewater treatment system for the AMG specifically for the “Agua Prieta” WWTP project, so this sewage in part of industry and farmers are going directly to the Santiago River through the municipality of Tonalá when going down the ravine.

Discussion and conclusions

The approach that was carried out in this study allows us to conclude that for the financial conditions for the development or private capital in the “El Ahogado” treatment plant project, it was not financially viable given the maintenance and operation costs required in this infrastructure. This is reinforced by the monthly payments that the Government of the State of Jalisco must currently make through CEA to the developer since they are notoriously higher than those proposed in the public tender.

These results strengthen the comments recorded in the literature and research against millionaire investments, which are approved without a guarantee against the proposed or promised results. In addition to this, it is once again demonstrated the lack of experience on the part of the public sector to carry out infrastructure works for social benefit without generating long-term indebtedness and making the provision of public services more expensive.

It has been shown in some studies that decentralized WWTPs can be an alternative to contaminating the state's water basins and water resources, but this would go against policies that protect companies and large monopolies already established in the AMG. If real estate developers, industrial complexes, shopping centers, and works that constantly generate waste or sanitary waste were approved to build their own WWTPs, in exchange for subsidies or discounts in their rates for the payment of services, the pollution of rivers and water sources could gradually recover. The literature review allows us to appreciate that the Mexican legislation to protect the environment is obsolete and leaves an open gap for the indiscriminate use of industries, for not typifying the use of chemical substances harmful to life and that their use should be prohibited not only in Mexico but in the whole world. Likewise, the permissiveness and negligence of governments at all levels, by not controlling wastewater discharges from chemical processes; the deception of the population for electoral purposes in many cases, by allowing million-dollar works that do not solve the pollution problem with technology aimed at industrial waste. To this must be added the indebtedness and long-term economic commitments to which citizens and future generations are exposed.

Although the results obtained in this investigation are relevant from the financial point of view, the operation of the WWTP requires continuing to analyze the cause of the problem to really solve the wastewater treatment. It is considered necessary to continue with the analysis to include the positive externalities, social, and economic impact to validate the legitimacy of the millionaire investments made by the governments. The experience that the development companies have should be evaluated for more objective purposes so as not to cast doubt on their results with significant investments from the public sector.

The Law of Public-Private Partnerships of January 12, 2012, states that the works under these contracts must be directed to social benefit and demonstrate the advantages of this financial scheme in comparison to other forms of financing, but in practice, it can be concluded that there is a lot of inconsistency when obtaining the results. This can be supported when submitting proposals in public tenders because in this case study, the technology to treat wastewater from the AMG did not address the real problem of contamination of the Santiago River due to not carrying out in-depth studies or because the important thing is to obtain the ruling in favor of the developer presenting the lowest proposal with very high expectations, but that in the inter-years of the concession the agreed payments increase substantially, without this guaranteeing the solution to the real problem. It is the bidders who submit proposals, initial investment costs, financial, maintenance and operation costs, delivery times for their operation, environmental impact studies, financial and social feasibility, among others, to achieve the objectives.

The issue of conserving water resources in the state, and very possibly in the country, has become an issue of proselytism, of permits to the industry, to real estate developers, to agribusiness industries, regardless of the cost of living and irreparable damage to the environment. The most viable solution that the Government sees in its different instances is to raise the tariffs for the use of water to the consumer, but the references mentioned here show that the problem is not the high tariffs, nor the subsidies, but rather the infrastructure in its total construction.

It is necessary to promote a change of vision for the public sector in the face of the responsibility to attend public services for the well-being of its inhabitants with public works that guarantee their purpose and where the private sector participates with the same interest, and even strictly regulating compliance and the payments agreed upon in public

tenders. In addition, it is necessary to promote and typify the use of decentralized WWTPs, where they are adapted to developments and projects approved under national and international laws; that is, each developer must generate their own WWTPs and be responsible for the waste produced. Current investments with conventional WWTPs can only serve to treat residual or domestic waters due to their initial nature for projects. Without a doubt, it is extremely necessary to promote international laws that do not allow countries to deliberately choose the systems they consider suitable for treating wastewater, changing the view that water resources belong to all of humanity.

The recovery of natural sources such as rivers, lakes, dams, among others, are issues that today acquire relevance for developing countries, with the construction of an entire infrastructure for channeling wastewater to be treated in wastewater treatment plants. The responsibility to invest in these projects is of the governments to attend to this problem; however, the responsibility to cover the obligations for the use and exploitation of drinking water, as well as that which is wasted as organic waste from personal property, is undoubtedly of the citizens, the main characteristic of the services is that whoever uses them pays for them.

The criterion of financial viability for the developer is assumed based on the comprehensive sanitation project in the AMG. This research not only intends to throw a number to determine the financial viability based on the developer, but also contextualizes the value of water and the responsibility assumed by both private actors and the public sector for decision-making to make financial alliances, and with this, solve social or infrastructure problems in favor of national development. It is suggested to continue with studies that show the responsibility of the developers before the obligations acquired in the failures of the tenders against the results of the works and close the biases in indiscriminate payments and far from those accepted in said tenders.

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PARTE 2. Iniciativas de Asociaciones Público Privadas (APP) aplicadas a infraestructuras de transporte terrestre

Capítulo 3. Análisis costo-beneficio del tramo carretero federal Querétaro-San Luis Potosí (Cost-benefit analysis of the federal highway section Querétaro-San Luis Potosí)

Análisis costo-beneficio del tramo carretero federal Querétaro-San Luis Potosí
(*Cost-benefit analysis of the federal highway section Querétaro-San Luis Potosí*)

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RESUMEN

Este estudio analizó el tramo carretero Querétaro-San Luis Potosí, el cual se encuentra dentro de la red federal número 57 de la República Mexicana, también identificada como la espina dorsal de México. Esta red vial es de libre tránsito para los diferentes usuarios. A diferencia de otras carreteras viales en México que también están bajo el esquema de Asociaciones Público Privada con cobro de cuota, el tramo carretero Querétaro-San Luis Potosí no genera costo para los usuarios de forma directa, dado que su financiamiento depende del Presupuesto Público de la Federación, es decir, de la recaudación de impuestos a través de la Secretaría de Hacienda y Crédito Público. El comparativo entre el tramo Querétaro-San Luis Potosí con la autopista México-Querétaro (57D) permitió identificar el costo-beneficio de la inversión de forma positiva para la vía de tránsito libre, para este análisis “peaje en sombra” bajo el esquema de Asociación Público Privado.

Palabras clave: Asociaciones Público Privadas, Peaje en sombra, estándares de calidad, costo/beneficio.

ABSTRACT

This study analyzed the Querétaro - San Luis Potosí highway section, which is located within the 57 Federal Network of the Mexican Republic, also identified as the backbone of Mexico. This red road is free transit for different users. Unlike other roads in Mexico that are also under the scheme of Public Private Partnerships with fee collection, the Querétaro-San Luis Potosí highway does not generate costs for users directly, since its financing depends on the Public Budget of the Federation, that is, on the collection of taxes through the Ministry of Finance and Public Credit. The comparison between the

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Querétaro-San Luis Potosí stretch with the Mexico-Querétaro highway (57D) showed to identify the cost-benefit of the investment in a positive way for the free transit route, for this "shadow toll" analysis under the Public-Private Association scheme.

Keywords: Public Private Partnerships, Shadow Toll, quality standards, cost/benefit.

Introducción

La implementación y aceptación de las Asociaciones Público Privadas (APP) en diferentes países del mundo ha permitido expandir su estructura jurídica y financiera en diferentes proyectos como alternativa por parte de los Gobiernos para atender problemáticas presentes en sus comunidades o para impulsar el desarrollo en beneficio de la sociedad. En las últimas cuatro décadas, México ha implementado cambios importantes en las inversiones públicas, fundamentalmente, modificando la legislación, gestión y políticas públicas de la Administración Federal, tendiendo hacia una liberalización y desregulación del papel del Estado en la economía.

La figura de APP en México es relativamente nueva y actualmente es una estrategia financiera para impulsar el desarrollo económico a través de infraestructura en obras públicas para todo el país. En el caso de México, la Ley de Asociaciones Público Privadas (LAPP) se expidió el 16 de enero de 2012. Lozan, Godínez & Albor (2017) consideran que las APP son una alternativa como estrategia financiera para impulsar el desarrollo económico de México a través del fortalecimiento de infraestructuras, principalmente en los proyectos carreteros.

Los recursos económicos que demandan las inversiones en el sistema federal carretero superan los recursos públicos federales destinados al Presupuesto de Egresos de la Federación (PEF). El Gobierno federal ha incentivado más inversiones provenientes del sector privado para satisfacer estas necesidades y mejorar las condiciones e infraestructuras actuales en el sistema carretero nacional en general. La financiación al sistema carretero federal también se dinamizó en los últimos años para alcanzar una mayor calidad de servicios de infraestructura terrestre a la sociedad, a las empresas de logística y al comercio nacional e internacional en distintas zonas estratégicas del país, incrementando el encadenamiento y eficiencia en la logística y transporte (Rangel, 2015; Giraldo-Ayala, 2013). Con ello se pretende, por una parte, mejorar la interconectividad entre las localidades del territorio nacional y municipales para hacer más eficiente la

productividad y reducción de costos de transacción y, por otra, buscar nuevas inversiones orientadas hacia el fortalecimiento de la expansión de la red troncal que une los principales territorios del país con los Estados Unidos de América (Mendoza-Méndez, 2017).

Lozano, «et al.» (2017), comentan que la relación contractual del modelo de Concesión Administrativa de los años 60 y 70 del siglo pasado en España y, posteriormente, el modelo “Private Finance Initiative” (PFI) promovido por el Gobierno británico en 1992 son referentes claros para aquellos países que buscan alternativas para impulsar el desarrollo en materia de infraestructura y servicios públicos. Cada país ajusta el modelo PFI de acuerdo con las leyes vigentes de su jurisdicción gubernamental. En el caso de estos proyectos aplicados en México, se ha adaptado el modelo británico en los Proyectos de Prestación de Servicios (PPS) aunque existen también modificaciones a las condiciones del país.

A lo largo de la Carretera Federal 57 se encuentra el segmento carretero Querétaro - San Luis Potosí, este tramo no tiene cuotas de peaje, cuyo método de financiación es el británico, es decir, el peaje en sombra o shadow toll. Éste está constituido por aquellos pagos que realiza la Administración Pública al operador privado a cambio de los servicios prestados, aplicando estándares de calidad y servicio, con penalizaciones económicas en caso de incumplimientos que afecten la calidad de los servicios pactados con el concesionario (Acerete Gil, 2003). Pina y Torres (2004) señalan que la financiación por parte del sector privado en infraestructuras públicas permite la construcción, mantenimiento y gestión de servicios públicos (escuelas, hospitales, carreteras, entre otras) donde los usuarios no pagan directamente por el servicio, pues el sector público paga al operador privado dependiendo de los niveles de actividad. El sector público seguirá siendo responsable de la supervisión de la prestación de los servicios y, a menudo, único comprador de los servicios.

Para el desarrollo de esta investigación, fue necesario focalizar la información disponible sobre el tramo carretero Querétaro – San Luis Potosí como objeto de estudio. Este tramo carretero forma parte de la Federal 57 cuya construcción es de norte a sur, desde su inicio estuvo a cargo de la Federación, a través de la recaudación de impuestos. Actualmente, este tramo está bajo el esquema de financiamiento de APP para los trabajos de Rehabilitación Inicial, Conservación Rutinaria y Periódica, conocido con el nombre

del proyecto “Programa Asociación Público Privada de Conservación Plurianual de la Red Federal de Carreteras, APP Querétaro – San Luis Potosí”. Los pagos para el desarrollador están a cargo de la Federación a través de la Secretaría de Comunicaciones y Transportes (SCT). Se le denomina autopista a los tramos carreteros (D) que tienen acceso restringido o que para hacer uso de estas vías, los usuarios deben realizar un pago de cuota o peaje (Gómez Martínez, Cruz Vargas, Dávalos Arriaga y Arenas García. 2017).

El objetivo de este trabajo de investigación fue analizar el costo/beneficio de la inversión realizada en la Carretera Querétaro - San Luis Potosí e identificar si existen beneficios para los usuarios o únicamente para el desarrollador. Para ello se calculan los ingresos por el cobro de tarifas de peaje para los diferentes tipos de vehículos en la autopista México - Querétaro, en comparación a los pagos que realiza la Federación al desarrollador. La autopista México -Querétaro hace conexión con la Libre Querétaro - San Luis Potosí, trazando una sola trayectoria vial y alternativa para los vehículos que desean moverse en esta región, con dirección de norte a sur y viceversa. Ver anexo 1.

Por otra parte, se analizó si es positiva la decisión del Gobierno federal de incluir las cargas presupuestarias de estos compromisos como parte de la programación en el PEF año con año y, en un futuro pueda ser factible su continuidad para la Conservación Rutinaria y Periódica bajo el esquema actual para este tramo vial o para toda la Federal 57. Esto se podrá identificar si el nivel de los pagos desembolsados por parte de la Federación para el desarrollador son menores a los que pagan los usuarios en la autopista de cuota México – Querétaro como vía alternativa de análisis, dependiendo del número de Transito Promedio Diario Anual (TPDA) reportado por la SCT y los kilómetros que abarca cada red vial.

Revisión de Literatura

La infraestructura vial de México se clasifica en diferentes tipos de carreteras que abarcan todo el territorio nacional; el Instituto Mexicano del Transporte (IMT, 2021), publica un reporte detallado de la infraestructura de caminos en México e incluye nuevos resultados actualizados al 2020, de la longitud total de la Red Nacional de Caminos (RNC), apoyándose de la alianza interinstitucional del IMT, la Secretaría de Infraestructura Comunicaciones y Transporte (SICT) y el Instituto Nacional de Estadística y Geografía

(INEGI,) bajo estándares internacionales y normativa del Sistema Nacional de Información Estadística y Geográfica (SNIEG). Tabla 1

Tabla 1. Datos Red Federal Carretera de México

Tipo de carretera	Detalles / km	Total kilómetros
Carreteras federales	50,685	
Carreteras estatales	102,719	
Otros (municipales, particulares)	21,375	
Carreteras pavimentadas		174,779
Vialidades urbanas e infraestructura de enlace		78,385
Caminos no pavimentados		527,345
Longitud total de la RNC		780,511
Otros datos	Detalles / KM	
Carreteras de Cuota	10,767	
Plazas de cobro	1,261	
Veredas	21,989	

Fuente: IMT (2021). Red Nacional de Caminos. Adaptación propia prueba piloto.

La Auditoría Superior de la Federación (ASF, 2013), indica que las carreteras libres de peaje en México son responsabilidad exclusiva de la Federación, garantizando su seguridad y estándares de calidad, para lo cual debe crear estrategias para el cumplimiento de objetivos de calidad, seguridad, servicios para la población; en cuanto a administración de construcción, reconstrucción, modernización y conservación está a cargo de la SCT.

Esta APP incluye la inversión inicial de \$1,520.5 millones de pesos a cargo del desarrollador que consiste en la rehabilitación y reconstrucción (tramos y puentes durante los primeros dos años y seis meses), equivalente a 324,822 km. El objetivo es cumplir con estándares de calidad y desempeño, mantenimiento y conservación, por el término de 10 años, los cuales serán evaluados por el Gobierno para posteriormente generar los pagos correspondientes.

La longitud total de esta vía libre representa un área muy importante en logística y transporte no únicamente para las tres entidades federativas por donde atraviesa sino para el sistema troncal entre los principales corredores industriales del Centro y Occidente del país, crecimiento ante el constante intercambio de mercancías con el país vecino del norte.

La SCT (2020) en su Informe de Rendición de Cuentas 2013-2018, destaca que en el Libramiento Oriente de San Luis Potosí se encuentra el Parque Logístico-Interpuerto, siendo el puerto interior más importante de México. El elevado tránsito de mercancías entre México y Estados Unidos, hace que los principales ejes carreteros, incluso los ferroviarios hacen de este tramo una ubicación estratégica logística, al manipular

alrededor de 100 mil contenedores al año, fortaleciéndose por sus conexiones viales, ahorros logísticos y flexibilidad para la distribución y movilidad.

El IMT (2021), comenta sobre el tema de autotransporte de carga a nivel nacional, que el tramo carretero que une a las entidades federativas de Querétaro, Guanajuato y San Luis Potosí representa una importante vía de tránsito y logística cuyo impacto económico se evidencia en las vías de flujo con mayor tonelaje anual de mercancías en circulación en el país (aproximadamente los 81,659,990 toneladas de movilización).

Al igual que el tramo libre Querétaro - San Luis Potosí, la autopista México - Querétaro, representa una vía terrestre de gran importancia para el impulso económico del país por su alto flujo de transporte de mercancías y por ser su trayectoria un trazo continuo a la Carretera Federal Querétaro - San Luis Potosí para finalmente convertirse en una conexión obligada con el tramo objeto de estudio. Dorado, Mendoza, Gutierrez y Abarca (2014), identifican en un estudio las carreteras con mayor circulación de tonelaje, enfocándose, en la reducción de tiempo para unidades de carga, dentro del territorio nacional. Ver tabla 2. Este estudio permite comprender la importancia del tramo en estudio, cuando los usuarios viales, continúan con dirección hacia el norte y/o sur del país.

Tabla 2. Tonelaje Anual de Mercancías en México

Carreteras con el mayor tonelaje anual de mercancías en circulación.	
Carretera	Tonelaje Anual en circulación
Aguascalientes - Zacatecas	112,833,180
Querétaro - San Luis Potosí	81,659,990
Saltillo - Monterrey (Cuota)	77,511,400
Ent. La Chicharrona - Cuencamé	75,275,775
México - Querétaro (Cuota)	63,598,695
León - Aguascalientes	59,271,620
El Sueco - Villa Ahumada (Cuota)	54,141,545
Chihuahua - El Sueco	53,161,155
Delicias - Chihuahua (Libre)	47,281,370
Maravatio - Zapotlanejo (Cuota)	46,351,715

Fuente: Dorado, Mendoza, Gutierrez y Abarca (2014).

El Consejo de Ciencia y Tecnología del Estado de Querétaro (CONCYTEQ, 2001), comenta que la autopista México - Querétaro y el tramo carretero Querétaro - San Luis Potosí tienen su dirección de sur a norte y norte a sur, siendo por largos años la ruta de

tránsito en esta dirección. El primer tramo carretero ha sufrido cambios, entre ellos, pasó a ser una moderna autopista de seis carriles, mientras que la carretera Querétaro - San Luis Potosí, sigue siendo libre de tránsito y no ha sufrido cambios fuertes como su ubicación.

De acuerdo a Coronado Garcia (1991) la red carretera conformada por los ejes viales de cuota y libre tránsito, México - Querétaro, Querétaro - San Luis Potosí y Querétaro - Irapuato, con centro en la ciudad de Querétaro, forman una importante región para captar áreas de producción y mover para su consumo a las principales ciudades del país. Según reportes de SCT (2020) en Datos Viales, la autopista México - Querétaro (Ruta:Mex-057D), parte desde la plaza de cobro Tepetzotlán en el Estado de México hasta Libramiento a Querétaro – San Luis Potosí. Continúa la carretera Querétaro – San Luis Potosí (Ruta:Mex-057) del Libramiento de Querétaro hasta el Periférico de San Luis Potosí.

La carretera federal 57 es la columna vial del país y la implementación de la APP en conservación y mantenimiento en el tramo carretero Querétaro – San Luis Potosí, ha registrado ventajas e impactos sociales en beneficio de los usuarios. La implementación de las APP en la dinámica de construcción, modernización, conservación y mantenimiento, en toda la red carretera nacional puede resolver problemas en todas las carreteras federales y caminos de tránsito vehicular de importancia para el país.

La Comisión Económica para América Latina y el Caribe (CEPAL, 2009), en el documento de trabajo para el Sistema de Cuentas Nacionales, 2008, señala a los compromisos contraídos en el esquema de las APP como una oportunidad, un beneficio o el camino que lleva a la eficiencia y la apertura de diferentes fuentes de financiamiento a los gobiernos con la esperanza de mejoras en servicios a través de la entrega de un activo público para la producción o explotación de éste, bajo un contrato a largo plazo. La definición y claridad estipulada en los contratos sobre la administración, tiempos, y fines sobre los activos, marcan el objetivo y éxito de esta alianza.

Metodología

Para analizar el costo/beneficio se consideraron como indicadores financieros el Valor Presente Neto (VPN), la Tasa Interna de Retorno (TIR) del 2016 al 2019, y posteriormente al 2026, finalmente la Tasa de Rendimiento Inmediata (TRI) para el primer año. En este análisis se consideró como base los valores esperados que puedan contrastar dos escenarios: un primer escenario que parte de los recursos consumidos por

la Federación, que se convierten en erogaciones potenciales, y un segundo escenario que se enfoca a los beneficios esperados por los usuarios donde se formula un cuestionamiento tácito: pago de impuestos o asumir una cuota de peaje.

Los indicadores financieros se calcularon con las fórmulas abordadas por el Banco de Programas y Proyectos de Inversión Pública de la Secretaría de Finanzas del estado de Oaxaca para proyectos de inversión social, y su enfoque hacia el análisis de la rentabilidad social para este proyecto (Abardía, Jiménez, Sierra y Solís, 2013). Lo relevante de estas fórmulas son los términos que la componen, pues los proyectos de inversión dirigidos a obras públicas tienen una visión con un enfoque hacia el bienestar social, donde contablemente estos proyectos pueden ser positivos y justificados en el presupuesto de egresos de la Federación año con año, en este caso en específico.

Valor Presente Neto (VPN)

$$VPN = \sum_{t=0}^n \frac{B_t - C_t}{(1 + r)^t}$$

B_t= Beneficios totales en el año t

C_t= Costos totales en el año t

B_t – C_t= Flujo neto en el año t

r= Tasa social de descuento

t= Año (0,1,2,...,n)

Tasa Interna de Retorno (TIR)

$$VPN = \sum_{t=0}^n \frac{B_t - C_t}{(1 + TIR)^t}$$

B_t= Beneficios totales en el año t

C_t= Costos totales en el año t

B_t – C_t = Flujo neto en el año t

n = Número de años del horizonte de evaluación

TIR = Tasa Interna de Retorno

t = Año (0,1,2,...,n)

El VPN es igual a cero (0)

Tasa de Rendimiento Inmediata (TRI)

$$TRI = \frac{B_{t+1} - C_{t+1}}{I_t}$$

B_{t+1} = Beneficios totales en el año t+1

C_{t+1} = Costos totales en el año t+1

I_t = Monto total de inversión valuado al año t (Inversión acumulada hasta el periodo t)

t = Año anterior al primer año de operación

t+1 = primer año de operación

Para la autopista de cuota México - Querétaro se obtuvo información de reportes oficiales emitidos por la SCT, Fondo Nacional de Infraestructura (FONADIN), y entidades oficiales relacionadas con los promedios del flujo vehicular, ingresos anuales por cobros de casetas, características de la autopista, entre otros.

Para el tramo Querétaro – San Luis Potosí, se recolectó información publicada por la SCT en Datos Viales para conocer el TPDA que se movilizan en esta vía federal de tránsito libre durante el periodo de 2016 al 2019, fechas que marcan el inicio del proyecto y la recolección de la información con acceso público al momento de iniciar este estudio, respectivamente. Igualmente, los pagos que periódicamente hace la Federación al desarrollador a través de la SCT. Para los cálculos en general para el año 2016 se toman 61 días por iniciar el proyecto objeto de estudio el 1 de noviembre de 2016.

Para el tramo Querétaro - San Luis Potosí, el desarrollador cobra a la Federación por rehabilitación inicial, conservación y mantenimientos de estándares de calidad y desempeño, mientras que la autopista México -Querétaro recaba sus ingresos para el concesionario FONADIN por el número y tipo de vehículos que transiten en este tramo, por lo que el comparativo permite concluir si la inversión millonaria para el tramo Querétaro - San Luis Potosí justifica el beneficio percibido inconscientemente por los usuarios, pues la trayectoria que por su origen lleva la autopista 57D México – Querétaro, entronca o sigue su ruta en la federal 57 Querétaro – San Luis Potosí, para continuar en dirección de norte a sur o sur a norte a través del país. En otras palabras los vehículos que van por la autopista México – Querétaro continúan su trayectoria en la libre federal Querétaro – San Luis Potosí.

A partir de este enfoque se obtiene información para conocer los ingresos percibidos anualmente por FONADIN de la autopista México – Querétaro basado en el número de usuarios o vehículos que transitan en esta vía con restricción y con pago obligatorio de cobro de peajes a través de Carreteras y Puentes Federales (CAPUFE).

Para la vía libre Querétaro – San Luis Potosí se obtienen dos datos, el primero son los pagos realizados por la Federación al desarrollador R&M Querétaro – San Luis, S.A. de C.V. a través de la información publicada en el PEF año con año; y el segundo dato es la información obtenida directamente de la SCT donde se reportan contablemente los pagos que hacen al desarrollador, la cual difiere de la primera. El análisis costo-beneficio permite llegar a la viabilidad del proyecto desde el punto de vista de la rentabilidad social, materializado en el ahorro de los usuarios al usar este tramo carretero.

Es importante tener la información oficial del tráfico vehicular del tramo libre de peaje, y así determinar el beneficio con esta inversión, al igual que el monto anual recabado en la autopista México - Querétaro por número de vehículos y kilómetros recorridos. Esto permitirá analizar que puede ser más económico para los ciudadanos, si pagar este proyecto con la aportación de los impuestos o a través de una cuota de peaje.

Resultados

Los resultados obtenidos parten de los supuestos de la relación costo/beneficio teniendo en cuenta las perspectivas analizadas de consumo de recursos (costos) así como también los beneficios percibidos por parte de los usuarios, como se describe en el siguiente análisis. En la tabla 3, se muestran los datos más relevantes de ingresos y tráfico de la autopista México – Querétaro, entre ellos el TPDA, el Tráfico Promedio Anual, los ingresos por cobro de peaje, promedio anual de ingresos por la cantidad de vehículos que transitan al año y finalmente el promedio de ingresos por kilómetros para la autopista México – Querétaro, lo cual permite realizar una inferencia sobre una valoración cuantitativa de una de las dimensiones de la relación costo/beneficio, para los vehículos que continúan su viaje o transiten por la vía libre Querétaro – San Luis Potosí y que deberían absorber su uso si esta vía estuviera bajo el esquema de autopista con restricción de paso.

En la tabla 4, se muestran los promedios con la información obtenida de la fuente de la SCT, para la vía libre Querétaro – San Luis Potosí, donde se relacionan los pagos que la Federación ha realizado año a año al desarrollador, igualmente el cálculo del beneficio

en promedio anual recibido por vehículo que transita en esta carretera y el promedio diario que se paga por kilómetro atendido por el sector privado.

Tabla 3. Promedio Ingresos y TPDA de la autopista México-Querétaro

AUTOPISTA MÉXICO-QUERÉTARO						
Kilómetros		349	174.5 c/tramo			
AÑOS	TPDA	TPANUAL	Ingresos Miles de Pesos Anual	Prom. Ingreso/Veh	Prom. Km./Veh.	Prom. Ingreso Diario/km
2016	56,508	3,446,988	767,436,654.79	222.64	0.64	36,048.51
2017	58,005	21,171,825	5,114,191,000.00	241.56	0.69	40,147.51
2018	61,024	22,273,760	5,793,760,000.00	260.12	0.75	45,482.28
2019 (1)	51,304	18,725,960	8,943,244,897.96	477.59	1.37	70,206.42
PROMEDIO TOTAL	56,710	65,618,533	20,618,632,553	300.47	0.86	47,971.18
FONADIN (TPDA - 2014-2020)						
(1) Las cifras reportadas en 2019, incluyen aforos e ingresos preliminares de Telepeaje de mayo – diciembre 2019.						
Nota: Se saca promedio para enero a abril 2019 para integrar el 2019 y para el 2016 se tomar 61 días						

Fuente: Elaboración propia con datos del FONADIN (2014-2020) y SCT - Datos Viales.

Tabla 4. Promedios calculados con información de pagos por la Federación al desarrollador a través de la SCT.

QUERÉTARO - SAN LUIS POTOSÍ							
Kilómetros		324.822					
AÑOS	TPDA	TP-ANUAL	Pagos anuales al Desarrollador- Datos SCT	Prom. Anual beneficio/Veh	Prom. Beneficio Pago Diario/km	Prom. Beneficio Km/ TP-ANUAL	Prom. Beneficio Total Km/ TP-ANUAL
2016	13,725	837,197	\$7,375,641.40	\$8.81	\$372.24	\$534,078.14	\$173,480,330.40
2017	14,205	5,184,786	\$246,515,088.31	\$47.55	\$2,079.24	\$3,588,591.84	\$1,165,653,577.66
2018	14,702	5,366,254	\$558,032,912.81	\$103.99	\$4,706.75	\$3,999,564.75	\$1,299,146,620.71
2019	15,217	5,554,157	\$739,326,546.76	\$133.11	\$6,235.88	\$7,600,527.22	\$2,468,818,451.36
TOTAL	14,462	16,942,393	\$1,551,250,189.28	\$73.36	\$3,348.53	\$14,586,691.04	\$5,107,098,980.14
SCT - Datos Viales 2017 al 2020							
Para el año 2016 se toman solo 61 días (inicio del proyecto)							

Fuente: Elaboración propia con datos de la SCT y – Datos Viales 2017, 2018, 2019 y 2020.

En la tabla 5 se aprecia un estimado económico que dejan de pagar los usuarios de esta vía libre, si se toma el promedio anual de ingreso por vehículo percibido en la autopista México – Querétaro promediado por los kilómetros, considerando que estás vías se

conectan y forman una sola infraestructura carretera y se convierte en un beneficio para quienes continúen su ruta hacia el norte o sur del país por esta vía.

Tabla 5. Beneficio Ingreso por kilometro para la Carretera Querétaro - San Luis Potosí

AÑOS	TP-ANUAL	Prom.Anual Ingreso/km México- Querétaro	COSTO - BENEFICIO
2016	837,197	207.22	\$173,480,330.40
2017	5,184,786	224.82	\$1,165,653,577.66
2018	5,366,254	242.10	\$1,299,146,620.71
2019	5,554,157	444.40	\$2,468,818,451.36
TOTAL	16,942,393	279.66	\$5,107,098,980.14

Fuente: Elaboración propia.

El porcentaje del total por tipo de vehículos que transitan en el tramo carretero Querétaro – San Luis Potosí se obtuvo a partir de la consulta de los datos publicados en el portal de la SCT en Datos Viales de los años 2017, 2018, 2019 y 2020.

En la tabla 6, se observa la base de la distribución porcentual que generaron las aproximaciones de vehículos (en términos absolutos) para futuros estudios en la carretera libre Querétaro – San Luis Potosí, pues no fue posible encontrar la cantidad por tipo de vehículos para la autopista México – Querétaro y así determinar porcentualmente datos más cercanos a los que obtienen mayor beneficio con la libre Federal Querétaro – San Luis Potosí.

Tabla 6. Porcentaje TDPA - Querétaro – San Luis Potos

PORCENTAJE DE VEHICULOS DIARIO POR AÑO										
AÑO	M	A	B	C2	C3	T3S2	T3S3	T3S2R4	D	TOTAL
	Motos	Automóviles	Autobuses	Camiones unitarios de 2 ejes	Camiones unitarios de 3 ejes	Tractor de 3 ejes con semi - remolque de 2 ejes	Tractor de 3 ejes con semi - remolque de 3 ejes	Tractor de 3 ejes con semi-remolque de 2 ejes y remolque de 4 ejes	Otros	
2016	1.364%	67.596%	3.214%	7.921%	2.636%	11.121%	3.000%	2.361%	0.786%	100%
2017	0.850%	58.786%	3.339%	7.929%	2.757%	19.400%	2.575%	3.893%	0.471%	100%
2018	0.943%	58.593%	3.361%	8.189%	2.832%	19.014%	2.864%	3.714%	0.489%	100%
2019	0.945%	59.381%	3.831%	8.282%	2.516%	18.007%	2.860%	3.704%	0.474%	100%

Nota: Los porcentajes son obtenidos de resultados publicados en Datos Viales por a SCT para cada año reportado

Fuente: SCT (2020). Adaptación propia basado en apartado de Datos Viales.

La proyección obtenida del total de vehículos que transitan en la carretera en estudio se muestra en la tabla 7. La clasificación por tipo de vehículos, para los años del 2016 al 2019, se proyectó a partir de los datos publicados por la Secretaría de Hacienda y Crédito Público (SHCP, 2017) en el documento “La rentabilidad social del proyecto (Análisis costo-Beneficio APP Querétaro - San Luis Potosí)”. La línea base comienza en el año 2014 cuando se registró un TDPA de 12,812. A partir de entonces se establece una proyección de la tasa de crecimiento anual del 3.5%. Los cálculos para el 2016 son de 61 días.

Tabla 7. Promedio de Vehículos diarios por año libre federal Querétaro–San Luis Potosí

Año	TPDA	NUMERO DE VEHICULOS POR DIA TDPA									
2014	12,812										
2015	13,260										
Año	Proyección	M	A	B	C2	C3	T3S2	T3S3	T3S2R4	Otros	Total Anual
2016	13,725	117	8,068	458	1,088	378	2,663	353	534	65	837,197
2017	14,205	134	8,323	477	1,163	402	2,701	407	528	70	5,184,786
2018	14,702	139	8,614	494	1,204	416	2,795	421	546	72	5,366,254
2019	15,217	144	9,036	583	1,260	383	2,740	435	564	72	5,554,157
TOTAL	57,848	533	34,041	2,013	4,716	1,580	10,899	1,617	2,172	278	57,848

Fuente: Elaboración propia obtenida de la SCT – Datos viales

En la tabla 8, se hace un comparativo de la información conseguida que difiere entre los extraídos del Diario Oficial de la Federación para el PEF para el ejercicio fiscal 2016, 2017, 2018, 2019 frente a los datos informados por la SCT en sus archivos internos contables, pero no como información pública.

Cabe mencionar que el monto reportado de inversión total es por la cantidad de \$3,397,605,443.69 pesos reales mexicanos incluido el Impuesto al Valor Agregado (I.V.A) que ascendería al 16%. Es importante destacar que la cifra estipulada en los documentos oficiales publicados para el inicio de esta APP resulta distinta a la que, posteriormente es publicada. Para soportar lo anterior, se puede señalar que fue posible obtener el estado financiero sobre las estimaciones emitidas por el desarrollador R&M Querétaro – San Luis, S.A. DE C.V. a octubre de 2020, y se ratifica que la inversión total programada para esta APP al 2026 es de \$5,758,179,432.20, I.V.A. incluido. No obstante, cuando se analizan cada una de las cantidades de inversión, la tasa interna de retorno

(TIR) se reduce una respecto a la otra. Por razones de confidencialidad no se autorizó publicar la ficha técnica correspondiente.

Tabla 8. Comparativo de información pública en el D.O.F. y la interna de la SCT

AÑO P.E.F.	Pagos anuales al Desarrollador – Datos SCT Inversión: \$5,758,179,434.20	Montos de Inversión Anual Reportados en el P.E.F Inversión: \$3,397,605,443.69	DIFERENCIA
2016	\$7,375,641.40	\$323,300,000.00	-\$315,924,358.60
2017	\$246,515,088.31	\$800,200,000.00	-\$553,684,911.69
2018	\$558,032,912.81	\$733,700,000.00	-\$175,667,087.19
2019	\$739,326,546.76	\$-	\$739,326,546.76
TOTALES	\$1,551,250,189.28	\$1,857,200,000.00	-\$305,949,810.72

Fuente: D.O.F y archivos de la SCT. Elaboración propia.

Cálculos con la Información de los PEF publicada en D.O.F.

El objetivo es analizar las dos informaciones recabadas para ver si la decisión del Gobierno federal para este proyecto carretero impacta de forma positiva a los ciudadanos y transeúntes de esta vía ó por el contrario favorece únicamente al desarrollador. En una primera parte se abordará los resultados obtenidos con la información publicada en los PEF año con año en el DOF. Posteriormente, se realizó el análisis financiero y su rentabilidad mediante el cálculo del Valor Neto Actual (VNA) y la Tasa Interna de Retorno (TIR) para el 2016 al 2019 y Tasa de Rendimiento Inmediata (TRI) para el primer año. Tabla 9.

Tabla 9. Valor Actual Neto (VAN), Tasa Interna de Retorno (TIR) y Tasa de Rendimiento Inmediata (TRI) – PEF.

DATOS REPORTADOS EN EL PRESUPUESTO DE EGRESOS DE LA FEDERACIÓN			
AÑO	BENEFICIO	EGRESOS p.reales	FLUJO NETO
	Ahorro estimado	Gastos/inversiones	
Inversión Total			-\$3,397,605,443.69
2016	\$173,480,330.40	\$323,300,000.00	-\$149,819,669.60
2017	\$1,165,653,577.66	\$800,200,000.00	\$365,453,577.66
2018	\$1,299,146,620.71	\$733,700,000.00	\$565,446,620.71
2019	\$2,468,818,451.36	\$-	\$2,468,818,451.36
TOTALES	\$5,107,098,980.14	\$1,857,200,000.00	-\$147,706,463.55
Tasa de Dto. 10%			
VNA	-\$1,120,712,756.80		
TRI	-4%		
TIR	-1.18%		

Fuente: Elaboración basada en datos de los PEF en el DOF 2016, 2017, 2018, 2019

Finalmente se hace una corrida financiera para abordar los indicadores para el periodo del proyecto de inversión carretero en estudio. Tabla 10. Se calcula con el costo total de la inversión, según datos oficiales publicados y hasta la fecha del término del contrato bajo el esquema de APP, con el objetivo de ver la aportación en beneficios para los mexicanos y usuarios o a favor del desarrollador.

Tabla 10. VAN, TIR y TRI – Promedio de Pagos al 2026 con datos del PEF.

PROMEDIO DE PAGOS EN EL PRESUPUESTO DE EGRESOS DE LA FEDERACIÓN			
AÑO	BENEFICIO	EGRESOS p.reales	FLUJO NETO
	Ahorro estimado	Gastos / inversiones	
Inversión Total			-\$3,397,605,443.69
2016	\$173,480,330.40	\$323,300,000.00	-\$149,819,669.60
2017	\$1,165,653,577.66	\$800,200,000.00	\$365,453,577.66
2018	\$1,299,146,620.71	\$733,700,000.00	\$565,446,620.71
2019	\$2,468,818,451.36	\$-	\$2,468,818,451.36
2020	\$1,612,535,577.64	\$220,057,920.53	\$1,392,477,657.11
2021	\$1,612,535,577.64	\$220,057,920.53	\$1,392,477,657.11
2022	\$1,612,535,577.64	\$220,057,920.53	\$1,392,477,657.11
2023	\$1,612,535,577.64	\$220,057,920.53	\$1,392,477,657.11
2024	\$1,612,535,577.64	\$220,057,920.53	\$1,392,477,657.11
2025	\$1,612,535,577.64	\$220,057,920.53	\$1,392,477,657.11
2026	\$1,612,535,577.64	\$220,057,920.53	\$1,392,477,657.11
TOTALES	\$16,394,848,023.61	\$3,397,605,443.69	\$9,599,637,136.23
Tasa de Dto. 10%			
VNA	\$3,509,547,764.41		
TRI		-4%	
TIR		23.80%	

Fuente: Elaboración basada en datos de los PEF en el DOF 2016, 2017, 2018, 2019.

Los resultados obtenidos con la información oficial publicados, se puede concluir que este proyecto de inversión en obra pública carretera para los primeros tres años, arroja números negativos, por ser mayor la inversión o el presupuesto destinado respecto al beneficio social recibido para el número de vehículos que transitan este tramo, por otra parte se debe entender que los primeros años, son los que tiene el desarrollador para elevar a estándares de calidad estipulados, siendo estos años los primeros que absorben mayor inversión en el tramo carretero en estudio. Dentro de los cálculos realizados se concluye

que en el 2020 algunos indicadores propuestos empiezan a ser positivos, aunque el VAN es de -\$256,093,687.61, el TIR es del 7.91%. Para el 2021 el VAN es de \$529,923,648.01 y un TIR de 13.86%.

Con el transcurrir del tiempo para el término del proyecto, los resultados obtenidos demuestran ser positivos y confirman que esta obra beneficia a los ciudadanos, si se mira como una aportación que impulsa el tráfico libre de vehículos para intercambio comercial, turismo, mejoras en infraestructura carretera vista como un patrimonio nacional, paso obligado o simplemente como conector entre localidades.

Cálculos con la información de los Registros Internos de la Secretaría de Comunicaciones y Transporte SCT

A continuación, se relacionan los mismos cálculos, pero basados en la información archivada en la SCT. En la tabla 11, se observan los resultados para los primeros tres años. Tanto el VAN como el TIR son negativos y solo hasta el 2022 empiezan a mejorar para el desarrollador, con un TRI del 3.11%. Ver tabla 12.

En esta última tabla, se aprecia la corrida financiera para el total del tiempo convenido para el proyecto, donde los indicadores propuestos son aceptables y viables para la toma de decisión por parte del desarrollador R&M.

No obstante, cuando se analizan cada una de las cantidades de inversión, la TIR se reduce en los cálculos trabajados con la información interna de la SCT respecto a los datos con acceso público, pero ambas TIR están en un nivel aceptable. Por razones de confidencialidad no se autorizó publicar la ficha técnica correspondiente.

Tabla 11. VAN, TIR y TRI. Reporte de pagos del Desarrollador

DATOS CON PAGOS REALIZADOS AL DESARROLLADOR			
AÑO	BENEFICIOS	EGRESOS p.reales	FLUJO NETO
	Ahorro estimado	Gastos/inversiones	
Inversión Total			-\$5,758,179,434.20
2016	\$173,480,330.40	\$7,375,641.40	\$166,104,689.00
2017	\$1,165,653,577.66	\$246,515,088.31	\$919,138,489.35
2018	\$1,299,146,620.71	\$558,032,912.81	\$741,113,707.90
2019	\$2,468,818,451.36	\$739,326,546.76	\$1,729,491,904.60
TOTALES	\$5,107,098,980.14	\$1,551,250,189.28	-\$2,202,330,643.34
Tasa de Dto. 10%			
VNA	-\$3,109,480,645.54		
TRI		3%	
TIR		-13.98%	

Fuente: Elaboración basada en datos de la SCT- registro de pagos al Desarrollador

Tabla 12. VAN, TIR y TRI. Promedio de pagos al 2026 con datos del Desarrollador.

PROMEDIO DE PAGOS REALIZADOS AL DESARROLLADOR			
AÑO	BENEFICIOS	EGRESOS p.reales	FLUJO NETO
	Ahorro estimado	Gastos/inversiones	
Inversión Total			-\$5,758,179,434.20
2016	\$173,480,330.40	\$7,375,641.40	\$166,104,689.00
2017	\$1,165,653,577.66	\$246,515,088.31	\$919,138,489.35
2018	\$1,299,146,620.71	\$558,032,912.81	\$741,113,707.90
2019	\$2,468,818,451.36	\$739,326,546.76	\$1,729,491,904.60
2020	\$1,612,535,577.64	\$600,989,892.13	\$1,011,545,685.51
2021	\$1,612,535,577.64	\$600,989,892.13	\$1,011,545,685.51
2022	\$1,612,535,577.64	\$600,989,892.13	\$1,011,545,685.51
2023	\$1,612,535,577.64	\$600,989,892.13	\$1,011,545,685.51
2024	\$1,612,535,577.64	\$600,989,892.13	\$1,011,545,685.51
2025	\$1,612,535,577.64	\$600,989,892.13	\$1,011,545,685.51
2026	\$1,612,535,577.64	\$600,989,892.13	\$1,011,545,685.51
TOTALES	\$16,394,848,023.61	\$5,758,179,434.20	\$4,878,489,155.21
Tasa de Dto. 10%			
VNA	\$254,106,575.46		
TRI		3%	
TIR		10.86%	

Fuente: Elaboración basada en datos del Desarrollador

Discusión

Dentro de la red vial general los corredores libres de peaje significan un patrimonio de gran importancia para ser conservados en buen estado físico (ASF, 2018). En México, la red federal carretera tiene en funcionamiento más de 30 años, y su operación es base fundamental para la actividad económica al movilizarse un 98% de pasajeros y un 55% en carga a lo largo y ancho del país.

Entre los objetivos que se pretenden atender a través de la APP Querétaro - San Luis Potosí se encuentra la conservación y mantenimiento, además, del cumplimiento de los estándares de desempeño y calidad para atender y satisfacer necesidades de los usuarios carreteros, llevar bienestar a las comunidades aledañas, facilidad de tránsito, reducción de costos de transacción de tiempo y logística, preservar el patrimonio federal de la red vial libre de peajes, activar la economía, entre otros.

La carretera libre examinada, permitió estipular ingresos aproximados en comparación con la autopista México – Querétaro para identificar la viabilidad y rentabilidad del proyecto, tanto para el sector privado como público. En el primer caso, se determina que la inversión puede ser justificada ya que, los indicadores financieros obtenidos demuestran que los pagos realizados por la Federación son financieramente rentables y viables para cubrir los gastos operativos y financieros, por lo tanto es positivo para el desarrollador; además, los porcentajes de vehículos que se movilizan diariamente se están incrementando anualmente según los datos oficiales, y con ello, seguramente el porcentaje de TIR, entre otros.

En cuanto al sector público, el correcto manejo que se le dé a los bienes públicos tenderá a impulsar grandes beneficios y valor social al existir una economía de mercado solidaria (Hernández, 2010). El sector del transporte es un asunto primordial para las políticas públicas como impulso para desarrollar la infraestructura vial dentro del territorio nacional. El materializar los estudios dedicados al transporte principalmente los dedicados a las políticas públicas adoptan este sector como objetivo primordial en su desarrollo. Rangel (2015).

Las inversiones público privadas presentan una amplia discusión sobre los beneficios y no beneficios que puedan generar en la sociedad dependiendo de la visión de corto, mediano y largo plazo. Por un lado, estas acciones generan nuevas fuentes de ingresos para el Estado pero también nuevas oportunidades para el sector financiero nacional e internacional, asimismo, también puede considerarse como un apoyo al Estado mexicano para incrementar su capacidad y mejorar la supervisión e infraestructura carretera en el país en el corto plazo.

Existen segmentos carreteros donde se presenta una gran afluencia de vehículos de automóviles y autobuses donde se beneficia una gran cantidad de la población, a diferencia de otros tramos carreteros donde la mayor afluencia se encuentran los camiones y tractocamiones que transportan materias primas y generan interconectabilidad entre la industria y comercio nacional e internacional. De esta forma, se evidencia que existe una diferenciación particularizada sobre el valor social y económico, los actores y beneficiarios aunque las externalidades sean positivas particularmente en puntos estratégicos de la carretera en estudio.

Los resultados permiten confirmar que la decisión del Gobierno federal para invertir en este tramo carretero de libre acceso bajo el esquema de APP, resulta un beneficio al

materializarse en un ahorro económico para los usuarios de esta vía. Dentro de las observaciones positivas para esta inversión, fue incluirla en el esquema de APP para garantizar el disfrute de vías elevadas a estándares de calidad, reducción de tiempo, acceso a diferentes direcciones del país, impulso comercial por ser atractivo contar con vías terrestres en buenas condiciones entre localidades, estados, en todo el territorio nacional y conexión internacional, principalmente con Estados Unidos, por ser parte primordial del corredor que conecta a la Ciudad de México con este país vecino del norte. Igualmente, por tener una continuidad de calidad desde la autopista México – Querétaro para continuar la ruta en la libre federal Querétaro – San Luis Potosí.

Conclusiones

Sin duda, se puede señalar que la nueva conformación en las inversiones hacia las carreteras en México mediante las APP representan un verdadero reto tanto para las empresas privadas como para el Estado mexicano; además, resulta fundamental establecer mayor transparencia en la información pública oficial, sobre todo, cuando es necesaria para ampliar otros estudios con datos oficiales, como por ejemplo, sobre el número de vehículos que transitan por cada uno de los tramos concesionados y, así como, de sus inversiones particulares para realizar un análisis más profundo y localizado según el territorio y tramo.

El Estado mexicano transfiere inversiones importantes hacia la sociedad generando externalidades positivas debido a que no existe un costo de peaje (de ninguna clasificación) a lo largo y ancho del tramo en estudio bajo el esquema de APP. Sin embargo, las inversiones que se generan son de gran relevancia e importancia dentro del PEF aunado con los recursos e inversiones privadas. Por ello, se insiste en la importancia de generar estudios de evaluación de impacto social y económica que legitimen las grandes inversiones que realiza el Estado mexicano con recursos públicos bajo el esquema de APP. Así mismo se considera de gran relevancia que la sociedad pueda tener mejor acceso a la información y esté al alcance, sobretodo, de los trabajos e inversiones que realiza el estado a favor del sistema carretero con el propósito de incrementar su legitimidad en la población.

El estudio costo/beneficio desarrollado demuestra como pese a no existir cobros de peaje en la APP y generar (obtener) ingresos de forma potencial en el tramo en estudio, se logró realizar un análisis que demuestra cómo la movilidad de los usuarios representan

una opción alterna de base para establecer una relación de Análisis costo - beneficio y alcanzar el desarrollo del objetivo propuesto.

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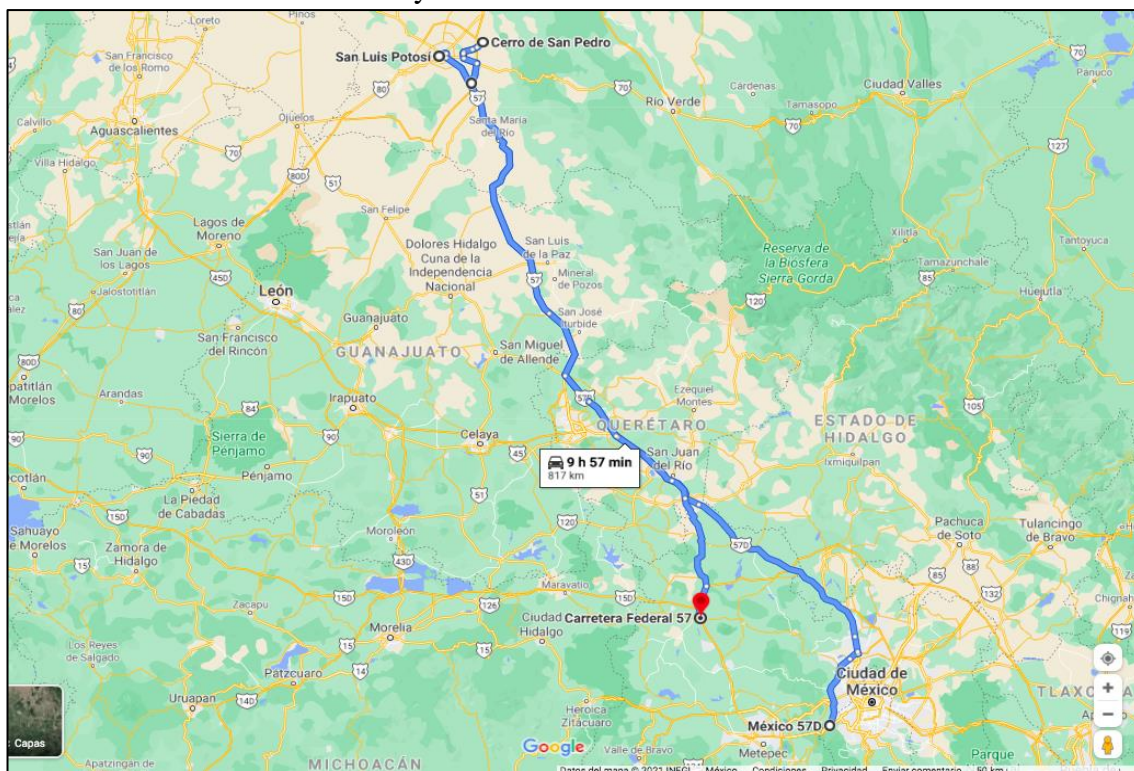
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Anexo 1. Carreteras Federal 57 y 57D desde CDMX a San Luis Potosí.



Fuente: INEGI (2021). Google map Elaboración propia.

Capítulo 4. Public Value Determinants in PPP Contracts. Application to Guadalajara Light Rail Line 4 (Determinantes del Valor Público en los Contratos APP. Aplicación a la Línea 4 del Tren Ligero de Guadalajara)

Public Value Determinants in PPP Contracts. Application to Guadalajara Light Rail Line 4 (Determinantes del Valor Público en los Contratos APP. Aplicación a la Línea 4 del Tren Ligero de Guadalajara)

“Case Studies on Transport Policy”

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Abstract:

Robust governance paradigm proposes new collaborative governance strategies, combining the stability of the public bureaucratic model and the adaptability of networked governance, based on hybrid forms of governance, to provide effective delivery of public value to citizens. The objective of this paper is to identify the key variables that currently define public value in PPP initiatives in developing economies. The study is focused on a light rail project, using the MICMAC methodology. The results show that these types of projects follow the social cost-benefit logic, and the public value is measured by the service they will provide to the community.

Keywords: public-private partnership, public value, light rail, infrastructures, mobility

Introduction

During the last decades of the 20th century, the public sector was subjected to transformations to enhance its efficiency and accountability in public service delivery. In the 90s, Hood (1995), Gray and Jenkins (1995), Olsen and Peters (1996) and other academics described the main features of the transformations brought about in the framework of the named New Public Management (NPM) doctrine in which the bureaucratic public administration model was strongly criticized. The majority of public sector reforms had the aim of introducing market mechanisms and outsourcing of public service delivery as a means of improving its governance and control.

The provision of government services by contractors was one of the most significant NPM recipes. The prevailing view was that public services would be provided by public-private partnerships (PPPs) with greater client satisfaction, efficiency and effectiveness,

in a more market-oriented environment which provides greater flexibility for management decision-making (Pina and Torres 2004, 2003). Nevertheless, these authors also concluded that private management of urban local public transport is not more efficient than public management (Pina and Torres, 2001).

Under PPPs, the public sector contracts services on a long-term basis so as to take advantage of private sector management skills and transfer the financial risk. However, in the framework of PPPs, although responsibility for many elements of service delivery may be transferred to the private sector, the public sector remains responsible for: deciding on the level of services that are required and the public sector resources which are available to pay for them. Likewise, it is responsible for setting and monitoring safety, quality and performance standards for those services, and enforcing those standards, taking appropriate action if they are not delivered.

According to Pina et al. (2017), in the early 21st century, there was a feeling among the citizenry that ‘managerialism’ had widened the distance between government and citizens instead of bringing them closer and that there had been a decline of public trust in government¹ (Welch et al., 2004). This loss of citizens’ trust in governments brought about the recognition of the limits of traditional forms of top-down government. Although interaction between public and private actors remains playing a crucial role in policy implementation, networks and informal partnerships under the New Public Governance (NPG) doctrine (Osborne, 2006) were increasingly perceived as an effective and legitimate mode of governance. However, the transaction costs are high in governance networks, because networks are often informal and unstable and the actors’ interdependence can increase the risk of failure Torres et. al. (2023).

Ansell, Sorensen and Torfing, (2022) agree with the NPG approach that large bureaucratic governmental systems have difficulties in adapting themselves to changing circumstances in a timely manner, because planning is central to bureaucracies and that requires time. Therefore, they propose new collaborative governance strategies, combining the stability of public bureaucracy and the adaptability of network governance

¹ Although there is little agreement in the literature about how to define citizen trust in government or how it is gained and lost, most writers agree that it is an important determinant of public action and cooperation (Ruscio, 1996; Welch, Hinnant and Moon, 2005).

in hybrid forms of governance, to provide reliable and effective delivery of public value to citizens².

In accordance with Chesney et al. (2020), hybrid forms of network governance that involve public and private actors can take the form of different types of partnerships, one of them is the collaboration of public partners and private companies in contractual arrangements which are legally enforceable and thus generates legal ties between the partners (especially in relation to the output that the contract partners want to achieve). However, a key difference between the PPPs view of 80s and 90s under the NPM doctrine and those based on new collaborative governance approaches is the need to involve also other stakeholders such as politicians, public managers and employees, experts and professional associations, private firms, civil society organizations, citizens and service users, during the process of designing, producing and delivering of public services to strengthen the focus on the creation of public value.

The objective of this paper is to identify the key variables or factors that currently define the public value in PPP initiatives in developing economies that are highly dependent on these forms of collaboration, because they consider this type of collaboration as a financial alternative to address social needs in infrastructure and public service management. These initiatives can be carried out on the basis of the cost-benefit analysis and financial viability following the last century NPM doctrine or inspired by collaborative governance approaches involving other stakeholders that contribute to improving the public value that these projects bring to the social and economic environment in which they are developed. The multi-actor collaboration stimulates innovation, because interaction dynamics create synergy and learning processes which might generate new ideas (Torfing 2019).

This paper focuses on a case study analysis of a public-private rail infrastructure investment partnership, the light rail line 4 in Guadalajara, an initiative that is currently viewed with great expectation as a substitute for the polluting effects of automobile transport. Notwithstanding, this infrastructure is a controversial project that has received both criticism and praise. We analyze this public-private investment project to identify

² The Robust European Union (EU) project (<http://robust-crisis-governance.eu>) states that robustness is conditioned on three independent variables: interactivity between layers of public administrations (EU, Central and Sub-central governments), hybridity, and negotiation between different public and private actor and sectors of society.

the key variables driving the project, through interviews and discussions with experts, to categorize the variables with the highest degree of influence on the project and the dependence between them, using the structural analysis provided by Matrix-based Multiplication Applied to a Classification (MICMAC). The results will show to what extent the creation of public value for users and their communities has been taken into account or whether, on the contrary, financial and cost-benefit aspects, typical of a view of PPPs already outdated in developed economies, have taken the precedence.

The contribution expected of PPPs in developing countries.

The main purpose of PPPs in the 21st century is not only to save costs as in the 20th century, but also to create public value by using the knowledge and skills of private sector to innovate in public service delivery to better meet citizens' needs. For Chesney et al. (2022), long-term collaboration of governments with the private sector is often beneficial, as private partners are able to introduce new knowledge and resources into infrastructure projects.

Torfining (2019) refers to a study by Roberts (2000) that compares hierarchical, competitive and collaborative strategies and concludes that multi-actor collaboration is superior to both hierarchy and competition when it comes to developing and implementing innovative solutions. This is due to collaborative strategies that facilitate the exchange of knowledge, competences and ideas between relevant and affected actors and thus stimulate processes of mutual learning that may improve the understanding of the problem or challenge at hand and extend the range of creative ideas about how to solve it.

The participants in collaborative innovation are public and private actors that either have relevant knowledge, ideas and resources or are affected by the problem or the innovative solution and, therefore should be included in order to ensure that the problem is properly understood and addressed and the solution is feasible (Torfining, 2019). From the perspective of collaborative innovation literature, PPPs are a mode of collaborative governance (Brogaard 2017). However, for PPP arrangements to use forms of collaborative governance rather than traditional forms of top-down governance, developing countries need to strengthen their legal frameworks to develop clear and well-defined public policies that address in a balanced and fair way economic growth and development, borrowing capacity, and the allocation of economic resources to cover other

budget needs at all levels of government (federal, regional and municipal). As Summar (2020) points out, PPPs are the result of the shortcomings of traditional public infrastructures to solve social problems (and generate public value) and a profitable opportunity for investors to participate in public works and services.

Economic and political alliances between geographically close Latin-American countries have also allowed the development of different sectors to be promoted, integrating private capital to take advantage of their financial capacity, experience, knowledge, guarantees and cost reductions. These alliances are born between countries or companies with financial capacity and those governments that, given their limited development, cannot afford short-term indebtedness or the construction of million-dollar projects. The participation of private capital aims to guarantee efficiency, quality and adequate management of expenditure, arguing that it better manages them than the public sector, resulting the PPPs being a way to optimize goods and services under the neoliberal model (Mendoza, J. E., 2017).

The literature sometimes highlights negative and discouraging comments on the results obtained by promoting projects through PPPs, often in cases where they adopt top-down governance rather than collaborative network governance forms. A more in-depth analysis is needed, including the vision of other actors, when governments decide on aspects such as indebtedness, risk distribution, links with corruption issues and lack of transparency, security, environmental impacts, viability of the work, and benefits for the inhabitants in the development areas, among others.

In Mexico the contracting, execution and maintenance, and all issues related to PPPs, are contained and regulated by article 134 of the Constitution, the Public-Private Partnerships Law (LAPP) of 16 January 2012, and the Regulations of the Public-Private Partnerships Law (RLAPP) of 5 November 2012. The Guadalajara Metropolitan Area (GMA) comprises the municipalities of Guadalajara, Zapopan, Tonalá, Tlaquepaque and Tlajomulco and the construction of Line 4 of the Guadalajara Light Railway (L4TLG) arises as a project to address the mobility needs of the Southern Zone (Tlaquepaque and Tlajomulco).

Literature Review Public-Private Partnerships in Light Railways

The resources allocated to infrastructure to strengthen transport and means of communication such as roads, railways, airports, maritime platforms, among others, generate not only an economic, but also a social, political and cultural impact, which favours the financial stability of a country. Saruchera (2017) notes that in developed and developing countries, the mobility of people and goods contributes to economic momentum and social progress, confirming that rail freight transport is of paramount importance due to the benefits it provides, including massive freight, fuel efficiency and environmental friendliness.

LRT is key to create connections between cities, regions or countries for economic and social growth. Li and Love (2022) argue that it is not always possible to carry out the construction and management of an LRT due to fiscal and budgetary constraints, public deficit and indebtedness capacity, so governments all over the world have chosen to seek financing through PPP. Nevertheless, the analysis of LRT does not have to be narrowed down to financial aspects, but to embrace a wider economic view of the impact of these investments, as Knowles and Ferbrache (2016) state. In this respect, Fageda (2021), notes that railway investments have a very high construction and maintenance cost compared to road transport. However, if a comprehensive and complete social evaluation were carried out, it would justify their implementation due to the reduction of negative factors produced by vehicular traffic, such as decongestion, reduced travel time and much less contamination and noise pollution. It concludes that LRT systems in European cities are useful and sustainable for urban mobility, considering the size of the cities and the design foreseen according to the number of passengers and their annual growth.

Smith and Gannon (2008), note that the UK is known to be a leading proponent of PPP to deliver public service by means of its domestic Private Finance Initiative (renamed as Private Finance 2). UK's experience covers nearly 700 projects categorised in sectors, such as, health, education, roads or housing, with a total capital value of \$68bn between 1999 and 2021 (HM Treasury, 2023). It is in the UK where PPP were born according to their current conceptualisation, and it is there where we can observe the results of works that can set a benchmark of failures to avoid and even highlight successes to ensure. Focusing in LRT, UK's projects have been developed by means of PPP: seven projects have been built and, although all are publicly owned, five were set up through Design,

Build, Operate and Maintain (DBOM) contracts and one subsequently franchised to a private operator (Knowles, 2007). The passengers transported by light rails have more than doubled in three decades (DfT, 2023). The Manchester Metrolink is an example of success with three expansions in this period of time (Winch and Msulwa, 2019) and multiplying its passengers by five. At the opposite end, in 2007, the companies set up to modernise London Underground went into administration when they became unable to meet their financial spending obligations. As a result, the Department for Transport made a grant of \$2.1 bn available to London Underground to assume the payment of the debt (NAO, 2009).

Spain is another world leader developer country of PPPs. According to Carpintero and Barcham (2012), in Spain there is a trend to incorporate trams or light rail transport (LRT) to solve problems of congestion, sustainable mobility, social and environmental friendliness, the latter being a transcendental issue on the global environmental agenda. This transport system has been developed to cover distances between 10 and 40 kilometres. Although LRT as a means of transport has different characteristics in terms of infrastructure and the way it operates, they all contribute to improving the quality of life in metropolitan areas. In Spain, thirteen LRT projects have been set up, nine out of them have been developed by means of a PPP arrangement. Martín et al. (2014) state that funding is mostly private in the majority of Spanish LRT PPP projects with a higher cost per kilometre, whereas cheaper LRT projects were mainly funded by public administration, so it is concluded that governments resort to private finance for more expensive projects.

Although PPP can be an answer to many social problems, unfortunately they are sometimes implemented by governments in conditions that are adverse to the objective that they represent owing to their nature, as they are influenced by political interests. Carpintero and Petersen (2014) conclude that there are few studies dedicated to the ex-ante analysis of LRT PPP projects, some of which show that PPP do not always guarantee lower costs, less risk for the public sector, doubtful economic efficiency and benefits for taxpayers compared to traditional financing. This is due, in part, to the intervention of interests and political opportunism in the selection of projects, omitting objective analyses of the profitability of these public works. Carpintero and Siemiatycki (2016) conduct a case study of light rail in two big Spanish cities (Zaragoza and Murcia). Each

city is governed by opposing political parties, socialist and conservative, respectively, and both projects were born in a period of austerity in the Spanish financial system. Nevertheless, in both cases, they conclude that political decisions have shaped the course of these projects.

The Netherlands is a country with a long-tradition of promoting means of public transport environment friendly and sustainable mobility, that has also developed fifteen LRT PPP projects at national level. De Bruijn and Veneeman, (2009), conclude that the decision-making was not nearly as swift as expected and not in line with the promise. Out of Europe, we find studies on experiences in Australia (Mwakabole et al., 2019; Zhang, 2022), Canada (Sietmatycki, 2006), or the USA (Zimmy-Schmitt and Goetz, 2020).

Formal studies and research on the LRT system as a means of transport for passengers and freight focus mostly on developed countries, but there are also initiatives in developing countries. Asia, the continent with some 60% of world population, is a field in which we find a place for the analysis of LRT PPP projects from several perspectives throughout Asian cities: the institutional context and different stages of the projects carried out in Bangkok, Kuala Lumpur, Manila and Singapore (Bray and Sayeg, 2013); planification and financing in Turkish cities (Alpkokin et al, 2016); factors that affect the outcomes of PPPs at the local level in Korean cities (Bae and Sayeg, 2016); farebox and land value capture issues in Tokyo, Hong-Kong, Singapore and Beijing (Chang and Phang, 2017); unbundling of project stages in Yakarta (Zetha, 2019); factors that contribute to ridership in Toyama (Japan) (Ito and Kawazoe, 2022); conceptual model to assist policy-makers with the procurement of rail infrastructure based on the case study of Delhi (Li and Love, 2022).

In South America there are no significant projects of LRT that been developed by means of PPP and Africa although it is the continent that is less developed (there is not a single country from there within the first 100 top positions of the Human Development Index of the United Nations), but we also find examples of LRT in South Africa (Fombad, 2015) and Namibia (Saruchera, 2017).

Guadalajara Light Rail Line 4 (L4TLG)

The metropolitan rail public transport system, as urban mass transport in the Guadalajara Metropolitan Area (GMA), currently consists of three lines and is operated by the Urban Electric Train System. These three train lines are not enough to address the mobility problem in the Southern Zone of the GMA, so the current State government is promoting a Tren-Tram type mass transport system, a rail transport system that will bring the Central zone of the GMA closer to the urban areas of the municipalities of Tlajomulco de Zúñiga and Tlaquepaque. Given the population increase and the scarce road structure, there is a delay in the attention to the public transport user population, mainly in the periphery of the Southern zone of the GMA. This new Line 4 will follow a route parallel to Via 1 Manzanillo, operated by Ferrocarril Mexicano S.A. (FERROMEX), with a concession of the right of way. It will cross the municipalities of Tlaquepaque and Tlajomulco to the Metropolitan Circuit and will connect the current Urban Electric Transport System with the Rapid Transport System (BRT), known as Macrobus, which has no direct connection with the electric road network system of Lines 1, 2 and 3. Given that this section will have mobility interaction with motorised and non-motorised vehicles, operational efficiency and service must be guaranteed for this work prior to the construction of this million-dollar infrastructure called "Urban-Railway Coexistence". The trajectory of this route will be through some uninhabited areas.

The participation by the State of Jalisco will not generate new debts and will be absorbed by the ordinary budget of 2022, 2023 and 2024.

Regarding the "social fare model" proposed for this project, although it was initially proposed that there would be no increase in the public price of \$9.50 MXN (El Informador, 2022), the new Law of Mobility, Road Safety and Transport of 15 October 2022, proposes the revision of public transport fares and incorporates the Support Fund for Users, with the aim of addressing the economic impacts that may arise from an increase in the price of the service (Congress of the State of Jalisco, 2022).

Table 1. L4TLG Project Information³

Financing scheme	Federal government of Mexico through the National Infrastructure Fund (FONADIN)	\$2 millions
	State Government of Jalisco (regular budget 2023, 24 and 25)	\$2 millions
	Private initiative	\$5.725 millions
Total investment S/I		\$9.725 millions
Internal Rate of Return		17.36%
Immediate Internal Rate of Return		20.34%
Developer	Mota Engil – Corporativo portugues	
Grant	\$600 millions/year.	
Time concession	(2 years of construction and 36 years of operation and return on investment). Current contracts do not exceed 35 years.	
Developer	Mota Engil – Corporativo español	
Model	Design, planning, construction, equipment and operation	
Beginning of works	May 2022	
Completion of works	March 2024	
Mobility	One hundred thousand passengers per day are expected. It will operate parallel to the Via 1 Manzanillo line used by FERROMEX. It will benefit 275,000 people living in a surrounding area of one kilometre. Two carriages with a capacity of 300 passengers per trip. It will move approximately 106,000 users per day.	
Public price	There will be no increase as long as the "social tariff model" exists. 9.50 pesos.	
Length	20.80 km	
Travel time	40 minutes	
Commercial speed	34 – 40 km/h	
Operator:	UETS (Urban Electric Train System)	
Stations	8 stations	

Source: State of Jalisco (2020). El Informador (2022). <https://www.informador.mx/jalisco/Linea-4-Estas-son-las-estaciones-y-el-recorrido-que-hara-el-Tren-Ligero-a-Tlajomulco-MAPA-20220524-0111.html>

Methodology

Prospective studies, based on the opinion of experts, have been gaining relevance in companies, governments and world organizations, for decision making and strategy definition. Since the 1990s, governments have begun to allocate resources to studies based on expert opinion and knowledge. The OECD defines prospective as "systematic

³ Information on financial data and the project in general were obtained from the "Análisis costo-beneficio modelo integral de movilidad de la zona sur del área metropolitana de Guadalajara (Línea 4)" of August 2020 (currently no longer available online).

attempts to take a long-term view of the future of science, technology, the economy and society, with the aim of identifying emerging technologies that are likely to produce the greatest economic and social benefits". Cortezo, J. R. (2001).

Prospective methodologies are used to expand the vision of a study or to detect key elements for decision-making that at first glance are not considered to be related, overlooking essential points involved in the medium and long term. Structural analysis aims to simplify the key factors that make up a system, and to identify the relationship of variables that constitute and directly influence the studies (Molés, 1995) because, in order to make decisions in the constant change and evolution of the environment with different unpredictable trajectories, there are multiple factors that can be related to each other, making it necessary to simplify them.

The methodology used to determine the key components of the Guadalajara Light Rail Line 4 project is the structural analysis known as MICMAC. MICMAC is a methodological tool developed by M. Godet (1971), which facilitates the systematization and simplification of the possible relationships of variables within a system (Villegas and Alejandro, 2011). With the review of the literature and the participation of experts, the key variables are designed, which are subjected to a systematic procedure to identify the hierarchy, with the aim of classifying them according to their greatest influence and dependence, to conclude with the implications they would have for the project (Han, Zhu, Ke and Hippel, 2019).

The key variables, or factors that influence and generate dependencies in a project are included in vertical and horizontal axes by the experts (see footnote 4 on page 9), who assign a value between 0 and 3, where 0 represents a null relationship between variables, 1 a weak level of relationship, 2 a medium level and 3 a strong relationship. This analysis by the experts generates a direct influence/dependence matrix (Nematpour, Khodadadi and Rezaei. 2021). MICMAC offers among its results a framework with four categories of variables/factors in which the aspects of maximum influence, or impact of one variable on others, and of dependence, or subordination of one variable to the others, in a project are mainly identified (Villegas, Platas, Gallardo and Lopez, 2020; Dwivedi, Agrawal, Jhav and Mathiyazhagan, 2022). MICMAC allows comparing the superiority or hierarchy of variables.

The four quadrants defined by MICMAC, referring to the influence and dependence of some variables on others, classify their importance within the system or project. Quadrant I is known as the critical or "key variables" zone given its high influence and high dependence. It includes the elements that must be acted upon and monitored to ensure the integration of the whole system. Their high influence and high dependence makes them unstable and volatile due to constant changes both internally and in the project environment.

Quadrant II is the area of opportunity to act on quadrant I, given its high influence and low dependence. It includes "determinant variables" that can be considered as the prerequisite for the system to function. In quadrant III we find the "autonomous variables", which do not affect the development of the system. The variables/factors in quadrant IV are called "outcome variables" of the system because of their sensitivity to the "key variables", as they have high dependence and low influence.

The number of experts needed for using the MICMAC methodology can vary depending on the complexity of the problem being analyzed and the scope of the study. In general, the MICMAC methodology involves a group of experts who provide their judgments and opinions on a set of factors and their interrelationships. The experts can come from various backgrounds, such as academics, industry professionals, and policymakers, depending on the problem being analyzed. The number of experts needed can range from a minimum of three to a maximum of 20 or more, depending on the complexity of the problem and the scope of the study. However, a minimum of five experts is recommended to ensure a diverse range of opinions and to mitigate the risk of bias (Lebel, L., and Ozawa-Meida, L., 2014; Wang, X., & Gao, J., 2019; Nguyen, V. H., & Le, T. D., 2021). Several studies in highly-ranked journals have used the MICMAC methodology in their analyses using a proportion between variables to be introduced into the statistical model and the experts to validate the influence/dependence behaviour between these variables similar to the proportion that we have in our study (Ahmad et al., 2021; Jafari-Sadeghi, 2021; Rana et al., 2019; Yada and Barve, 2015). If we focus on studies that use MICMAC in the analysis of PPP, we find studies (Zhang et al., 2019; Zhang et al., 2022) with similar results in the key issue of the relationship between variables and experts, having a lower number number of experts (five) and a higher

number of variables (20 and 14, respectively), or even a much higher number of variables (48) (Han et al., 2019)

Fig. 1. Diagram of influence and dependence of variables or factors.

HIGH	influence	II) Determinant, contextual and regulating high influence low dependence	I) Key and target variables <div style="border: 1px solid red; border-radius: 50%; padding: 5px; display: inline-block;">high influence high dependence</div>
		LOW	III) Autonomous variables Secondary levers low influence low dependence
		dependence	
		LOW	HIGH

Source: Prepared by the authors, based on Villegas, Platas, Gallardo, López (2020).

It is important to note that the quality of the results obtained from the MICMAC methodology is heavily dependent on the selection of experts and the quality of their input. Therefore, it is essential to carefully select experts who have the necessary knowledge and expertise to provide valuable insights and to ensure that the process is transparent and well-documented. The analysis of the variables in this study has been carried out through the collaboration of eight experts knowledgeable on the subject, in online and semi-presential sessions⁴. The two methodological phases applied in this study are described below.

⁴ **Expert 1** is a Master and former Director General of the Secretariat of Communications and Transport (SCT) of Jalisco, and is currently a consultant and advisor on infrastructure and public works for the state of Jalisco; **Expert 2** is a Doctor and former Director General of Management and Promotion of Infrastructure (SIOP) and is currently CEO of a company dedicated to consultancy for municipal, state and federal public services in PPPs in Jalisco and other states; **Expert 3** is PhD and Research Professor at the University of Guadalajara in Innovation Management with prospective approaches and is among the highest levels of the National System of Researchers; **Expert 4** is PhD and Researcher at the Centre for Research and Assistance in Technology and Design of the State of Jalisco - CIATEJ; **Expert 5** is PhD, Research Professor at the University of Guadalajara in urban mobility, transport and territory and has conducted studies focused on the AMG; **Expert 6** is PhD, Research Professor at the University of Guadalajara in investment project evaluation, environmental accounting and sustainability, with a Scientific Relevance Award 2022, awarded by the Center for Social and Environmental Accounting Research (CSEAR) of the University of Saint Andrews, Scotland (UK) and introduced environmental aspects in the study; **Expert 7** is a Doctor, Research Professor

Phase 1. Data collection

In order to define and propose the key variables, the first phase of the methodology involves a literature review and an analysis of cases of public works under the PPP modality in the passenger transport sector to identify the characteristics of these infrastructures. The initial proposal of key variables was completed in the working sessions and meetings consulting the experts directly related to the subject, whose vision made it possible to define the strategic elements of this railway project. The key variables agreed represent major aspects to be taken into account in the development of the project for the L4TLG, in the opinion of the experts (see Table 2).

Phase 2. Development of the double-entry matrix of influence of the variables.

In this second phase, the eight experts, based on their opinion and experience answer the question how does the variable "row" (y) influence the variable "column" (x)?, and they rated the level or degree of influence that the variables on the horizontal axis (rows) have with respect to those on the vertical axis (columns). The number of interactions suggested by the software to achieve stability of the set of variables was 3. The information is cross-referenced between columns and rows.

At this stage, some different criteria -usual in any process of obtaining opinions- were observed among the experts, so it was necessary to reach a consensus in a joint discussion about the final score of each variable to obtain the relationship of the direct variables (Figure 2).

at the University of Guadalajara in the PPP research line (Specialisation in PPP at the Tecnológico de Monterrey); and **Expert 8** is a Doctor, Research Professor at the University of Camagüey in the Faculty of Economic Sciences, expert in prospective methodology, in sustainable management with a prospective approach.

Table 2. Key variables

No.	Name	Acronym	Description
1	Financial viability	FV	Availability of public resources budgeted and earmarked to guarantee compliance with the investor to ensure the quality of management, construction, maintenance and service provision for this work. Relationship between commitment to the developer and availability of public funds to sustain costs throughout the project.
2	Cost – Benefit to society	CBS	Evaluation of the project for operating costs against the benefits to society in terms of time savings, cost reduction in vehicle operation for users, logistical benefits.
3	Years of the project	YP	Duration of the financial commitment. This project is for 36 years.
4	Price to the public	PP	Prices are affordable to the public and these revenues guarantee the operation of the project to rule out the use of subsidy in contracts.
5	Annual Grant	AG	Decision in contracts to grant an annual subsidy of MXN 600 million to the investor, if the revenue from the number of users is not sufficient to cover costs. .
6	Security in the premises	SP	Application of regulations that address the safety of the facilities, wagons, stairs, elevators and in general the infrastructure that integrates the L4TLG.
7	Legal Viability	LV	Legal capacity of the parties, clarity of the legal and legal terms established within the current regulations that guarantee the commitments for the investor and the public sector.
8	Investor experience	IE	The investor's experience is sufficient to guarantee the success of this project.
9	Risk	R	Degree of security and guarantee for users, transit users and citizens in general, with respect to the investment of millions of dollars. Mobility parallel to the freight train.
10	Technology & Innovation	TI	It is a work with cutting edge technology and innovation, which guarantees attention to technical, design, safety and economic sustainability problems.
11	Functionality	F	L4TLG's physical, legal, social, environmental, service and overall characteristics work together, in a balanced way and can be adjusted to unexpected changes in order to ensure the project's implementation.
12	Capacity	Cap.	Capacity of trains used for L4TLG to meet user/passenger demand.
13	Connectivity	C	Full integration of the transport network of the GMA's electric train lines. Ease, speed and direct connection within the same infrastructure of lines 1, 2 and 3.
14	Route and Distance	R&D	Strategic points within the GMA. Length and key stops (dismissing the feasibility that the best option was a BRT and continuing the BRT to the Calzada. Length to be crossed by this line vs. satisfaction to shorten distances to reach strategic points.
15	Efficiency	E	Constant and sufficient departures of the L4 train to meet user demand.

Analysis of results

The categorization of the variables shown in the matrix of direct influence and indirect dependence allows the importance and role of each variable for the L4TLG project. The variables included in the matrix will be distributed in four quadrants, according to their influence and degree of dependence on the rest of the variables (see Figure 3).

Fig. 2. Matrix of direct influence and indirect dependence with expert and academic scores.

	1 : F.V.	2 : CBS	3 : YP	4 : PP	5 : AG	6 : SP	7 : LV	8 : IE	9 : R	10 : TI	11 : F	12 : Cap	13 : C	14 : R&D	15 : E.	16 : EI	17 : SI
1 : F.V.	0	3	3	3	3	2	2	2	3	2	2	2	2	3	2	2	2
2 : CBS	3	0	3	3	3	2	2	2	3	2	2	2	2	3	3	2	2
3 : YP	3	3	0	3	3	2	2	2	2	2	2	2	2	2	2	2	2
4 : PP	3	3	2	0	3	1	2	2	2	2	2	2	2	2	2	2	2
5 : AG	3	2	3	3	0	1	2	1	2	2	2	2	2	2	2	1	2
6 : SP	2	2	2	2	2	0	2	2	3	2	2	3	2	2	3	2	2
7 : LV	2	2	2	2	2	2	0	2	2	2	2	1	1	2	1	2	2
8 : IE	2	3	3	2	2	2	2	0	3	2	2	2	2	2	2	2	2
9 : R	2	3	2	2	2	3	3	3	0	2	2	2	2	2	2	2	2
10 : TI	2	2	2	2	2	2	2	3	2	0	2	2	2	2	2	2	2
11 : F	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2
12 : Cap	2	3	3	2	2	2	2	2	2	2	2	0	2	3	2	2	2
13 : C	2	3	2	2	2	2	2	2	2	2	2	2	0	2	3	2	2
14 : R&D	3	3	2	2	2	2	2	2	2	2	2	2	3	0	3	2	2
15 : E.	2	2	2	2	2	2	1	2	2	2	2	3	2	2	0	2	2
16 : EI	1	1	2	2	2	1	2	1	2	2	2	2	2	2	2	0	2
17 : SI	2	2	2	3	2	2	2	2	2	2	2	3	2	2	2	3	0

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Quadrant 1: key variables and target variables.

The group of key variables includes the most important variables of the L4TLG project according to the experts: 2 "cost-benefit to society", 1 "financial viability", 3 " years of the project", 9 "risk" and 14 " route and distance ". In the group of target variables, only 4 "price to the public" is found.

According to the experts, the key variables make it possible to propose strategies for their control and monitoring, because they represent a challenge to guarantee the functionality of the project. They must be adapting to possible changes. In this group, the "cost-benefit to society" variable stands out as having a high influence on the project and a high dependence from other variables, being located at the extreme point of the upper right-hand side, making it a vital challenge for the project.

The target variables are in the central part on the right in the map of influence and dependence. They are highly dependent and moderately influential. They are treated as targets since they can be influenced, so that their evolution is as expected. This is the case of the variable "prices to the public", which aims at affordable prices for the user.

Quadrant 2: determinant, contextual and regulating variables.

The determinant variables are located in the upper left zone with high influence and low dependence. In our study no variable is located in this group.

The contextual variables are in the middle zone on the left-hand side of the map of influence and dependence. Four variables are in this group: 6 "security in the premises" with no dependence and medium influence, and 13 "connectivity", 16 "social impact" and 8 "investor experience", which represent and complement the added value in terms of public value of the project.

The regulating variables are in the central zone of the map of influence and dependence and become a gateway to achieving compliance with the key variables. They determine how well the system functions under normal conditions. It is suggested that these variables be evaluated consistently and periodically. This group includes the variable 12 "capacity" of the trains to meet demand. Therefore, this variable is also important in terms of the public value generated by the project.

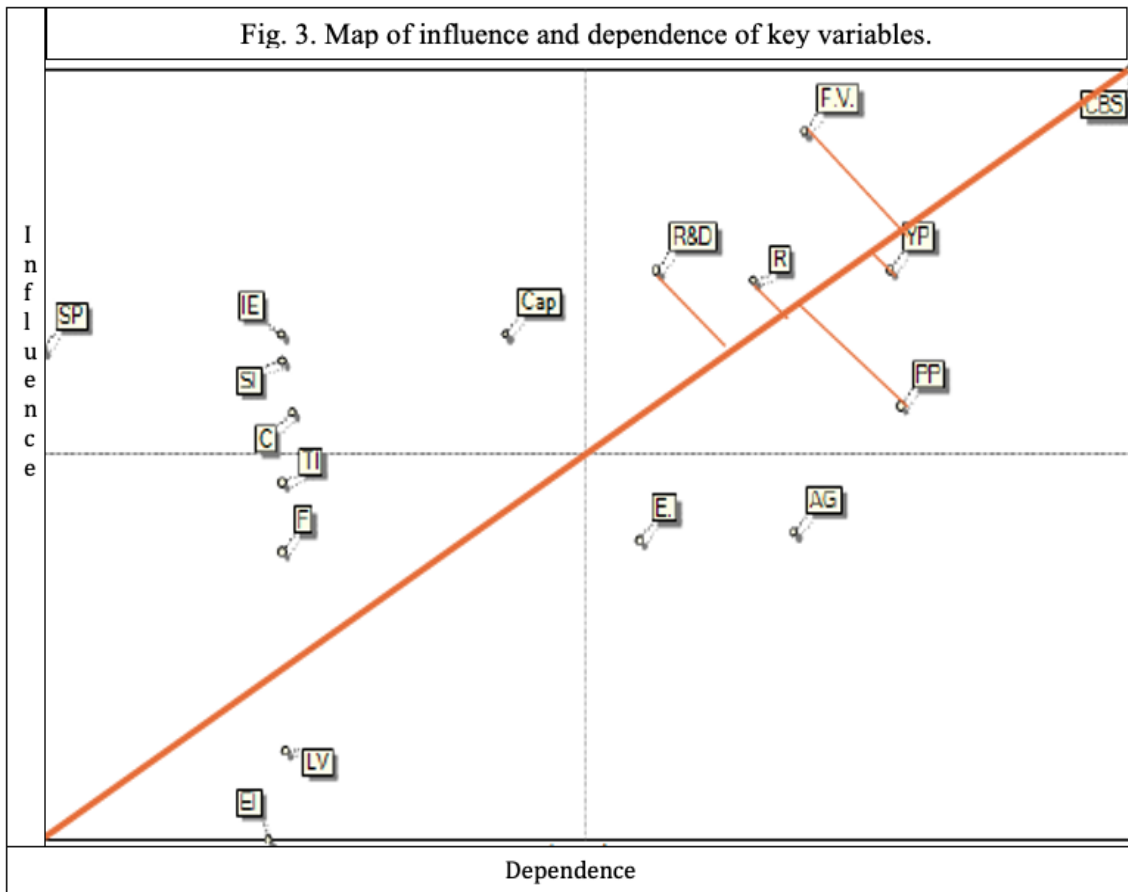
Quadrant 3: autonomous variables and secondary levers.

Autonomous variables, due to their low influence and dependence, are variables that have little influence and are not determinant for the development of the project. Within this quadrant are the variables 10 "technology and innovation", 11 "functionality", 7 "legal viability" and 16 "environmental impact". In this group, it is noticeable how little weight is given to concepts such as technology & innovation and the environmental impact of the project.

The group of secondary levers is located in the upper right-hand side of this quadrant and includes variables that are complementary to the regulatory variables and can affect the key variables. In this study, no variable is located in this area.

Quadrant 4: outcome variables.

These variables are in the lower right-hand area of the map of influence and dependence. Therefore, they are variables that are defined by their low influence and high dependence. Together with the target variables they indicate the evolution of the project. They are variables that depend on the rest of variables of the project. These variables require close monitoring to verify the effectiveness of the overall project in terms of public value. The variables 5 "annual grant" and 15 "efficiency" are in this quadrant.



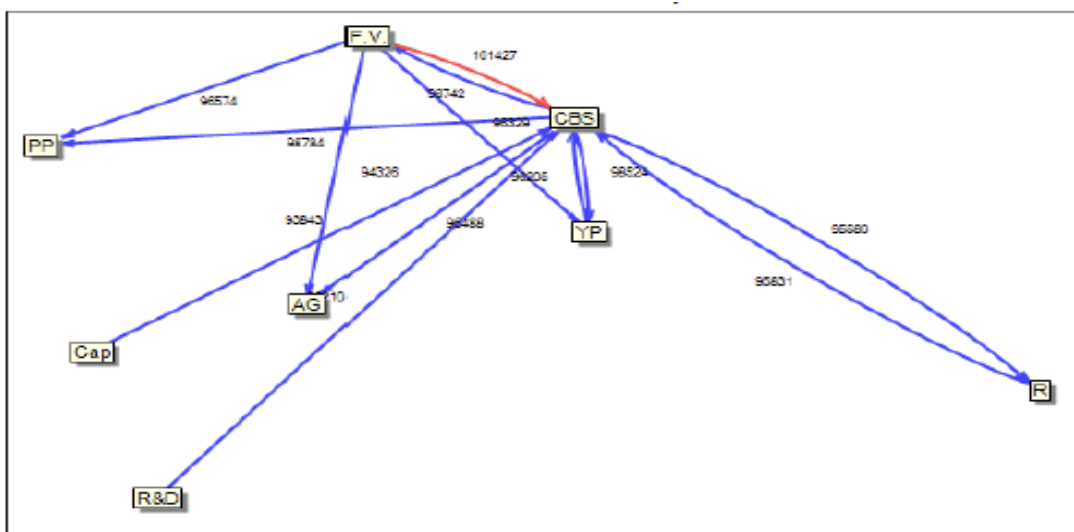
The results also show the potential relationships among all the variables analyzed, that have the most relevance for the future of this project. This analysis is taken with a 5% to 10% visualization to indicate the main relationships with representative or important influences. Graphs 4 A and B show influence-dependence relationships between variables at 5% and 10% respectively. As can be seen, in both graphs the variable cost-benefit to society is in a central position. This variable represents operating costs versus the benefits to society in terms of time savings, cost reduction in vehicle operation for users and

logistic benefits. Therefore, the benefit is represented in terms of public value for users, which indicates a effective project design as proposed by the Robust governance approach that encourages network collaboration between public and private entities to improve the public value contribution of public projects and policies.

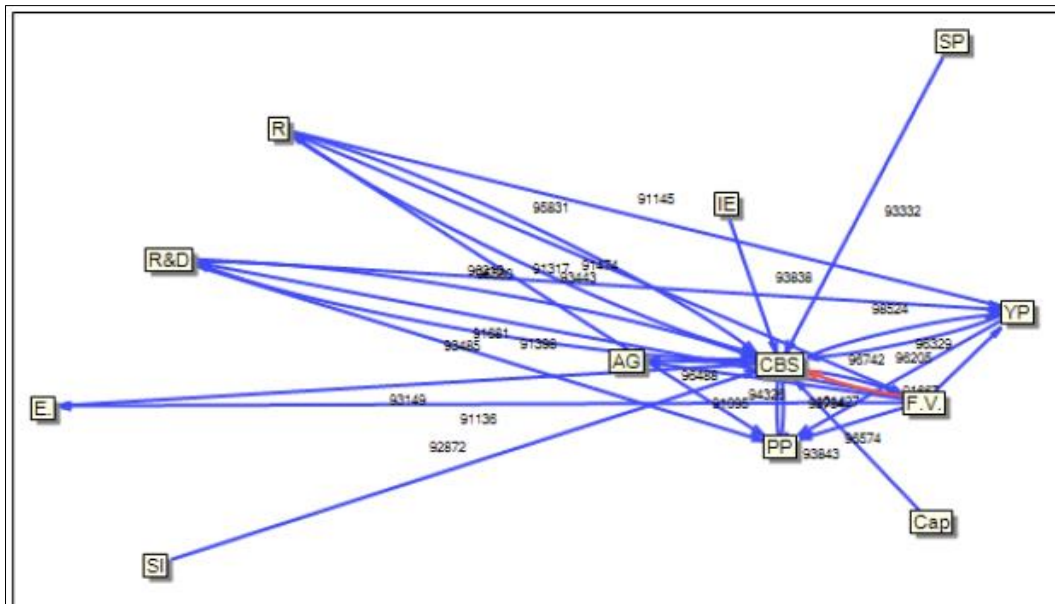
This “cost-benefit to society” variable on which the whole network of influences-dependencies pivots is influenced by most of the other variables, as would be expected. Among them, the financial viability variable stands out, i.e. the budgeting of the necessary resources, so that the project can be developed in a sustainable way for the private partner. Other variables that influence the “cost-benefit to society” variable are the capacity of trains to meet demand variable and the R&D variable (extension and key stops, line length and satisfaction to shorten distances). These relationships represent a first approximation of the essential components of public value for the experts in terms of satisfaction of social needs.

Together with the above-mentioned variables, Graph 4A identifies other variables that are influenced but also influenced by CBS. This is the case of the variables “years of the project “and “risk” (degree of guarantee for users with respect to the investment), both of which are also related to financial viability. Finally, an influence of CBS is detected in the “annual subsidy” variable in case of insufficient demand. Consequently, the more demand there is, the higher the degree to which the needs of the public and the “prices to the public” are met, since the higher the usage, the lower the price and the subsidy needed to reach the minimum revenue agreed with the private partner.

Graph 4A- Chart of potential indirect influences at 5%



Graph 4B- Chart of potential indirect influences at 10%



Graph 4B includes four additional variables that influence CBS, but to a lesser extent than the others: three are environmental variables and one is an outcome variable. The contextual variables are “experience of the private investment partner”, “(social impact” and “infrastructure security”. The outcome variable is E (sufficient frequency to meet demand).

Finally, in Graphs 4A and 4B none of the autonomous variables are shown, which indicates their low incidence in the development of the project due to their low influence and dependence. In this project, the low relevance of the variables “technological innovation” and “functionality” is remarkable, when especially the first one should have a great potential to facilitate or reinforce key variables such as “cost-benefit to society” and R&D (extension and key stops, line length...).

Some comparatively important influences can be observed among other variables, e.g. the "financial viability" has an influence on the "annual subsidy" and likewise for the "price to the public" variable.

As can be seen, the comprehensive system in Figure 4, concentrates the greatest strength of influence on "cost-benefit to society", being the main challenging combination for this project, the relationship between "cost-benefit to society" and "financial viability".

Discussion

The scheduled construction and putting into operation of the L4TLG is foreseen for 2024, so it is a project in progress. Therefore, although the questions asked to the experts refer to the specific PPP-L4TLG, as the project is not yet completed, they should also be seen in terms of both what should be required of the L4TLG and what should be expected of such contracts.

The analysis of expert opinions through MICMAC highlights the relevance of the "cost-benefit to society" variable from the perspective of the expected public value that the PPP-L4TLG adds to its social and economic context. The concept of public value added is refined by other quantitative variables such as the key variables "route and distance" (length, departure frequency and key stops) and the target variable "price to public", which show some of the most relevant operational aspects in which the public value added by the project is represented. However, these three variables -included in quadrant 1- are highly dependent on other variables and, therefore, the achievement of balance between them represents an important challenge, because they will determine the success of the PPP-L4TLG, in term of public value for citizens.

The above variables are reinforced by the contextual variables -quadrant 2-, with a higher-than-average ability to influence other variables, being less dependent. For example, the "cost benefit to society" variable also depends on the contextual variables related to the safety of equipment and facilities and the connection of the L4TLG with the rest of the public transport network, complemented by the "capacity" of the trains to meet the demand.

The legality requirements, environmental impact and other externalities, autonomous variables found in the quadrant 3, show little influence on the definition and success of this project and little dependence on the rest of the variables, as well as the technology and innovation variable. It is surprising how little importance is given to the environmental impact and the innovation and technology used in the design and development of L4TLG. Infrastructure development in developing countries seems to give priority to meet basic social and economic needs in the short term, relegating environmental and innovation issues to second place. However, the contract is for 36 years, and the environment will become increasingly important in the future, which may affect L4TLG operations in the long term. Similarly, innovation and technology can

improve the quality, safety and cost of the transport service in the long term, so these issues should require greater prominence in future PPP contracts.

The quadrant 4 contains variables that do not influence the development of the project, such as the “annual subsidy” for public prices and constant and sufficient departures to meet user demand (“efficiency”), but are highly dependent on other variables. The quality of service in terms of frequencies at an affordable price could sum up what the citizen ultimately demands from this infrastructure to meet his needs. These expected results are highly conditioned by the behavior and interaction of the other variables.

Graphs 4A and 4B indicate the dependencies between variables. As can be seen, the basic variable cost-benefit to society (CBS) is strongly conditioned by the financial sustainability of the project. Financial viability, which is the other basic variable of the project, depends on the project duration (36 years) and the annual subsidy in case of insufficient demand and the risk. The evaluation of the public value added by L4TLG in non-financial terms (CBS) depends largely on variables defined as essential in the map of influences such as the capacity of trains to meet demand, the length of the line and the annual subsidy in case of insufficient demand that will determine the final price to public of the service.

Although this infrastructure will not enter into service until 2024, there have been some comments and criticisms issued by experts other than those who collaborated in our study through magazines or newspapers, which make direct or indirect reference to the key variables of the project. So, the construction of the L4TLG is a controversial issue. Thus, *El Informador*, *Milenio*, *El Universal*, *Excélsior* and *La Jornada* state some advantages of L4TLG: it will improve mobility for the inhabitants of Guadalajara and its surroundings, as it will connect several densely populated neighbourhoods, the city centre with important destinations such as the airport and the University of Guadalajara and the city centre with important areas such as Zapopan and Tlaquepaque; the construction of L4TLG will generate jobs and boost the region's economy; it is a more environmentally friendly transport alternative to private vehicles, as it reduces the emission of polluting gases and it is a necessary infrastructure project for the urban development of the city and will contribute to reducing traffic congestion. For Chávez (2022), this work is the dream longed for by the inhabitants of Tlajomulco de Zúñiga because they lack a means of transportation that brings them directly to the other municipalities of the GMA and that a

significant change is expected in this regard. For Rangel (2022) this project guarantees free circulation by having six lanes, four of which are for vehicles, and a bridge on Adolf Horn Avenue so as not to affect circulation. Other opinions emphasize that this project meets the important need to connect the municipalities of the GMA, which represents a significant change in the mobility of their inhabitants, although, in the opinion of other experts, this connectivity need could have been satisfied through other less costly and more operative options.

On the other hand, others have criticized the construction of L4TLG because of its cost, environmental impact and safety especially in the more densely populated areas where light rail could interact with pedestrians and cyclists. Barajas, D. (2022), criticizes that there are hardly any studies on the neighborhoods surrounding the municipality of Tlajomulco de Zúñiga, which need to ensure public services such as street lights, long and unpopulated distances to reach this new line with records of high levels of insecurity in the area. He also considers that the route of the L4TLG line fits the permit granted by FERROMEX and not the need required by the urban development that currently exists in the area. Villaseñor (2020) points out that there were other alternatives for connection to the center of the GMA and that the project was designed from the center of the GMA to the southern zones and not the other way around: the mobility problem of this southern zone of the GMA could have been solved with the growth of Line 1 of the Light Train and complemented with the Macrobus service, and this investment would have cost approximately 20% of the total cost of the construction of the L4TLG. Another proposal of experts was to increase the route of Phase One of the Macrobus to the southern zone or a connection to the Periférico Sur along the Gobernador Curiel route. Rios (2022), points out that this new investment compromises the State's finances for a period of 36 years, and this project should not integrate the current electric train system (lines 1, 2 and 3) because it does not have a direct connection with it, but through a BRT of the Macrobus. In addition, its route will be interrupted by crossings, a characteristic of the Macrobus. The option of implementing a BRT with connection to the electric train system would cost five times less than what is currently owed under contract. As can be seen, some criticisms focus on insufficient attention to the equipment of the L4 surroundings to favor its accessibility in terms of citizen safety and the fact that the design of the L4

route has taken into account factors other than the needs of citizens. These contextual variables have been of little importance in our study.

We note, therefore, the difficulty in establishing a priority to guide decision making when investing in these infrastructures, since Guadalajara, as the second most important city in the country, lacks an integral system that would allow its inhabitants to move throughout the GMA and thus shift the use of private automobiles by public transportation that really addresses the mobility problem. Finally, we also note that all these opinions underline the interest in this project and highlight the nuances that can arise in a PPP project, although there is almost unanimity in identifying the key variables to be addressed and controlled, given the hybrid nature of a direct impact on their daily life, such as the mobility of the area and construction of the project. This kind of projects has to address the importance of the cost-benefit and financial viability variables, especially to ensure the support of the private partner, but also to the relevance of other variables more related to the public value for the citizen, which have to do with the needs of citizens, which are not always aligned with the economic or financial perspective. The balance between the cost of the project and the benefit, not only financially but also in terms of the affected and/or benefited population, is relevant in the feasibility reports prior to the start of any public work of these characteristics. For Vasallo (2019), the availability of resources and experience of the investor must be backed up by studies prior to the acceptance of the project to guarantee its execution and operation, and will be supported by information that includes the cost-benefit analysis of the affected actors, the services that the PPP will offer, the risks, financial analyses, designs, technology and legal aspects, among others. Transport infrastructure projects are necessary for the urban development of cities and comprehensive and sustainable solutions must be sought that benefit the majority of the population and minimize negative impacts.

Conclusions

The priority of the PPP-L4TLG is the development of an infrastructure that generates public value in the community. The public value added by this project is measured by the service it will provide, in terms of capacity of trains used for L4TLG to meet user/passenger demand, frequency, route, stops and length, integrating urban areas and equipment safety, at an affordable price. Investments under PPP contracts in general, and in railway infrastructures in particular, do not always follow the logic of financial viability

and cost-benefit, typical of investment projects in the business sector because, although the private partner aims to ensure a minimum that guarantees a return on its investment, the public partner may assume a project very costly financially, as it takes into account other parameters of a social nature and territorial equilibrium. The opinions of experts, both those who have collaborated in the survey and those expressed in the media, make this clear in the railway project studied. The cost-benefit to society is represented in this paper in terms of public value for users, which indicates a project design as proposed by the Robust governance approach, that encourages network collaboration between public and private entities to improve the public value contribution of public projects and policies.

This paper contributes to identifying the essential components of public value for the experts in terms of satisfaction of social needs to be considered when designing, constructing and managing public transport infrastructures and services through PPP contracts in order to take into account the key aspects in the process. According to the experts, the fundamental aspects to be considered are related to the daily usefulness that L4TLG can bring to citizens and the extent to which it can meet communication needs. As public value is a conceptually clear variable, but difficult to measure, this paper identifies some operational aspects on which the cost-benefit to society also depends, such as financial viability, project years, risk and route, stops and distance, being the ticket price to the public a target of the project. Once this infrastructure is in operation, citizen satisfaction surveys should be conducted on the variables that define the concept of public value to establish whether the PPP-L4TLG has met the expectations placed on it.

Two aspects relegated to the second place in this project, in the opinion of the experts, has been the technological innovation issues, which can have a significant impact on the quality, safety, cost and price of the service in the long term, as well as the environmental issues that will have an increasingly greater relevance in the near future, especially if we consider that the management is planned for 36 years. Infrastructures in developing countries seem to give priority to meeting basic social and economic needs in the short term, relegating environmental and innovation issues. So, these issues should require greater prominence in future PPP contracts.

The classification of the variables of a PPP project in the different quadrants of influence and dependence provided by the MICMAC methodology makes it possible to generate strategies for the success of this project. The results of this study, obtained through an accepted foresight methodology, help to reduce uncertainty and anticipate possible conflicts throughout a PPP project. These methodologies are increasingly used in different fields of science to integrate the opinion of experts, academics and actors in the face of social problems, the search for future solutions and proactivity in the face of unexpected events.

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RESUMEN Y CONCLUSIONES

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Dado que las Asociaciones Público Privadas (APP) pretenden impulsar obras públicas que ayuden a resolver problemas sociales con financiamiento a través de capitales privados ante la falta de liquidez o de experiencia de los gobiernos, esta Tesis Doctoral incluye varios estudios sobre proyectos de infraestructuras de gran relevancia para México, con el objetivo de contribuir a su análisis y difusión, y a poner de manifiesto sus puntos fuertes y débiles para que la experiencia de estos cuatro estudios del caso ayude a mejorar la planificación de iniciativas futuras en estos ámbitos.

Los trabajos que se incluyen en la Tesis -algunos ya publicados-, se desarrollan en la línea de investigación *colaboración público-privada y co-producción de servicios públicos*, y presentan una metodología diferente en cada uno de ellos, aunque su enfoque está dirigido principalmente al análisis financiero, de impacto y beneficio social, por lo que la colaboración de actores y agentes sociales clave en la toma de decisiones de este tipo de proyectos de infraestructuras, nos ha permitido obtener resultados y conclusiones más concretos y detallados respecto al desempeño que hasta hoy han mostrado estas inversiones en obra pública.

PARTE 1

En el **Capítulo 1** se analizan las infraestructuras destinadas al saneamiento de aguas en México financiadas por APP y, a través de un estudio de caso, se obtienen resultados sobre la Planta de Tratamiento de Aguas Residuales (PTAR) de “Agua Prieta”, ubicada en el Área Metropolitana de Guadalajara (AMG) del estado de Jalisco, que es la segunda planta de estas características más grande de México y la tercera de Latinoamérica.

El trabajo de campo permitió aclarar la problemática intrínseca de esta obra, ya que la información pública no siempre facilita los fallos de su planificación inicial. Así, se detecta el deficiente diagnóstico por parte del gobierno y del desarrollador para proponer una PTAR de residuos domésticos, cuando lo apropiado era que fuese de residuos industriales, considerando que el Río Santiago, que es donde se vierten los desechos, es uno de los más contaminados del mundo, y en el que estudios realizados por varias organizaciones aseguran que hay residuos industriales no permitidos por la ley mexicana y los tratados internacionales. Por ello, ya en sus inicios, esta PTAR debió planificarse

para el saneamiento de aguas industriales. Esta obra generó una deuda que se trasladó a las comunidades implicadas en su recibo de cobro de agua, pero no ha cumplido las expectativas esperadas.

En cuanto a su estructura técnica, todavía falta por construir el colector de San Gaspar-Agua Prieta, para que conduzca las aguas residuales o negras del oriente de Guadalajara a la PTAR de Agua Prieta, ya que actualmente se vierten directamente al río Santiago por la Barranca de Huentitán, conocida por ser una reserva forestal. Actualmente, el gobierno viene permitiendo asentamientos de urbanizaciones a lo largo del Río y la Barranca, sin estructuras colectoras, agudizando el problema de contaminación. En la entrevista realizada, se aclara que el gobierno no presupuestó este colector por lo que, si en un inicio se trataba de sanear ocho mil quinientos litros de agua por segundo, en la práctica, solo se sanean seis mil litros por segundo, y los otros dos mil van sin tratamiento de forma directa al Río Santiago.

Una conclusión relevante de este estudio es que la alternativa de financiamiento para solucionar el saneamiento de aguas a través de las APP para el caso de la PTAR “Agua Prieta” no ha cubierto las expectativas esperadas desde el inicio de esta obra pública. La literatura sobre el tema, los comunicados de prensa y los medios de comunicación consultados, así como la entrevista con un exfuncionario del gobierno, nos permiten concluir que desde su inicio se protegieron los intereses del desarrollador -operador privado- al no poner en evidencia que la infraestructura planeada -una obra para aguas residuales- no ayudaría al saneamiento de las aguas del Área Metropolitana de Guadalajara, donde era necesario un vertedero de aguas industriales y agrícolas.

Además, sin el colector de San Gaspar, no hay conectores de las aguas residuales del oriente del Área Metropolitana de Guadalajara hacia a la PTAR “Agua Prieta”, por lo que se vierten de forma directa a la Barranca de Huentitán aproximadamente dos mil litros de agua sin tratamiento y, por ello, la contaminación sigue presente, no habiendo tomado conciencia de esta problemática el gobierno estatal, ni el municipal, ya que siguen permitiendo asentamientos urbanos en estas zonas, que agudizan el problema.

Esta mega-obra no está operando al 100% por falta del colector de San Gaspar. Los datos recopilados demuestran que los resultados obtenidos hasta hoy están lejos de lo que

se pretendió y se prometió a la ciudadanía, al adquirir un compromiso y endeudamiento con un inversor privado para la construcción de esta PTAR. Por todo ello, la intervención y opinión de expertos, académicos y sociedad civil, deben ser tenidas en cuenta para el desarrollo de estas obras, pues no se está midiendo el bienestar social y el impacto ambiental adecuadamente. Aunque se endurezcan los contratos y las leyes, no servirán de nada si no se aplican a los monopolios del poder.

Este caso de estudio permite concluir sobre la corrupción en obras millonarias bajo el esquema de APP, donde los intereses del sector privado están por encima del beneficio social. La vigilancia y control de este tipo de infraestructuras dirigidas a la sociedad, que generan endeudamiento público, deben estar estrictamente integrados en los futuros contratos de APP para fortalecer la transparencia que tanto se promulga en campañas electorales por todos los partidos políticos.

El objetivo del trabajo incluido en el **Capítulo 2** es analizar la viabilidad financiera para el desarrollador, u operador privado, en la construcción de la Planta de Tratamiento de Aguas Residuales “El Ahogado”, ubicada en el Área Metropolitana de Guadalajara, Jalisco. Desafortunadamente, muchas inversiones destinadas a resolver los problemas sociales y, en particular el saneamiento del agua, carecen de evaluaciones y análisis previos para determinar limitaciones y obstáculos, así como una rendición de cuentas a los ciudadanos adecuada para mostrar suficiente transparencia en estas obras financiadas mediante APP, para demostrar si son o no exitosas y obtener la aprobación social, en su caso. Esta obra se inició en el 2012 e integra el sistema de saneamiento de aguas residuales del Área Metropolitana de Guadalajara, junto con la PTAR “Agua Prieta”.

La metodología de trabajo se basó en determinar la viabilidad financiera para el desarrollador, definida como la relación entre los ingresos financieros (los ingresos y posibles subsidios) y los costos financieros (los costos de inversión inicial, operación y mantenimiento). Los resultados obtenidos pusieron de manifiesto que la relación final entre los ingresos financieros y costos financieros es menor que uno, de donde se concluye que la planificación de esta obra no fue adecuada desde el punto de vista del desarrollador. Por ello, se llevan a cabo algunas proyecciones donde se simulan ingresos por subsidio o subvención durante todos los años de la concesión, y la relación se muestra positiva.

Los altos costos por mantenimiento y operación generaron un endeudamiento público a largo plazo, inviable para un país en desarrollo como es el caso de México. Además, resultó un fiasco para el gobierno de turno la aprobación de esta obra que evidenció intereses políticos, ya que el desarrollador resultó excesivamente beneficiado por cobros millonarios, ante una situación que previsiblemente no podría atender esta PTAR, al no aplicar la tecnología necesaria para resolver el problema del saneamiento de estas aguas industriales. Otra consecuencia grave de las deficiencias de este proyecto es el aumento de la tasa de mortalidad por leucemia, cáncer, enfermedades renales, entre otras, en zonas de El Salto (lugar donde está la PTAR “El Ahogado”) y Juanacatlán. Al final, esta planta está trabajando por encima de la capacidad del proyecto inicialmente planteado, ante el incremento de asentamientos habitacionales permitidos por el gobierno en estas zonas.

Este estudio aborda principalmente la viabilidad financiera desde el punto de vista del desarrollador -operador privado- en la construcción de la PTAR “El Ahogado”, así como la responsabilidad del sector público y privado en la toma de decisiones ante los problemas sociales y obras de infraestructura destinadas al bienestar social.

Los resultados permiten concluir que, desde su inicio, no era viable financieramente esta infraestructura, dados los altos costos de mantenimiento y operación necesarios para su funcionamiento. Además, el análisis de la construcción de esta obra pública muestra la falta de experiencia del sector público a la hora de tomar decisiones sobre obras destinadas al bienestar de los ciudadanos.

También se pone en evidencia en este estudio la protección habitual a grandes empresas y monopolios que funcionan en el Área Metropolitana de Guadalajara, AMG. Junto con éste, varios estudios han demostrado que las políticas públicas deberían exigir a las grandes corporaciones la creación de plantas de tratamiento de aguas residuales para sanear sus propias aguas contaminadas, producto de su industrialización, prohibiendo verterlas en cuencas naturales, ríos o zonas protegidas. El daño que ocasionan las industrias a fuentes naturales de agua se traslada a la ciudadanía. Estas mismas políticas se pueden aplicar a los desarrolladores inmobiliarios para que en sus proyectos contemplen los sistemas de saneamiento de aguas residuales para contribuir positivamente al cuidado del agua. Por el momento, la permisividad y negligencia del gobierno permiten la urbanización en zonas cercanas al Río Santiago, sin contemplar sus

daños ambientales y ecológicos. Sería interesante y necesario continuar este trabajo con estudios desde diferentes líneas de investigación, analizando esta problemática desde otros ángulos, para contribuir a su mejora con soluciones reales y puntuales.

PARTE 2

En el **Capítulo 3** se analiza el caso del tramo carretero federal Querétaro-San Luis Potosí. La carretera Federal 57 es conocida como la columna vertebral del sistema carretero en México porque atraviesa el territorio de norte a sur, y representa una estructura vial de gran importancia para el impulso económico, de comunicación y transporte. Esta vía es de libre tránsito para todos los ciudadanos y su diseño, construcción, mantenimiento y operación ha estado a cargo de la Federación. Dentro de la Federal 57 se encuentra el tramo de Querétaro-San Luis Potosí cuya conservación rutinaria y periódica está a cargo de una APP que debe mantener este tramo con estándares de calidad y servicios establecidos en el contrato, garantizando también su seguridad. Los pagos al desarrollador están incluidos en el Presupuesto de Egresos de la Federación (PEF), es decir, se llevan a cabo a través de la recaudación de impuestos. Paralela a esta vía, se encuentra la autopista México - Querétaro, conocida como la 57D, con tramos de acceso restringido o de peaje.

El objetivo de este artículo es analizar el costo/beneficio del tramo federal Querétaro-San Luis Potosí para los usuarios, frente a los ingresos por cobro de los controles de peaje en la autopista México-Querétaro 57D para determinar si los pagos que hace la Federación a través de la APP justifican esta carga presupuestaria. Asimismo, se pretende conocer el ahorro -inconsciente- que obtienen los usuarios de la federal Querétaro-San Luis Potosí, identificando si los pagos que hace la Federación a través de la Secretaría de Comunicaciones y Transporte (SCT), son menores que los pagos percibidos por cobro de los controles de peaje, teniendo en cuenta el Tránsito Promedio Diario Anual (TPDA), de acuerdo a los datos reportados por la SCT, y los kilómetros de cada red vial.

Para analizar el costo/beneficio se utilizaron tres indicadores financieros utilizados por el Banco de Programas y Proyectos de Inversión Pública de la Secretaría de Finanzas del Estado de Oaxaca: el Valor Presente Neto (VPN), la Tasa Interna de Retorno (TIR) del periodo 2016 al 2019 y, posteriormente al 2026 y, la Tasa de Rendimiento Inmediata (TRI) para el primer año. Para la autopista de peaje, se revisaron informes emitidos por

la SCT, el Fondo Nacional de Infraestructura (FONADIN) y Carreteras y Puentes Federales (CAPUFE). Para el tramo federal se revisó la información de los TPDA emitidos por la SCT y los pagos al desarrollador reportados por la Federación a través de la SCT en los reportes del Presupuesto de Egresos de la Federación año por año.

Los resultados del trabajo muestran que, para la vía federal Querétaro-San Luis Potosí, la decisión del Gobierno federal es positiva porque se pone de manifiesto un ahorro económico para los usuarios de esta vía frente a los costos de peaje en la autopista, además de que son requisitos de esta APP garantizar la calidad y el buen mantenimiento de la vía para conseguir una reducción del tiempo de desplazamiento, el tránsito libre, la conexión de las fronteras norte y sur del país, y el desarrollo económico de las zonas colindantes, entre otros. Para el desarrollador a cargo de este tramo federal, también los indicadores financieros fueron positivos, lo que demuestra una viabilidad financiera para el sector privado y un beneficio para la sociedad.

Se puede concluir que las alianzas de las APP para la conservación y mantenimiento, para elevar los estándares de calidad en el uso de las carreteras federales, como en el caso de la carretera Querétaro-San Luis Potosí, representan un beneficio en ahorro económico para sus usuarios puesto que, en caso contrario, deberían utilizar la autopista 57D y pagar el peaje.

En el desarrollo de este estudio, se pudo constatar la ausencia de información pública, puesto que no fue posible obtener para la libre Querétaro -San Luis Potosí, los datos del aforo vehicular, ni la distribución por secciones o zonas donde están los contadores de vehículos, ni el tipo de vehículo para un análisis más profundo. Tampoco fue posible conocer los pagos que hace la Secretaría de Comunicaciones y Transporte, SCT, al desarrollador privado.

Los indicadores financieros utilizados demostraron que la inversión es viable financieramente tanto para el tramo libre de la carretera como para la autopista. La decisión del Gobierno federal para proteger los bienes carreteros de la nación en los tramos de libre tránsito es pertinente para asegurar la conectividad interna y de los países vecinos, así como estar en buen estado, para generar crecimiento económico para la nación. Sin embargo, se deben proponer estudios que evalúen los impactos sociales,

ambientales y económicos para optimizar los tramos que la nación entrega en concesión a través de una APP.

Por último, el **Capítulo 4** analiza los determinantes del valor público en los contratos APP, mediante una aplicación a la Línea 4 del tren ligero de Guadalajara.

Este trabajo pretende identificar las variables clave en obras con esquema de APP para determinar su valor público a través de técnicas prospectivas. Para ello, nos centramos en el proyecto de la Línea 4 del tren ligero de Guadalajara y utilizamos una herramienta metodológica, el MICMAC, que permite clasificar por jerarquías las variables más relevantes e influyentes obtenidas, tanto de la revisión de literatura, como de la opinión de expertos en la materia a través de talleres participativos y tormenta de ideas. El total de variables analizadas fueron diecisiete, relacionadas con aspectos financieros, económicos, ambientales, tecnológicos y de innovación.

Los resultados permitieron detectar una clasificación jerárquica de acuerdo con el nivel de influencia y dependencia de todas las variables, ubicándose como eje central del proyecto la variable “costo-beneficio social”. De acuerdo con dicha clasificación jerárquica, las siguientes variables en cuanto a su nivel de influencia en el proyecto, y dependencia son: la “viabilidad financiera”, los “años del proyecto, el “riesgo”, la “ruta y distancia” y el “precio público”. Puede concluirse que estas variables clave son las que más influyen las estrategias de planificación y control para asegurar la funcionalidad y el éxito de un proyecto de este tipo. Este estudio contribuye también a seguir identificando la relación “costo-beneficio social” como variable clave para generar valor público a la sociedad, en obras con contratos APP.

El estudio permite identificar como elemento primordial para el éxito de infraestructuras ferroviarias como las de la Línea 4 del Tren Ligero de Guadalajara, LATLG, el *valor público*. Este concepto puede definirse como el servicio que se presta para satisfacer la demanda de usuarios/pasajeros con una frecuencia adecuada, así como una ruta, paradas y longitud, conectividad, seguridad y precios accesibles. Aunque el concepto costo/beneficio social es fundamental en este tipo de proyectos para atraer el interés de la parte privada, no siempre tiene que ser prioritario para este tipo de infraestructuras en su sentido tradicional, sino que puede incluir parámetros diferentes:

para el sector privado tiene que suponer la recuperación de su inversión, pero, para el sector público, tiene que representar un beneficio social y armonía territorial, aunque asuma proyectos elevados económicamente.

Podemos concluir, además, que los países en desarrollo deben promover en el futuro también contratos de APP para la protección del medio ambiente y de innovación, pues actualmente se centran básicamente en satisfacer necesidades sociales y económicas, descuidando estos dos elementos.

Por último, los resultados nos permiten concluir que el uso de metodologías prospectivas, cada vez más utilizadas en la ciencia, en las que toman gran valor la participación y opinión de actores clave, puede ayudar a diseñar y planear estrategias que permitan anticipar los posibles problemas, y disminuir el alto nivel de incertidumbre de este tipo de proyectos.

En general, las APP van tomando relevancia a nivel nacional y, día a día, son más conocidas por la población, lo cual es una oportunidad para aumentar la información sobre estos modelos financieros a través de los gobiernos y en todo el territorio, aprovechando la visión y las expectativas de las comunidades y los distintos sectores implicados para el desarrollo de planes estratégicos de futuras obras de infraestructura social. El éxito de estas obras dependerá, en gran medida, de la participación de los colectivos, de los operadores clave, de la transparencia y vigilancia social, y de las políticas públicas que realmente favorezcan a los ciudadanos por encima de los intereses de los capitales privados.

Finalmente, se espera concienciar a los gobiernos para aprender de las experiencias concretas, a través de los logros y fracasos de este esquema de financiamiento, que registra la literatura, antes de tomar decisiones que pueden ocasionar endeudamientos críticos para futuras generaciones, obras no sostenibles en el tiempo, caprichos políticos, y malestar y decepción entre la población cuando se anuncia una obra de interés social.

La alianza entre el sector público y privado puede generar impactos sociales muy positivos, pero las políticas y medidas públicas se tienen que revisar para hacer los ajustes necesarios e idóneos para México, en este caso concreto. Por ello, será necesario seguir realizando estudios de este tipo y también, bajo el enfoque de otras disciplinas,

panoramas, saberes y experiencias, robustecer desde la ciencia las contribuciones o desaciertos que estas alianzas generan a toda una sociedad.

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