

## **Dynamic Toll Lane: A Success Story as Part of the of Public Private Partnerships in the Commonwealth of Puerto Rico**

**Benjamín Colucci Ríos, PhD, PE, PTOE, FITE, API, JD**  
abertis Chair, University of Puerto Rico Mayagüez Campus  
PO Box 9000 Mayagüez, PR 00681  
Benjamin.colucci1@upr.edu

### **ABSTRACT**

The Commonwealth of Puerto Rico, a territory not incorporated of the United States, through the Puerto Rico Highway and Transportation Authority (PRHTA) and Autopistas Metropolitanas of Puerto Rico, LLC established the first highway public-private partnership (PPP) in the island under Act No. 29 of June 8, 2009, known as the Puerto Rico Public-Private Alliance Law. Under this consortium, Metropistas will be responsible to rehabilitate, conserve and improve the built freeway infrastructure and enhance safety to all road users of PR-22 and PR-5 to provide world class services, under a 40 years Grant Agreement.

As part of this consortium, the design, construction, operation and management of a Dynamic Toll Lane (DTL) was included to reduce traffic congestion and expedite traffic flow, while using the Metro Urbano lane, a Bus Rapid Transit System (BRT). The DTL has an exclusive right of way operated at 40-45 mph that was constructed in the median of the PR-22, has a length of 10.4 kms (6.4 miles) which connects the Western Region of Toa Baja with Metropolitan Area of San Juan. The DTL ensures traffic flow using a dynamic toll adjusting rates according to traffic conditions in real time, using video technology to identify crashes and communicates with drivers through electronic signs.

This paper will describe the process of how the PPP was established in the Commonwealth of Puerto Rico, its major components, followed by a description of the DTL, how it was designed and constructed, and its impact in reducing traffic congestion and improving the overall Level of Service (LOS) of the PR-22 corridor. The variable fare structure associated with guaranteeing a particular level of service will also be documented as well as the lessons learned in establishing this innovative PPP in this freeway corridor of the Island.

**KEYWORDS:** Dynamic toll lane, DTL, managed toll lane, advanced transportation management systems, Public-Private Partnerships, PPP, Metropistas, Bus Rapid Transit, BRT, Metro Urbano

### **1 INTRODUCTION**

The Commonwealth of Puerto Rico is a territory not incorporated of the United States, located within the Greater Antilles of the Caribbean. Its main island is 161 km (100 miles) east to west by 56 km (35 miles) north to south, and hosts a diversity of ecosystems from tropical rainforests to dry forests and coastal ecosystems with warm temperatures year round. Its transportation infrastructure consists of 27,000 km (16,800 miles) of highways that provide mobility and accessibility to private motor vehicles and freight to the islands' 3,725,789 habitants. Its capital city is San Juan with a metropolitan area population of 2,306,633 making it the 22<sup>nd</sup> largest metropolitan area in the United States by population. San Juan traffic reaches the rest of the Island through major freeways namely, PR-22 (westbound), PR-18/PR-52 (southbound) and PR-26/PR-66 (eastbound). Over the last 25 years PR-18 and PR-22 rank as the freeways with the highest Average Annual Daily Traffic (AADT) in Puerto Rico, currently with 286,800 and 257,000 vpd, respectively (Pesquera et al., 1997).

Puerto Rico’s recent economic situation has negatively affected the government’s capacity to maintain its infrastructure. Additionally, with reduced revenues in a staggering economy, government transportation agencies have had to resort to high-interest loans to cover operational costs. In light of these challenges, the government has been pursuing public policy that favors greater collaboration between the public and private sector to meet the growing demands of the public sector. Public-private partnerships have stepped in to serve these public needs through alliances that show success in delivering key service objectives and maintaining world-class facilities with more efficient operations that capture the most value from investments made with public monies. These infrastructure partnerships are driven by private sector firms with a record of success on the international stage and backed by reliable financial capital.

A Public Private Partnership (PPP) is a medium to long term arrangement “between the public and the private sector whereby some of the services fall under the responsibilities of the public sector are provided by the private sector, with clear agreement on shared objectives for delivery of public infrastructure and/ or public services,” (See Webs-1, 2 & 8).

There are many different kinds of PPPs that can be developed. Figure 1 shows how PPP arrangements compare in terms of private sector participation to other administration schemes where public or private sector assume the greatest risk. The Teodoro Moscoso Bridge inaugurated in February 1994, that provides access to the Luis Muñoz Marín International Airport (PR-26) connecting the municipalities of Carolina, San Juan and Trujillo Alto (PR-181), and PR-22 & PR-5 PPPs that connects San Juan with the western municipalities of Toa Baja, Manatí and Hatillo are examples of two successful bridge and highway concession agreements in the Commonwealth of Puerto Rico during the last 20 years. (Webs-1, 2 & 3)

It is worth to emphasize that the 2.3-km (1.4 mile) long Moscoso Bridge was the first major Greenfield project in the United States under a PPP and was recognized by the Federal Highway Administration with the *Innovative Highway Finance Award* in 1992. It was also the first PPP to operate a transportation facility in the United States and was completed two months in advance through the method known as “Fast Tracks” ensuring cost savings.

Key features of PPP concessions are:

1. Private operator takes responsibility for financing and investment management as well as operation and maintenance of a facility
2. The operator takes risk for condition of the assets and investments
3. Existing assets or utilities may be operated through concessions, as well as extensive rehabilitation or extension of an existing facility
4. When concession period concludes, ownership rights revert to the awarding authority



Figure 1: Key Issues of Concessions in PPP’s (Webs-2 & 3)

Other examples of successful PPP in the Commonwealth of Puerto Rico under previous legislation includes Dos Hermanos Bridge in 1908 and Doña Fela Parking Garage in 1964.

While PPP are used widely around the world, Europe leads the infrastructure PPP market with more than 45% of the nominal value of all PPPs worldwide from 1985-2011. There has been a

considerable amount of interest in recent years from states to develop projects as PPPs and to such effects many states have enacted PPP legislation including Virginia (1995), Michigan (2008), California (2009) and the Commonwealth of Puerto Rico (2009).

## 2 PUERTO RICO PUBLIC-PRIVATE ALLIANCE LAW

The Commonwealth of Puerto Rico passed Law 29 of 9 June 2009, also known as the “Puerto Rico Public-Private Alliance Law”, which created the Public-Private Partnership Authority (PPPA) (Web-3). The PPPA is dedicated to improving the viability of infrastructure projects that have a high degree of public interest. In addition, through Article 3 of this law, the Government of Puerto Rico adopted a public policy to favor and promote public-private partnerships for the creation of new projects as well as for the operation and maintenance of existing ones. The law specifies the following type of projects as potential PPPs: (1) landfills, (2) facilities for the production, treatment and distribution of water, (3) power plants, (4) transportation systems of any kind, (5) educational, health, security and correctional facilities, (6) social housing, (7) sports, recreational, cultural and tourist facilities, (8) communications infrastructure and (9) information technology infrastructure. The PPPA has the responsibility to evaluate and select which projects to proceed with, determine contract provisions, negotiate contracts, obtain necessary approvals from government entities, and authorize concession extensions and other obligations. (Web-3)

Amongst the PPPs pursued thus far under the new legal framework, include a tolled highway concession agreement and an airport concession agreement.

A desirability and convenience study was commissioned by the PPPA to Macquarie Capital, Inc. and completed in June 2010 evaluating toll roads administrated by the PRHTA. The study also documented the construction of a Bus Rapid Transit service (BRT) along the PR corridor, which would operate along the proposed Dynamic Toll Lane (DTL). The major tasks of the study included:

1. Identify key objectives of the PRHTA and the service needs of each tolled highway
2. Analyze potential options to meet the aforementioned service needs and select a preferred alternative
3. Compares preferred alternative to other alternatives and determines which alternative is in the best interest of the public based on public agency objectives
4. Analyzes the feasibility of PPP based on available funding

## 3 DESCRIPTION OF PR-22 AND PR-5 CORRIDORS

The PR-22 corridor known as *José de Diego Expressway*, is an 84-kilometer long limited access divided highway that connects 12 municipalities along the Northern coast of Puerto Rico with San Juan at the eastern terminus and Arecibo at the western terminus. The 4-10-lane tolled freeway has seven fare-collection plazas and these are: Buchanan, Toa Baja, Vega Alta, Manatí, Arecibo, Arecibo ramp and Hatillo (See Figure 2).



Figure 2: Aerial Digital Photograph Illustrating PR-22 and PR-5 Toll Expressways

The Buchanan toll facility collects the largest share of revenues at 30% (See Figure 3). This freeway serves the largest seaport in the Caribbean, the Port of San Juan (1.97 million TEUs per year,

12<sup>th</sup> largest in North America). The PR-22 corridor also boasts a high concentration of manufacturers and pharmaceuticals between Dorado and Arecibo. PR-22 is the most travelled freeway corridor in Puerto Rico and with 257,000 AADT, it is the 23<sup>rd</sup> most travelled urban highway in the United States according to Federal Highway Administration (FHWA). Based on these facts, PR-22 is the most important freeway corridor in the Commonwealth of Puerto Rico.

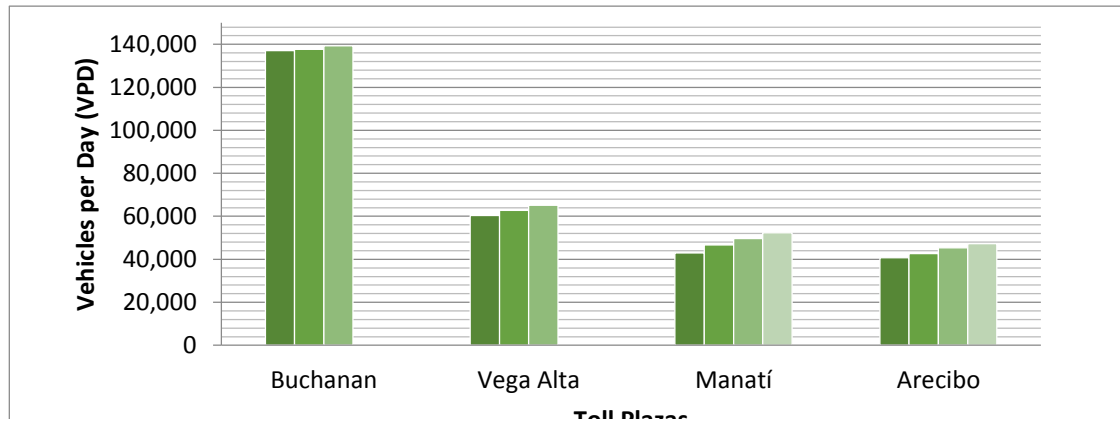


Figure 3: AADT at Toll Plazas of PR-22 (2000-2003) Source: Web-4

*Río Hondo Expressway* (PR-5) is a 4-kilometer (2.5 mile) limited access divided highway that was opened in February 2006 and has one (1) toll plaza. This 4-6-lane tolled freeway serves as the primary urban arterial for travelling in Bayamón, which has a population of 205,693. As of 2009, PR-5 has a reported AADT of 57,270 by the PRHTA.

#### 4 CONCESSION TO METROPISTAS

Puerto Rico’s first PPP under this new law was the concession agreement for PR-22 and PR-5, both which belong to the tolled freeway network that provides the highest degree of mobility in Commonwealth of Puerto Rico. The concession of the PR-22 and PR-5 corridors was contemplated to provide more efficient operations while expanding capacity for capital improvements. In addition, it was planned to emphasize synergy of this concession with a planned extensions to PR-22 and PR-5 through a “greenfield” public-private partnership. The P3 would also fulfill the service needs established by the 2030 Puerto Rico Long Range Transportation Plan. The service objectives determined in the feasibility study were summarized in Table 1:

Table 1 Service Objectives for PR-22 and PR-5 Freeway Corridor

PR-22	PR-5
<b>Extension of PR-22 to Aguadilla</b>	<b>Extension of PR-5 to PR-167</b>
<b>Reduction of leakage through ETC</b>	<b>Reduction of leakage through ETC</b>
<b>Efficient operations and maintenance</b>	<b>Efficient operations and maintenance</b>
<b>Continued rehabilitation and investment</b>	<b>Long-term capital expenditure requirements</b>

Specific infrastructure challenges of PR-22 and PR-5 that are being addressed through the public-private partnership during the first four years of the contract:

- Rehabilitation of bridges
- Enhanced and secured lighting systems
- Implementation of state-of-the-art safety features such as crash cushions
- Leakage issues to be addressed through Electronic Toll Collection (ETC)

- Preserving and upgrading the existing pavement structure
- Maintenance of signage and implementation of latest in traffic control devices
- Maintenance and renewal of Concrete barriers and steel guardrails
- Maintenance of drainage systems
- Roadside assistance program
- Landscape design and maintenance

The concession agreement was formalized on June 27, 2011 for a period of 40 years. The concession was awarded to Metropistas, a privately held limited liability corporation (LLC). The company is a consortium between Abertis and Goldman Sachs Infrastructure Partners II. Abertis recently became the majority stakeholder in Metropistas upon acquiring 6% of Goldman Sachs' share on February 2013. As part of the agreement, Metropistas paid PRHTA \$1,080 million for the lease with an additional \$356 million secured in upgrades and safety improvements to the freeway along the entire duration of the contract for a total administrative concession of \$1.436 billion. PRHTA used almost all of the upfront payment to eliminate public debt defeasance on PR-22 and PR-5. Metropistas has the obligation to invest \$56 million of the funds for improvements within the first 3 years as part of immediate safety improvements.

An important part of the concession agreement is that it protects drivers from sharp and unexpected hikes in toll fares by capping the fares at 1.5% additional to the Consumer Price Index (CPI). The annual revenue of PR-22 and PR-5 prior to the PPP agreement (2008-2009) was \$85,081,300 and \$4,172,600, respectively.

## 5 DYNAMIC TOLL LANES

Dynamic Toll Lanes (DTL) is a proven technology of congestion pricing, which is a solution for reducing traffic congestion. Congestion pricing works by shifting purely discretionary rush hour highway travel to other transportation modes or to off-peak periods, taking advantage of the fact that the majority of rush hour drivers on a typical urban highway are not commuters (Web-5). This method of congestion pricing pays for the externalities associated with congestion such as travel delays, automobile pollution, lost productivity as well as a range of significant health consequences. Congestion occurs when the volume of freeway traffic exceeds a certain level. It is well established that this threshold level is free-flow speeds between 45 and 65 mph. PRHTA was responsible for the design and construction of the 10.4-km long DTL. (See Figure 4) An investment of \$100 million was made as part of the Creole Stimulus Plan by the Government of Commonwealth of Puerto Rico.



Figure 4: Aerial Satellite Photograph of Dynamic Toll Lane and Bus Rapid Transit facilities on PR-22 and PR-5 in Puerto Rico

Designed with future expansions in mind, the BRT service currently consists of two stops, one at the Campanillas Ward in Toa Baja and the Bayamón Station of the Tren Urbano. The express lanes offer drivers an expectation to be able to travel at free-flow speeds; and variable pricing ensures the



DTL does not get significantly crowded as to reduce Level of Service below appropriate. As reported by National Household Travel Survey, the majority of rush-hour trips are not related to commuting to work. (Web-2)

The implementation of the DTL on PR-22 is an innovative arrangement that has not yet been applied anywhere else in the world. Every managed lane has unique objectives and design parameters that influence the operations. In the case of Metropista's DTL, the following criteria were addressed: (1) coexistence of public transport (BRT) and private transport (personal vehicles), (2) algorithms that prioritize the flow of traffic and minimize delays for BRT and (3) facility with limited entrances and exits. By serving drivers and the BRT service in the direction of peak hour traffic, the DTL maximizes the function of its ROW by benefitting rush hour traffic needs. In case of an emergency, the DTL is equipped with 4 metallic barriers designed to be used as access points for response vehicles or exits to reroute DTL traffic. The DTL essentially operates with three (3) traffic schemes, namely AM peak inbound towards San Juan, PM outbound towards Toa Baja and Arecibo and Holidays, respectively. The workday AM peak period is from 5:00 AM to 11:00 AM, whereas the workday PM peak period is from 1:30 PM to 9:00 PM. The variable fare structure applied during the peak period is to guarantee a predetermined minimum Level of Service (LOS) to road users of the DTL. During holidays and weekends the DTL typically operates 10 hours a day.

In Figures 5a and 5b, a conceptual sketch of PR-22 BRT & DTL configuration is illustrated with the AM and PM peak operation of the reversible lanes. Other pertinent geometric characteristics of the PR-22 segment and appurtenances as part of the DTL are illustrated in Figure 6 and complemented with the list below:

- Tolloed Traveled Way: 2 lanes at 3.6-meter (12-feet) wide each with 3.0-meter shoulder where possible for Emergency Responders and Enforcement
- DTL Posted Speed Limit: 40 mph
- General Traveled Way: 6 lanes at 3.6-meter (12-feet) wide each and 3-meter (10-feet) wide shoulders
- General Traffic Posted Speed Limit: 55 mph
- Concrete barriers divide tolloed traffic from general traffic

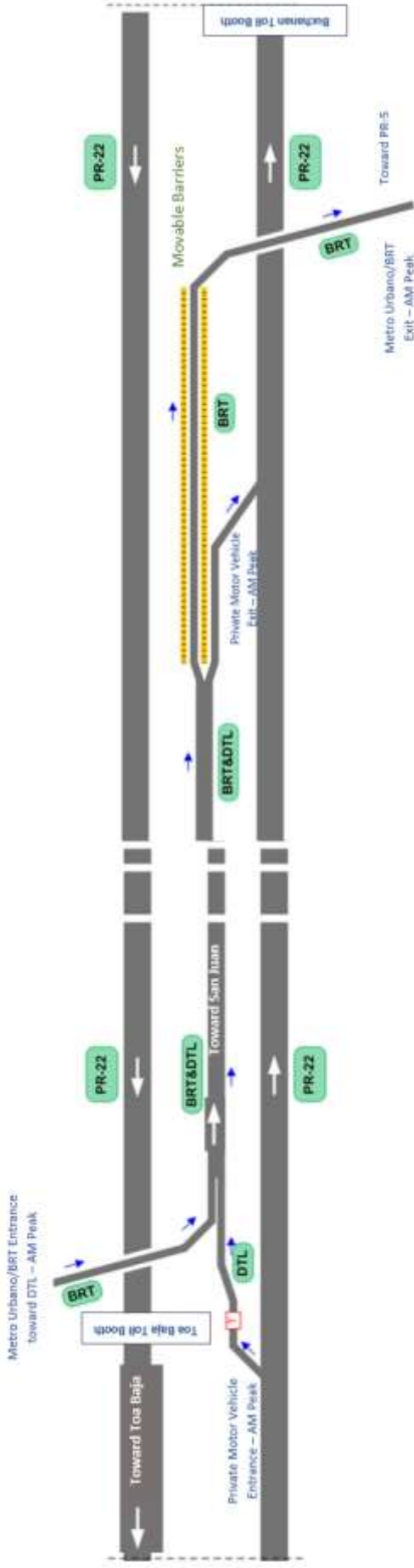


Figure 5a: Conceptual Sketch of PR-22 BRT & DTL of Puerto Rico - AM Peak Operation Source: Adapted from Web-6

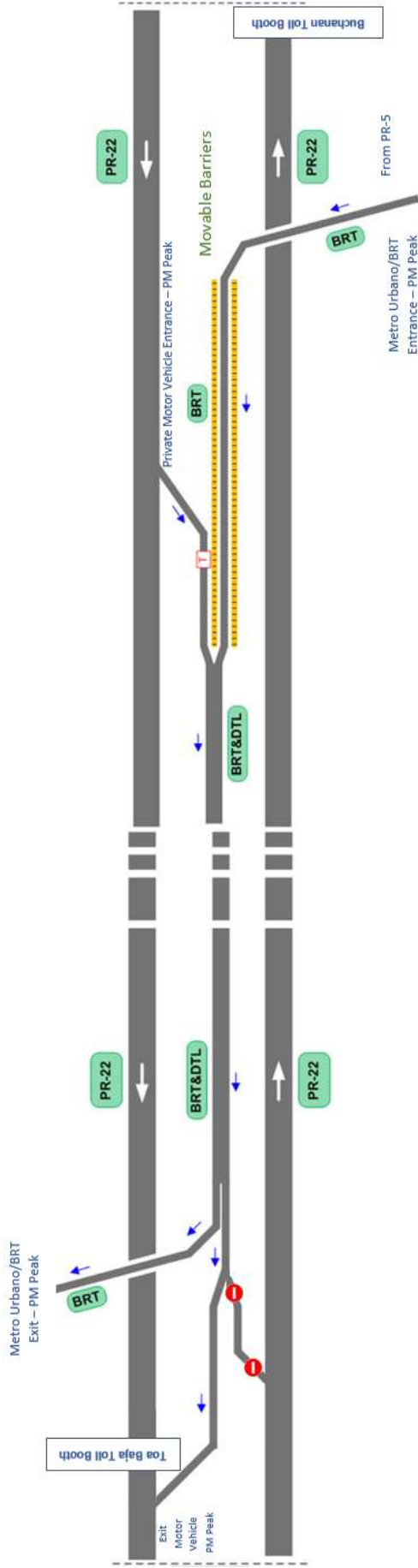


Figure 5b: Conceptual Sketch of PR-22 BRT & DTL of Puerto Rico - PM Peak Operation Source: Adapted from Web-6

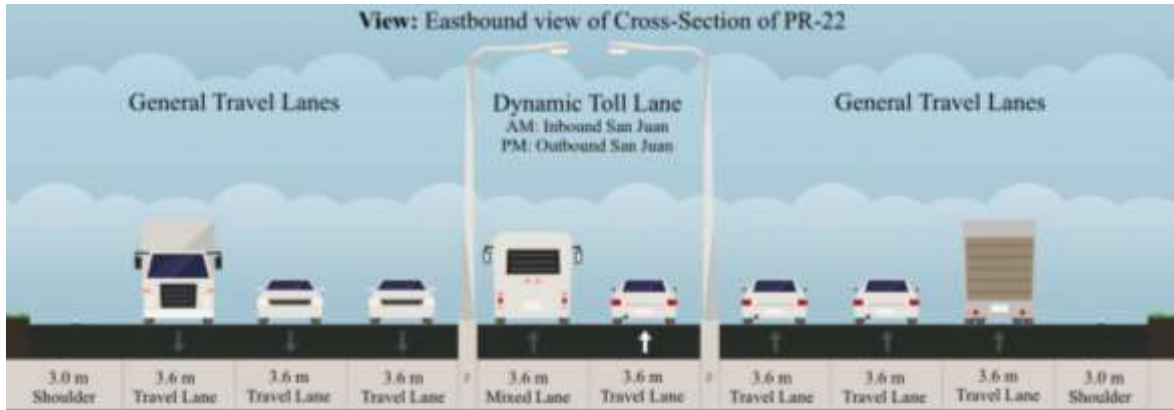


Figure 6: Eastbound View of Typical Cross-Section of PR-22

Figure 7 shows how traffic volumes within the DTL compare between these periods. The highest daily volumes are observed during the AM operating hours at an average of 4,850 vehicles per day, compared to PM which has 3,500 (1,350 less). These data reflects 58% of DTL trips on a workday happen in the morning and 42% in the afternoon. The direction of traffic in the DTL changes depending upon the traffic scheme in operation. During the AM period, traffic of the DTL is inbound San Juan (eastbound) and in the PM period it is outbound San Juan (westbound). Peak hour traffic was observed from 6:40 AM to 7:40 AM and 5:00 PM to 6:00 PM.

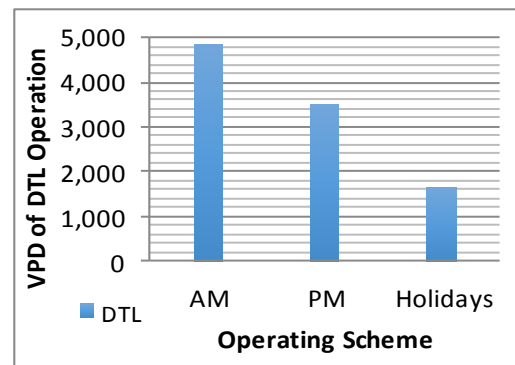


Figure 7. AADT of DTL by Operating Scheme

In order to accomplish these various schemes of operations along the same right-of-way, the DTL has a series of 4 entrance and exit gates (2 on each end) for private vehicles with 36 sequential arrows, 2 entrance and exit gates for BRT equipped with detection antennas that open and close and in some segments use zipper barriers to serve the BRT segment between PR-167 and PR-5. The operations are closely monitored from the 24-hour control center located in Buchanan by communicating with 13 CCTV cameras, 24 Data Collection Stations, 3 Variable Message Signs (VMS), 3 Directional Arrow Signs and 3 toll points connected by 15 miles of fiber optic cables and 2 radio links that provide a layer of redundancy between the Buchanan and Toa Baja offices. From 11:00 AM to 1:30 PM the DTL remains closed to perform a series of tasks to transition between the AM and PM operating schemes including:

- Zipper barrier relocation
- CCTV camera reconfiguration
- Verification of the condition of pavement markings
- Opening and closing of sequential arrow barriers
- Activation and deactivation of toll points
- Communication between Metropistas and BRT operator

Figure 8 depicts the Variable Message Signs (VMS) with Spanish text used to illustrate toll pricing or status of operation to drivers. The DTL fare structure fluctuate between \$0.50 to \$4.00 with the objective of providing fluid BRT service. An algorithm adjusts tolls depending on certain criteria including: (1) queue lengths at DTL exit, (2) traffic incident detection, (3) traffic density and (3) DTL segment analysis in



Figure 8: VMS Signs placed upstream of DTL entrance



entrance, middle or exit. The signage is located 200 meters (656 feet) prior to the DTL entrances to give drivers advanced information on the road. A “courtesy window” algorithm is programmed to avoid charging drivers a toll different from the one displayed on the VMS signs. Since there is a distance between these and the DTL entrances, the algorithm determines the time in advance in which it should display the pricing on the VMSs. Commercial vehicles are not authorized to travel on DTL.

Revenues were at \$8 million for the DTL which is split 50-50 with PRHTA which leaves \$4 million for Metropistas.

## 6 METRO URBANO, BUS RAPID TRANSIT (BRT) SERVICE:

*Metro Urbano*, Bus Rapid Transit (BRT) is a form of public transportation that provides enhanced bus services with either mixed or dedicated Right-of-Way (Web-6). Its primary benefits include high-capacity bus service, reduction in traffic congestion, and its corresponding carbon monoxide pollution. BRT has many benefits in highly congested cities and corridors, specifically it “combines the flexibility and low cost of bus service with the comfort, efficiency, cost-effectiveness and versatility of light rail transit.” Leal and Bertini (2003) and Hoque et al. (2013)

*Metro Urbano*, the current BRT service, is a significant step forward to making the PR-22 corridor a truly multimodal corridor by integrating mass transit as a congestion management strategy (See Figures 9 &10) (Web-2). Currently, with two stations built, the service operates in a park-and-ride manner from Campanillas Station with a parking capacity of 500 vehicles. *Metro Urbano* offers an alternative to drivers whom:

- Do not want to bear the delays and stress of traffic congestion during peak hours
- Cannot afford the DTL pricing on a specific occasion
- Wish to connect with the Tren Urbano mass transit system



Figure 9: BRT buses can also carry bicycles



Figure 10: BRT buses merge with DTL traffic

In addition to transporting drivers and other vehicle occupants, *Metro Urbano* helps transport cyclists and pedestrians who live in the vicinity of the Campanillas station or commuters who wish to take their bicycle to the San Juan metro area. *Metro Urbano* uses 2 exclusive ramps to access or exit the DTL facility: one is at the Toa Baja toll plaza and the other is at the PR-22 and PR-5 interchange. Once the bus enters the DTL as previously shown in Figure 10, it mixes with tolled traffic for 10.4 kilometers (6.5 miles) until the PR-167 interchange where the DTL traffic exits and the BRT continues in an exclusive lane.

*Metro Urbano* operates 6 trips from 6:15 AM to 7:30 AM in the morning period and 6 trips from 1:00 PM to 6:15 PM in the afternoon period. The fare for this service is \$2.00 and includes a complementary transfer to Tren Urbano, a 17.2 km heavy rail system inaugurated in December 2005 with 16 stations that provides service to users in the Metropolitan Area of San Juan.

## **7 DTL BENEFITS TO COMMUTERS**

The DTL offers significant benefits to commuters namely reduction in travel times and reduced vehicle operating costs. Other benefits to commuters that have been provided through the Public Private Partnership between PRHTA and Metropistas include better quality of infrastructure (including pavement and signage conditions), enhanced traffic incident management (TIM) and roadside assistance.

Improve quality of life is achieved to all road users of PR-22 thanks to the DTL even if they don't use the facility. In the morning periods there are 50% reductions in travel time and 30-40% reductions in the afternoon periods. This amounts to savings of 30 minutes in the morning and up to 24 minutes in the afternoon for a total of 54 minutes for each day. General Purpose Lane (GPL) users benefit from a reduction of 1 lane of traffic being removed which also provides some relief.

Roadside assistance is utilized 40-50 times a day, or about 40,000 times since September 2011 when the concession was made.

## **8 CONCLUSION**

PPP are becoming increasingly important for the operational success of key transportation infrastructure in the Commonwealth of Puerto Rico. Throughout the process, both transportation agencies and commuters benefited from the Public Private Partnerships. The concession of PR-22 & PR-5 to Metropistas has enabled this corridor on the North coast of Puerto Rico to continue growing capacity, improve operations and receive proper maintenance even if the public sector is in a financially constrained situation.

The unique DTL arrangement implemented in Puerto Rico has allowed the PR-22 & PR-5 corridors to continue expanding capacity through managed lanes and public transportation. The assurance that such a facility would be maintained from the time of the signing of the contractual agreement, allowed the project to move forward without cost complications or delays. The DTL has in its own regard become an additional source of funding for Metropistas and PRHTA.

Other PPP's with similar ROW constraints and public transportation needs may consider Puerto Rico's DTL / BRT hybrid as a tool to improve capacity in congested corridors, provide better access to public transportation and increase revenues and options of services provided. The Dynamic Toll Lane (DTL) has been well received by commuters, and PRHTA is already exploring additional corridors to expand this technology further.

## **9 ACKNOWLEDGEMENTS**

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