EMPLOYING BIG DATA ANALYTICS TO MONITOR TRANSPORTATION IMPACTS IN EL PASO DURING POPE’S VISIT TO THE CITY OF JUÁREZ

by

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EXECUTIVE SUMMARY

THE PROBLEM

The papal visit to Juárez (southern neighboring city to El Paso, Texas) on February 17, 2016, was a rare international event on the U.S.-Mexico border, providing a unique opportunity for understanding the multimodal impacts on transportation systems and traffic interaction with planned road closures within the cities of El Paso and Juárez. An influx of visitors to the City of El Paso to see the pope in Juárez and El Paso (video streaming at Sun Bowl Stadium) was expected. However, prior to the event, the number of pedestrians and vehicles—and their impact—was unknown.

RESEARCH APPROACH AND METHODOLOGY

With the overall goal of studying the effects of the papal visit on the regional transportation systems, researchers set up an elaborate data collection effort. Researchers collaborated with INRIX® (a provider of historical and real-time traffic information) to better understand the traffic impact of the papal visit. INRIX data are based on one million real-time, anonymous probes used to analyze and compare the traffic conditions the day of the pope’s visit, with that of an average weekday and weekend. The probe data were aggregated and post-processed to provide various performance metrics such as travel time and travel time reliability. Researchers also set up video cameras at multiple land ports of entry (LPOEs) and other locations to understand the traffic impact. To study the multimodal aspect of the traffic impact, the research team collected pedestrian data by setting passive infrared pedestrian counters and video cameras at LPOEs. The ridership data were obtained from Sun Metro (transit agency) in El Paso. In order to validate the collected data or fill the missing data gaps, the Texas A&M Transportation Institute (TTI) worked with the Texas Department of Transportation (TxDOT), City of El Paso, and U.S. Customs and Border Protection (CBP) to obtain additional data collected with their equipment.

Since INRIX probe data were not available for the City of Juárez, TTI researchers leveraged INRIX traffic maps and Google traffic maps to monitor the traffic patterns in Juárez. Researchers developed an automated tool to capture screenshots at multiple resolutions at regular 5-minute intervals throughout the day of papal visit. Researchers compared the traffic patterns on the day of the papal visit with average weekdays and weekends on major corridors in El Paso using various performance measures. This comparison also extended to another special event day in El Paso. The pedestrian and vehicle data at LPOEs were also compared to develop an understanding of congestion at the border entry and exit points on the day of the papal visit.

CONCLUSIONS AND RECOMMENDATIONS

Despite what many believed would be a day of reduced traffic mobility because of congestion, most areas experienced free-flow or manageable conditions; if anything increased, it was travel time reliability. While some locations experienced a dramatic increase in both vehicular and pedestrian traffic, border crossings had no major security or congestion issues,
including processing times at border crossings in terms of traffic queues. Researchers found that attendees relied heavily on foot and transit modes than driving their own vehicles when traveling to see the pope. There is a likelihood that given the traffic uncertainty and road closures many people avoided travel. It also seemed that pro-active measures and earlier coordination among all agencies led to seamless traffic and travel conditions. This study recommends a demand responsive incremental approach for implementing countermeasures and staffing to the agencies during a special event.

The novelty of the work is multifaceted; as it was a rare opportunity to study a mega event on a congested border crossing in the United States, researchers employed big data analytics for understanding performance of major corridors, and advanced pedestrian counters to obtain a complete picture of the impacts of the papal visit on El Paso’s transportation system. This work is original and timely as the congestion on the U.S. border has been increasing in the past decade and security is being tightened. Any failure to manage demand during a special event can have a cascading effect on the already constrained infrastructure of El Paso and wait times at the border crossing. This study was the first step toward measuring the resilience of infrastructure at a border city during a special event in El Paso, which provides a long-term value.

The developed methodology and comprehensible results will be useful for City of El Paso, TxDOT, CBP, and Sun Metro to manage the similar special event at the same scale. The data collected were consistent with typical data collected by these agencies and will be shared to assist in coordinating next special event. Some of the results of the study are being used to model the impact of closures on weekday traffic.
CHAPTER 1:
INTRODUCTION AND BACKGROUND

INTRODUCTION AND LITERATURE

Special events (sporting events, concerts, fairs, conventions, etc.) cause high levels of congestion as attendees overload streets and highway networks adjacent to the venue. This sudden spike in traffic can negatively affect surrounding traffic operations. In contrast to unplanned events, agencies and organizers can easily coordinate a mitigation plan to deploy the proper resources, minimizing the effects on normal traffic operation (1). The perceived impacts of special events have been very well studied in the technical literature (2, 3). However, limited studies have been conducted to quantify or estimate the traffic impact of special events on transportation systems (4), ranging from optimizing the signal timing plan for special events traffic (5) to traffic management, including evacuations and traffic incidents (6, 7, 8). The challenge is considerable, as the impact of special events on transportation systems varies by type of special event, geography, supply constraints, and demand uncertainty.

To efficiently manage the special events, state departments of transportation and metropolitan planning organizations either use their own published guidelines (9, 10, 11) or follow the federal guidelines (12). The transit agencies also have their guidelines for managing special events, including security and management concerns (13). These guidelines and prescribed measures are critical for interagency coordination and interoperability for special events, as was the case during Pope Francis’ visit to various cities in the United States (14). In September 2015, thousands of people from all over the country arrived in Washington, D.C., New York, and Philadelphia to see the pontiff. The major hurdle faced by the state agencies and host cities was managing their transportation system during the papal visit. Seamlessly moving large numbers of people in an urban area from event to event is not an easy task. Given the complexity and uncertainty surrounding the transportation system and demand, gridlock traffic conditions were predicted in all three cities even after employing appropriate measures (15). Interestingly, the follow-up studies on traffic impact after the papal visit found otherwise. According to a study in the Capital region, during the papal visit a modest reduction in traffic volumes in Washington, D.C., subsequently led to a significant reduction in congestion on major corridors with a notable decline in transit ridership for the week (16). The traffic conditions reported on the freeways in Philadelphia also seemed better on the day of the pope’s visit compared with an average weekday (17). There was no published report on impacts of Pope Francis’ visit to New York City’s transportation system.

The papal visit to Juárez on February 17, 2016, was a rare international event on the U.S.-Mexico border, providing a unique opportunity in terms of understanding the multimodal impacts on the transportation system and traffic interaction with planned road closures within the cities of El Paso and Juárez. An influx of visitors to the City of El Paso to see the pope in Juárez and El Paso (video streaming at Sun Bowl Stadium) was expected. However, prior to the event, the number of pedestrians and vehicles—and their impact—was unknown.
This event was different from recent papal visits to the United States (Washington, D.C., New York, and Philadelphia) in many ways. First, the transportation system of El Paso is unique, with only one major interstate (I-10), reliance on public transit, multiple LPOEs, and the presence of multiple interchanges (spaghetti bowl) near LPOEs. The truck freight crossing border, border security issues, and wait times for custom checking at the U.S.-Mexico border add complexity to the transportation system. Second, it was a major event for Catholics residing in this region of the United States (Texas, New Mexico, and Arizona) and a rare opportunity to see the pope with family and friends. This involved traveling in groups (in private cars and chartered buses) and crossing the border. Third, there are multiple LPOEs in El Paso, where U.S. CBP check vehicles, passengers, drivers, and pedestrians and validate their entry. This results in long queues on typical weekdays and weekends.

Lastly, some bridges on the LPOEs have tolls while others do not (creating a bias toward some LPOEs without tolls). Typically, commuters use private vehicles or walk across the bridge and then use public transit on either side of the border. Further, for those who were not planning to cross the border, there was a live video stream planned at Sun Bowl Stadium (football stadium) at the University of Texas, El Paso. The venue had limited seating, an unknown number of attendees, and inadequate road capacity. All this posed a unique challenge for the agencies planning for the papal visit to Juárez and a unique opportunity for researchers to study the impact of a papal visit on El Paso’s transportation system.

With the overall goal of studying the effect of the papal visit on transportation systems, TTI researchers proposed to address the following questions:

- How will this event impact transportation system in El Paso and Juárez?
- How will the performance of freeways, state routes, and major arterials get impacted?
- How many pedestrians will travel across LPOEs to see the pope, and how will this number compare to pedestrians crossing on a normal weekday?
- When will pedestrian traffic peak? What would be the duration of the span?
- Which LPOE will experience the maximum pedestrian traffic due to the mass gathering?

**POPE’S VISIT SCHEDULE**

The official schedule for the pope’s visit and related events in Juárez and El Paso on February 17, 2016, follow.

**City of Juárez**

Pope Francis arrived at Juárez airport at 10 a.m. MST. From there, he traveled via motorcade to the CERESO prison where he met and prayed with several inmates starting at 10:30 a.m. The pope’s next expected stop was Colegio de Bachilleres where he met business leaders and workers from 12:00–1:15 p.m. Pope Francis then traveled to the seminary for a private lunch and rest. The mass event was planned at 4 p.m. at El Punto, a large field near Benito Juárez Stadium. The event ended around 6:30 p.m., followed by his return to the Juárez airport for a farewell ceremony attended by Mexican President Enrique Peña Nieto. Pope Francis then departed for Rome around 7:15 p.m. The pope’s travel through the city streets of Juárez was estimated to be around 31 miles (50 km).
City of El Paso

In the City of El Paso, a public event was planned at the Sun Bowl Stadium where the pope’s message was telecasted in real time. The gates opened at 12 p.m., where people had ample time to get ready for the Papal Mass Event scheduled to start around 4 p.m. with an approximate duration of two hours.

PLANNED CLOSURES

In order to manage vehicular and pedestrian traffic flow, both El Paso and Juárez planned multiple road closures as discussed below, and shown in Figure 1 and Figure 2.

City of El Paso

The planned closures around the City of El Paso were:

- Loop 375 from U.S. Highway-54 to Santa Fe was closed in both directions to all traffic (vehicular, pedestrian, etc.) for approximately a 24-hour period starting at 3 a.m. on February 17, 2016.
- Loop 375 from U.S. Highway-54 to Yarbrough was closed to all traffic (vehicular, pedestrian, etc.) from 10 a.m. until the pope departed the mass location and his motorcade traveled away from roadways adjacent to the El Paso-Juárez border.
- City streets in south-central El Paso bounded by Loop 375 to the south, Campbell to the west, Paisano to the north, and Coles/First to the east had limited access to vehicular traffic starting at 3 a.m. on February 17, 2016. Vehicular access in the restricted area was limited to residents and businesses.
- Residents and businesses were allowed to enter and exit the restricted area through one location: the intersection of Delta and Coles.
- Once Pope Francis arrived at the mass location in Juárez, no one was allowed to leave or re-enter the restricted area until the pope departed the mass. This closure was scheduled for 2:00 p.m.
- Campbell from Paisano to I-10 was closed to traffic starting at 3 a.m. on February 17, 2016. This road was designated for emergency vehicle use. The closure remained until the pope departed the mass.
- Vehicular traffic was allowed to cross Campbell (east or west) between Paisano and Franklin. Vehicles in parking lots and garages that have exits facing Campbell were allowed on Campbell. Vehicles exiting these lots and garages must yield to traffic on Campbell and must turn immediately off of Campbell at the first intersecting roadway traveling east or west. This action was necessary to avoid possible collisions with emergency units that could be traveling southbound on the roadway.
- Cotton from Paisano to I-10 was closed to traffic starting at 3 a.m. on February 17, 2016. This road was designated for emergency vehicle use. The closure stayed until the pope departed the mass.
- Vehicular traffic was allowed to cross Cotton (east or west) between E. San Antonio and Texas. Vehicles in parking lots that have exits facing Cotton were allowed on Cotton. Vehicles exiting these lots and garages were required to yield to traffic on Cotton and must turn immediately off Cotton at the first intersecting roadway traveling east or west.
• Delta Street was closed from Paisano to Boone to traffic starting at 3 a.m. on February 17, 2016. The closure stayed until the pope departed the mass location.
• Contingency Plan for I-10 (eastbound and westbound lanes): If traffic leading to downtown or to the Bridge of the Americas (BOTA), Paso Del Norte (PDN), or Stanton LPOEs and their surrounding neighborhoods became gridlocked due to traffic not moving swiftly across the border, the El Paso Police would work with its partners to alleviate the traffic congestion by limiting access to downtown and south-central streets from I-10.
• Off-ramps to I-10 could be closed in both directions from Geronimo to Executive Center.
• Contingency Plan for Paisano (eastbound lanes): Close eastbound lanes on Paisano from Executive Center to Santa Fe.

Figure 1. Planned Road Closures in El Paso on the Day of the Pope’s Visit.

City of Juárez

The planned closures around the City of Juárez were:
• Complete closures of Avenida Panamericana (Avenida Tecnológico) Avenida Rafaél Pérez Serna, Calle Barranco Azul, Calle Manuel Gómez Morín, and Calle Pedro Rosales de León, from midnight Tuesday to 7 p.m. on Wednesday.
• All roads within five blocks east and west of those streets and avenues were closed.
• Some traffic north to Juan Pablo II Boulevard (which runs parallel to the César Chávez Border Highway in El Paso), south to Avenida Hermanos Escobar, east to Calle Oro in downtown Juárez, and west to Avenida Antonio J. Bermúdez were rerouted.
TRANSIT ARRANGEMENTS

City of El Paso

In El Paso, Sun Metro provided an extended schedule for some of their fixed routes. For multiple routes, additional hours were added all day of the event. Further, Sun Metro offered park and ride services to the Sun Bowl, as shown in Figure 3. The park and ride had scheduled departures every 30 minutes from 10:00 a.m.–3:30 p.m. with similar arrangements at the end of the event. Sun Metro routes around downtown were detoured all day on the day of the pope’s visit. Fixed routes departing downtown ran through at 10:15 p.m. with all other buses running on regular schedule.

City of Juárez

In order to provide a transportation option for those attending the mass event, the municipality of Juárez established 11 transit stations across the region as shown in Figure 3. The color-coded stations represented the recommended location for mass event attendees who held that particular color coded ticket. This free transit service (among other factors) helped to further reduce the vehicular density across the local streets, as many attendees could just walk to their nearest station.
DATA SOURCES

Traffic Data

Researchers collaborated with INRIX to better understand the traffic impact of the papal visit. INRIX data are based on one million real-time, anonymous probes used to analyze and compare the traffic conditions the day of the pope’s visit, with that of an average weekday and weekend. The probe data were aggregated and post-processed to provide various performance metrics such as travel time and travel time reliability. Researchers also set up video cameras at multiple LPOEs and other locations to understand the traffic impact, as shown in Figure 4. All the necessary permissions were obtained from TxDOT, CBP, and the City of El Paso for the various locations.

Pedestrian Data

To study the multimodal aspect of the traffic impact, researchers collected pedestrian data by setting passive infrared pedestrian counters, video cameras, and other detectors at all LPOEs (see Figure 4). Combining all these data provided a complete picture of traffic conditions before and during the papal visit.

Figure 3. Transit Arrangements in El Paso and Juárez for the Pope’s Visit.
The transit and ridership data were obtained from Sun Metro to understand the transit usage during the day of the pope’s visit.

**Social Media Data**

Data from Twitter were collected and explored to understand commuter engagement and issues on the day of the event.

**CBP and City of El Paso Data**

In order to validate the collected data or fill the missing data gaps, TTI worked with TxDOT, City of El Paso, and CBP to obtain additional data collected with their equipment.
CHAPTER 2:
TRAFFIC IMPACT ON MAJOR CORRIDORS IN EL PASO

TTI obtained INRIX historical and real-time traffic information data to understand the traffic impact of the papal visit on major corridors in El Paso. These data are based on a million real-time anonymous probes and needs to be aggregated to provide travel time related performance measures on various corridors.

PERFORMANCE MEASURES

Before understanding the traffic impact based on the INRIX probe data and other traffic data, it is critical to understand the performance measures used in this report.

Buffer Time

Buffer time is the extra time (or time cushion) that travelers must add to their average travel time when planning trips to ensure on-time arrival (95 percent Travel Time − Average Travel Time).

Buffer Index

The buffer time’s percentage value of the average travel time is the Buffer Index ((95 Percent Travel Time − Average Travel Time) / Average Travel Time). Its value increases as reliability gets worse. For example, a Buffer Index of 0.4 (40 percent) means that, for a 20-minute average travel time, a traveler should budget an additional 8 minutes (20 minutes × 40 percent = 8 minutes) to ensure on-time arrival most of the time.

Travel Time

Travel time is the time it will take to drive along the roadway segment (Distance/Speed).

Comparative Speed

Comparative speed is the measured speed as a percentage of the historic average speed for a particular time of day and day of the week.

MAJOR ROADS

Figure 5 shows the corridors selected for traffic performance analysis in El Paso during the pope’s visit. These major traffic corridors in El Paso had the highest impact potential because of the closure of the Border Highway, downtown streets, and the special event at the Sun Bowl (video streaming of the mass). The corridors of study were:
- 19-mile section of I-10 between Executive Center Blvd. and US-62/US-180/E Paisano Dr.
- 9-mile section of US-62 (East Paisano Dr.) between Loop-375 (Border Highway) and TX-20/Alameda Ave.
- 20-mile section TX-20 (Mesa St.) between US-62/Paisano Dr. and Mesa Hills Dr.
- 1.7-mile section of I-110.
- 3.5-mile section of US-54 between TX-375 Loop and Montana Ave.

Figure 5. Corridors Selected for Traffic Impact Analysis in El Paso, TX.

I-10

Researchers analyzed the average performance measures before and during the workweek of the visit to better understand the traffic impact on the interstate in El Paso. Researchers decided to divide the analysis into five logical periods:

- Morning Peak (7 a.m.–9 a.m.).
- Afternoon Peak (11 a.m.–1 p.m.).
- Evening Peak (4 p.m.–6 p.m.).
- Before Mass Period (1 p.m.–3 p.m.).
- After Mass Period (6 p.m.–9 p.m.).
Researchers focused on the 9-mile section of I-10 between Executive Center Blvd. and US-62/US-180/E Paisano Dr. that feeds into major LPOEs in El Paso, as shown in Figure 6.

![Figure 6. Section of I-10 in El Paso between Executive Center Blvd. and US-62/US-180/E Paisano Dr.]

Figure 7 shows the comparison of travel time (minutes) on the section of I-10 on the day of papal visit with average travel time during weekdays and weekends for February. For comparison, another special event in El Paso (i.e., Monster Jam at Sun Bowl Stadium\(^1\) [Saturday, March 5, 2016]) was selected. There is rarely a special event in the border region that can draw an exact parallel to the pope’s visit, but this comparison assists in understanding corridor performance near special event areas in El Paso.

Researchers focused on aggregated performance measures (i.e., travel time, buffer index) in both directions of the section of I-10 to identify trends. Since there was not much difference in directional travel times on the day of the papal visit, unlike weekdays, the performance measures were averaged for both directions. Researchers also looked at the traffic performance before and after the mass. Typically, commuters experience higher travel time on I-10 during the evening

\(^1\)Monster Jam is a racing and freestyle competitions by monster trucks that is widely attended in El Paso. Although Monster Jam continued until Sunday, March 6, 2016, the network performance was not compared with that day because of scheduled utility work that led to bi-directional closure of I-10 from 3 a.m. to 3 p.m. between Sunland Park Dr. and Executive Center Blvd. For consistency, the comparison throughout the document is only with Saturday, March 05, 2016.
peak hours on weekdays than travel time at any other hour. The travel time on the I-10 section the day of the pope’s visit was similar to that of an average weekend because the weekday evening bottlenecks did not occur (see Figure 7). However, the day after the papal visit, the evening peak travel time on I-10 was 30 percent more (18 minutes) than an average weekday (13.5 minutes) and 80 percent more than an average weekend day (9.5 min). This can be attributed to increased commercial traffic and bottlenecks created by traffic incidents in both westbound and eastbound directions (see Figure 8).

![Figure 7. Comparison of Travel Time on I-10 between Executive Center Blvd. and US-62/US-180/E Paisano Dr.](image)

![Figure 8. Comparison of Travel Time on Section of I-10 on the Week of the Pope’s Visit with Average Weekday, Day before Visit, and Day after Visit.](image)
Figure 9 shows the comparative speed at 4 p.m. (evening peak hour) the day before, the day of, and the day after the papal visit, and the following Wednesday (average weekday). Comparative speed is a percentage of the historic average speed for a particular time and day. Figure 9 shows that traffic was almost at free flow speed at 4 p.m. on the day of the papal visit, while the succeeding day (February 18, 2016), there was a major bottleneck that reflects the increase in travel times in Figure 8.

Figure 9. Comparative Speed between 4–5 p.m. on the Day before (Feb. 16), the Day of (Feb. 17), Day after (Feb. 18) and a Week after the Pope’s Visit (Feb. 24).

Figure 10 shows the daily comparison of travel time reliability on a section of I-10 on an average weekday, average weekend, the day of the pope’s visit, and the first day of Monster Jam. As shown in Figure 10, a Buffer Index of 0.8 on the evening of an average weekday means that on that time of the day, a traveler should budget an additional 8 minutes to the average travel time of 10 minutes on that corridor (i.e., 10 minutes×0.8+10 minutes = 18 minutes) to ensure on-time arrival. On the day of the pope’s visit the buffer index was zero; hence, the travel time reliability on the corridor was high in comparison with regular weekdays, regular weekends, and even on the day of another special event in El Paso (Monster Jam).
Figure 10. Comparison of Travel Time Reliability (Buffer Index) on Section of I-10.

US 62 (East Paisano Dr.) between Loop TX-375 and TX-20/Alameda Ave.

Researchers also analyzed the average performance measures on the 9-mile section of US-62 (East Paisano Dr.) between Loop-375 (Border Highway) and TX-20 in El Paso (see Figure 11).

Figure 11. Section of US-62 in El Paso between TX-375 Loop/Border Highway and TX-20/Alameda Ave.
Figure 12 compares peak hour travel times on section of US-62 (Paisano Dr.) for a typical weekday, weekend, the day of the papal visit, and Monster Jam. US-62 (Paisano Dr.) experienced similar peak hour travel times on the day of the papal visit as an average weekday or weekend (between 12–13 minutes). On the day of the papal visit, average travel times on US-62 (Paisano Dr.) were closer to an average weekday, in contrast to I-10 where the travel times were closer to an average weekend. The reduced capacity (i.e., downtown road closures) and reduced demand (i.e., closed schools and businesses) did not have a major impact on the performance of US-62 (Paisano Dr.), unlike I-10.

![Figure 12. Comparison of Travel Time on US-62 in El Paso between TX-375 Loop/Border Highway and TX-20/Alameda Ave.](image)

Figure 13 compares peak hour travel time on the section of US-62 (Paisano Dr.) on a typical weekday, with before, during, and after the pope’s visit in El Paso. The travel time on the day after the pope’s visit was slightly higher than an average weekday. Further, as shown in Figure 14, the travel time reliability on the section of US-62 was much higher than on any average weekday and weekend. This reflects normal and uncongested traffic conditions because of less variance in travel times on US-62.

From this analysis, it appears that the pope’s visit and the road closures did not have any impact on the average travel time on this corridor, which is likely due to the balancing of the reduced demand with the reduced capacity in the network. However, the increased travel time reliability compared to an average weekday and an average weekend shows the consistent flow of traffic with no major variations.
Figure 13. Comparison of Average Weekday Travel Time on US-62 with Travel Time on the Day before, Day of, and the Day after the Pope’s Visit.

Figure 14. Comparison of Travel Time Reliability on US-62 on Average Weekday, Average Weekend, and the Day of the Pope’s Visit.
TX-20 between US-62/Paisano Dr. and Mesa Hills Dr.

Researchers also analyzed the average performance measures on the 20-mile section TX-20 (Mesa Street) between US-62/Paisano Dr. and Mesa Hills Dr., as shown in Figure 15.

![Map of TX-20 between US-62/Paisano Dr. and Mesa Hills Dr.](image)

**Figure 15. Section of TX-20 between US-62/Paisano Dr. and Mesa Hills Dr.**

Figure 16 compares peak hour travel times on a section of TX-20 on a typical weekday and weekend, with the day of the pope’s visit, and Monster Jam in El Paso. The travel time on the section of TX-20 (Mesa Street) before the mass event was the same as on an average weekday. The similarity between travel times during the papal visit and an average weekday are attributable to traffic heading toward Sun Bowl Stadium for the live telecast of the mass. Interestingly, the average travel time on this section of TX-20 the day before, after, and on the day of the pope’s visit (Figure 17) was similar to average weekday, which is in contrast to findings on the other parallel route I-10. However, the travel time reliability on this section was high compared to a typical weekday and weekend (Figure 18).
Figure 16. Comparison of Average Weekday Travel Time on TX-20 (Mesa Street) with Travel Time on the Day before, Day of, and the Day after the Pope’s Visit.

Figure 17. Comparison of Average Weekday Travel Time on TX-20 (Mesa Street) on the Day before, Day of, and the Day after the Pope’s Visit.
Researchers also analyzed the average performance measures on the 1.7-mile section of I-110 and a 3.5-mile section of US-54 between TX-375 Loop and Montana Ave. as shown in Figure 19.
I-110 is gateway to one of the congested LPOEs in El Paso. The travel time on the I-110 and US-54 sections the day of the papal visit is similar to that of a weekend (i.e., between 4–5 minutes) (see Figure 20). A bottleneck on I-110 led to higher travel time on this corridor on the day of Monster Jam in El Paso.

Figure 20. Comparison of Average Weekday Travel Time on I-110 and US-54 with Travel Time on the Day Before, Day of, and the Day after the Pope’s Visit.

There was not much variation in travel time the day before and after the pope’s visit (see Figure 21). However, congestion in terms of comparative speed, less than 60 percent was observed around 6–7 a.m. on I-110 the day of the pope’s visit (see Figure 22). This was mainly because of a large number of chartered buses arriving at the border crossing.
Figure 21. Comparison of Travel Time on the Day of the Pope’s Visit with the Day before and after Pope’s Visit.

Figure 22. Congestion on I-110 at 6 a.m. on the Day of the Pope’s Visit.
DISCUSSION

On the day of the pope’s visit to Juárez, the travel time on major corridors (interstate and state roads) in El Paso throughout the day was similar to that during an average weekend except for corridors near Sun Bowl stadium (Mesa and Paisano) that experienced congestion before beginning of mass. Interestingly, the travel time reliability was high on all major corridors compared to any day because of small variation in traffic and/or incidents on the roads. On East Paisano Dr., the reduced capacity due to various road closures in downtown and reduced demand due to closed school and offices balanced itself, resulting in travel time similar to an average weekday.

Some of the presented results were expected due to closure of major traffic generators such as schools (in El Paso, Ysleta, and Socorro districts), college campuses (University of Texas El Paso, El Paso Community College), manufacturing hubs (maquiladoras in Juárez), and many local and state agency offices on the day of the pope’s visit. Further, commercial vehicle traffic was nonexistent due to restrictions at BOTA. However, the impact of road closures and the pope’s visit on major corridors was only to be known after the study.
CHAPTER 3: PEDESTRIAN AND TRAFFIC IMPACT ON POINT OF ENTRIES

El Paso has four major points of entry: Stanton; BOTA; PDN; and Zaragoza/Ysleta international bridges. The City of El Paso’s International Bridges Department manages three of the region’s international ports of entry the PDN, Stanton, and Zaragoza/Ysleta international bridges. CBP manages BOTA. BOTA connects Mexican Federal Highway 45 to the south and I-110 to the north and carries more than half the vehicles (trucks and passenger cars) entering El Paso from Mexico. BOTA is fifth largest LPOE in Texas, with more than 330,000 U.S.-bound trucks every year and average waiting time for inspection around 37 minutes. This is due in large part to the fact that BOTA is the only bridge between Mexico and Texas that does not charge a toll. PDN is the busiest border crossings for pedestrians with BOTA and Zaragoza/Ysleta international bridges being second and third in the region, respectively. PDN is the busiest border crossings for pedestrians with the BOTA and the Zaragoza/Ysleta international bridge being the second and third in the region, respectively.

Researchers set up video cameras on PDN, Stanton, and BOTA on the day of the papal visit for collecting traffic data. Zaragoza LPOE is far from the event location and does not carry much traffic because of the toll. Hence, researchers focused on these three LPOEs. For comparison, researchers also captured video data for typical weekday traffic at these LPOEs. In addition, data for validation were requested from the City of El Paso and CBP. The PDN equipment malfunctioned on the day of the pope’s visit leading to loss of traffic data for that particular day.

For pedestrian counts, the research team used passive infrared counters and a video recording trailer. The pedestrian counts were performed at (a) the BOTA LPOE to cover southbound and northbound movements and (b) the PDN LPOE to cover northbound. Southbound movements for PDN Bridge were requested from the City of El Paso International Bridges office. The data collection activity was planned to be performed during and after the papal visit (from February 15–19 and February 24, 2016).

STANTON STREET

Locals know southbound US 62/85 as Stanton Street and it aligns with the Good Neighbor Bridge immediately to the east of PDN crossing. The Stanton Bridge allows only southbound movement of pedestrians and traffic. As shown in Figure 23, the passenger car traffic at Stanton Bridge was 40 percent less than that during an average weekday and average weekend with around 2,000 passenger cars crossing the bridge toward Juárez on that particular day.
Figure 23. Comparison of Passenger Car Traffic on the Day of the Pope’s Visit with Average Weekday and Weekend.

Figure 24 provides the number of pedestrians crossing to Mexico during the day of the papal visit and the average weekday and weekend. Researchers deduced from the figure that the southbound pedestrian traffic peaked during the morning period on the day of the papal visit. Usually, southbound pedestrian traffic at this LPOE peaks from 1–3 p.m. and 4–6 p.m. The graphs show that there was a significant amount of border crossing to attend the pope’s arrival before the pontiff’s first morning event.
Researchers analyzed the video recordings to understand the traffic at BOTA on the day of the pope’s visit and a typical weekday (Wednesday). Figure 25 shows a comparison of passenger car traffic at BOTA on the day of papal visit with a typical weekday in both directions. At an average, the passenger car traffic at BOTA was 70 percent lower in both directions on the day of the papal visit when compared with a regular weekday. Between 5–8 a.m. on the day of papal visit passenger car traffic increased when compared with a typical weekday. During this time, there was also a significant increase in the number of pedestrians crossing BOTA in comparison with an average weekday as groups of people disembarked from their buses to cross the international bridge to attend the event in Mexico. The comparative speed also validates the observations of congestion in Figure 22.

Figure 24. Comparison of Pedestrian Counts on Stanton

**BOTA**
The pedestrian traffic at BOTA experienced a significant increase in the number of crossings compared to an average weekday. The pedestrian southbound flow overpassed the average flow for a typical weekday in February. BOTA experienced its maximum peak pedestrian traffic in the evening (4–6 p.m.) and after the mass (6–9 p.m.) as people returned to El Paso after the event. During the afternoon peak (Figure 26), the pedestrian traffic doubled the average amount during an average weekday.
Figure 26 displays the number of pedestrians crossing northbound at the BOTA during the day of the pope’s visit and a following average weekday and weekend. During the day of the event, BOTA experienced its maximum peak hours of pedestrian traffic in the evening (4–6 p.m.) and after the mass (6–9 p.m.). There was an influx of pedestrians early morning (5–9 a.m.) in the southbound direction on the day of the pope’s visit; however for the evening peak, pedestrian traffic almost quadrupled the average weekday traffic, and for the following peak period (i.e., 6–9 p.m.), the traffic was more than eight times the typical weekday traffic.

**PDN**

The PDN crossing is located northbound on US 62/85, locally known as El Paso Street, and LP 375 in El Paso, Texas. Due to malfunction of the recording equipment, researchers do not have traffic data for PDN. Neither the city of El Paso nor CBP could provide these data. However, the pedestrian data were collected and reported as follows.

As shown in Figure 27, the number of pedestrians crossing northbound the day of the papal visit stayed below the weekend and weekday averages, during the morning and afternoon hours. The pedestrian traffic peaked after the mass, with traffic increasing considerably as people started to head back to El Paso. The pedestrian traffic was more than five times greater than a typical weekday for the peak period after the mass. Further, most of the southbound pedestrian...
traffic on the day of the event was seen during the morning peak hours (i.e., 7–9 AM) almost doubling the traffic during a typical weekday but nearing the traffic during a typical weekend. For the rest of the day, the southbound pedestrian traffic decreased as compared with weekday or weekend traffic.

**Figure 27. Comparison of Pedestrian Counts on PDN in Both Northbound and Southbound Directions.**

**ZARAGOZA**

Another LPOE that is mostly used by passenger car traffic and trucks is Zaragoza. Based on the video recordings and compiled data, researchers observed the passenger car traffic on Zaragoza was well below the traffic observed on typical weekday and weekend (Figure 28). Zaragoza being far from the location of mass was not considered for pedestrian analysis.
DISCUSSION

To make sense of overall pedestrian movement compared with a regular weekday and weekend, researchers collected pedestrian data from February 17, 2016, to March 2, 2016, at the nearby LPOEs to the mass event (Stanton, BOTA, PDN). Researchers used these data to develop an average of weekday and weekend pedestrian traffic exiting and entering the United States. Figure 29 compares total pedestrians entering and exiting the United States from Stanton, PDN, and BOTA on a typical weekday, weekend, and the day of the papal visit. Despite the significant hourly increase in pedestrian traffic entering and exiting the United States during the day of the event, the daily average or weekend average was greater than the amount observed during the papal visit. Some of the pedestrians might have stayed in Juárez and did not return to the United States the same day. Nevertheless, fewer pedestrians crossed all three LPOEs on the day of the event as compared with a typical weekend or weekday.

Figure 28. Passenger Cars Entering the United States through the Zaragoza LPOE.
Figure 29. Total Pedestrians Entering and Exiting Using Stanton, BOTA, and PDN.
CHAPTER 4:
IMPACT ON TRANSIT IN EL PASO

TRANSIT

Sun Metro provided some extended schedules for some of their fix routes. Table 1 shows the list of routes and the corresponding additional hours each route ran the day of the event.

Table 1. Extended Hours on Sun Metro Routes on the Day of the Papal Visit.

<table>
<thead>
<tr>
<th>Route</th>
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<tbody>
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</tr>
<tr>
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<td>84</td>
<td>4:00</td>
</tr>
</tbody>
</table>

According to Sun Metro representatives, BRIO (bus rapid transit system) experienced the biggest change in transit ridership during the day of the event. For the current year, Sun Metro reported an average of 1,750 riders (inbound and outbound directions) using BRIO including weekdays and weekends. In contrast, BRIO experienced a year peak total on February 17 (day of the event) of 2,290 riders along the Mesa corridor. The second highest ridership along BRIO occurred the Saturday after the pope’s visit (February 24, 2016). These numbers have a strong relationship with the pope’s visit since the highest concentration of riders was observed in the Sun Bowl stop where the mass was broadcasted and the Downtown Transfer Center, which it is located half a mile from the PDN international bridge.

Figure 30 shows changes in ridership on the BRIO route on the day of the pope’s visit. The average weekday and average weekend ridership was generated based on the data available for the preceding and following Wednesdays (i.e., Feb. 10 and 24, 2016) and Saturdays (i.e., Feb. 27
and March 5, 2016). Nevertheless, the ridership on this route was high on the day of the pope’s visit compared with the average weekday and average weekend except during morning.

![Graph showing ridership on the BARIO Route of Sun Metro.](image)

**Figure 30. Ridership on the BARIO Route of Sun Metro.**

Researchers also compared the ridership for all the routes that shows that overall the ridership was not as high (Figure 31). Even after adding additional hours on routes on the day of the event, the cumulative ridership was below average weekday and average weekend. Figure 32–Figure 34 shows the transit ridership on selected routes a Wednesday before the Papal Visit (10th Feb. 2016), the day of the Papal Visit and a Wednesday after the Papal Visit (24th Feb. 2016).

![Graph showing ridership on all transit routes.](image)

**Figure 31. Ridership on All Transit Routes.**
Figure 32. Transit Ridership on Selected Routes a Week Before the Papal Visit.
Figure 33. Transit Ridership on Selected Routes on the Day of the Papal Visit.
Figure 34. Transit Ridership on Selected Routes a Week After the Papal Visit.

TWITTER ANALYSIS

To better understand commuter and traveler engagement on the day pope visit, researchers used a Python based Twitter API to track Twitter activity from 10 AM, February 16, 2016 until 9 AM, February 19, 2016 for the following HashTags:

papaenmexico, juarez, elpapaenjuarez, 915pope, popevisit, pope, papa, francis, juarez, chihuahua, elpapaenjuarez, elpaso,
popeinjuarez, papaencdj, pope915, papaenmexico, papaenmex, papaenméxico, juárez, elpapaenjuárez, popeinjuárez and papaenméx.

As a part of this effort a total of 1,741,573 Tweets were collected that matched the criteria. The hourly distribution of Hashtags is represented in the Figure 35:

![Twitter HashTag Analysis](image)

**Figure 35. Twitter HashTag Analysis.**

Location and event specific hastags (e.g. papaenméxico, elpapaenjuárez, papaenmexico, popeinjuárez, elpapaenjuarez, popeinjuarez, papaenmex, 915pope, pope915, papaencdj, papaenméx, popevisit) related to the Pope’s Cd. Juárez visit were observed to have peak activity around February 17, 2016 around 10 AM. However, the data was not enough to make general assessment of commuter or traveler activity.
CHAPTER 5:
TRAFFIC IMPACT IN JUÁREZ

JUÁREZ – MASS TRANSIT SERVICE

The municipality of Juárez established 11 transit stations across the region to provide transportation options for those attending the mass event, as shown in Figure 36. The color-coded stations represented the recommended location for mass event attendees who held that particular color coded ticket. This free transit service (among other factors) was supposed to reduce the vehicular density across the local streets as many attendees could just walk to their nearest station.

Figure 36. Mass Event Transit Stations throughout Juárez Plus Street Closures.
JUÁREZ – TRAFFIC IMPACT ANALYSIS

The research team leveraged INRIX and Google Traffic Maps to monitor the traffic patterns in the City of Juárez. TTI researchers captured traffic screenshots for both INRIX maps and Google Traffic Maps at regular 5-minute interval throughout the day of papal visit and analyzed them to obtain insights. These maps were analyzed for monitoring traffic prior to the pope’s arrival at the Abraham Gonzalez International Airport, during his travel along Avenida Panamericana, and after the mass event at the northwest region of the city.

During the morning of February 17, there was congestion in the southern part of the city particularly on three corridors (i.e., Avenida Panamericana northbound upstream of the airport, Blvd. Oscar Flores and Eje Vial Juan Gabriel) (see Figure 37). Local residents commuting from the southwest region toward the northern border would be mostly inclined to use one of these three options. Furthermore, two mass event transit pick-up areas located near these corridors may have caused this congestion as drivers were dropping off pedestrians. After the pope’s landing, city traffic was almost free flow on major arterials or the ring road around Juárez (see Figure 38). This is not the case on regular weekdays, partly because the school districts and maquiladoras were closed on the day of the papal visit. People who attended the mass event could make use of the free mass transit locations all over the city. Furthermore, for those who did not manage to get a mass event ticket could tune to a local channel for live coverage of the event.

Figure 37. Slight Congestion prior to the Pope’s Arrival – Southwest Region.
Researchers observed that most traffic congestion occurred after the mass event. After 6:00 p.m. (MST), major arterials and highways throughout the city started to show signs of traffic build-up. As shown in Figure 39, around 7:00 p.m. (MST), Avenida de las Americas going south experienced sluggish speeds. One of the main reasons behind the observed conditions is that this avenue provides direct access to Federal Highway 45 (i.e., Panamericana), which travels to the heart of the metropolitan area. After 8:00 p.m., congestion spread to major arterials like Avenida de la Raza and Ejército Nacional as well as some portions of Federal Highway 45 near the BOTA LPOE (see Figure 40). The congested condition on the aforementioned avenues was observed until approximately 10:00 p.m. Afterward, the traffic had dissipated all around, as shown in Figure 41.
Figure 39. Post Mass Event Traffic Congestion on Avenida de las Americas near BOTA LPOE.
Figure 40. Post Mass Event Traffic Congestion on Major Arterials and Federal Highway 45.
Figure 41. Post Mass Event Traffic Dissipation All over the Urban Sprawl after 10 PM
CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

Researchers performed a simple analysis that can capture the demand and supply impacts of a special event (papal visit) on the U.S.-Mexico border. In anticipation of major gridlocks and pedestrian influx, all the agencies in El Paso took proactive measures and coordinated the efforts. This study and other studies in the literature have confirmed that demand and supply interaction during special events can also lead to unexpected low congestion. In this case, the real and perceived supply constraints for traffic (multiple road closures, long lines at the border crossing) led to the low usage of private cars compared with average weekend or weekday. People relied on public transit and walking, while many may have chosen to watch the televised event at home. Further, closure of schools, universities, state and local agency offices in El Paso and manufacturing hub in Juárez resulted in few commuters and low commercial vehicle traffic. These all above-mentioned facts led to a lower demand than anticipated on the day of papal visit; the sudden spike in pedestrian traffic before and after the event seemed manageable at the border crossing.

Researchers saw congested traffic conditions only during early morning at BOTA and before the mass near Sun Bowl Stadium in El Paso. The congestion was also observed next day after the papal visit because of commuter traffic interaction with commercial vehicles and returning traffic from Juárez.

Some recommendation to the agencies involved in managing special event will be to develop a demand responsive incremental approach for implementing countermeasures and staffing. A flexible approach may be more cost-effective way of addressing a special event given the demand uncertainty and possibility of low traffic on the border crossing on the day of a special event.

The novelty of the work is multifaceted; as it was a rare opportunity to study a mega event on a congested border crossing in the United States, researchers employed big data analytics for understanding performance of major corridors, and advanced pedestrian counters to obtain a complete picture of the impacts of the papal visit on El Paso’s transportation system. This work is original and timely as the congestion on the U.S. border has been increasing in the past decade and security is being tightened. Any failure to manage demand during a special event can have a cascading effect on the already constrained infrastructure of El Paso and wait times at the border crossing. This study was the first step toward measuring the resilience of infrastructure at a border city during a special event, which provides a long-term value.

The developed methodology and comprehensible results will be useful for City of El Paso, TxDOT, CBP, and Sun Metro to manage a similar special event at the same scale. The data collected were consistent with typical data collected by these agencies and will be shared to assist in coordinating next special event. Some of the results of the study will be used to model the impact of closures on weekday traffic.
REFERENCES


