EAST END DISTRICT IMPACT STUDY

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Table of Contents

Executive Summary

Overview

The East End Impact Study examines the effects freight train railroad crossings, and specifically blocked crossings, have on businesses located in the East End District Management District, a premier area in the southeast side of Houston, TX.

This research considers the sixteen square miles and nine zip code areas that are part of the East End Management District. Locales included complete or parts of the neighborhoods of Eastwood, Second Ward, Fifth Ward, Denver Harbor, Magnolia Park, Harrisburg/Manchester (Port of Houston), Pecan Park, Idylwood, and the Gulfgate Communities. Over the last year, the Rail Safety Task Force (comprised of representatives from the East End District, the City of Houston, and other stakeholders) has discussed the ubiquitous problems that freight trains produce in this community. According to the Houston Landing, stopped trains are common in the East End District. Additionally, "Houston Fire Department Chief Samuel Peña says that as recently as two months ago, his department experienced, on average, "96 instances a month where our crews were either delayed or they had to reroute because of blocked crossings." The obstructions added up to 10 minutes to response times."

Data for this study were provided by Trainfo[1] for ninety-four crossings within the East End District, measuring train blockage time, train blockage length, and the number of vehicles impacted on an hourly and daily basis. From this assessment, we identified which crossings created the most blockages, thereby causing traffic congestion, and possibly hindering business economic activity. We then collected data from Data Axle that yielded over 6,000 businesses in the East End District and conducted a regression analysis. Thereafter, a regression analysis was performed to observe a relationship between the number of crossings within a half-mile radius and sales volumes. The regression analysis

[1] https://trainfo.ca/

confirmed that vehicle delays, proximity to railroad crossings, and blockages correlated with decreased business sales

In addition, we administered a survey to businesses in the East End District to ascertain perceptions of blocked rail crossings on business activities. The survey quantified the business owners' perceptions of the railroad crossings, how railroad crossings impacted their businesses, and if those businesses within the same zip code of crossings with frequent blockages contributed to unfavorable business experiences. With the survey we found that of the fifty-four respondents, 36 at 67% were from those severely crossing zip codes (77003, 77011, 77023), revealing those respondents are answering the survey because there is an urgent need to come to an expedient response (see **Table 1**).

Table 1 Tabulation of Q7 What is the zip code for your business?

Zip code of Business	Freq.	Percent	Cum.
77002	3	5.56	5.56
77027	1	1.85	7.41
77011	8	14.81	22.22
77029	3	5.56	27.78
77003	15	27.78	55.56
77012	2	3.70	59.26
77023	13	24.07	83.33
77021	1	1.85	85.19
77020	5	9.26	94.44
77087	2	3.70	98.15
77547	1	1.85	100.00
Total	54	100.00	

The survey found that a majority of respondents favored regulation to prevent train blockages over a certain amount of time or construction to separate freight transportation and non-freight transportation.

The survey found that a majority of respondents favored Overpasses and Underpasses. Thus, based on those results, we propose the following solutions:

- Replacing at-grade crossings with[2]
    - Overpasses/Underpasses

[2] https://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_320.pdf

    - Trenches
    - Elevation
    - Tunneling
    - Capping
- Symmetrical communication with all stakeholders (transparency)
    - Freight providers and community engagements
- Software applications enabled to detect train stalls in real time
- Continued maintenance of infrastructure

It is our recommendation that a structure such as an overpass or underpass is constructed at one of the severe crossings identified in this report. After construction, an analysis should be conducted in ensuring that an overpass or underpass is the best fit for mitigating traffic congestion at that location. Furthermore, if that location supplies positive results, construction should continue at other severe locations.

1. Introduction & Background

1.1 Introduction

Historically, railroads were one of the first modes of transportation in our nation, not only to transport people but to deliver goods across state lines. However, over the years, deficiencies within the freight network have increased as its capacity has grown–resulting in extended train durations, increased noise attributed to the movement of freight, delays in train schedules, and a lack of communication between freight companies. “Today, the freight network is rife with substantial grade crossing delays, a direct result of railroads’ implementing an operating model that has increased train lengths and congested lines” (Surface Transportation Board 2023).

We’ve all experienced long delays caused by trains and know the frustration and anxiety it can cause. Moreover, these delays may impact public safety and security, increase traffic congestion, strain mobility options, and limit access to quality of life. Of the 50 states, Texas ranks #1 with reported blocked trains. According to the 2021 Federal Railroad Blocked Crossing Database, Texas has 2,882 blocked trains. Of that number, 1,353 are in Houston with a little over 600 being in the East End alone (Federal Railroad Blocked Crossing Database 2021). Unfortunately, without major changes to the operating model by railroad companies or sufficient policies and solutions to mitigate these railroad crossing delays, residents and the traveling public will continue to be inconvenienced and rail companies will continue experiencing service disruptions.

The East End, a historical neighborhood in the city of Houston is inundated with railroad crossings in close proximity. With daily extended grade crossing delays, employers and employees in the East End who travel by vehicle or public transit experience major setbacks when trying to commute to and from work. Some employers pose that as a major challenge for operating a business in the East End despite the opportunities to take advantage of its location, development opportunities, and population boom.

The data presented in this paper aims to introduce infrastructure, technology, and policy solutions that provide relief to residents and the traveling public in the East End who are adversely affected by delays attributed to the movement of freight within the region,

while also prioritizing the operations of the freight network. Specifically, this paper will focus on the economic impact on East End businesses—many of which are small businesses that rely heavily on their employees and patrons to keep their doors open.

1.2 Research Question

What solutions and/or policies may be implemented to mitigate traffic congestion, delays to first responders' response times, and business disruptions in the East End caused by blocked railroad crossings?

1.3 History of the East End District

Located in Houston, Texas, the East End is in the heart of the historic Second Ward and Magnolia Park. The district is home to Houston's early history and industrial companies. It consists of several ethnic groups, including Hispanic, Asian, White, and African American, while Latinos make up more than half of the over 100,000 residents (The East End 2023). The area is a culturally diverse residential area known for its thriving art scene, rich Latino roots, restaurants, and green space. With its close proximity to major interstates, including I45 and 610, and direct access to downtown, the East End serves as a desirable location for residents and businesses. However, in order to safeguard the heritage of this area while taking advantage of growth opportunities, "The East End Management District was created by the 76th Texas legislature and signed into law by Governor George W. Bush on May 10, 1999" (Gibbens 2007). The district is governed by a Board of Directors composed of East End commercial property owners, business owners, and residents that are able to fund infrastructure improvements, beautification projects, security and public safety, workforce development, and other special programs based on assessments from commercial property owners.

Since its inception, the East End Management District in collaboration with the city of Houston has been responsible for transitioning from industrial building sites and railroads to recently remodeled parks, farmer's markets, condominiums, restaurants, METRORail, bike trails, and small businesses (The East End 2023). Like other urban and fast-growing cities, Houston is experiencing high rates of development, but without zoning restrictions, new development is intersecting with old infrastructure like railroads, causing immense challenges for residents, businesses, motorists, and pedestrians to thrive. In the midst of the

area's makeover, it continues to be a major hub in and out of the city of Houston for freight trains to transport bulk commodities such as chemicals, energy products, construction materials, metals, oil, and other supplies (Association of American Railroads 2020). The East End has sixty percent (60%) of the 124 freight trains in Houston, making this vital area in the eastern quadrant of Houston challenging for pedestrians, drivers, cyclists, and emergency vehicles (Berryhill 1997). Moreover, residents have voiced their grievances with the extended delays experienced daily at railroad crossing sites. According to the Houston Chronicle, "Residents and business owners in Houston's East End and Fifth Ward communities vented their frustration Thursday over stopped trains blocking major intersections, creating traffic jams as drivers wait—sometimes over an hour—for a train to clear the crossing" (2023). This inconvenience affects safety, mobility, traffic patterns, emergency services, economic impact, and quality of life. However, city leaders, East End management district, residents, business leaders, and academia are committed to creating a model where revitalization and the freight network can coexist efficiently.

1.4 Texas Rail System

Texas has over 10,000 miles of track. Texas has three Class I freight railroads and fifty-five Class III freight railroads.[3] The stakeholder for Class I freight railroads includes BNSF Railway, Kansas City Southern Railway, and Union Pacific Railroad. Union Pacific Railroad owns and operates the most rail tracks in Texas, owing 5,000 miles of track and operating over 6,000 miles of tracks.[4] According to the Surface Transportation Board "Class I carriers are those that earn revenue more than $943.9 million and Class III carriers are those that earn less than $42.4 million.[5] Class III or short line railroads are smaller railroads that run shorter distances and connect shippers with larger freight networks.[6]

Union Pacific is the dominant freight railway in Houston and the East End District. This is significant because the East End has dealt with issues of train blockages, which has been a topic of great importance for stakeholders locally and federally. According to

[3] AAR-State-Rankings-2019, https://www.aar.org/wp-content/uploads/2021/02/AAR-State-Rankings-2019.pdf
[4] Texas Freight 2021 data. https://www.aar.org/wp-content/uploads/2021/02/AAR-Texas-State-Fact-Sheet.pdf
[5] Surface Transportation Board. https://www.stb.gov/reports-data/economic-data/
[6] Texas Rail Plan Executive Summary. 2019https://ftp.dot.state.tx.us/pub/txdot-info/rail/texas-rail-plan-executive-summary.pdf

Click2Houston, Union Pacific's Senior Director of Government Affairs, Richard Zientek, stated, "They would work with the community and area leaders to develop a solution for the blockage.[7] Congresswoman Sylvia Garcia has introduced H.R. 1347, Don't Block Our Communities Act. This bill sets out to prohibit a railroad carrier from stalling for more than ten minutes unless there is a casualty or serious injury, accident, or track obstruction. Any railroad carrier that has had three blockages within a month, must present evidence explaining why the incidences occurred.[8] Texas Transportation Code "§ 471.007. Obstructing Railroad Crossings" limited railroad crossing blockages to 10 minutes.[9] Violating railway companies were charged with a misdemeanor offense and were subject to fines ranging from $100 to $300.[10] In 2001, the Fifth Circuit Court of Appeals ruled that "states lack authority to enforce time limits on blockages."[11] Consequently, Section 471.007 was removed in 2005 by then-Attorney General Greg Abbott, in his opinion Attorney General Abbott stated that "Section 471.007 of the Texas Transportation Code is preempted by the federal Interstate Commerce Commission Termination Act of 1995 and the Federal Railroad Safety Act."[12] As of 2021, the Federal Railroad Blocking Database reports over 2800 blocked crossings in Texas.

1.5 Economic Benefits of Texas Freight Rail

Not all freight railway concerns are negative. The annual freight rails boast approximately 122,000 jobs and $8.7 billion in labor income.[13] The Houston District boasts approximately 12,000 railways jobs.[14] Freight trains produce less greenhouse gas emissions, less congestion on the highways, and a better safety record.[15] For example, it would take

[7] Click2Houston. https://www.click2houston.com/news/local/2022/04/22/business-owners-in-houstons-east-end-fifth-ward-say-stalled-trains-are-costing-them-money/
[8] H.R.1347 - D-BLOC Act. https://www.congress.gov/bill/118th-congress/house-bill/1347/text
[9] Texas Transportation Code Chapter 471. Railroad and Roadway Crossings. https://law.justia.com/codes/texas/2005/tn/006.00.000471.00.html
[10] Ibid
[11] Texas Department of Transportation. Rail frequently asked questions (txdot.gov)
[12] Texas Attorney General. Greg Abbott Opinions. https://www.texasattorneygeneral.gov/sites/default/files/opinion-files/opinion/2005/ga0331.pdf
[13] The Economic Role of Freight Rail in Texas.https://ftp.dot.state.tx.us/pub/txdot/move-texas-freight/resources/economic-rolefreight/economic-impact-freight-rail.pdf
[14] The Economic Role of Freight in the Houston District. https://ftp.dot.state.tx.us/pub/txdot/move-texas-freight/resources/economicrole-freight/freight-houston.pdf
[15] Texas Rail Plan Executive Summary. 2019https://ftp.dot.state.tx.us/pub/txdot-info/rail/texas-rail-plan-executive-summary.pdf

385 trucks to transport the same amount of freight as only 100 freight train cars.[16] To better understand the freight railway systems, we have to investigate what type of freight is transported into Texas. According to the American Association of Railroads, shippers currently use rail to move approximately 380.8 million tons of freight in Texas. The United States Department of Transportation Bureau of Transportation Statistics estimates that statewide rail tonnage will increase to approximately 421.8 million tons by 2040.[17]

Texas transports the following via freight rail: chemicals, non-metallic minerals, petroleum, intermodal, primary metals, and others. These products total over 2 million carloads for 2021.[18] The question to ask is how can both communities and freight trains work together in harmony.

[16] Ibid
[17] Texas Department of Transportation 2023-2024 Educational Series, Rail and Safety, https://ftp.txdot.gov/pub/txdotinfo/sla/education_series/rail.pdf
[18] Texas Freight 2021 data. https://www.aar.org/wp-content/uploads/2021/02/AAR-Texas-State-Fact-Sheet.pdf

2. Literature Review

2.1 Class I Railroads

The Class I freight railroads are divided up into three types of services, Intermodal, Manifest (or carload), and Unit Train services. Intermodal is defined as trains that carry shipping containers between rail terminals then the shipping containers are transported by truck between rail terminals and shipper locations.[19] Intermodal services are those most in competition with freight truck services. According to the Texas Rail, "Texas is home to approximately 20 intermodal rail facilities, concentrated mostly in the eastern portion of the state. BNSF and UP operate intermodal facilities at the Port of Houston, which is the number two seaport, by volume (tonnage), in the U.S" (p.2-3).[20]

The issues that intermodal cars present are mostly if not all double-stack cars and must adhere to a strict schedule, and very costly to build maintain, and operate.

Manifest or carload transports goods via rail from the shipper to the receiver in a smaller amount. Manifest trains stem from a variety of cars including boxcars, flatcars, hoppers, gondolas, and other specialized cars with different commodities traveling to different locations. The issue with Manifest trains is that the service is slow since they must be separated between trains at classification yards.[21]

Contrary to Manifest service, Unit Trains are a little faster. Unit trains are a service provided by Class I railroads and carry only one commodity to a single shipper and receiver. Unit trains are also used for large volumes of coal, grain, automotive, and sometimes oil.

Although Texas has only three Class I's, since they are required to adhere to a strict schedule, the intermodal service could be the most beneficial to the traffic-congested communities including the East End District.

[19] Texas Rail Plan Executive Summary. 2019https://ftp.dot.state.tx.us/pub/txdot-info/rail/texas-rail-plan-executive-summary.pdf
[20] Ibid
[21] Ibid

2.2 Class III Railroads

Most of Texas' rail roads are Class III railroads. Class III railroads are private. According to the Texas Rail Plan, "Class III railroads usually engage in specialized services and are typically geographically concentrated. One characteristic of short lines is that they may be privately owned to serve only a specific company or industry" (p.2-9).[22] The Port Terminal Railroad Association (PTRA) operates Class III. Through mergers and acquisitions, the PTRA today is an Association of the Port of Houston Authority of Harris County, Houston Belt & Terminal Railway Co. It is funded by UP, BNSF, and KSCR. The PTRA operates seven rail yards.[23] They are the North Yard, Storage Yard, American Yard, Penn City Yard, Manchester Yard, Pasadena Yard, and Old City Yard. The North Yard lies just east of Wayside Drive between Market Street and Clinton Drive.[24] In Houston's East End District, Wayside Drive reports 32,000 vehicles crossing the train tracks per day.

Research shows supporting evidence that Class I freight trains are mostly responsible for train blockages and causing traffic congestion. Evidence also revealed support that Class III trains cause additional traffic congestion because of the proximity of the PTRA to the East End District and its busy roads as seen in **Figure 2.1**.

Figure 2.1 North Yard

[22] Ibid
[23] About Us," https://www.ptra.com/index.php/about-us/ptra-yards.html
[24] https://www.google.com/maps/place/NORTH+YARD/@29.7596832,-95.2958421,17z/data=!3m1!4b1!4m6!3m5!1s0x8640bd3e78eaa393:0x4ba4db1a4cdeb2db!8m2!3d29.7596786!4d-95.2932672!16s%2Fg%2F11rkp7kvv2

2.3 Houston Rail System

With over 1300 blocked railroad crossings reported in the East End[25]; it is reasonable to conclude that freight trains have frustrated the Houston community. One can imagine with that volume of vehicles how much traffic congestion a blocked train could produce. Trainfo demonstrates that over 20,000 vehicles are affected in the East End District due to train blockages. Houston is a hub for six rail lines for UP. The North Yard on average receives fifty-two trains and departs thirty-four trains per week.[26]

2.4 Decreasing Freight Congestion

According to the National Cooperative Highway Research Program (NCHRP) Synthesis 320 (2003), two of the issues of freight rail traffic include traffic congestion and facility, which disrupts economic activity analogous to the East End District. The NCHRP Synthesis 320 illustrates examples that have shown success in cities across the United States.[27]

- The Express Rail overpass at Port Newark/Elizabeth, 2002
    - Completed a rail overpass (Elevation) in 2002
    - Initially rail traffic would interfere with the truck road, causing substantial delays
- The Freight Action Strategy for Seattle-Tacoma (FAST) Corridor, since 1998
    - 19 projects have been completed to eliminate almost all of at-grade crossings in this corridor, with more projects to come.
- The Alameda Corridor, connects Los Angeles and Long Beach ports
    - Eliminated 200 at-grade intersections
    - Improved freight rail flow, improved traffic flow in the area, and enhanced economic development

Schnabel & Brasseur (2011) proposed numerous methods to remedy concerns stakeholders have in their community with freight railroads. They commenced their study

[25] U.S. DOT Federal Railroad Administration. Blocked Crossing Data. https://www.fra.dot.gov/blockedcrossings/incidents
[26] About Us," https://www.ptra.com/index.php/about-us/ptra-yards.html
[27] National Cooperative Highway Research Program Synthesis 320 https://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_320.pd

by surveying all the stakeholders involved. They then recommended numerous solutions to accommodate both the freight rails and the community. Solutions included building a bridge, or a tunnel, capping, and elevation. Schnabel & Brasseur (2011), state capping is the development of the air rights above another use with a new structural platform that supports additional development. It allows the existing ground-level activities to continue while offering significant new development opportunities above. In other capping projects, this development has included parks, civic buildings, and commercial activities (p.1).

Gorman (2009) in a regression analysis, states the main factor contributing to congestion in regard to freight trains is due one train passing or overtaking another train. What Gorman's analysis revealed is that not only does the train that that the overtaken train causes delay as well as the passing train. This revealed empirical evidence of costs related to train speed.

Taslimi et. al (2022), concludes that time delays are caused by "resource-related factors." This affects time travel approximately 80 percent of the time (p.686). Hiring efficiently appears to be an issue as well as the workload to sustain the strict schedules. These articles reveal a lingering effect on communities that may continue to persist without policy intervention.

Vromans (2006) concludes congestion is decreased when trains are distanced about an hour away from each other and when the train traffic is homogenous. Vromans (2006) also states that delays stem from having to share the same infrastructure, employee schedules, dispatching, and even when a train has to transfer to a truck or another train can cause delays.

Van Thielen et al. (2018) proposed a model that includes a rerouting program that finds alternate routes. In order for the rerouting to be successful, a train can be dispatched on a route. If a more efficient solution is found, it is executed. Another proposal by Van Thielen et al. (2018) is reordering the conflicting train or delaying it.

Delays also incur costs Gedik et al. (2014). According to Lovett, A. H. et al. (2015) the longer the route of a freight train, the more costs are incurred per hour. For instance, if the route of a train is 500 miles and it is stalled for 2.5 hours, it would cost that train approximately $12,640. As a result, it would be in the best interest of stakeholders of the

East End Business District as well as the Class I stakeholders should find ways to decrease delays.

2.5 Impact of Railroad Crossings

Sullivan (2018) states that blocked railroad crossings restrict the growth in the community by decreasing the number of individuals wanting to rent homes, fewer homes are built, local businesses' revenue decreases, and customers limit their frequency to businesses due to the fear of being detained by stopped trains. Thomas (2022) also echoed the same sentiment as Sullivan (2018) in that blocked railroad crossings hurt small businesses, it is responsible for driving away patrons and causing employees to be late for work. Bartholomew et. al (2014), identified how freight railways were a disruption to the community. The community issues included noise, disruption to air quality, and the impact of how the rail lines have divided their community. Additionally, according to the Trainfo scorecard, the East End District has over 1,200 blocked crossings per day with over 20,000 vehicles affected per day with a delay of 1.36 hours.[28] The Trainfo data is significant because it describes the same issues of the concerns the East End stakeholders have.

The East End Impact Study produced over 6,000 businesses in the East End District, implying those 6,000 business owners believed that their businesses would thrive because of what the East End offers, but if 20,000 vehicles are affected per day, how are businesses in the East End District expected to thrive?

Karakaya, F et. Al (1998) states a few reasons a particular location is chosen by business owners, is for the availability of skilled labor, transportation facilities, and access to highways. Furthermore, Płaziak, M et al. (2014) report that a business owner looks for IT infrastructure, academic centers, banks, the capital market, and the culture and history of a location.

The East End embodies a culture that businesses are attracted to. This district is sparking hope among proponents that the area will be a model nationally for how to turn

[28] Trainfo. https://app.powerbi.com/view?r=eyJrIjoiYmJjZmQ3MjYtOGY5Ni00NWYzLWFjMzMtMDQzMzVhMWUxMDI3IiwidCI6IjE3MDU1YzFjLTE3ZjktNDgxNS05ODVjLWJjMTBhZGI3MjNiNyJ9

a traditionally industrialized area into a sustainable, urban district while maintaining its historic character.

In order for the East End District to preserve its business development and its continued growth, there should be a sense of urgency to fix the blockage plaguing a historic region of the fourth largest city in the United States.[29]

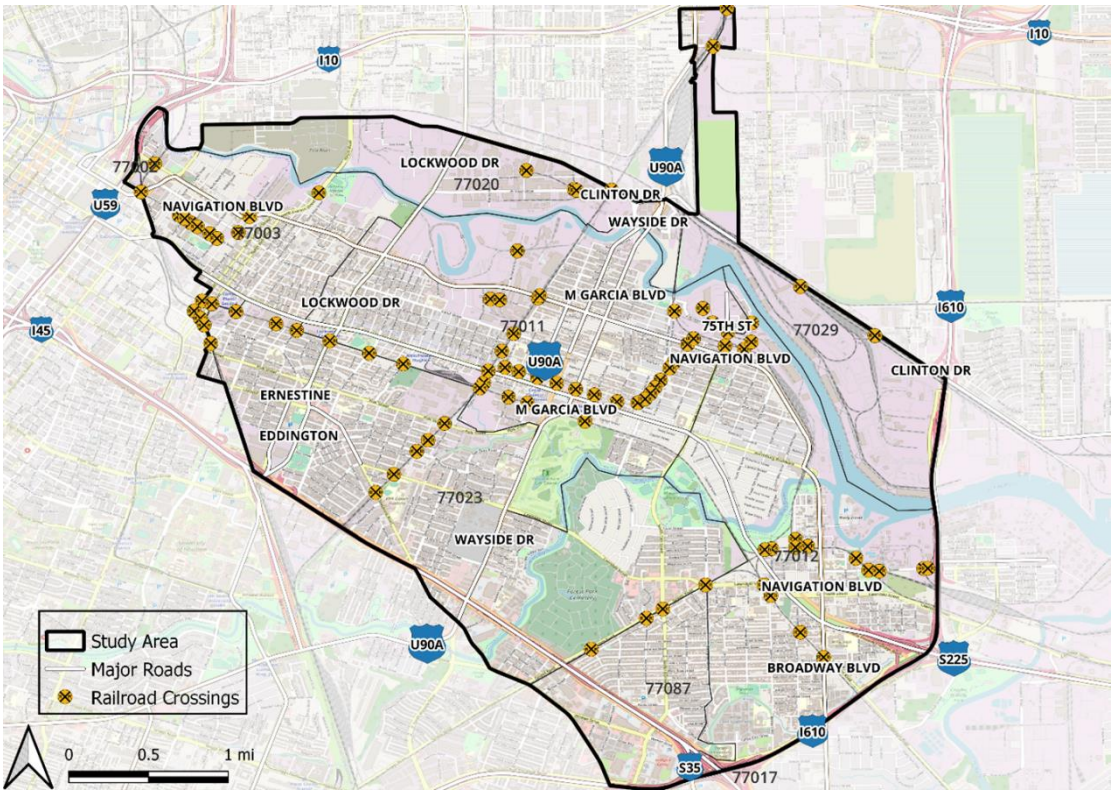
[29] About Houston, https://www.houstontx.gov/abouthouston/houstonfacts.html

3. Research Design

3.1 Railroad Crossings

The East End Community has a plethora of railroad crossings that not only affect the surrounding communities and their businesses, but also affects commuters and pedestrians that use these roads. **Figure 3.1** details the location of railroad crossings in the East End District. This study will examine 94 railroad crossings scattered throughout the East End District, although there are hundreds of crossings in our study area, we excluded those that are located within private property (e.g., Port of Houston property), inaccessible to the public.

Figure 3.1 Railroad Crossings



3.2 Business Impact and Traffic Delays

Traffic delays are exacerbated by freight railways and are a constant complaint by the community. The remedies to this issue could be adjusting the railway hours, and manufacturing an above-grade or below-grade crossing railway. Above grade crossing is a freight train that travels above the traffic and never interferes. A below-grade crossing is a

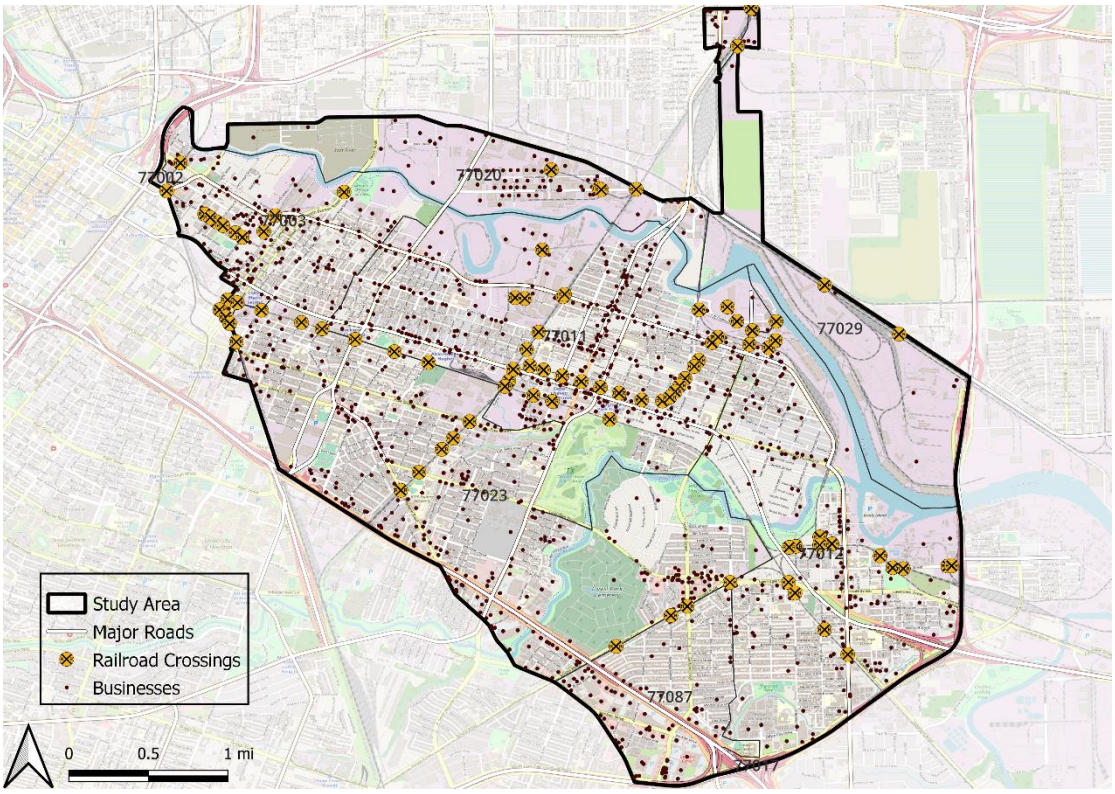
freight train that travels below the traffic and does not interfere with traffic. These suggestions can optimize travel for traffic and emergency vehicles as well.

Businesses could also benefit from the aforementioned suggestions. Some concerns with freight railways include trespassers on the freight railways entering into their city, noise, and traffic congestion that affects patrons, deliveries, and employees. Implementing a strategic model that most stakeholders can agree with appears to be the most pragmatic solution. We can expect the same issues and concerns from the East End District community after they have been surveyed.

In order to accurately measure the economic impact on businesses in the East End District due to railroad-blocked crossing events, a survey was created to determine the effects on businesses, customers, deliveries, and other services. Survey participants include the East End Management District and East End Chamber of Commerce members who hold substantial equity in the area, while also providing services and amenities to residents and businesses in and around the East End. We believe their perspective would yield the most tangible evidence of economic impact. The survey is approximately 5 minutes. Participation is completely voluntary, and answers will be confidential. (Locate survey in Appendix). The East End Chamber of Commerce has since mailed at least 2,300 business owners the survey.

Figure 3.2 below illustrates the location of East End businesses and their proximity to railroad crossings. We're able to see that businesses located in the center of our study area are more likely to be affected by trains as they are surrounded by railroad crossings located at all of its entrances and exits.

Figure 3.2 East End Businesses



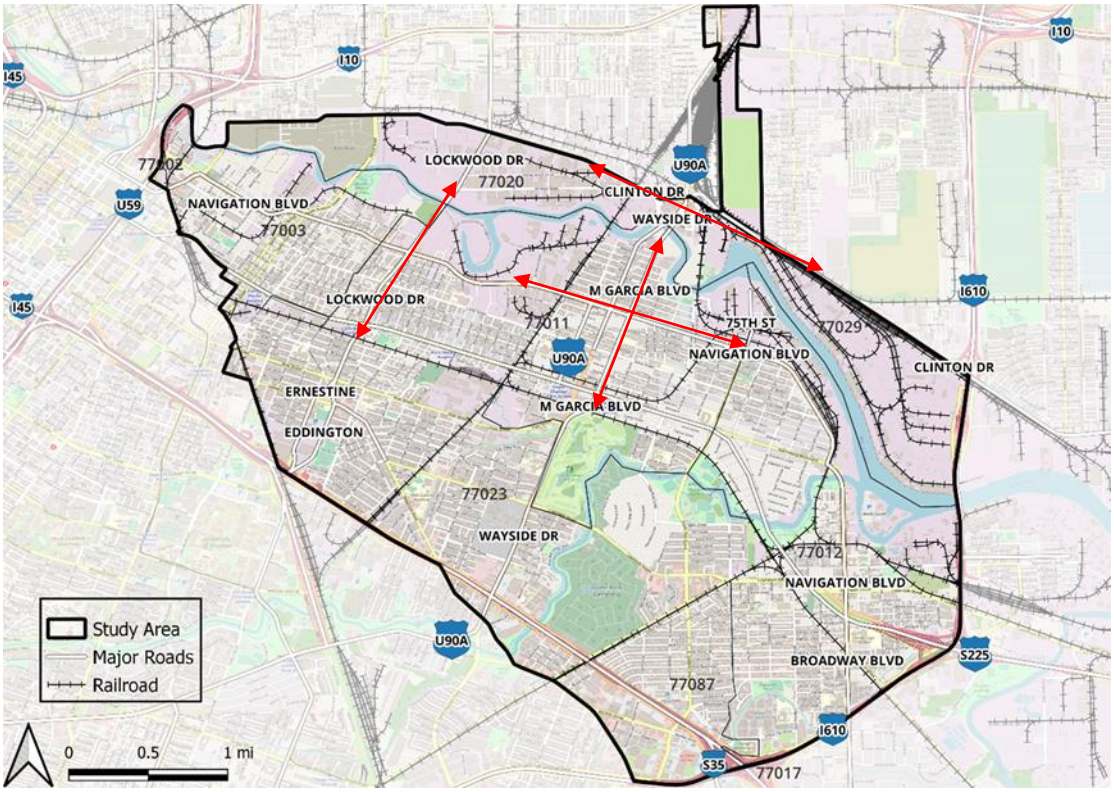
3.3 By-Pass Roads

These railroad crossings present challenges to drivers that use these roads by creating traffic delays that not only affect drivers but people living in these communities that can't leave their homes as a result of trains. The railroad crossings in the study area are at-grade crossings, meaning that they are leveled with the road. If a train is traveling through the railways, traffic will be unable to proceed as a result. This is a major problem for the community as these roads are typically used as shortcuts.

Figure 3.3 details the major roads and highways in and surrounding the community, as well as the railway system that runs through the East End District. These roads are used to bypass the traffic along the interstates, but ultimately cause traffic in the community. Drivers can use roads like Lockwood Dr., and Wayside Dr. (US ALT 90) to avoid traffic or as a by-pass (North-South) to reach I10 from I45 or vice versa. Drivers can also use Clinton Dr. (East-West) to reach I610 East from US 59, and I10. Additionally, Navigation/Broadway Blvd. (East-West) can be used to reach S225 from US 59 and I10. The problem is not drivers using these roads as shortcuts, the problem is that drivers are unaware of what is going on in the

roads. Some roads may be blocked by trains and unexpected drivers will continue to use them, backing up traffic and increasing delay times.

Figure 3.3 Bypass Roads



3.4 Community Services

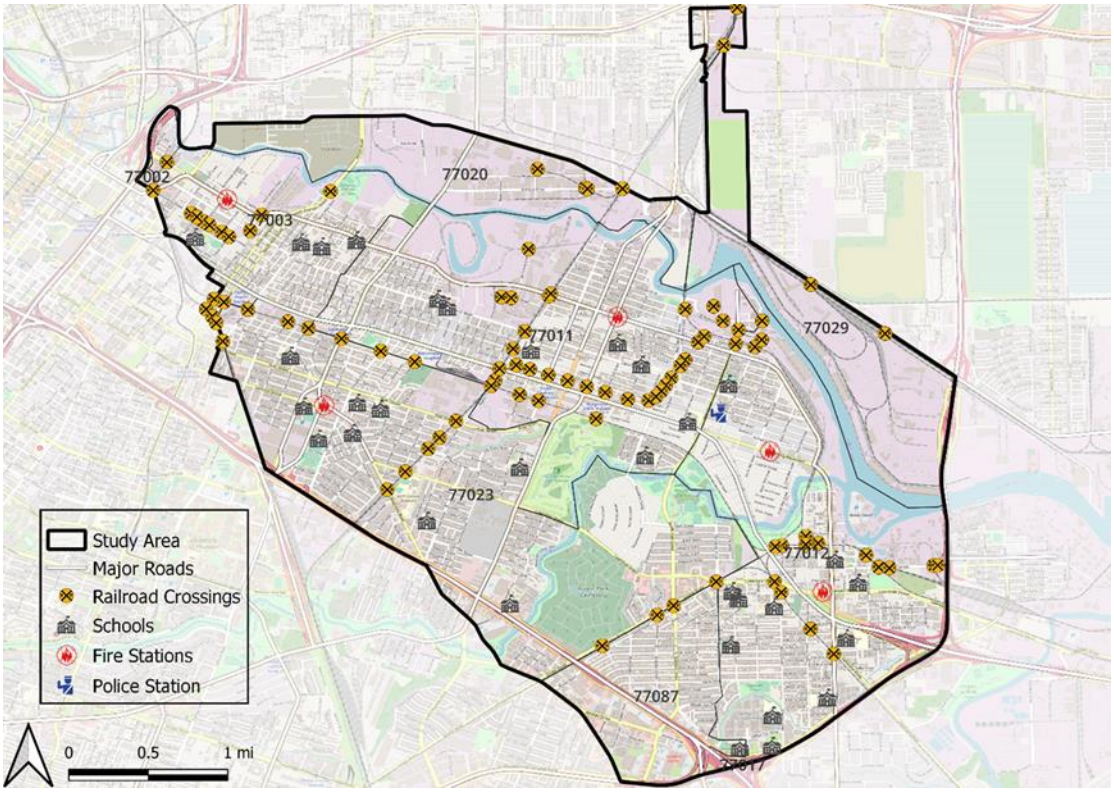
The East End District has one police station and five fire stations that are affected by trains on a daily basis. Population in the East End community has been increasing as new homes continue to be built, which increases the demand for these services. Stalled trains cause delays and traffic that ultimately affect these EMS services, since 2019 the Houston Fire Department logged 3,200 detours as a result of blockages caused by trains (Begley, 2022). These trains often cause lines of traffic even in areas without railroad crossings that eventually affect EMS responders when they receive calls. Trains cause problems when responders because every minute counts and trains could ultimately decide whether someone lives or dies.

The study area is also home to thirty-two schools that are also affected by railroad crossings. These crossings can affect bus routes, which will have an effect on the times students arrive and depart schools ultimately impacting the academic performances of students. Stalled trains near schools pose the threat of students walking under trains to

reach their destinations. This is a major problem because trains can be deadly once they get moving.

Figure 3.4 details the locations of schools, fire stations, and police station and their proximity to the railroad crossings. For example, Fire Station 18 (located towards the Southwest of the study area) is severely impacted by railroad crossings based on citizen and HFD complaints (Desselle, 2023). Fire Station 18 has two main routes when they receive a call, North through Lockwood and Southeast to Lawndale via Telephone. Most if not all Fire stations are surrounded by railroad crossings which affects response times and leads to detours, if possible, while sometimes there are no alternatives and EMS must wait for the trains to go by.

Figure 3.4 Community Services



4. Survey

4.1 About

The Hobby School of Public Affairs in partnership with the East End Management District and the East End Chamber of Commerce is conducting a survey to understand the impacts of blocked railroad crossing events. The goal of this study is to understand how railroads, and blocked railroad crossing events, affect your business, customers, deliveries, and other services.

This section outlines solutions proposed in the business impact survey by members of the East End Management District and East End Chamber of Commerce.

In order to accurately measure the economic impact on businesses in the East End District due to railroad-blocked crossing events, a survey was created to determine the effects on businesses, customers, deliveries, and other services. Survey participants include the East End Management District and East End Chamber of Commerce members who hold substantial equity in the area, while also providing services and amenities to residents and businesses in and around the East End. We believe their perspective would yield the most tangible evidence of economic impact. The survey is approximately 5 minutes. Participation is completely voluntary, and answers will be confidential. (Locate survey in Appendix).

More than 2,300 surveys mailed, we received fifty-four responses. **Figure 4.1** illustrates the preferences of those business owners.

Possible Solutions may include:

- Overpasses
- Underpasses
- Restrictions on train length
- Restricted times when trains can operate through East End
- Constructions of bridges wide enough to allow for development and green space on top ("capping")
- Bypass signage (way-finding signage
- Signage with wait times

- Quiet hours
- Regulation on how long a train can block a crossing
- Construction of walls between freight yards and adjacent uses ("walling")
- Other (please specify):
- 4.2 Results

Pulling from the previously mentioned data sources, nine railroad crossings were identified as severe based on the number of blockages, and vehicles affected per day and hourly. Of the nine crossings, eight (one crossing is an entrance to the Port of Houston) of them are below:

- Sampson St 859516V- 77003
- York St 859517C- 77003
- Lockwood Dr 859523F- 77011
- Dumble 859524M- 77023
- Lawndale 288050B-77023
- Telephone 288051H-77023
- Polk 288039b-77023
- Hughes 288035Y-77023

Table 4.1 Respondents

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Q21Whichofthefollo~i	54	20.019	11.07	1	41

Table 4.1 demonstrates the number of respondents. **Figure 4.1** illustrates that most of the fifty-four respondents want a regulation on how long a train can block a crossing. From the most severe list, we tallied the results from the question on the survey requesting solutions. Of those fifty-four respondents, thirty-six, at sixty-seven percent. Respondents were from zip codes 77003, 77011, and 77023 (see **Table 4.2**). This demonstrates those respondents are answering the survey because there is an urgent need to come to an expedient response. To further confirm the need for a resolution for freight train blockages, the survey results revealed over 65% of patrons were delayed by trains (see **Figure 4.2**)

Table 4.2 Tabulation of Q7 What is the zip code for your business?

Zip code of Business	Freq.	Percent	Cum.
77002	3	5.56	5.56
77027	1	1.85	7.41
77011	8	14.81	22.22
77029	3	5.56	27.78
77003	15	27.78	55.56
77012	2	3.70	59.26
77023	13	24.07	83.33
77021	1	1.85	85.19
77020	5	9.26	94.44
77087	2	3.70	98.15
77547	1	1.85	100.00
Total	54	100.00	

Figure 4.1 Survey Solutions

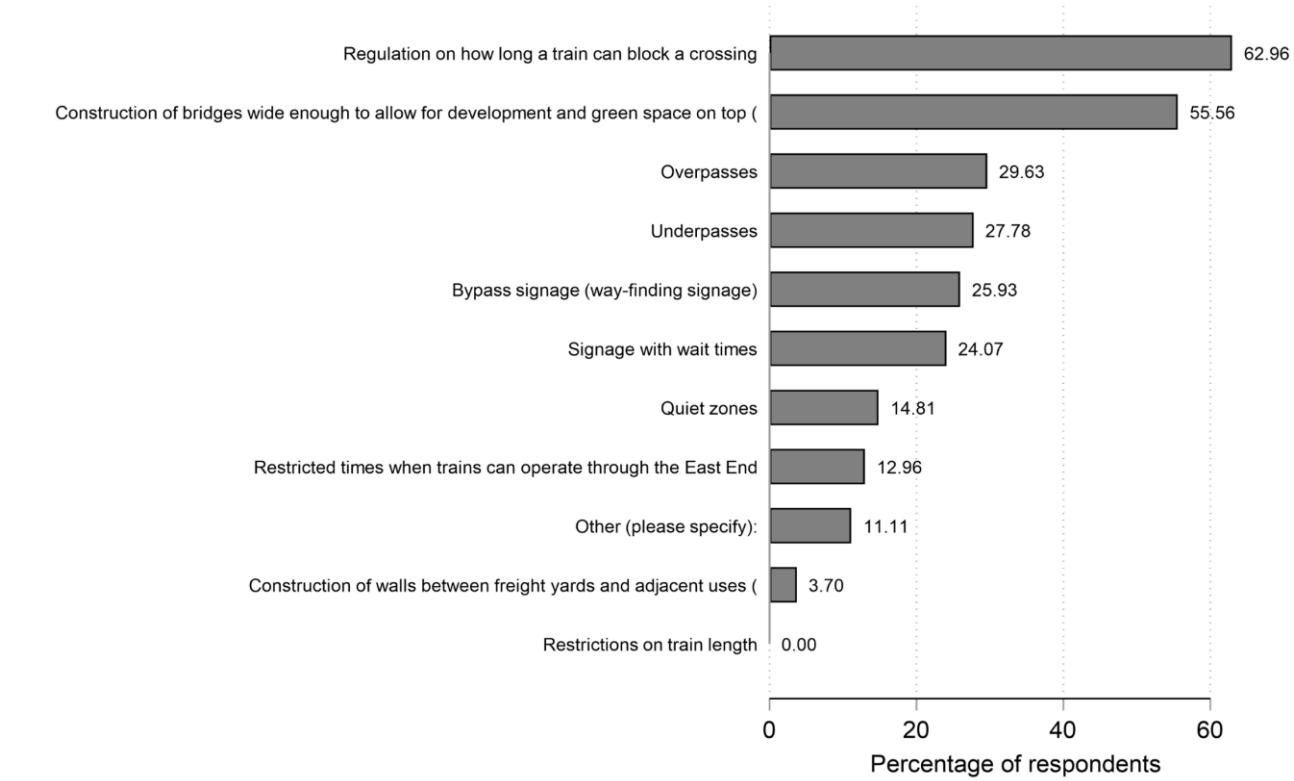
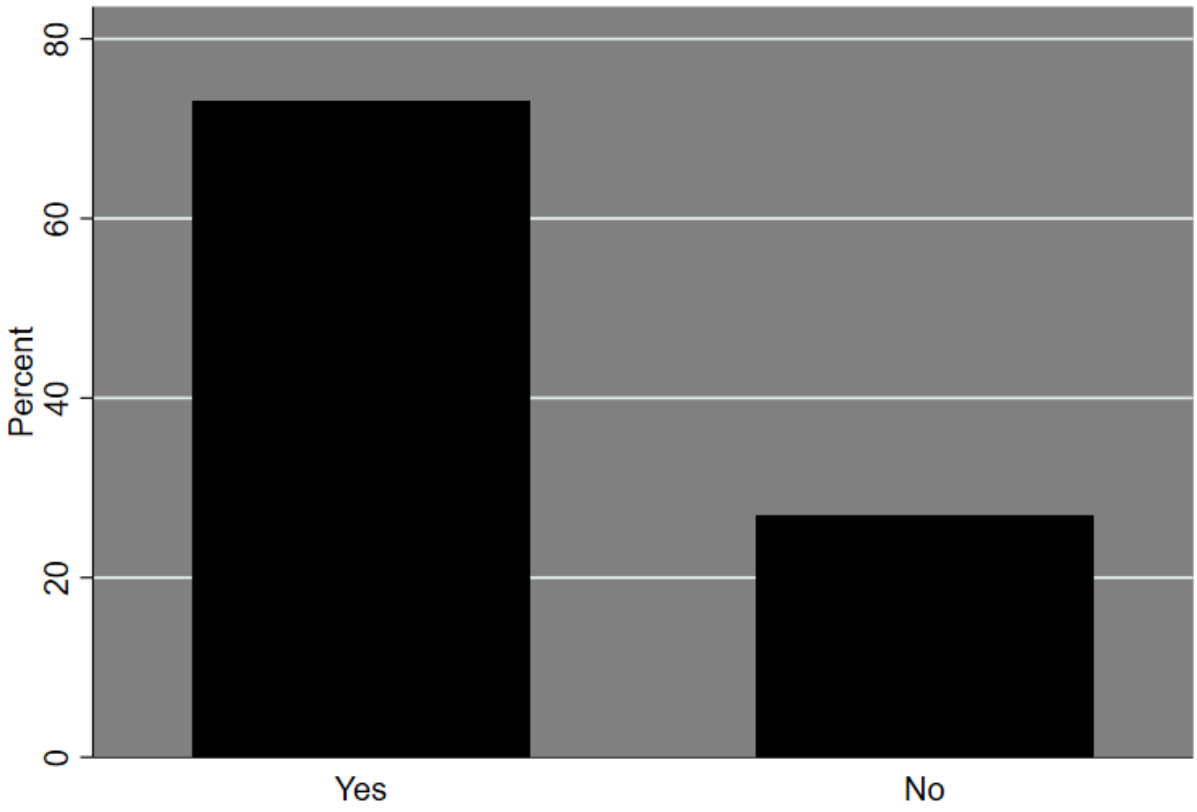


Figure 4.2 Customers delayed by Freight Trains



5. Data and Variables

5.1 Trainfo

The railroad crossings data is provided by Trainfo and is collected by placing sensors near railroad crossings in the East End District. Some railroad crossings have visual sensors, audio sensors, or a combination of both, **Figure 5.1** below illustrates both sensors.

Figure 5.1 Sensors

Visual ***Audio***

The combination of both sensors improves the accuracy of detecting trains when blocking and passing a railroad crossing. The sensors detect trains by listening to horns and bells activated when the crossing "arms" are lowered. The information is gathered by placing these sensors near the 94 railroad crossings located in the East End District. As stated in an earlier section, these 94 railroad crossings are on public roads, we excluded railroad crossings that are located on private roads. The level of measurement for variables from this dataset is the number of vehicles that drive through a railroad crossing. The variables include Cross product, Average Annual Daily Traffic (AADT), Average blockages per day, Vehicles impacted per day, and Average vehicle delay per day (hr.). The variable Cross product measures the number of vehicles that drive through a railroad crossing within a year. AADT variable estimates the daily traffic (vehicles) for a railroad crossing. Average blockages per day estimated the number of times a day a railroad crossing is blocked (train or crossing arms). The Vehicles impacted per day variable measures the number of vehicles that are affected by blockages at each railroad crossing. Average vehicle delay per day (hr.)

estimates the number of vehicles affected by blockages an hour at each railroad crossing. **Table 5.1** below offers a statistical summary of the variables from the Trainfo dataset.

Table 5.1 Summary of Railroad Variables

Variables	*Count*	*Mean*	*Std. Dev.*	*Min.*	*Max*
Cross product	94	38973.94	77860.64	200	368820
AADT	94	2855.33	4616.34	20	30000
Avg. blockages per day	94	13.06	10.64	1	54
Vehicles impacted per day	94	162.35	324.41	1	1537
Avg. vehicle delay per day (hr.)	94	8.19	16.22	.04	76.84

5.2 U.S. DOT: Federal Railroad Administration

A separate dataset that reports railroad crossing blockages was retrieved from the U.S. Department of Transportation Federal Railroad Administration. The data measures the number of times a railroad crossing is blocked for the years 2022-2023. There were a total of 1360 railroad crossing blockages reported between 2022-23 in the East End District. This data is compiled from incident reports made by citizens, drivers, and others that state the time, duration, and impacts caused by the blockages. A blockage is anything that prevents traffic from crossing a railroad crossing. There are three ways to define a blockage. The first is a moving train, a train that is performing its task correctly. The second is a stalled train, just blocking the road. And the final way does not require a train to be present, as long as the crossing arms/gates are activated (lowered) the crossing will be considered blocked. Four variables were gathered from this dataset: Time interval, Reason, Duration, and Impact. Time interval is a categorical variable that details the time of day the blockage occurred. Reason is a variable that defines the way the crossing way blocked. Duration is an ordinal variable that details the duration of each blockage. The final variable provides the immediate impact caused by the train. **Table 5.2** provides a tabulation using the Department of Transportation Federal Railroad Administration dataset of the blockage duration variable, with 1-2 hours being the most frequent, while the majority of the blockages fall within 16-60 minutes.

Table 5.2 Tabulation of Blockage Duration

Duration	*Freq.*	*Percent*	*Cum.*
0-15 minutes	174	12.79	12.79
1-2 hours	382	28.09	40.88
12-24 hours	1	0.07	40.96
16-30 minutes	286	21.03	61.99
2-6 hours	214	15.74	77.72
31-60 minutes	280	20.59	98.31
6-12 hours	23	1.69	100.00
Total	1360	100.00	

Table 5.3 Tabulation of Blockage Reason

Reason	*Freq.*	*Percent*	*Cum.*
A moving train	38	2.79	2.79
A stationary train	1313	96.54	99.34
No train was present but the lights and/or gates were activated	9	0.66	100.00
Total	1360	100.00	

Table 5.3 above details the reasoning for the blockages more than 96% of the blockage reasoning is due to a stalled train while a train performing its duty accounts for less than 3% of the blockages. Table 6.4 below details the times of the day blockages occur. The majority of the blockages fall under the 8pm to 12am time interval, while approximately 36% of the blockages occur from 11am to 5pm.

Table 5.4 Tabulation of Time Interval

Time Int.	*Freq.*	*Percent*	*Cum.*
11AM-1PM	251	18.46	18.46
12AM-3AM	146	10.74	29.19
1PM-5PM	239	17.57	46.76
3AM-6AM	31	2.28	49.04
5PM-8PM	161	11.84	60.88
6AM-9AM	50	3.68	64.56
8PM-12AM	343	25.22	89.78
9AM-11AM	139	10.22	100.00
Total	1360	100.00	

Figure 5.2 below explains what caused the blockage. Nearly 97% of the blockages are due to stalled trains preventing cars from crossing. Less than 3% of the blockages are

because of trains performing their task properly and less than 1% are because the gates have been activated with no train present.

Figure 5.2 Blockage Reason

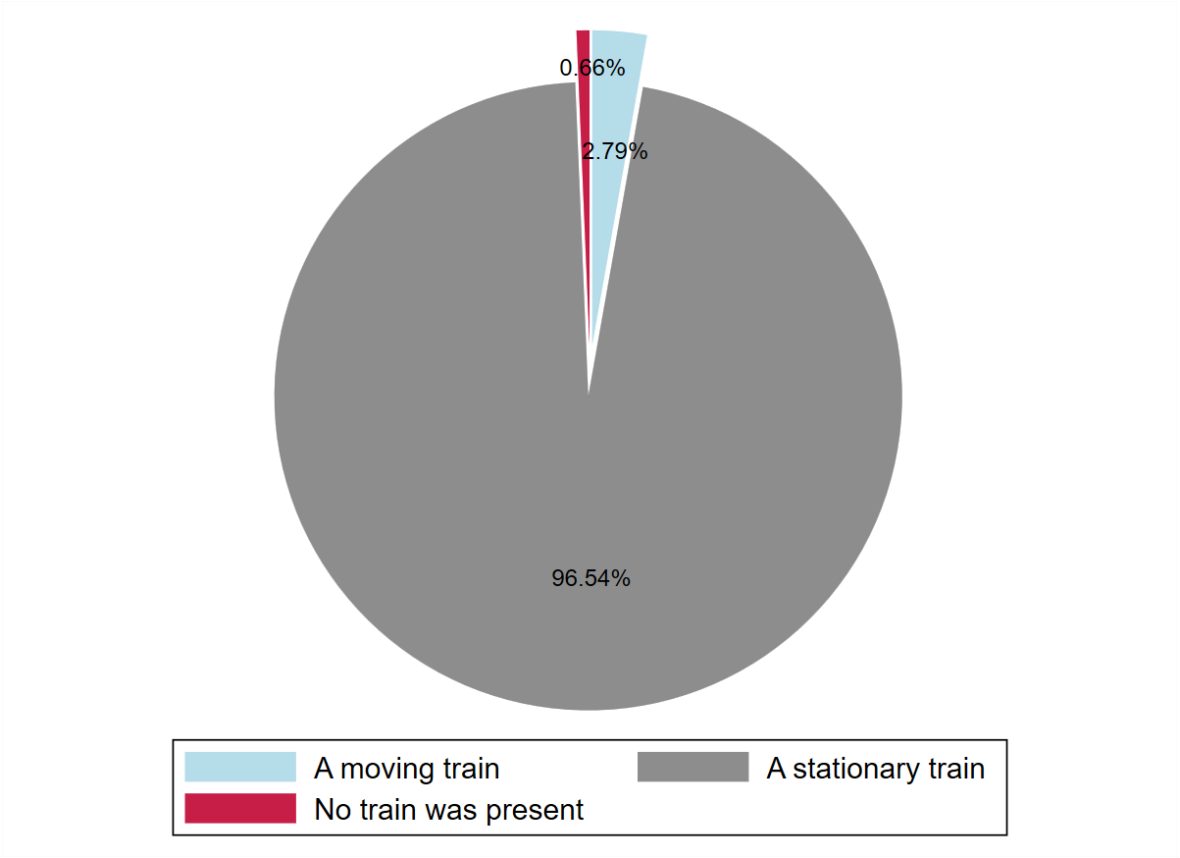


Figure 5.3 Blockage Impacts

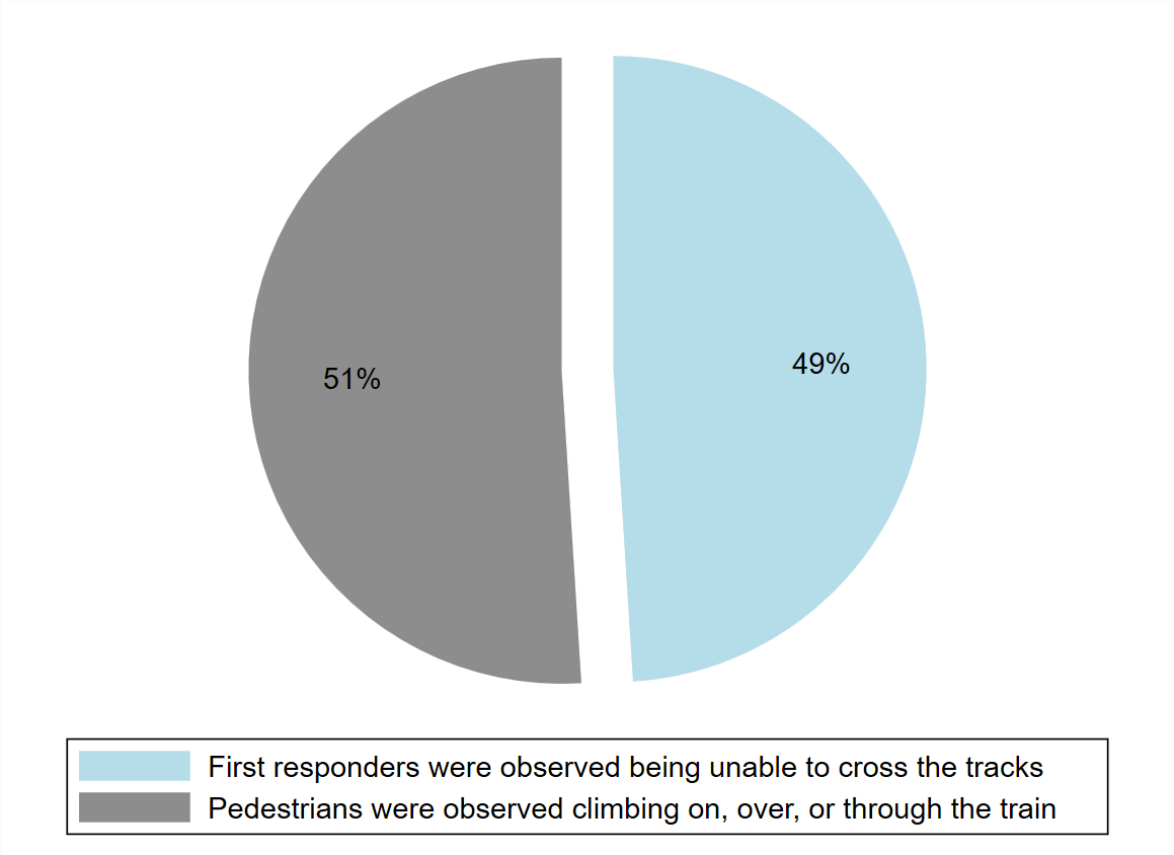


Figure 5.3 above illustrates the immediate impacts caused by the train blockages. 51% of the blockages affect pedestrians from reaching their destinations, giving them no alternative but to go under, over, or through the train, placing them in immediate danger if the train were to start moving. 49% of the blockages affect first responders, preventing them from performing their services creating a life-or-death situation for the recipient of the first responders' services.

5.3 Data Axle

The dataset regarding businesses located in the East End District was retrieved from Data Axle. The dataset is from the year 2022 and lists the 5603 businesses located in our study. The dataset offers detailed information for each business, like Business type, Sales, Number of employees, and Years in business. The variable Sales measure the income a business makes from sales in dollars. The Number of employees is a continuous variable that measures the number of employees each business has at the individual level (person). And Years in business measures the years a business has been in operation. Additionally, a new variable was created by combining the Trainfo and Data Axle databases. This new

variable is called the Number of crossings. The new variable measures the number of railroad crossings a business has within a ½ mile radius. **Table 5.5** displays a statistical summary of the variables from this dataset.

Table 5.5 Summary of Data Axle Variables

Variables	*Count*	*Mean*	*Std. Dev.*	*Min.*	*Max*
Sales (USD) [in log]	4893	13.91	1.56	10.20	20.72
Number of crossings (1/2 mi. radius)	5603	1.69	3.47	0	27
Number of employees	5603	11.96	46.44	0	2000
Years in business	5603	15.14	10.91	1	40

6. Model and Analysis

6.1 Model Specification

We will conduct a multivariate OLS regression analysis to look for a relationship between the number of railroad crossings within a ½ mile radius and sales reported for business in the East End District. For this study, the dependent variable will be the natural log of Sales, while the independent variable will be the number of railroad crossings within a ½ mile radius. The control variables will be AADT, Average blockages per day, Vehicles impacted per day, Avg. vehicle delay per day (hr.), Number of employees, and Years in business.

We expect a negative relationship between the number of railroad crossings within a ½ mile radius and sales, as the number of crossings increases near a business, sales will decrease. The reasoning for this is that people may deter people from conducting business in these locations. Furthermore, the chances of a business being affected by blockages increase the number of crossings increases, ultimately preventing people from reaching these businesses. A negative relationship is also expected for the following variables: AADT, Average blockages per day, Vehicles impacted per day, Avg. vehicle delay per day (hr.). The following variables are expected to have a positive relationship with sales: Number of employees, and Years in business. Businesses with more employees are expected to earn more because more employees increase productivity, thus earning more income. And lastly, as years businesses have been operating increase so will sales because older businesses have a better establish clientele than more recently established businesses. The equation for the hypothesis is presented below:

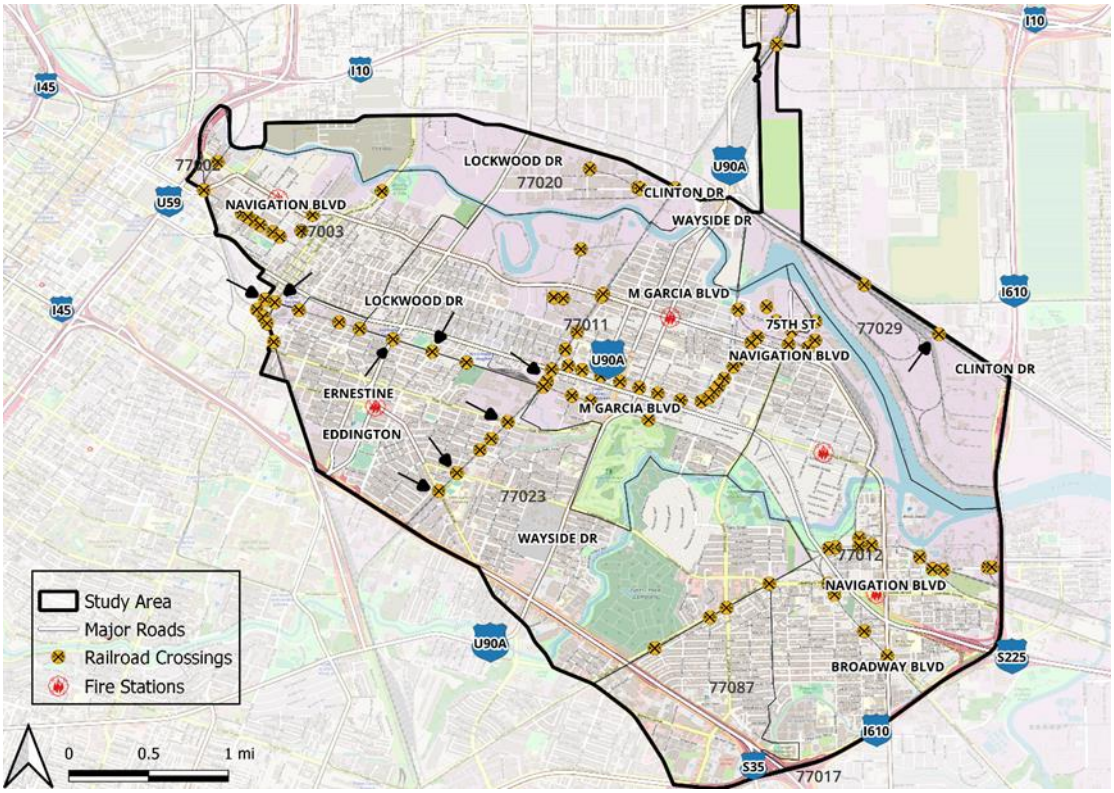
$$\begin{aligned}\log(Sales) = {} & \beta_0 - \beta_1(Number\ of\ crossings) - \beta_2(AADT) - \beta_3(Avg.\,blockage\ per\ day) \\ & - \beta_4(Vehicles\ impacted\ per\ day) - \beta_5(Avg.\,vehicle\ delay\ per\ day\ (hr.)) \\ & + \beta_6(Number\ of\ employees) + \beta_7(Years\ in\ business) + \varepsilon_i\end{aligned}$$

7. Empirical Results

7.1 Identification of Severe Crossings

We were able to map and identify severe railroad crossings based on the number of blockages, and vehicles affected per day and hourly. We identified 9 railroad crossings as severe. Those railroad crossings are located on Sampson St (859516V), York St (859517C), Lockwood Dr (859523F), Lawndale (288050B), Telephone (288051H), Gate 1 (758421H), Polk (288039B), Hughes (288035Y). **Figure 7.1** identifies the location of the 9 railroad crossings mentioned above that match the criteria. Four of the nine crossings are within the same railway that travels North/South. While another set of four crossings is within the same railway that travels East/West. These eight railroad crossings are found in the southwestern region of the East End District. The single outlier is the Gate 1 railroad crossing which is the entry to the Port of Houston.

Figure 7.1 Severe Railroad Crossings



7.2 OLS Regression

Table 7.1 OLS Regression for Sales

Variables	*Model 1*	*Model 2*	*Model 3*	*Model 4*
Number of crossings (1/2 mi. radius)	-0.01502**	-0.01155**	-0.04709***	-0.03493***
	[0.006]	[0.006]	[0.011]	[0.010]
Avg. annual daily traffic [in log]			0.03484	0.02637
			[0.045]	[0.041]
Avg. blockages per day			0.02143***	0.01896***
			[0.005]	[0.005]
Vehicles impacted per day			0.04384	0.02967
			[0.147]	[0.132]
Avg. vehicle delay per day (hr.)			-0.89111	-0.60486
			[2.932]	[2.635]
Number of employees		0.01591***		0.01458***
		[0.001]		[0.001]
Years in business		0.02666***		0.03008***
		[0.002]		[0.003]
Constant	13.93103***	13.32243***	13.78477***	13.11435***
	[0.025]	[0.037]	[0.367]	[0.332]
Observations	4,893	4,893	1,685	1,685
R-squared	0.0011	0.2045	0.0324	0.2196

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 7.1 presents the relationship between the independent variables and the dependent variable. *Model 4* is the equation presented in the *Model Specification* section of the paper. The relationship between the number of crossings and sales is negative and statistically significant at the 99.9% significance level. This can be interpreted as for any single unit increase in the number of railroad crossings near a business, there will 3.43% decrease in sales. The AADT variable has a positive relationship with sales and can be interpreted as AADT increases by 1%, sales will increase by .026%. The variable Avg. blockages per day is positive and statistically significant at the 99.9% significance level. This variable is interpreted as any single unit increase avg. blockages per day sales will increase by 1.91%. The variable Vehicles impacted per day is also positive. This variable is interpreted at any single unit increase in the number of vehicles impacted, we will see a 3% increase in sales. The variable Avg. vehicle delay per day (hr.) is negative and can be interpreted as any single unit increase in the avg. vehicle delay per day (hr.), we will see a 45.40% decrease in sales. The variable Number of employees has a positive relationship with sales and is statistically significant at the 99.9% significance level. This variable is interpreted as the number of employees increases by one unit; we will see a 1.47% increase in sales. The last

variable, Years in business also has a positive relationship and is significant at the 99.9% significance level. Years in business is interpreted as the number of years a business has operated increases by one, sales will increase by 3.1%.

8. Recommendations

8.1 Policy Recommendations

Since its inception, railroads have been privately owned and operated, and in many instances, unregulated. Moreover, “They were regarded with distrust by much of the public, who charged them with anything from farming monopolies and wielding corrupt political influence on stock manipulations and rate discriminations. None of these accusations were unfounded (PBS 1996). Unfortunately, while public grievances may be different now than what they were in the 1800s, the public demand regarding the railroads’ conduct ensues. Therefore, federal lawmakers should make a more aggressive attempt to review the current models for railroad operations and determine if they are suitable for modern cities’ framework. Additionally, by utilizing a parallel approach to support public interest, elected leaders and the appropriate agencies at the local, state, and federal levels can work with community organizations to amend current laws and address specific railroad practices that will eliminate block crossings and lessen the risks to the public. Moreover, freight network stakeholders should want to come to the table with the community and elected leaders in their respective areas to discuss challenges and unfavorable experiences endured by residents and businesses in impacted areas. Such discussions are advantageous for effective policymaking by lawmakers and operational revisions on the part of the railroad industry.

One model of success that is worth considering when exploring models that work to address city and rail company cooperation is the Chicago Regional Environmental and Transportation Efficiency Project (CREATE). Chicago, while very similar to Houston in population size, it differs vastly because of its significantly smaller land mass of 228 square miles compared to Houston’s 639 square miles. However, “CREATE is a joint effort of six Class 1 railroads, Illinois state and local governments, and a local commuter rail agency to restructure, modernize, and expand the freight and passenger rail facilities and highway grade separations in the Chicago metropolitan area while reducing the environmental and societal impacts of rail operations on the public. To date, 19 CREATE-sponsored projects have been completed, 4 are under construction, and 16 are in final design phase or undergoing environmental review” (CHANGE 2003). In September 2022, the Greater

Houston Collaborative Rail Working Group established the HART Program, Houston Area Rail Transformation. This advocacy group is focused on developing a collaborative and programmatic approach to leverage private and public funding opportunities for railroad projects in the region. Like the CHANGE program, the members of the working group include representatives from the Class 1 railroads, Gulf Coast Rail District, the City of Houston, Port Houston, Harris County, the Metropolitan Transit Authority of Harris County (METRO), Houston-Galveston Area Council, and TxDOT. This coalition is mission-driven in providing measurable outcomes to increase the efficacy of Houston's unique rail network, which encompasses in large part, the challenges in the East End.

Secondly, the East End District has worked in collaboration with federal lawmakers to grant the Surface Transportation Board (STB) the authority to review, write, recommend, and enforce interstate commerce rules. "The STB is an independent federal agency that is charged with the economic regulation of various modes of transportation, primarily freight rail. It succeeded the former Interstate Commerce Commission (1187-1995) and is now recognized as a wholly independent federal agency since December 18, 2015" (Surface Transportation Board home page). Granting the STB, the authority to review, write, recommend, and enforce interstate commerce rules would help streamline reporting issues, while also allowing the federal government to take into consideration public comments, studies, and other pertinent data that spells out the case as to why direct oversight of the railroad companies is needed. It has become intolerable in many communities, like Houston of what the unchecked and not closely managed industry has done to escalate issues ranging from economic impact to environmental justice. Moreover, the Interstate Commerce Act should be amended to reflect current railroad operating practices. What is striking about this legislation is it was passed by Congress in 1887, essentially acknowledging the railroads as the first industry subject to federal regulation and governed by a five-person enforcement board known as the Interstate Commerce Commission (PBS 1996). From then until now, the Interstate Commerce Act has not been changed, although Congress has made several attempts to reign in the powers of the ICC and has ultimately been placed under the supervision of the Surface Transportation Board.

Thirdly, the Interstate Commerce Act should be amended to reflect current railroad operating practices. What is striking about this legislation is it was passed by Congress in

1887, essentially acknowledging the railroads as the first industry subject to federal regulation and governed by a five-person enforcement board known as the Interstate Commerce Commission (PBS 1996). From then until now, the Interstate Commerce Act has not been changed, although Congress has made several attempts to reign in the powers of the ICC and has ultimately been placed under the supervision of the Surface Transportation Board. It would also be beneficial for rail network leaders to provide the agency with modernized, tailored operational plans so that local leaders are able to address their communities' concerns while attempting to forge meaningful partnerships with the rail companies that are traversing throughout their areas of jurisdiction. This would also provide transparency and accountability between the rail companies and residents, like those in the East End.

Lastly, the city of Houston in collaboration with the East End District has worked with congressional members that represent the area to submit Community Funded Project (CFP) proposals, affectionately known as "earmarks" through the federal appropriations process. This program is specifically reserved for congressional members to request funds from the federal government to fund projects within the congressional district. Depending on the leadership that controls both chambers, "earmarks" may or may not be permissible. However, East End residents and even district council members who represent that area have petitioned its congressional members countless times to submit a CFP request for quiet zone installations. "In a quiet zone, railroads are directed to cease the routine sounding their horns when approaching public highway-rail grade crossings" (Federal Railroad Administration 2020). These installments are quite expensive but provide an opportunity for localities to mitigate the effects of train horn noise by establishing "new quiet zones". While this installment does not mitigate stopped trains, it does help ease concerns from residents in areas that are overburdened with trains that travel through neighborhoods during the night when many residents may be asleep. In addition to CFPs, the city of Houston's Public Works Department has been working aggressively with its federal partners at the Department of Transportation, specifically the Federal Railroad Administration to identify and apply for funding opportunities such as the Railroad Crossing Elimination Grant and others in the bipartisan Infrastructure Law. Such allocations will

overwhelmingly benefit the unique rail challenges and infrastructure needs Houston faces with the East End being a major catalyst for these improvements.

8.2 Blockage Restrictions

The results from the U.S. DOT blockages report provided further understanding of blockages that occur in the east end. **Figure 8.1** below illustrates the most common time interval blockages occur, which is from 8PM-12AM at over 25%. More than 36% of the blockages fall between the combined intervals of 11AM-1PM and 1PM-5PM. These blockages create disruptions to the community because these intervals include times people return from work and the time students are released from school, affecting bus routes.

Figure 8.1 Blockage Hours

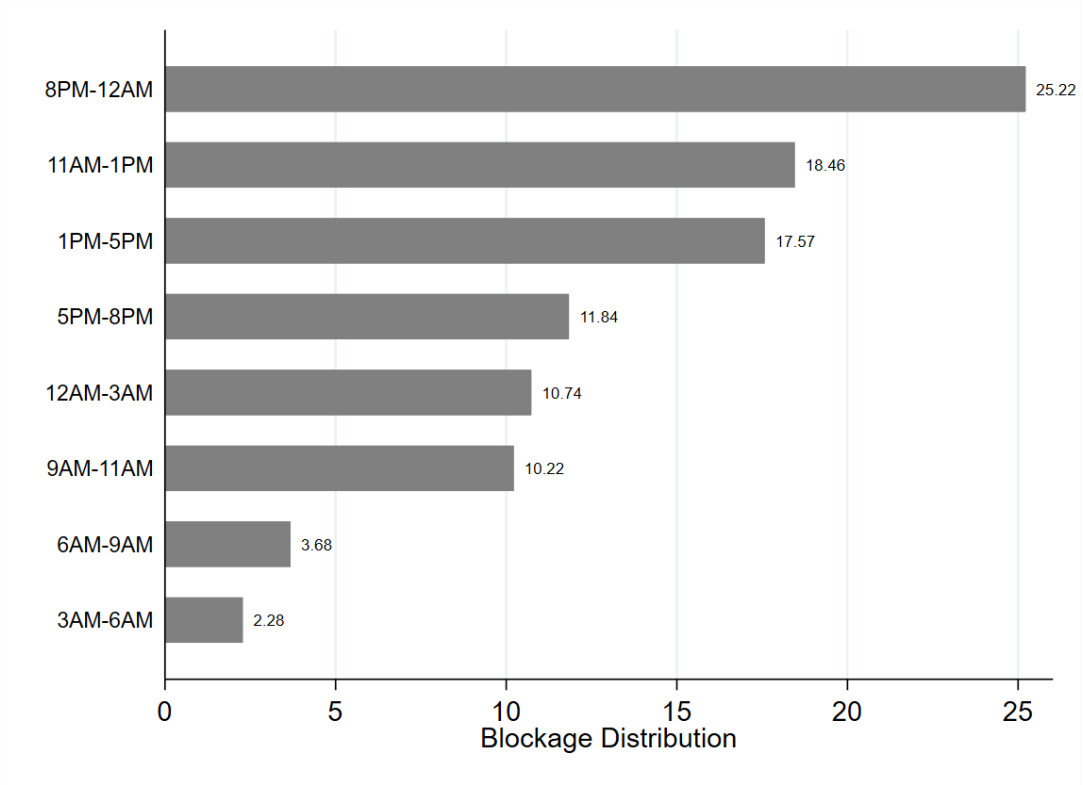


Figure 8.2 Blockage Duration

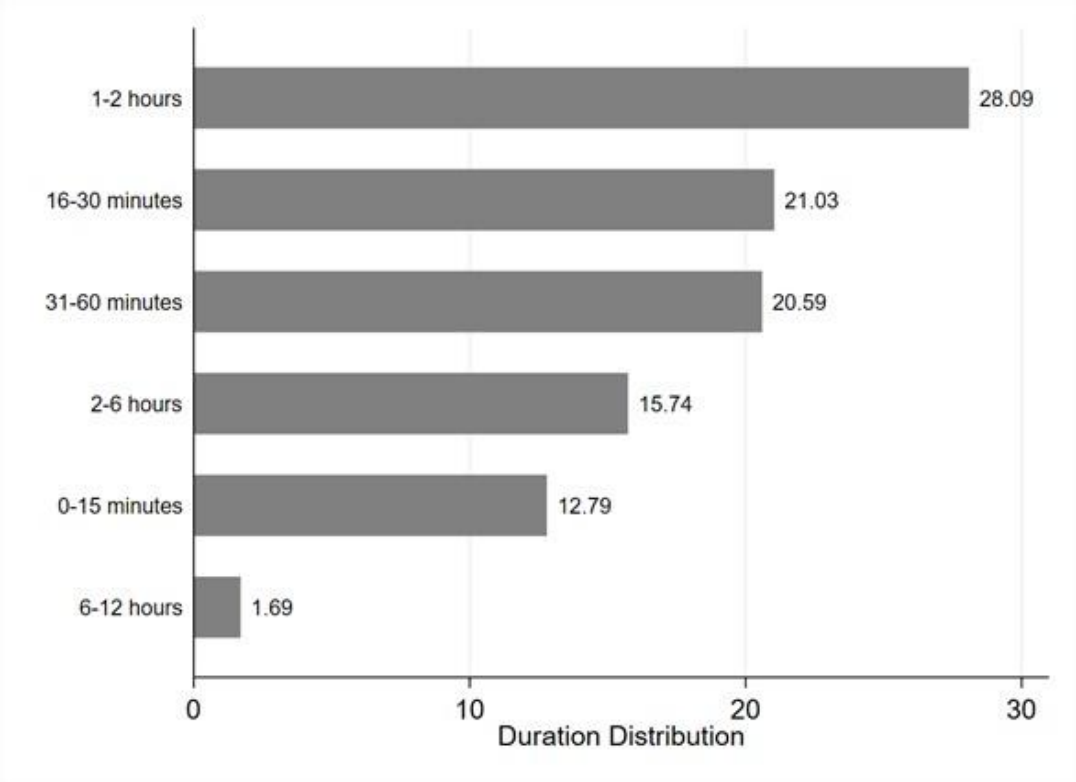
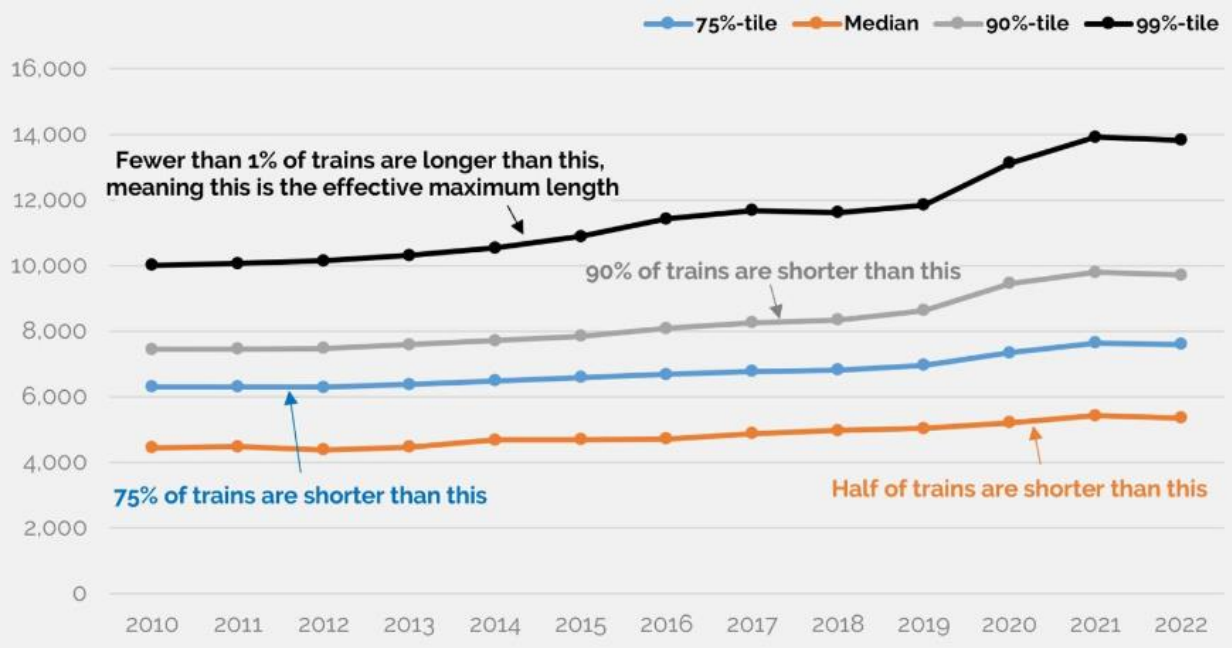


Figure 8.2 above illustrates the duration of the blockages. 28% of the blockages that occur in the East End District last around 1-2 hours, while 16-30 minutes make up 21% of the blockage duration. The combined intervals of 16-30 minutes and 31-60 minutes account for nearly 42% of the blockage duration. Figure 8.4 below explains what caused the blockage. Nearly 97% of the blockages are due to stalled trains preventing cars from crossing. Less than 3% of the blockages are because of trains performing their task properly and less than 1% are because the gates have been activated with no train present.

Based on blockage reports and the survey results, we have two suggestions that will help alleviate the blockage problems in the East End District. The first recommendation is to restrict train blockages between 9am-5pm. These times are the times' train blockages are reported the most and coincide with the busiest times for businesses in the area. Restricting blockages during these hours will not only help businesses, but it will also benefit residents and students returning home. An alternative to the policy above would be implementing restrictions on the time trains can block crossings. Based on the blockage results, the most common blockage time is anywhere from 31 minutes to 2 hours. placing a restriction on blockage duration will help alleviate traffic problems in the area. This is the number one

suggestion from survey respondents and would solve the problem of stationary trains blocking crossings. In order for this policy recommendation to work we suggest a policy combination of blockage duration restrictions-based train length. The US does not have train limits, so we suggest 15-minute blockage periods for trains that are shorter than 8000 (approx. 1.5 miles). And for trains that are longer than 8000 (approx. 1.5 miles), we suggest a blockage period of no more than 30 minutes. As mentioned before, this will decrease the number of stationary train blockages. We came up with these numbers based on the average train lengths in the US. **Figure 8.3** below illustrates how train lengths in the US have slightly increased since 2010.

Figure 8.3 Changes in Train Length



8.3 Solution Strategies

Schnabel et al. (2011) afford several infrastructure mitigation solutions to combat traffic congestion. They include relocating, trenching, elevating, tunneling, bridging, and capping.

Relocating involves moving the rail yard to another location or city

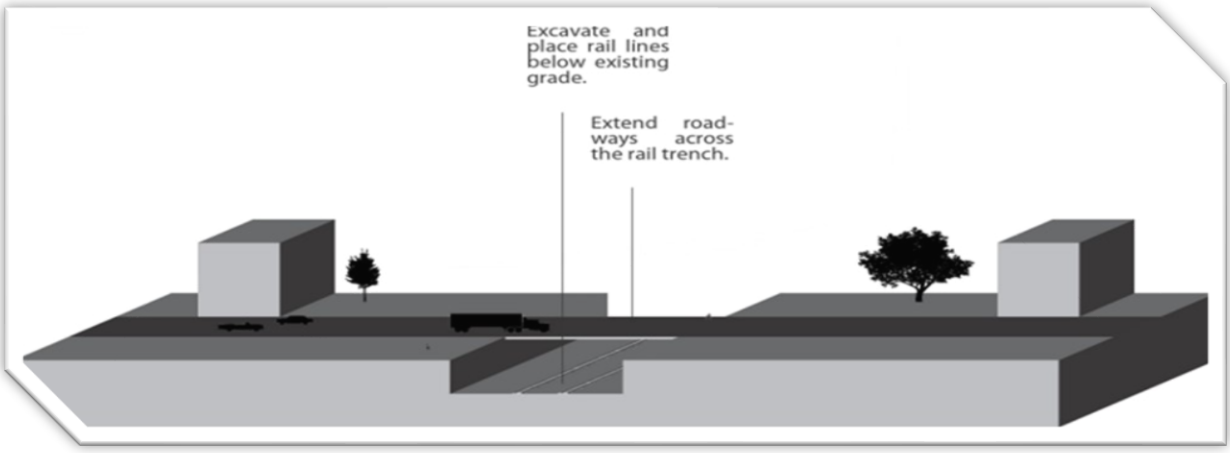
- **Positives:**
    - Relocated rail yard, decrease in traffic congestion in that area
    - Old area could be a new development for that community

- **Negatives:**
    - Costs are high
    - Another location will experience same issues as old area
    - Neighborhoods would lose and employer

Trenching provides the freight train to travel below traffic (see **Figure 8.4**)

- **Positives:**
    - Auto delays and pedestrian safety issues are eradicated
    - At-grade crossing problems are eliminated
- **Negatives**
    - Costs and maintenance challenges
    - Hinders future expansion

Figure 8.4 Trenching



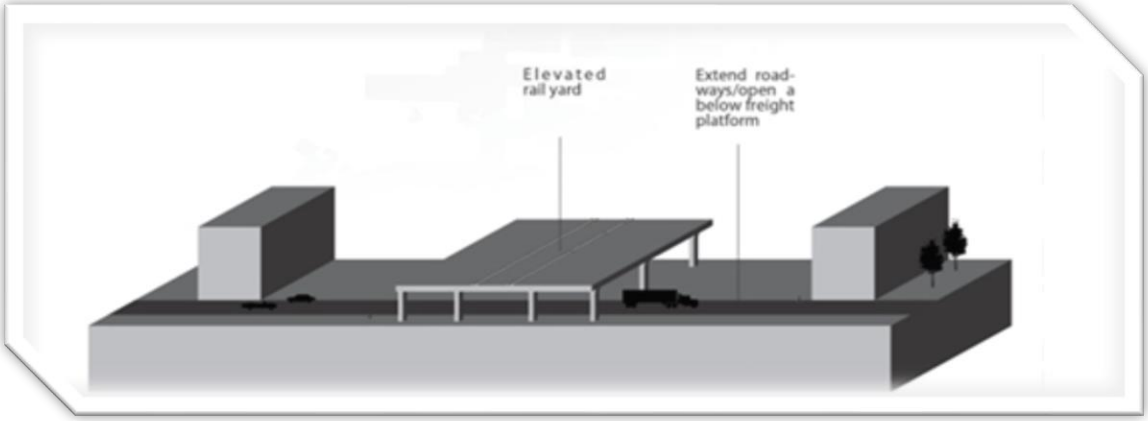
Source: A Capping Case Study: Integrating Freight Rail into a Community Setting

Elevating provides a raised structure for the freight train to travel above non-freight traffic (see **Figure 8.5**)

- **Positives:**
    - Freight transportation and non-freight transportation would be independent of each other
    - More opportunities for freight rail activity
    - No interruption of current freight activity during construction

- **Negative attributes:**
    - Construction costs
    - Limit maintenance and expansion
    - Damaging impact on intermodal operations

Figure 8.5 Elevating

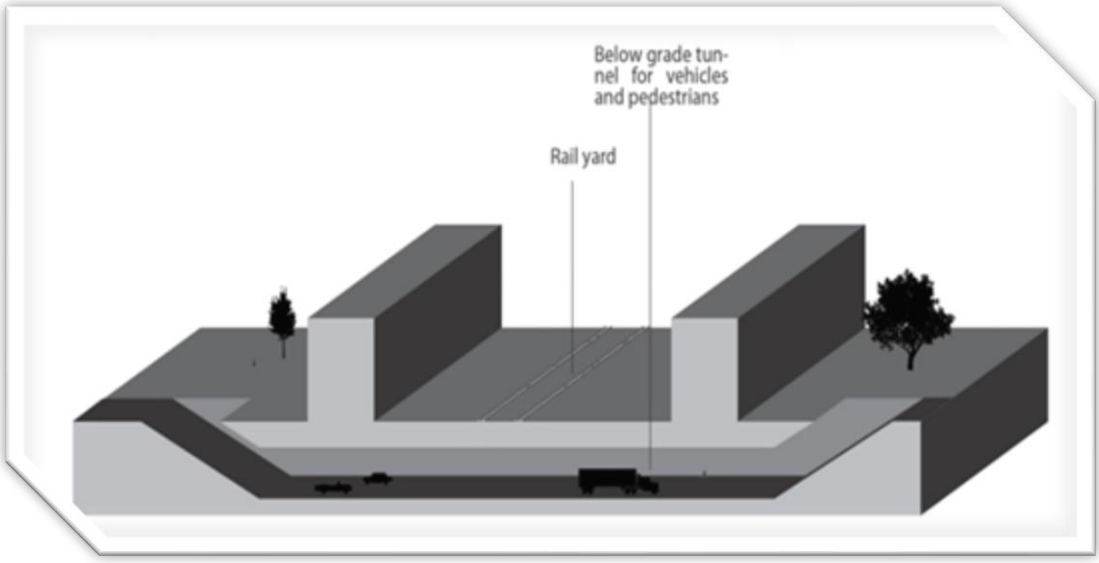


Source: A Capping Case Study: Integrating Freight Rail into a Community Setting

Tunneling provides an underground route for non-freight traffic to travel below freight traffic (see **Figure 8.6**).

- **Positives:**
    - Non-freight transportation and freight transportation would be independent of each other
    - Construct without interrupting current rail activity
- **Negatives:**
    - Costs are probably the highest of all
    - Lighting and ventilating requirements would also incur additional costs

Figure 8.6 Tunneling

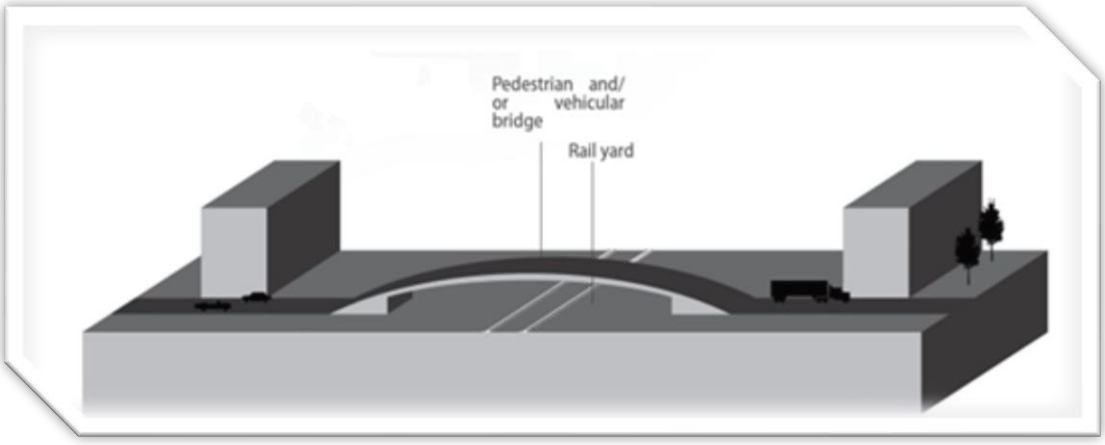


Source: A Capping Case Study: Integrating Freight Rail into a Community Setting

Bridging provides a raised structure for non-freight transportation to travel (see **Figure 8.7**).

- **Positives:**
  - Separation of non-freight and freight transportation
  - Great for connection between communities
- **Negatives:**
  - Construction costs
  - Noise

Figure 8.7 Bridging

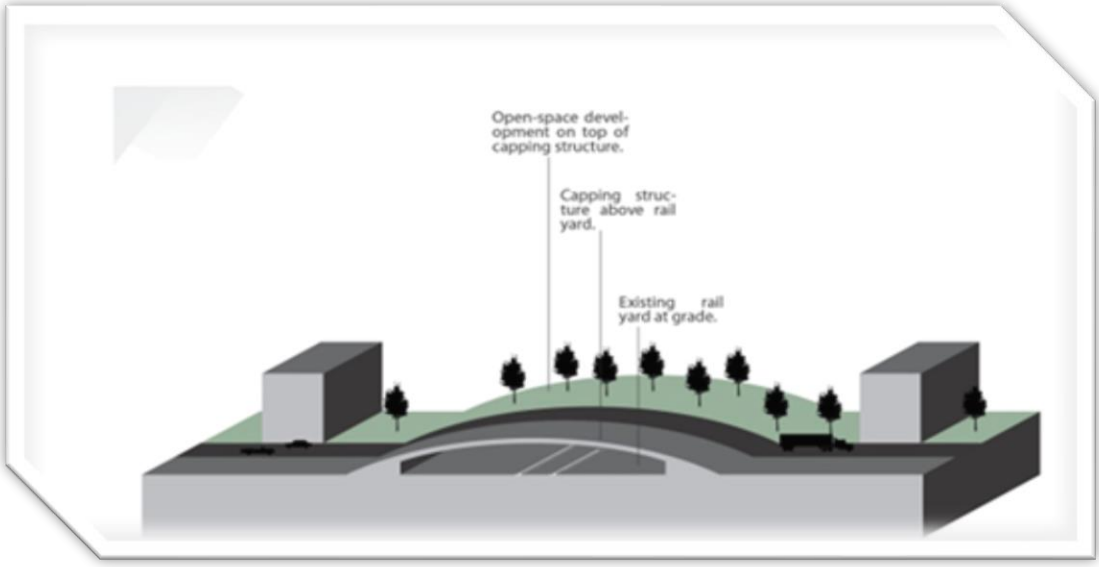


Source: A Capping Case Study: Integrating Freight Rail into a Community Setting

According to Schnabel et al. (2011), “This strategy is the development of the air rights above the rail yard. Like bridging it provides elevated connections for non-freight vehicles to cross the rail yard. However, in the case of caps, the scale of the bridges is wide enough to accommodate significant development” (p.16).

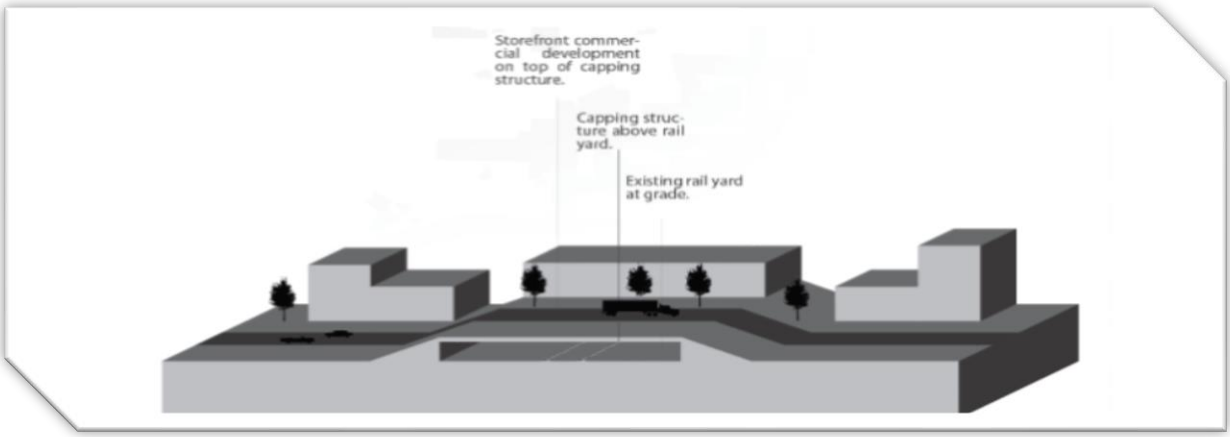
- **Positives:**
    - Separation of non-freight and freight transportation
    - Great connection between communities
    - Great for pedestrians and bicycles
    - A community can cap a park, retail development or additional rail yard area (see **Figures 8.8**, **8.9**, and **8.10**).
- **Negatives:**
    - Costs are high

Figure 8.8 Capping **with open space development**



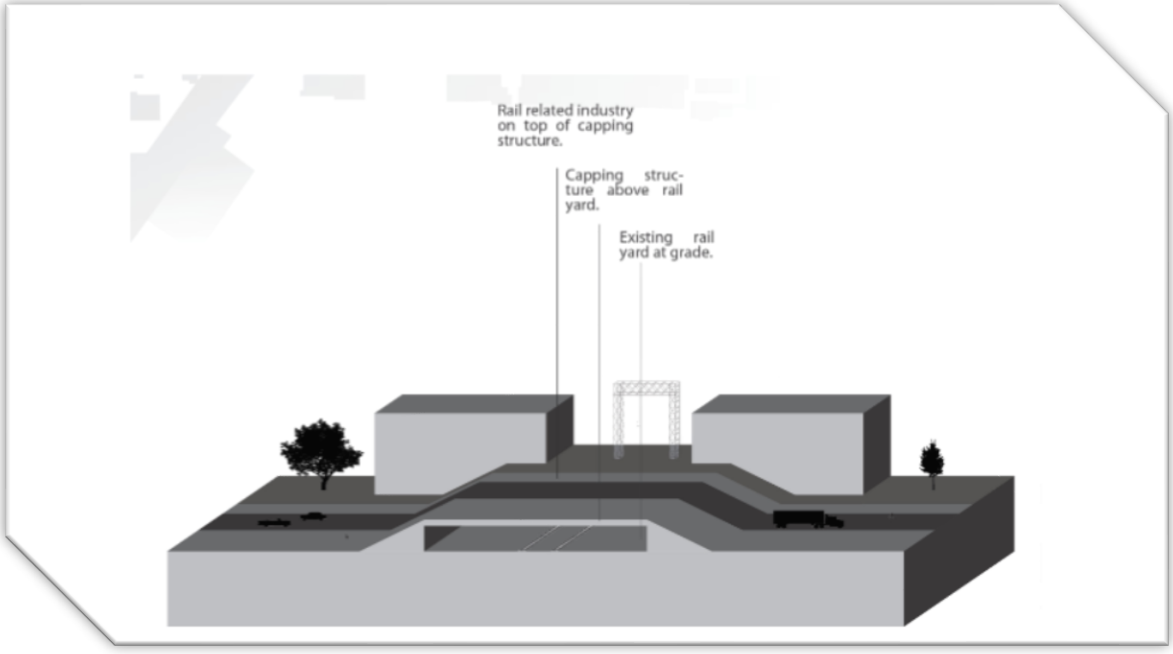
Source: A Capping Case Study: Integrating Freight Rail into a Community Setting

Figure 8.9 Capping with Retail & Commercial Development



Source: A Capping Case Study: Integrating Freight Rail into a Community Setting

Figure 8.10 Capping with Rail-related Industry



Source: A Capping Case Study: Integrating Freight Rail into a Community Setting

9. Cost Benefit Analysis

The East End District has an urgent need to decrease traffic congestion and increase economic development. According to Schnabel et al. (2011), trenching, elevating, tunneling, bridging, and capping demonstrate the best results for traffic congestion along with modifying rail hours (see **Table 10.1**).

Table 10.1 Solutions

Aim	Solution Strategies
• Traffic Congestion	• Replace at-grade crossing with ○ Trenching ○ Elevating ○ Bridging ○ Tunneling ○ Capping • Modify Rail hours

Source: A Capping Case Study: Integrating Freight Rail into a Community Setting

The City of Saskatoon's *Rail Relocation versus Grade Separation* (2018), provides empirical cost-benefit analysis data for each of the aforementioned structures that could prove beneficial in recommending the best fit for the East End. The following data constitutes overpasses, underpasses (bridges), elevating, and trenching. The significance of this data is how each cost is itemized.

Figure 10.1 Underpass

Cost Components	Cost ($M)
Bridge	$6.18
Roadway Work	$24.7
Railway Work	$2.09
Utility Cost	$5.00
Environmental	$0.55
Mobilization	$3.85
Engineering	$4.24
Land Acquisition	$0.40
Contingency (30%)	$14.1
Total Cost (2017$)	**$61.1**

Figure 10.2 Overpass

Cost Components	Cost ($M)
Bridge	$2.69
Roadway Work	$10.8
Railway Work	$0.76
Utility	$2.00
Environmental	$0.55
Mobilization	$1.68
Engineering	$1.85
Contingency (30%)	$6.11
Total Cost (2017$)	**$26.5**

Source: Rail Relocation versus Grade Separation (2018)

Figure 10.3 Elevating

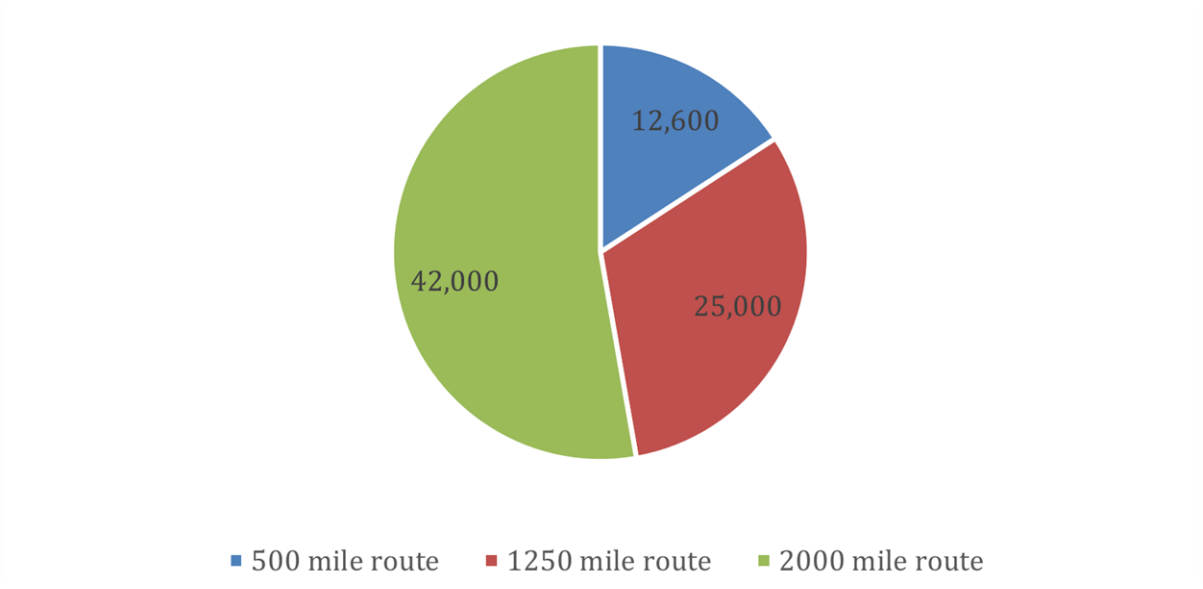
Cost Components	Cost ($M)
Bridge	$36.9
Railroad Work	$47.1
Shoofly Track	$9.35
Drainage	$10.0
Utilities	$15.0
Environmental	$9.00
Traffic Control	$6.36
Mobilization	$12.7
Engineering	$14.0
Contingency (30%)	$48.1
Total Cost (2017$)	**$208.4**

Figure 10.4 Trenching

Cost Components	Cost ($M)
Trench	$255.1
Earthwork	$16.3
Barrier	$1.86
Dewatering and Water Treatment	$10.0
Utilities	$30.0
Drainage	$8.00
Bridge Cost	$12.5
Railroad Work	$10.1
Shoofly Track	$13.0
Environmental Costs	$11.5
Traffic Control	$9.21
Mobilization Costs	$36.8
Engineering Costs	$40.5
Contingency (30%)	$136.5
Total Cost (2017$)	**$591.4**

Source: Rail Relocation versus Grade Separation (2018)

Figure 10.5 Delay by route at 2.5 hours per day



Source Lovett, A, H. et al. 2015 (in thousands of dollars)

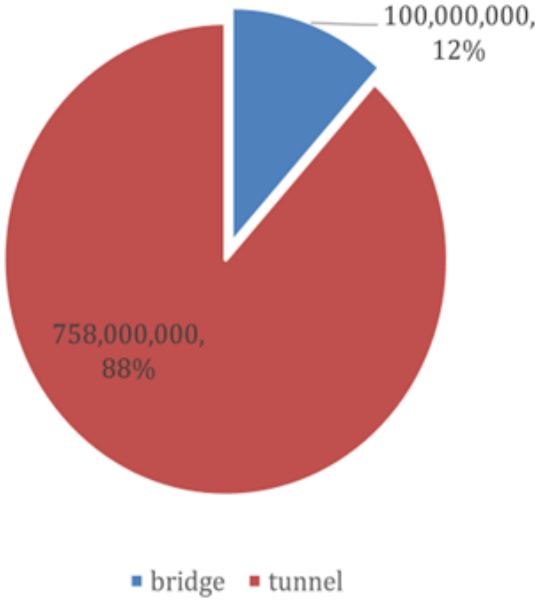
Figure 10.5 depicts the range of routes and what it would cost the railroad a year at just 2.5 hours, ranging from $378,000 per month to $1,590,000, which ranges from over 4 million to 139 million dollars a year accounting for inflation.[30]

According to Lovett, A.H. et al. (2015), freight trains stalled cost thousands per month.[31] Although the costs incurred negatively affect the freight providers, constructing infrastructure to decrease non-freight traffic congestion could potentially save the freight providers in time and increase efficiency. For example, if the rail crossings and non-freight traffic is not mitigating factor in travel time, a constant speed would decrease delays for deliveries.

[30] Inflation Calculator" https://www.dollartimes.com/inflation/"

[31] Lovett, A. H., Dick, C. T., & Barkan, C. P. (2015). Determining freight train delay costs on railroad lines in North America. *Proceedings of Rail Tokyo*.

Figure 10.6 Cost Comparisons



According to the Washington Post reported in 2003 a Maryland railroad bridge would cost $61 million. If we account for inflation in 2023, that is $100,000 but it is probably much higher in today's economy.[32] The tunnel costs are derived from The Tunnel Business Magazine. As of August 2020, a tunnel in the United States besides New York would be $600-900 million dollars, accounting for inflation, it would be, $758 million dollars to $1.1 billion dollars.[33] **Figure 10.6** portrays that the bridge and tunnel scenario. This confirms the cost associated with **Figure 10.4**.

The 2.5-hour delays identify costs that are more than multiple bridges. It may be worth a more in-depth analysis to consider bridges (overpasses and underpasses) in the most severe blockages. In **Figures 10.3** and **10.4** we observe how much more costly elevating and trenching are. It is possible that the costs of delays in relation to the costs of bridges could prove advantageous for both freight providers and the community of the East End District. Relocating a rail yard was estimated at $767 million in Tennessee for CSX (freight rail owner, class I) in 2016. Relocation would prove to be too costly in relation to the delays the freight provider would incur and merely change sites of traffic congestion.[34]

[32] Ibid
[33] Why Tunnels in the US Cost Much More than Anywhere Else in the World. https://tunnelingonline.com/why-tunnels-in-the-us-cost-much-morethan-anywhere-else-in-the-world
[34] https://www.tennessean.com/story/news/2016/07/04/moving-radnor-yard-could-game-changer-nashville-transit/86468984/

Capping would also have a high construction cost, but capping could aesthetically improve the East End District with parks and bike trails. Additionally, capping could also include enhanced features for the rail yard or a retail/commercial industry (Schnabel et al. (2011).

Modifying rail hours first has to begin with communication. The Congressional Research Service on Positive Train Control; (PTC) details the appropriate form of communication for freight trains. PTC is defined in federal law as a "system designed to prevent train-to-train collisions, overspeed derailments, incursions into established work zone limits, and the movement of a train through a switch left in the wrong position." [35] Most trains are equipped with a type of overlay system, which is a one-way form of communication. Signals are installed over the tracks to monitor information, but not in real time. Communication-based train control (CBTC) is more advanced than PTC in relaying information from the tracks. It is in real time and it can communicate with other systems utilized by other railroads. CBTC has the potential to present fuel savings and more efficient scheduling, which could modify rail hours to lead to decreased traffic congestion. Despite the benefits of CBTC, U.S. railroads' cost-benefit analysis sways them to decline this communication method. [36] Although most U.S. railroads have not acquiesced to CBTC, two of the East End Districts freight providers have agreed to PTC, BNSF, and Union Pacific, and should have been fully operable in 2018. The costs associated with the implantation of Union Pacific's PTC were expected to be approximately $2.9 billion.[37] With other PTC-type approval communication systems and its capability of interoperability communication, Kansas City Southern Railway and the 55 private trains that travel through the East End District, may be able to save on costs, which may offer options of modified rail hours, that could decrease traffic congestion.

[35] 49 C.F.R. §236
[36] "Positive Train Control" https://sgp.fas.org/crs/misc/R42637.pdf
[37] Ibid

10. Conclusion

Blockages are more likely to occur during business hours increasing the likelihood that businesses will be affected. These blockages are more likely to last between 0-60 minutes and are widely caused by stalled trains preventing the movement of traffic. Additionally, the immediate parties affected are first responders and pedestrians.

The OLS Regression gave mixed results. Some variables (AADT, Avg, blockage per day, etc.) where we expected negative relationships turned out to be the opposite. Despite the mixed results, we are able to conclude that railroad crossings negatively affect businesses. The most surprising result is from the Avg. vehicle delay per day (hr.) variable, which has the most effect compared to the other variables.

Regression analysis and survey results combined elucidate blockages, vehicle delays, and proximity to rail crossings expose undesirable economic effects on businesses. Cost-benefit analysis explicates those structures that provide the best solution in traffic congestion, with an overpass or underpass proving the best fit in relation to delay costs of freight trains.

Policy implementation and construction structures, i.e., bridges have proven successful in other cities in reducing traffic congestion and increasing economic development, matters of great concern in the East End District. It is our recommendation that a structure, i.e., overpass or underpass be constructed at one of the severe crossings. After construction, an analysis should be conducted in ensuring that that overpass or underpass is the best fit for mitigating traffic congestion. Furthermore, if that location supplies positive results (deterring traffic congestion), construction should continue at other severe locations.

This paper had one major limitation that may have the blockage results. There is a way to know the actual number of blockages trains cause. The problem is that one is more likely to report a stalled train in comparison to a train that is moving and properly functioning. This problem may have led to biased results.

The data and analyses only explain half of the problem. From a basic structural perspective, the coordination between railroad providers and the affected business communities should work in concert in answering the questions and concerns of the damaging impacts associated with railroad congestion and at-grade crossings delays.

We are hopeful the East End Impact Study has provided a detailed examination in emphasizing the issues and best practices for resolving blockages. Continued research is deemed beneficial for the East End District in assessing the freight train industry and its freight train providers.

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12. Appendix

12.1 Business Characteristics

Q1: Consent to Participate in a Human Subject Research Study

Q2: Which of the following best describes your industry (profit or nonprofit)?

Q3: Which of the following describe your industry? (Please mark all that apply)

Q4: Which of the following best describes the overall size of your business, including full-time, parttime, and contracted employees?

Q5: Is your business certified as a Minority Business Enterprise (MBE), Woman Business Enterprise (WBE), or LGBTQ owned business?

Q6: How long has your business been operating?

Q7: What is the zip code for your business's (main) establishment in the East End District?

Q8: Could you give us the closest street intersection of your business in the East End?

Q9; Which of the following are your businesses peak times for customers? Please select all that apply.

Q10: What is your position or title in the business?

12.2 Railroad Impacts

Q11: Approximately how often are employees delayed to work because of train delays?

Q12: What is the longest amount of time that an employee has been delayed by a train?

Q13: Have your patrons expressed being delayed by trains en route to your business?

Q14: How often are deliveries delayed to your business address because of stalled trains?

Q15: How often are services like mail and trash delayed to your business address because of stalled trains?

Q16: How often do you think railroad delays are impacting customers' arrival to your business?

Q17: What is the longest amount of time a stopped train has blocked your business?

Q18: Do you believe the amount of railroad tracks near your business decrease mobility to and from your location for persons who may ride public transit or walk?

Q19: Which of the following solutions do you believe would be the best fit to mitigate problems caused by railroad crossings in the East End? Please select that apply.

Q20: Why is the East End District an ideal location for your business? Please select all that apply.

Q21: What are some drawbacks to having your business located in the East End? Please select all that apply.

Q22: Which of the following solutions do you believe would be the best fit to mitigate problems caused by railroad crossings in the East End? Please select that apply.

- Overpasses (1)
- Underpasses (2)
- Restrictions on train length (4)
- Restricted times when trains can operate through East End (5)
- Constructions of bridges wide enough to allow for development and green space on top ("capping") (6)
- Bypass signage (way-finding signage (7)
- Signage with wait times (8)
- Quiet hour (9)
- Regulation on how long a train can block a crossing (10)
- Construction of walls between freight yards and adjacent uses ("walling") (11)
- Other (please specify): (12)