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Analysis of Freight Movements in the San Joaquin Valley

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MINETA TRANSPORTATION INSTITUTE

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16. Abstract

Freight transportation plays a primary role in supply chains, costs, and availability of goods and is a major part of the economy. This study identifies, assesses, and utilizes different data sources to uncover and understand the patterns and movements of different types of freight in the San Joaquin Valley's (SJV's) different counties. The San Joaquin Valley region consists of eight counties: San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, and Tulare. This research explored some major datasets with freight information, such as Global Trade Atlas (GTA), Port Imports and Exports Reporting Systems (PIERS), and Streetlight data insights for the year 2019 (to explore movements of freight pre-COVID-19). The primary software programs used for this analysis include MS Excel, MS Access, ArcGIS, and StreetLight InSight. This research investigated all modes of freight transportation (air, water, rail, and road) for domestic and international trade. This research's findings demonstrate the strengths and limitations of different data sources for understanding freight movements in the San Joaquin Valley. These findings should be valuable for different government and private agencies for various use cases such as developing transportation infrastructure, freight business, and environment assessments.

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Executive Summary

As freight traffic continues to grow and congest ports and roadways, inland ports seem to represent possible solutions to alleviate some of this congestion. An inland port is a physical site outside of traditional land, air, and coastal borders that aims to facilitate international commerce. Well-designed inland ports can provide superior logistics and economic incentives for their geographic regions. However, an accurate feasibility study for an inland port requires a good understanding of the volumes and types of freight being transported into and out of the region, as well as knowledge of the origins and destinations of these volumes. While different freight data sources exist, properties, capabilities and limitations of these data sources vary. Accordingly, the objective of this work involves identifying different existing data sources, understanding their strengths and limitations, and analyzing their suitability for a good understanding of the volumes and types of freight being transported into and out of the San Joaquin Valley (SJV) and its counties.

The eight counties of SJV were analyzed using data acquired from multiple raw data sources. Global Trade Atlas (GTA) provided state level trade data while the Port Import/Export Reporting System (PIERS) provided county level data using the geocoding function in ArcGIS. Freight Harmonized System (HS) Codes, which are typically classified into 99 codes, were further reclassified into four groups for ease of computing and better understanding of the data. The four HS groups are farm produce, minerals and chemicals, textiles, and industrial materials. StreetLight InSight provided truck volumes for the SJV counties. Data was further processed using Microsoft Access and Excel.

Results showed that, per GTA statistics, HS codes: Industrial Materials group has the largest value of freight moved, whereas HS codes: Minerals and Chemicals has the highest amount. This pattern continues to hold true for both exports and imports. When compared to PIERS data, GTA data has been shown to be more dependable. This assertion is supported by trade statistics from the California Chamber of Commerce (2022), which show that the trade data from GTA are remarkably similar to those on the website. It is clear that, while the state as a whole imports more than it exports, the trend in the San Joaquin Valley is the opposite, with the valley exporting more freight than it imports. Los Angeles, Long Beach, and Oakland are the main three ports in California where the majority of trade operations take place. The Port of Los Angeles is the most active in terms of imports, while the Port of Long Beach is the most active in terms of exports. Kern County has the highest index among the San Joaquin Valley's counties, while Kings County has the lowest.

Findings of this work should be helpful for other researchers and practitioners who are interested in understanding the strengths and limitations of the different freight data sources. The work presented in this manuscript should help those interested identify the freight data sources that could help answer their freight data inquiries.

1. Introduction and Background

As freight traffic continues to grow and congest ports and roadways, inland ports seem to represent possible solutions to alleviate some of this congestion. An inland port is a physical location outside of traditional land, air, and coastal borders that facilitates and processes international trade. Inland ports are a strategic investment in multi-modal transportation assets and encourage value-added services as goods move through the supply chain. Superior logistics, huge buildings, near proximity to rail and highways, abundant truck parking, less traffic congestion, and economic incentives are all advantages of inland ports.

Planning for the development of a new inland port could rely on the inclusion of an inter-modal rail spine that connects seaports to key markets in the region. Implementing the inland port concept in the San Joaquin Valley (SJV) supports a wide range of State and local community public policy objectives, including a significant increase in economic competitiveness. It will be beneficial in creating new jobs. It will be a more efficient distribution system that will reduce shipping costs. There will be a significant reduction in air pollution by reducing number of truck trips and in highway congestion, particularly along CA-99. Freight Transportation planning impacts traffic, congestion, energy demand, air pollution and greenhouse emissions, and transportation infrastructure.

However, an accurate feasibility study for an inland port requires a good understanding of the volumes and types of freight being transported into and outside from the region, as well as knowledge of the origins and destinations of these volumes. While different freight data sources exist, properties, capabilities, and limitations of these data sources vary. Accordingly, the objective of this work involves identifying different existing data sources, understanding their strengths and limitations, and analyzing their suitability for good understanding of the volumes and types of freight being transported into and out of the SJV and its counties.

2. Literature Review

In Germany, road freight transport is on the rise, accounting for 6% of the country's CO_2 emissions (Léonardi and Baumgartner 2004). Quantifying the potential for additional CO_2 reduction and the impact of specific initiatives, such as providing computer-assisted scheduling tools to trucking businesses, has received little attention. During 2003, a survey was conducted that connected fuel usage to transport performance indicators in 50 German haulage businesses. For 1kg of CO_2 emissions, emission efficiency ranged from 0.8tonne-km to 26tonne-km (Léonardi and Baumgartner 2004). The results suggest room for improvement in these areas:

- Low vehicle utilization and load factor levels
- Limited adoption of lightweight vehicle design
- Lot of empty trips
- Poor selection of vehicles

Scheduling systems based on IT that use telematics for data transmission, navigation, and location have shown to improve efficiency.

Air emissions, such as CO_2, NO_x, PM_{10}, etc., are emitted in the atmosphere by the transportation of freight by rail, road, and air. The life cycle of this emissions in the U.S. is studied by Facanha and Horvath (2006), who analyzed the different aspects related to freight transportation, such as its manufacturing, maintenance, end-of-life of transportation infrastructure, oil exploration, fuel refining and distribution, and end-of-life of the vehicle itself. A hybrid life cycle assessment is used to make the comparisons (Facanha and Horvath 2006). The results found that the rails had the least percentage contribution towards the total emission caused by freight transportation, about 50–94% lesser than road emissions. Use of road vehicles alone contributes the maximum percentage towards the total emissions caused by freight transportation, i.e., 70%. With respect to fuel efficiency, air cargo emits the most CO_2, about 18 and 35 times more than road and rail cargo, respectively.

Maritime transportation continues to be the most popular form of international commerce for both bulk and containerized break-bulk goods (Rodrigue 2008). Logistics firms, marine shipping lines, freight forwarders, and transport operators now manage ports as part of global commodities chains. In terms of ports of call, hierarchy, and frequency of services, their policies and asset allocation have impacted the structure of marine transport networks.

ITS or Intelligent Transportation Systems generally refers to innovative approaches to Infrastructure, Services, and Technology, and it also refers to the Operations, Planning, and

Control methods that are used for the transportation of humans and freight (Crainic, Gendreau, and Potvin 2009). Examination of freight is traditionally classified into two classes:

1. Commercial Vehicle Operations (CVO)
2. Advanced Fleet Management Systems (AFMS)

Multiple stakeholders are involved in the deployment, development, and operations of ITS, mostly government agencies at the regional, municipal, and even national level; highway operators, such as CalTrans; system vendors, and equipment manufacturers, etc. This paper intended to demonstrate how better decision-support software might dramatically enhance the overall performance of Intelligent Freight-Transportation Systems (Crainic, Gendreau, and Potvin 2009). Freight ITS changes with method of transportation activities performed, and that is exactly how it is expected to be.

Whether the existing urban and suburban rail networks can be used for the distribution and delivery of freight is explored in this research (Marinov et al. 2013). A total of six case studies were taken into consideration and discussed, of which Dresden, Amsterdam, Zurich, and Paris have already implemented and are using these networks for their distribution of freight/goods (Marinov et al. 2013). This research concluded that the concept of using urban and suburban rail networks for the distribution and delivery of freight is feasible.

A country's socioeconomic progress is affected by freight transportation, a major component of which involves moving raw materials from sources to industries and then carrying the finished product to customers in various places (Adetunji and Atomode 2014). This study focused on six significant places (terminals) in the city of Ibadan where freight vehicles frequently load and off-load their cargo. Structured questionnaires were utilized to acquire data on aspects of freight transport, including origin-destination of freight vehicles, different types of freight transported, and vehicle characteristics, due to a paucity of research on freight movement in the Ibadan metropolitan area. The waybills which show the description of goods carried were also collected and registered as a part of data in the questionnaire (Adetunji and Atomode 2014). The percentage of freight vehicles when compared to that of certain European countries was 29.2% vs. 30%, respectively. The study indicates that adequate steps must be adopted to incorporate freight transportation into urban transportation planning in the metropolis and other developing world cities.

Table 1. California Freight Data Sources Summary Table

Data Set	Shipment Data				Mode					Fee	Other
	Weight	Value	Vehicle/ mode Count	Ton	Air	Truck	Rail	Water	Multi		
Air Carrier Statistics	x		x		x					N	
Carload Waybill Sample	x	x	x	x			x			N	
Commodity Flow Survey (CFS)	x	x		x	x	x	x	x	x	N	
Foreign Trade Data	x	x			x	x	x	x	x	N	
Freight Analysis Framework (FAF4)	x	x		x	x	x	x	x	x	N	forecasts
North American Transborder Freight Data Set					x	x	x	x	x	N	
U.S. Waterway Data								x		N	
Transearch	x	x	x	x	x	x	x	x	x	Y	forecasts
American Transportation Research Institute (ATRI)						x				N	GPS Data
Cal-Freed										N	Data Source Archive
Manufacturing Survey										N	
USDA Agriculture data	x									N	
American Trucking Association						x				Y	forecasts
The Port Import/Export Reporting System (PIERS)	x	x						x		Y	

The movement of freight in Upper Midwest is described in this paper, and the assessments, which are based on secondary data, give a picture of how products travel to, from, and within the region, allowing for a better understanding of the corridor's freight transportation needs (Mcneil 2014). Over the last decade, a great deal of attention has been paid to the bottlenecks in and around Chicago, but less attention has been paid to freight movements in the context of the greater corridor. These freight flows are rising and are expected to continue to increase at a high rate in the future (AASHTO, 2003). Depending on how they are structured physically, data on freight movements may be classified into two kinds: segment or link specific (Mcneil 2014). Intrastate truck travel generally accounts for less than 10% of overall truck traffic, but regional truck traffic can account for up to 80%. This emphasizes the significance of a regional framework for addressing freight concerns.

The network of freight transportation must be streamlined on a regional basis in order to make freight distribution more efficient (Sonny et al. 2015). Potential freight transport generation utilizes variables that consider generalized transport costs, with a freight distribution model to determine freight commodity supply and demand in each location. It was also discovered that a positive value of β indicates that every increase in trip time reduces the rate of freight movement, which reflected real-world conditions: the greater the travel expenses, the fewer the flows between zones (Sonny et al. 2015).

Victoria, Australia is expected to grow quickly in the coming decades, making it important to establish an action plan that promotes an acceptable mix of efficiency and community livability and amenity (Perera, Thompson, and Chen 2018). As a result, the first step in this process should be to understand Victoria's freight transportation system and make ideas for improvement. Because there has never been enough data gathered before to effectively support policy formulation or planning, the Australian Bureau of Statistics (ABS) has collected comprehensive freight data for the first time. The main goal of this study was to examine freight movement to comprehend the current state of urban delivery. The analysis considered the commodities carried, the vehicle types used, and the number of kilometers traveled. The main findings were given, with some of them shown using GIS mapping techniques. Models for freight forecasting were created based on land use and employment, which corresponded to generation and attraction (Perera, Thompson, and Chen 2018). Also, several cost factors of freight vehicles were introduced, and their relevance in freight transportation planning was explored. These findings may be utilized as input for future model improvements such as optimization, emission prediction, and land use optimization, all of which are important tools for creating sustainable freight movement.

For any country's commerce and economic development, air freight transportation is essential. According to current statistics, rising nations, such as India, are seeing continued growth in the airfreight business; nevertheless, modeling efforts for airfreight remain limited when compared to other types of freight transportation (Veerappan et al. 2020). To estimate the air freight tonnage in an airport, a series of statistical models were built using regression analysis. The models were designed with practical applications in mind, such as facility planning and airport infrastructure investment decisions. According to the research, the number of industrial units in a city is the most relevant element in projecting air freight demand, followed by population. One of the important conclusions from this paper is that they airport's location has a huge impact on air freight demand (Veerappan et al. 2020). Overall, the air freight demand models proposed in this research might be beneficial in India for facility design, policy analysis, and airport access road enhancements.

3. Objective

Freight transportation plays a primary role in supply chains and the costs and availability of goods and is a major part of the economy. Understanding freight patterns and movements in, out, and through a region is vital for developing efficient transportation systems. This study aims to:

- Review the characteristics, strengths and limitations, and value of different data sources for understanding freight movements.

- Understand the patterns and movements of the different types of freight in and out of different counties of the San Joaquin Valley.

4. Methodology

This section reviews key terms in the methodology of data collection as it pertains to data processing and analysis.

4.1 Classification of Freight

In the field of import and export of goods, the term *freight* refers to goods or cargo transported by any means of transportation (e.g., air, rail, truck, vessel, etc.). Across the globe, freight is uniformly classified in a system called the Harmonized System (HS), which is used throughout the export process for goods. The HS is a standardized numerical method of classifying traded products and is used by customs authorities around the world to identify products when assessing duties and taxes and for gathering statistics.

The HS assigns specific six-digit codes for varying classifications and commodities. Countries are allowed to add longer codes to the first six digits for further classification.

For this research, HS codes were classified into four different categories:

- HS Farm Produce: Animals, Vegetables, Prepared Foods, Tobacco Products
- HS Minerals and Chemicals: Minerals, Chemicals, Leather, Wood
- HS Textile: Textile and Textile Products
- HS Industrial Materials: Construction Materials, Metals, Machineries, Vehicles, Miscellaneous

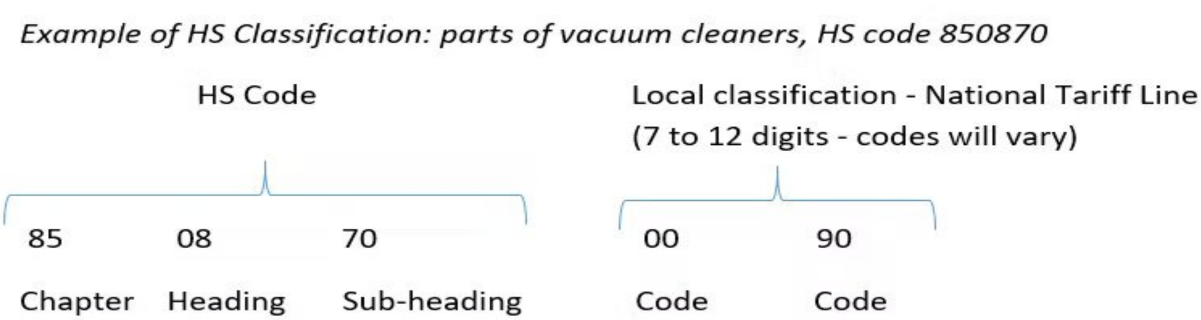

Figure 1. Example of HS Classification (Rules of Origin Facilitator, n.d.)

4.2 Data Sources

This section describes the data sources used for this research.

4.2.1 Global Trade Atlas (GTA)

GTA is the data source for access to a comprehensive view of global trade data in every commodity at the most detailed level of HS code. Each record is unique to each trade within each country. GTA data consists of attributes such as Year; Reporting Country; Trade Direction; Trade Partner; HS codes with description; State; Mode of Transport; and Value, Quantity and Units of the Freight. Pivot Tables were used for processing.

Year	Month	Reporter	Trade Direction	Trade Partner	HS2 Code	HS2 Description	State	Transport	Value (USD)	Quantity	Unit Price	Units
2019	9	U.S. State	Import	Australia	1	Live Animals	California	Air	17665	212	83.33	KG
2019	8	U.S. State	Import	Belgium	1	Live Animals	California	Air	262747	3275	80.23	KG
2019	10	U.S. State	Import	Belgium	1	Live Animals	California	Air	2915203	6375	457.29	KG
2019	7	U.S. State	Import	Belgium	1	Live Animals	California	Air	2162734	8600	251.48	KG
2019	11	U.S. State	Import	Canada	1	Live Animals	California	Air	123790	854	144.95	KG
2019	3	U.S. State	Import	Australia	1	Live Animals	California	Air	41425	654	63.34	KG
2019	5	U.S. State	Import	Denmark	1	Live Animals	California	Air	72541	1000	72.54	KG
2019	5	U.S. State	Import	Australia	1	Live Animals	California	Air	110080	1053	104.54	KG
2019	12	U.S. State	Import	Belgium	1	Live Animals	California	Air	1388616	5860	236.97	KG
2019	5	U.S. State	Import	Czech Republic	1	Live Animals	California	Air	28484	1000	28.48	KG
2019	7	U.S. State	Import	Czech Republic	1	Live Animals	California	Air	6100	26	234.62	KG
2019	1	U.S. State	Import	Australia	1	Live Animals	California	Air	14300	23	621.74	KG
2019	1	U.S. State	Import	Belgium	1	Live Animals	California	Air	2650462	9785	270.87	KG
2019	12	U.S. State	Import	Canada	1	Live Animals	California	Air	19700	692	28.47	KG
2019	6	U.S. State	Import	Croatia	1	Live Animals	California	Air	2200	9	244.44	KG
2019	12	U.S. State	Import	France	1	Live Animals	California	Air	452406	2500	180.96	KG
2019	7	U.S. State	Import	Colombia	1	Live Animals	California	Air	5700	80	71.25	KG
2019	3	U.S. State	Import	China	1	Live Animals	California	Air	15900	240	66.25	KG
2019	7	U.S. State	Import	China	1	Live Animals	California	Air	15040	377	39.89	KG
2019	2	U.S. State	Import	Germany	1	Live Animals	California	Air	1687020	17036	99.03	KG
2019	1	U.S. State	Import	China	1	Live Animals	California	Air	41910	334	125.48	KG
2019	5	U.S. State	Import	Colombia	1	Live Animals	California	Air	6830	78	87.56	KG
2019	4	U.S. State	Import	France	1	Live Animals	California	Air	84495	1000	84.5	KG
2019	12	U.S. State	Import	Hong Kong	1	Live Animals	California	Air	19842	34	583.59	KG
2019	2	U.S. State	Import	Colombia	1	Live Animals	California	Air	11700	183	63.93	KG
2019	7	U.S. State	Import	France	1	Live Animals	California	Air	445308	2882	154.51	KG
2019	12	U.S. State	Import	Netherlands	1	Live Animals	California	Air	2271057	15612	145.47	KG
2019	5	U.S. State	Import	Kenya	1	Live Animals	California	Air	27140	95	285.68	KG
2019	9	U.S. State	Import	Kenya	1	Live Animals	California	Air	18856	66	285.7	KG
2019	3	U.S. State	Import	France	1	Live Animals	California	Air	59346	1509	39.33	KG

Figure 2. GTA Data Example Snippet

4.2.2 Port Import/Export Reporting System (PIERS)

PIERS offers extensive trade data, including specific commodity descriptions, tonnage shipped, TEUs, estimated value, and profiles of import/export firms. PIERS data is based on trade company addresses, making it the most time consuming to work on out of the three data sources for extracting county-level data. The application of ArcGIS for extracting county-level data is explained in the image below.

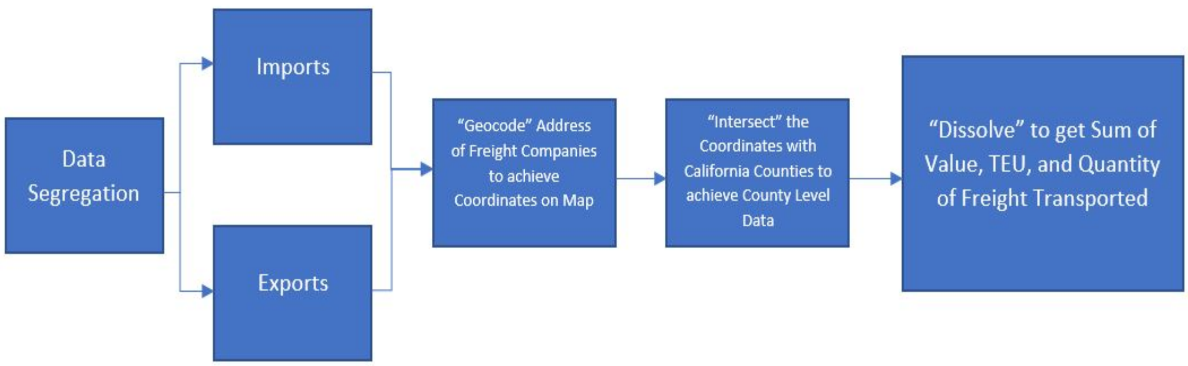

Figure 3. PIERS Data Processing Flow Chart Using ArcGIS

Data is segregated from MS Access into Imports and Exports to export it into MS Excel. The data was divided into imports and exports as two files because of the limitation of MS Excel to not hold more than about a million records. Next the data was Geocoded using ArcGIS. With this function, the Excel file addresses were transformed into coordinates on map. Geocoding was not completely successful because the address locator did not have the most updated list of cities associated with their respective counties. Those cities which were not geocoded were replaced with the cities which were in the list of cities in the address locator, making sure the counties remained the same so that the results remained unchanged. While trying to intersect those cities with their respective counties, ArcGIS failed to execute the Intersect function as the size of the data set and information exceeded its capacity. Further, Exports were divided into records from Los Angeles and the Rest using the "Select by Location" function. Imports were divided into Rest, LA part1, and LA part2 by using the same function. This function helped to achieve county-level information in the data. The Dissolve function was used to dissolve the data with respect to counties to calculate the sum of Value, TEUs, and Quantity of Freight Transported.

4.2.3 Streetlight Insights

StreetLight InSight identifies mobility patterns for planners, modelers, and engineers by giving them on-demand access to the ideal Big Data resources and processing software for transportation.

Data is collected via a GPS or Fleet control system fitted on the trucks. ArcGIS was used to input Desired Zones (the eight counties of SJV).

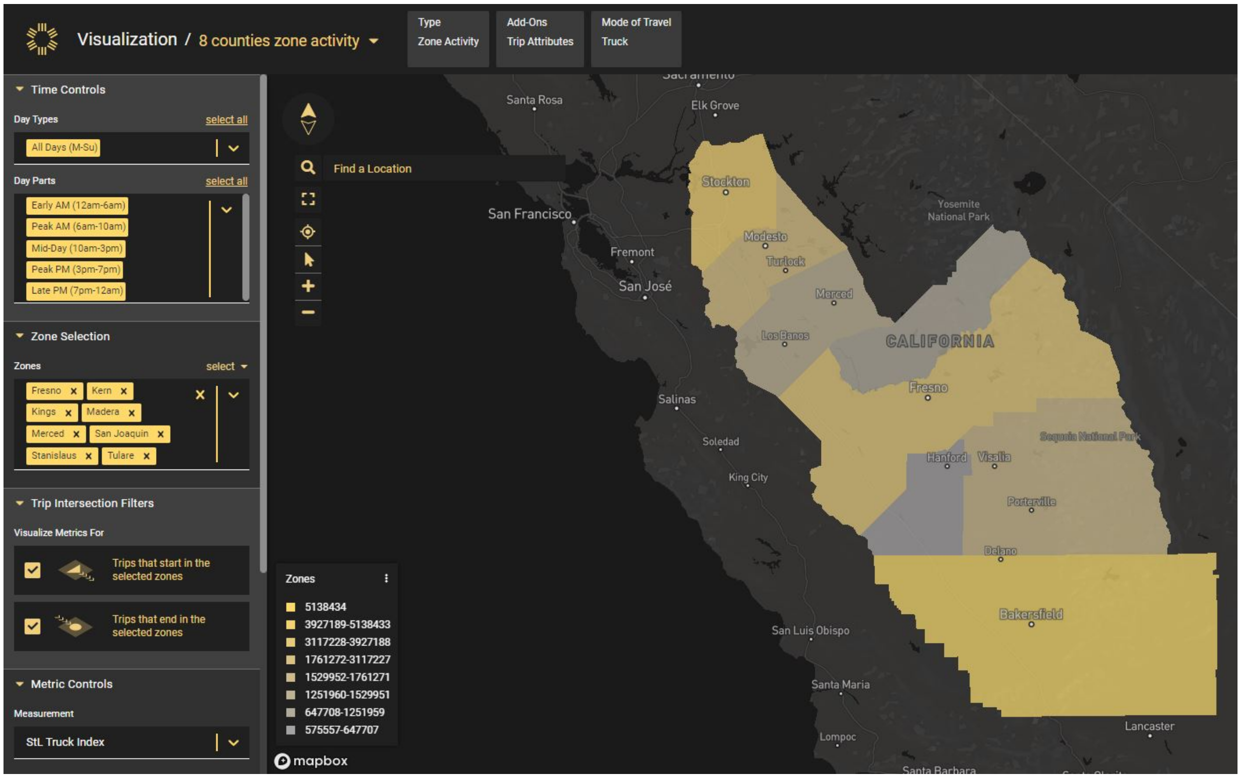

Figure 4. Streetlight Data Processing Snippet

An attempt was made to create an Origin-Destination Matrix between eight counties of SJV, 10 major ports of California, California, and the U.S. But due to the limitation of the platform, it is unable to process an analysis if the total area of the analysis zones exceeds 90,000 square miles; only analysis of truck trips between the eight counties of SJV was produced. Out of multiple different options to run analysis, Zone Activity Analysis was used. The output of the Zone Activity Analysis is measured with StreetLight Truck Index. This metric is a numerical value that is normalized with permanent counter data to account for monthly and seasonal changes in the underlying sample. U.S. projects are normalized with Sacramento, CA counters.

5. Results

This section reviews the findings from this research, which are categorized into four categories: comparison of attributes at state level, comparison of attributes between state and counties of the San Joaquin Valley, port trade compared between the counties of San Joaquin Valley, and truck indexes.

5.1 State Comparison

Table 2 compares imports-exports with respect to mode of transportation and different HS codes within the GTA data. Table 3 compares imports-exports based on value and weight of the freight between two different data sources.

Table 2 reveals a trend that there are more imports compared to exports in the state of California. When comparing the value with the quantity of freight transported, air stands at the highest in value and lowest in quantity of freight exported at the same time. Maximum quantity of goods is transported through vessels for both imports and exports. Highest value of freight transported is HS codes: Industrial Materials Group. Highest quantity of freight transported is HS codes: Minerals and Chemicals. This trend remains similar for both exports and imports.

Table 2. State Exports vs. Imports Based on Value and Weight

Classification	Weight (M Tons)		Value ($ Billions)	
	Export	Import	Export	Import
Total	61,241	141,966	507	170
Mode of Transport: Air	540	803	106	81
Mode of Transport: Container	19,720	36,258	173	36
Mode of Transport: Vessel	40,982	104,905	228	52
HS Codes: Farm Produce	15,022	18,092	40	33
HS Codes: Minerals and Chemicals	34,723	79,721	79	27
HS Codes: Textile	823	7,498	68	4
HS Codes: Industrial Materials	10,674	36,655	320	106

Data Source: GTA

Table 3 shows the comparison of imports and exports data between GTA and PIERS. This comparison demonstrates that the trade numbers from GTA are more closely aligned with the California Chamber of Commerce (2022) trade statistics, which suggests it is the more reliable source of data.

Table 3. State Imports vs. Exports (PIERS and GTA data)

Data Source	Attribute	Imports	Exports
PIERS	Value ($ Billions)	85	63.9
	Quantity (M Tons)	27.4	16.1
GTA	Value ($ Billions)	507	170
	Quantity (M Tons)	141,966.1	61,241.4

5.2 State vs. San Joaquin Valley Comparison

Table 4 compares PIERS data of the freight trend between the State of California and the San Joaquin valley. The data trends demonstrate that, whereas the state as a whole imports more than it exports, the trend is reversed for the San Joaquin Valley as it exports more freight than it imports.

Table 4. State vs. San Joaquin Valley Imports/Exports

Attribute	Imports			Exports		
	State	SJV	% Of State	State	SJV	% Of State
Value ($ Billions)	85	2	2.65	63.9	4.1	6.39
Quantity (M Tons)	27.4	.8	3.03	16.1	1.6	10.13
TUEs (Millions)	2.1	0.07	3.08	1.4	0.13	8.79

Data Source: PIERS

5.3 San Joaquin Valley Counties and Ports Trade Movement Comparison

Table 5 compares imports and exports from the eight counties of the SJV with respect to the HS code classification groups. Table 6 depicts a comparison of imports-exports of major ports of California. Table 7 shows the top three ports with respect to HS codes.

In the valley, San Joaquin County stands first with maximum imports with HS codes: Industrial Materials. Kings County stands last with both the least imports and exports. The trends reveal the valley imports HS Industrial Materials the most and exports HS Farm Produce the most. Fresno County stands second for Imports, whereas Kern County stands is first for exports, with HS Industrial Material being exported the most.

Table 5. County Imports/Exports with respect to Freight Classification

County	Imports			Exports		
	Value ($ Millions)	Quantity (Kilo Tons)	TEUs (Thousands)	Value($ Millions)	Quantity (Kilo Tons)	TEUs (Thousands)
Fresno	**490.9**	**186.3**	**14.3**	**538.6**	**175.0**	**16.8**
HS Farm Produce	146.0	105.9	6.6	313.5	121.9	11.7
HS Minerals and Chemicals	71.5	30.0	3.3	52.1	8.9	0.9
HS Textile	5.9	0.8	0.2	69.5	32.0	3.2
HS Industrial Materials	267.4	49.6	4.2	103.5	12.1	1.1
Kern	**467.9**	**128.6**	**17.0**	**1,843.1**	**953.2**	**60.8**
HS Farm Produce	10.5	11.0	0.9	297.5	162.0	15.1
HS Minerals and Chemicals	33.5	9.8	1.3	521.8	584.8	27.7
HS Textile	31.8	4.2	0.8	448.3	125.1	12.9
HS Industrial Materials	392.0	103.6	14.0	575.5	81.2	5.2
Kings	**8.4**	**1.3**	**0.2**	**88.6**	**21.3**	**2.2**
HS Farm Produce	4.1	0.5	0.1	5.3	1.7	0.2
HS Minerals and Chemicals	1.6	0.5	0.1	0.1	0.0	0.0
HS Textile	0.1	0.0	0.0	76.6	18.4	1.9
HS Industrial Materials	2.6	0.3	0.0	6.6	1.2	0.1
Madera	**21.6**	**14.9**	**1.0**	**144.4**	**37.0**	**3.4**
HS Farm Produce	7.6	4.7	0.4	121.2	33.7	3.1
HS Minerals and Chemicals	7.6	9.5	0.5	0.5	0.2	0.0
HS Textile	0.0	0.0	0.0	0.4	0.2	0.0
HS Industrial Materials	6.4	0.8	0.1	22.3	3.0	0.3
Merced	**31.9**	**14.5**	**1.4**	**289.3**	**87.7**	**6.8**
HS Farm Produce	3.1	4.8	0.5	210.5	79.5	6.3
HS Minerals and Chemicals	11.2	4.2	0.5	52.9	6.3	0.4
HS Textile	2.1	0.3	0.0	15.8	0.3	0.0
HS Industrial Materials	15.5	5.1	0.5	10.1	1.7	0.2
San Joaquin	**689.3**	**362.5**	**22.9**	**638.8**	**130.4**	**14.0**
HS Farm Produce	155.7	120.7	4.2	277.7	76.9	7.8
HS Minerals and Chemicals	97.4	162.7	5.6	151.6	37.3	2.4
HS Textile	87.0	7.3	1.5	60.9	4.6	1.1
HS Industrial Materials	349.2	71.7	11.6	148.5	11.6	2.7
Stanislaus	**413.6**	**74.9**	**4.4**	**365.3**	**162.7**	**15.5**
HS Farm Produce	46.1	20.6	1.8	313.1	149.3	14.2
HS Minerals and Chemicals	44.6	8.7	1.1	18.2	7.2	0.7

County	Imports			Exports		
	Value ($ Millions)	Quantity (Kilo Tons)	TEUs (Thousands)	Value($ Millions)	Quantity (Kilo Tons)	TEUs (Thousands)
HS Textile	5.9	1.1	0.1	1.6	0.3	0.0
HS Industrial Materials	317.0	44.5	1.4	32.5	5.9	0.5
Tulare	**114.2**	**47.2**	**4.2**	**171.8**	**63.2**	**6.9**
HS Farm Produce	29.4	30.5	2.2	142.5	58.6	6.3
HS Minerals and Chemicals	36.0	8.7	0.9	14.9	2.8	0.3
HS Textile	1.6	0.4	0.1	1.1	0.3	0.1
HS Industrial Materials	47.3	7.7	1.0	13.3	1.4	0.2

Data Source: PIERS

Table 6 shows that, of the 10 major ports in California, the top 3 most active ports are Los Angeles, then Long Beach followed by Oakland. The Port of Los Angeles has the most import activities whereas the Port of Long Beach has the maximum exports. While the Port of Oakland is not significant for imports, it is more active than the Port of Los Angeles for exports. Trends reveal that the Port of Redwood City stands last for imports, while the Port of San Diego has the least exports.

Table 6. State International Imports and Exports by Ports in California

Major Ports of California	Imports			Exports		
	Value ($ Millions)	Quantity (Kilo Tons)	TEUs (Thousands)	Value ($ Millions)	Quantity (Kilo Tons)	TEUs (Thousands)
LONG BEACH	32,223.2	7,189.3	933.2	23,664.9	6,191.0	471.3
LOS ANGELES	38,125.4	7,403.3	897.3	17,376.7	5,297.6	536.7
OAKLAND	6,850.4	1,765.4	225.4	21,620.4	4,068.2	421.1
PT HUENEME	1,053.7	431.5	14.0	282.6	43.1	6.8
REDWOOD CY	58.7	1,087.4	0.0	255.5	312.9	0.0
RICHMOND	4,430.1	6,754.7	0.0	46.5	62.8	0.0
SAN DIEGO	918.8	652.3	54.0	30.6	4.8	2.0
SAN FRANCISCO	387.7	1,754.6	0.0	541.7	41.4	0.0
STOCKTON	524.5	332.7	0.0	35.3	67.2	0.0

Table 7 shows a comparison of imports and exports of the top three performing ports with respect to HS code groups. It shows that HS Industrial Materials are both the most imported and exported category of goods. The second most imported items are from HS Textiles, whereas HS Minerals and Chemicals is in second position for exports.

Table 7. Top 3 Ports for State Imports/Exports with respect to HS Groups

Port	Imports			Exports		
	Value ($ Millions)	Quantity (Kilo Tons)	TEUs (Thousands)	Value ($ Millions)	Quantity (Kilo Tons)	TEUs (Thousands)
LONG BEACH	**32,223.2**	**7,189.3**	**933.2**	**23,664.9**	**6,191.0**	**471.3**
HS Farm Produce	1,557.1	808.4	71.3	1,736.7	1,230.0	115.5
HS Minerals and Chemicals	4,394.1	2,837.9	144.9	2,657.9	3,462.9	159.7
HS Textile	6,343.6	505.8	106.9	997.8	182.6	20.9
HS Industrial Materials	19,928.5	3,037.2	610.0	18,272.5	1,315.6	175.3
LOS ANGELES	**38,125.4**	**7,403.3**	**897.3**	**17,376.7**	**5,297.6**	**536.7**
HS Farm Produce	1,762.8	809.3	77.9	1,716.0	1,401.8	137.0
HS Minerals and Chemicals	4,079.3	1,847.7	165.7	2,929.9	2,419.2	220.3
HS Textile	5,523.7	463.9	102.7	1,159.8	191.4	20.4
HS Industrial Materials	26,759.7	4,282.5	550.9	11,570.9	1,285.2	159.0
OAKLAND	**6,850.4**	**1,765.4**	**225.4**	**21,620.4**	**4,068.2**	**421.1**
HS Farm Produce	1,193.3	622.9	52.2	4,128.4	2,073.8	192.0
HS Minerals and Chemicals	1,155.0	430.7	52.5	2,060.3	1,325.3	143.5
HS Textile	525.1	59.0	13.0	240.0	45.1	5.3
HS Industrial Materials	3,976.9	652.8	107.7	15,191.7	623.9	80.3
Grand Total	**77,199.0**	**16,358.0**	**2,055.9**	**62,662.0**	**15,556.8**	**1,429.1**

5.4 Truck Volumes

StreetLight InSight provided a county-level overview of truck activity to assess the movement of freight by truck. Zone activity analysis was produced in the form of StreetLight Truck Index comparison. The results show that out of all eight counties in SJV, Kern County has the maximum index of 5.1 million, whereas Kings County stood at the last spot with an index of 575,000.

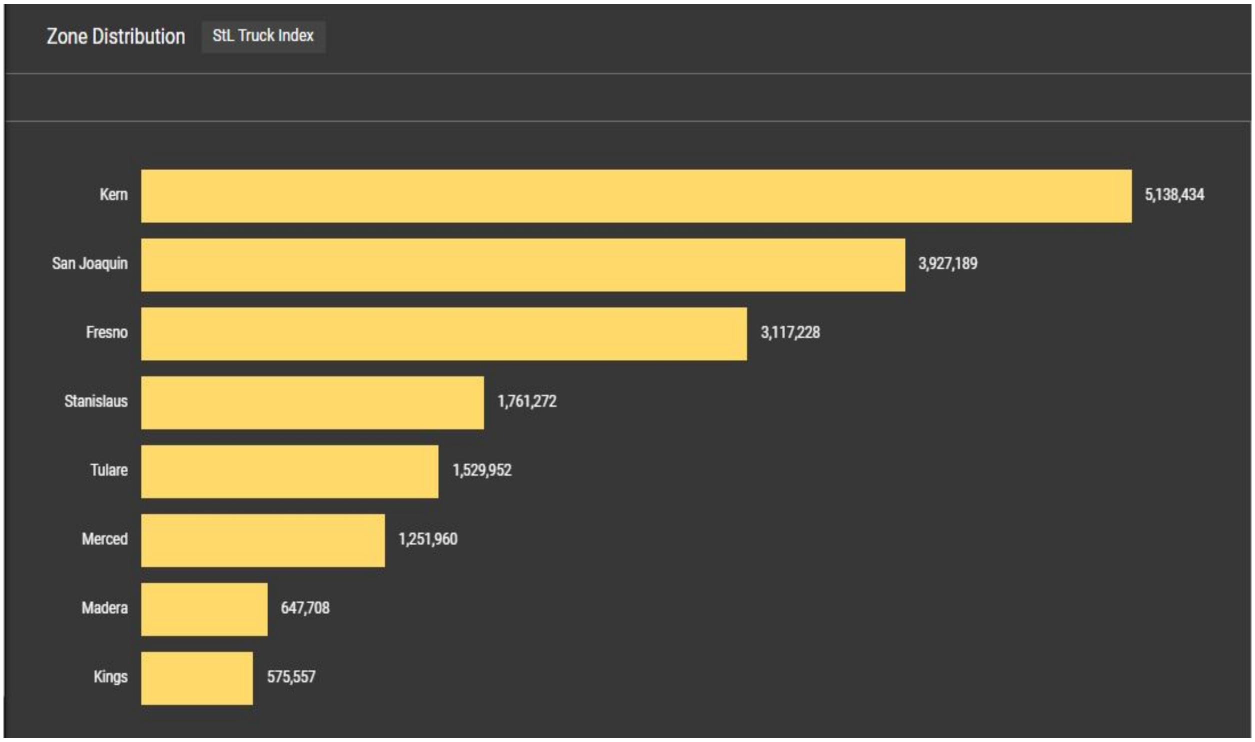

Figure 5. Truck Trips Zone Distribution Chart for Eight Counties of SJV

6. Conclusions

The main findings of this work include the following:

- The GTA data provides state-level data and is considered the most reliable out of all three data sets. It was validated with help of reference literature and Import-Export state trade portals. Its limitation is that it did not provide county-level information.

- The PIERS data was useful to extract county level information by geocoding company addresses in ArcGIS. Its main limitation is housed in the assumption that the location of the exporting and importing company is identical to the location from which the freight is being exported and imported. An additional limitation involved that it does not provide the different modes of transportation.

- StreetLight InSight provided county-level Truck index but has some limitations such as a restricted zone size and restrictions in its definition of a trip end when the vehicle does not move for more than 5 meters in 5 minutes. Also, it has a limitation that it cannot process an analysis if the total Zone Area exceeds 90,000 square miles.

- General freight trade results suggest there is an international trade deficit because California imports more than it exports.

- Although California is more of an importer than an exporter for international trade, the trend is reversed for San Joaquin Valley, which exports more goods than it imports.

- When comparing state trends in the SJV, the state-to-SJV import percentage is in the range of 2–3% whereas for exports that percentage rises to 6–10%.

- In SJV, San Joaquin County tops the chart with most imports and exports, with Fresno and Kern counties next in order.

- The trend in the SJV is that it imports HS Industrial Materials more than any other freight category. Trends suggest it exports HS Farm Produce the most.

- In terms of California State's international trade, the ports of Los Angeles and Long Beach are used the most, but the Port of Oakland is significant in terms of exports, as it exports even more than the port of Los Angeles.

- The overall trend for state international trade suggests that through all top three ports, the most imported or exported commodity is the HS Industrial Materials group.

Further Work: Numerous other data sources are available with which better comparison can be made using different visualization software.

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