

Tracking Truck Flows for Drayage Efficiency Analysis

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Presentation Outline

1. Problem
2. Background
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4. Our Tracking Device
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Problem

- Due to the growth of container volume at the Southern California Twin Ports, congestion has become a chronic problem.
- Inefficient port drayage causes not only congestion but also high costs and pollution.
- Solving this issue can bring a healthier environment, lower costs of product and less traffic.
- Pollution problem has been mitigated through Alternative Maritime Power for vessels & Clean Truck Program.
- Congestion problem persists. Solution requires a clear understanding of current state of drayage efficiency through detailed tracking.

Background

■ Facts

- The San Pedro Twin Ports are the largest port complex in the U.S. and 9th largest port in the world.
- POLA has handled an average of 7.8-million TEUs, and POLB an average of 6.4 million-TEUs per year over the last 10 years.
- They account for approx 40% of the U.S. international container volume, and 61% market shares of all West Coast container ports in 2014.
- 50% of cargo unloaded is bound for local Southern California markets. Those imports for local distributions and exports from local shippers are handled by drayage trucks. Drayage is significant in Southern California.
- Volume had been stagnant through the years of global financial crisis, but is about to recover to previous peak.

Cargo Volume (in million TEUs) in LA/LB Ports

Year	POLA	POLB	Total	Change from prior year	% changed
2003	7.1	4.7	11.8	1.2	11%
2004	7.3	5.8	13.1	1.3	11%
2005	7.5	6.7	14.2	1.1	8%
2006	8.5	7.3	15.8	1.6	11%
2007	8.4	7.3	15.7	-0.1	-1%
2008	7.8	6.5	14.3	-1.4	-9%
2009	6.7	5.1	11.8	-2.5	-17%
2010	7.8	6.3	14.1	2.3	19%
2011	7.9	6.1	14.0	-0.1	-0.7%
2012	8.1	6.0	14.1	0.1	0.7%
2013	7.9	6.7	14.6	0.5	3.5%
2014	8.3	6.8	15.1	0.5	3.4%
2015	6.1 (to Sep)	5.4 (to Sep)	11.5 (to Sep)	0.1 (YTD)	0.7%

Truck Tracking

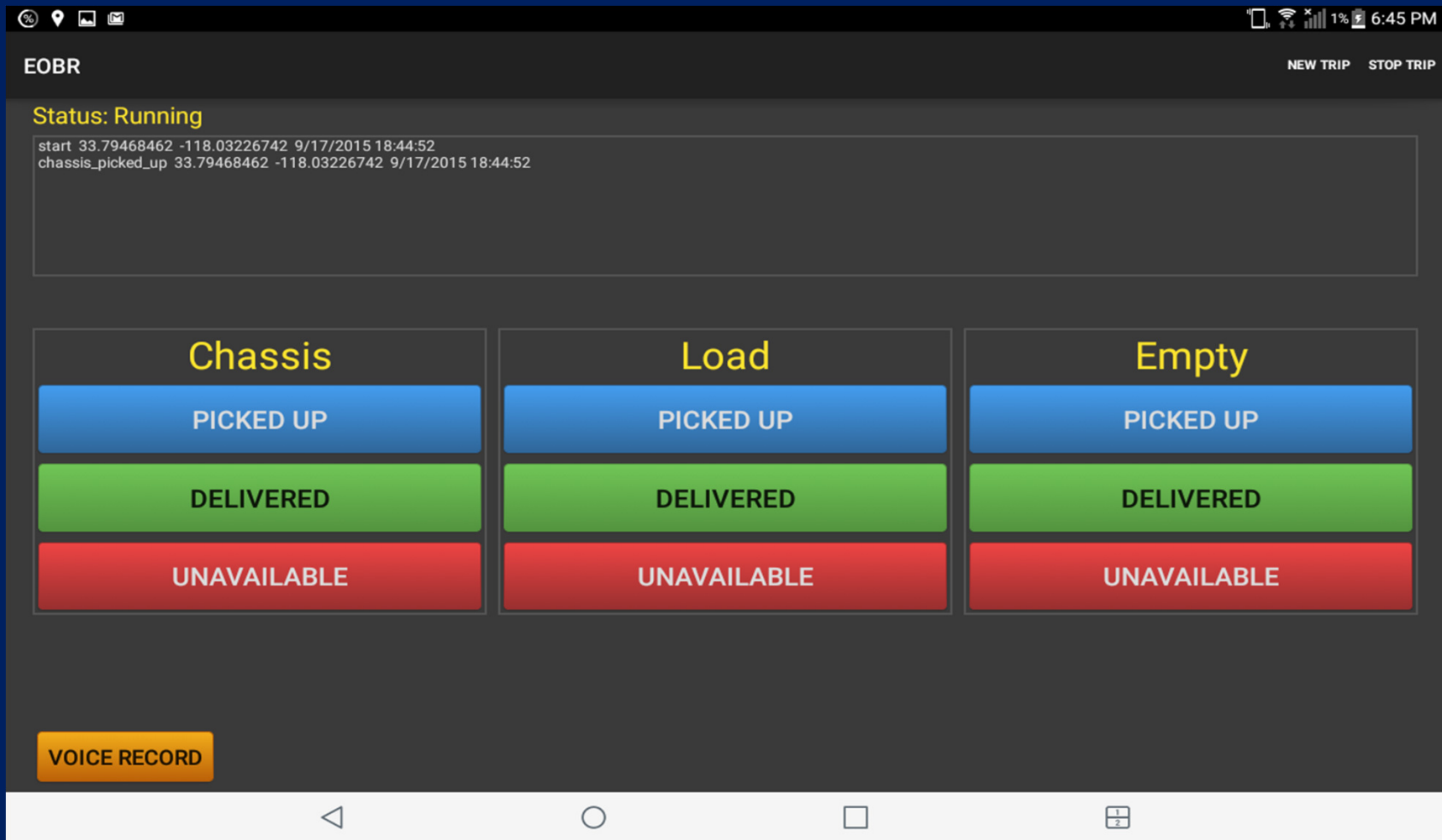
- Tracking of container trucks is of great interest to & being done by various stakeholders in the drayage industry (e.g., companies that provide drayage services, marine terminal operators, PierPass, Harbor Trucking Association). Some use GPS, others use RFIDs.
- GPS tracking is a mature technology. Many commercial tracking products and services are available on the market.
- GPS tracking collects data on where a truck has been and at what time, but does not provide info on what the truck is there for. Such info can be provided by the driver.

Our Tracking Device

- Hardware – tablets & server. Reasons for using tablets:
 - Large touch screen for easy driver input.
 - Software development tools readily available.
- Software – 3 applications:
 - Mobile application: logs GPS locations & events, and transmits to server.
 - Server application: receives data from mobile device & performs preliminary analysis using predefined geofences; and responds to Web client for trip data retrieval & display.
 - Application for data organization & extraction: helps with organization of logged data into transactions & extraction into CSV file.

User Interface on Mobile Device

- We built a mobile application with simple user interface to collect these trip data.



User Interface for Web Client

Browser tabs: FOBR Analysis tools, CSS trick: Always show sc..., Android Developer at MyDev... | Byung

Address bar: 134.139.249.76:8888

Bookmarks: Apps, New ad, Skill Enhancement, Arduino, Fortran, Cloud Related, SoftwareEngineering, JobRelated, neuralnetwork, MaterialDesign, General recommend..., Other Bookmarks

EOBR

Trip List

Trip Id	Truck Id
20150811	0c:48:85:be:3d:00
20150811	0c:48:85:e9:b7:4c
20150812	0c:48:85:e9:b7:4c
20150812	0c:48:85:be:3d:00
20150813	0c:48:85:be:3d:00
20150814	0c:48:85:e9:b7:4c
20150815	0c:48:85:e9:b7:4c
20150817	58:3f:54:c0:f7:fa
20150917	64:89:9a:8f:22:91
20150917	0c:48:85:be:3d:00
20150918	0c:48:85:be:3d:00
20150919	0c:48:85:be:3d:00
20150920	0c:48:85:be:3d:00

Trip Data

Date	Time	Type	Dist.
2015			
8-15-2015	11:56:43 PMT	Running	1.92 M
8-15-2015	11:58:41 PMT	Running	0.77 M
8-15-2015	11:59:41 PMT	Running	0.34 M
8-15-2015	12:00:42 PMT	Running	0.29 M
8-15-2015	12:01:40 PMT	Running	0.70 M
8-15-2015	12:02:41 PMT	Running	0.85 M

Total Distance = 54.03 M

Map

CSULB Research

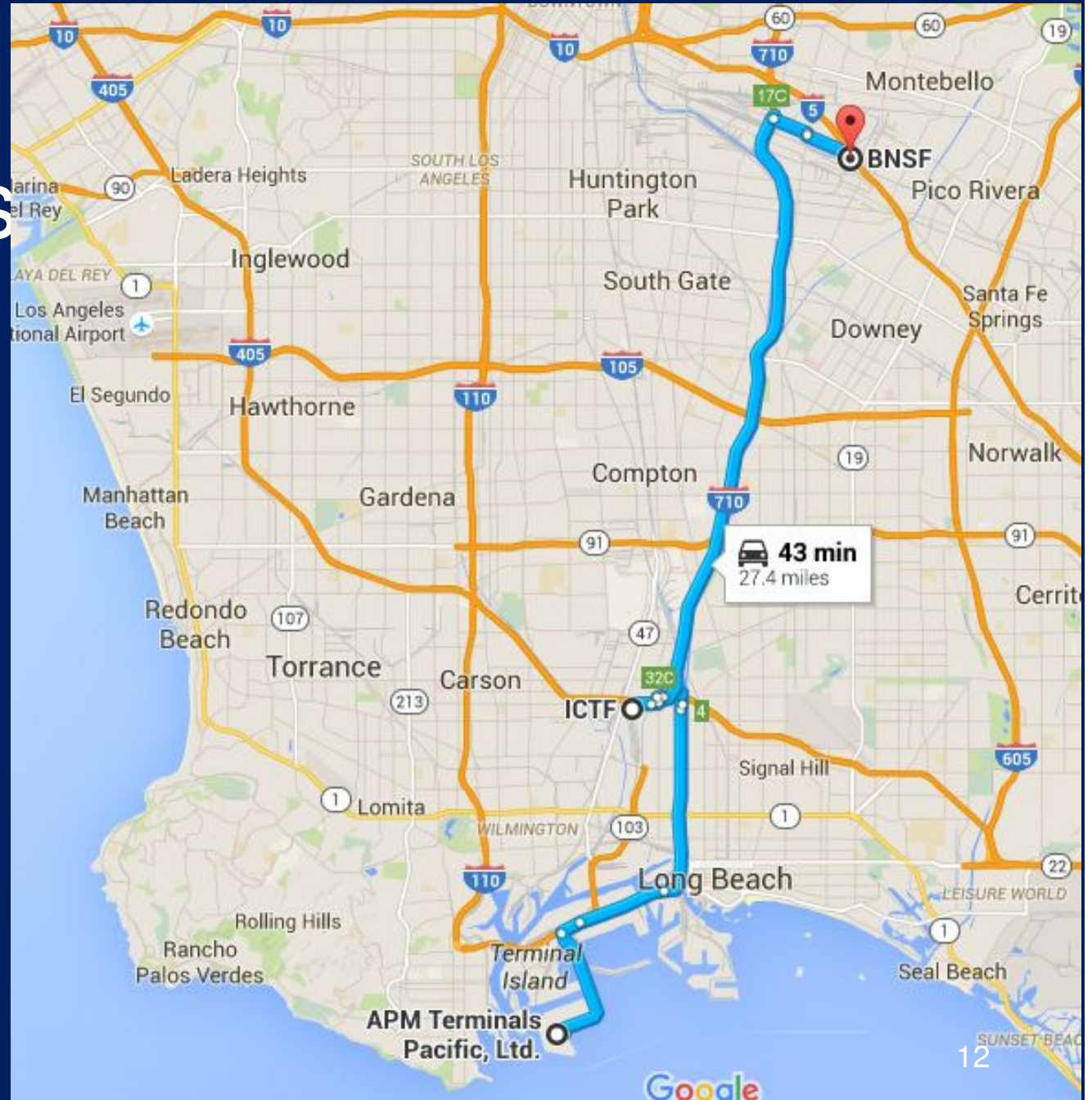
Data Collection

- 5 drivers from a drayage company participated in the data collection.
- Collection spanned from 6/8/15 to 8/12/15.
- Work types of drivers:
 - 2 heavy-tag (truck can only run on heavy container corridor)
 - 1 delivery to rail
 - 1 Target delivery
 - 1 store delivery

Heavy Container Corridor



Rail Locations



Data Analysis

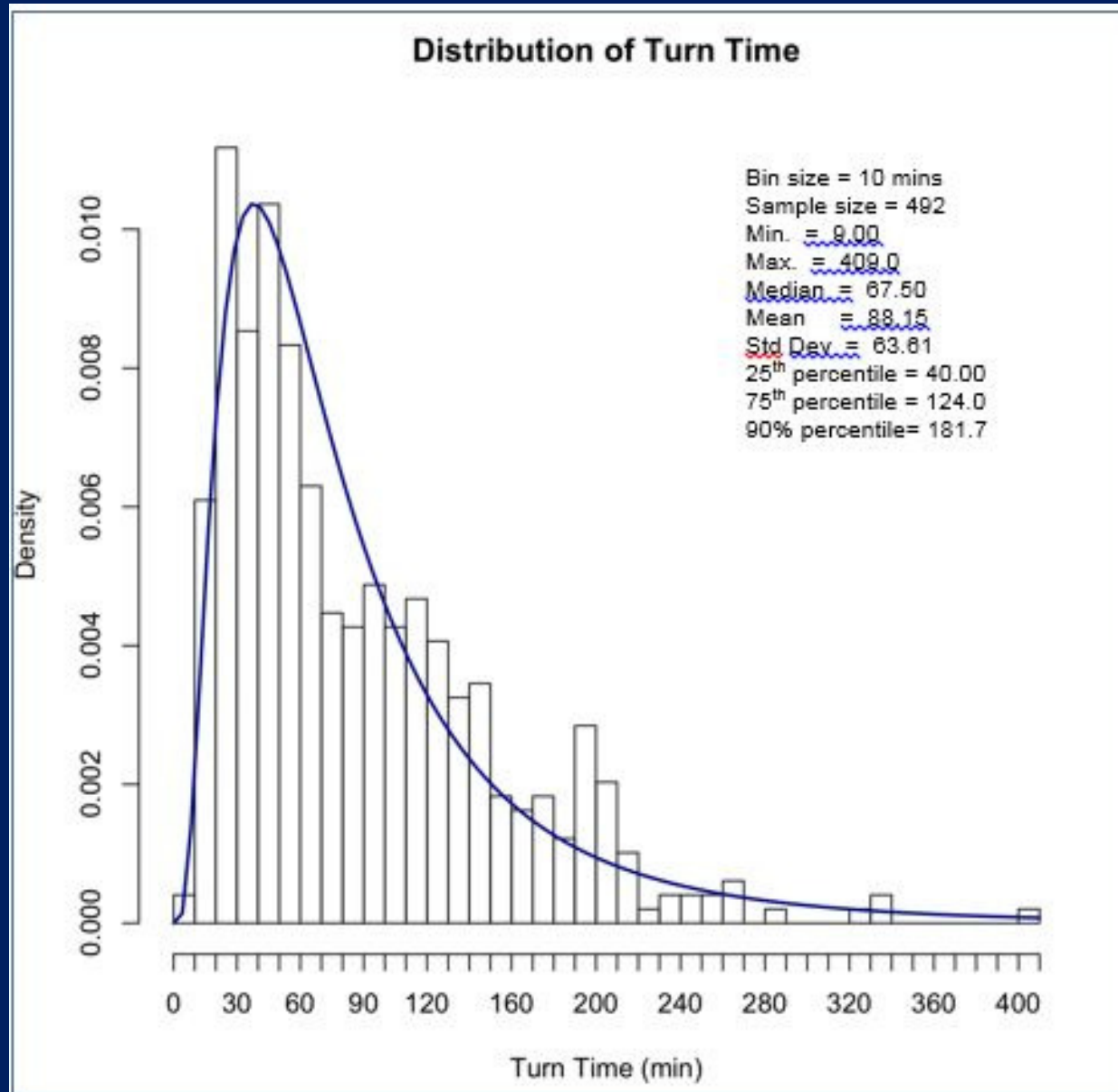
- Data organized into a total of 2405 transactions, 533 of which are terminal transactions (492 after cleanup).
- 12 terminals were covered.
- Arrival time at terminal is between 7:00 am and 20:30 pm
- 5 single transaction types:
 - Load Picked Up
 - Load Delivered
 - Empty Picked Up
 - Empty Delivered
 - No Transaction (job either related to chassis, or no specific job indicated)
- 4 Dual transaction types:
 - Load Delivered - Load Picked Up
 - Load Delivered - Empty Picked Up
 - Empty Delivered - Load Picked Up
 - Empty Delivered - Empty Picked Up

Data Analysis

Time Spent in Terminal

- Turn time = Queue time + Flow time
 - Queue time is time between entering terminal and gate-in
 - Flow Time (also referred to as Transaction time) is time between gate-in and exit of terminal
- Average turn time is 88 minutes, median 68 minutes. One quarter of the transactions took more than 2 hours, 10% more than 3 hours, likely the results of trouble tickets.
- Distribution has a long tail.

Turn Time Distribution



Turn Time Statistics

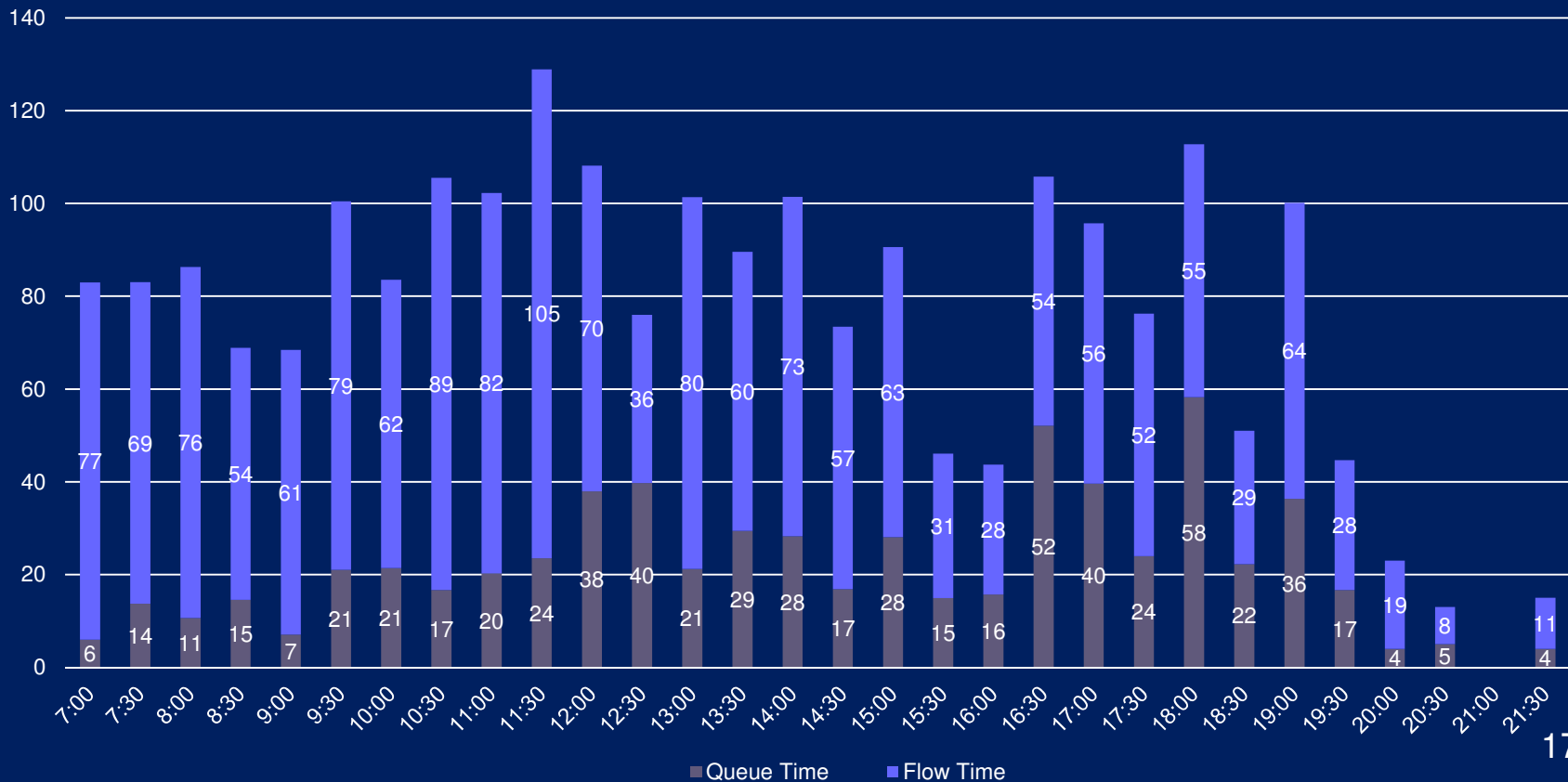
- 88 minutes average turn time is longer than several previous studies on single terminal
 - 40 min. by Lam et al., 38-61 min. by Giuliano and O'Brien, 72 min. by Monaco & Grobar
- Comparing with recent statistics:
 - PierPass reported an August 2015 average turn time of 47 minutes on day shifts & 51 minutes on night shifts, based on RFID derived data that excluded lunch hour, breaks, and trouble tickets.
 - Journal of Commerce reported an average of 89 minutes visit time based on data extracted from Harbor Trucking Association's truck mobility project.

Data Analysis

Time Spent in Terminal by Arrival Time

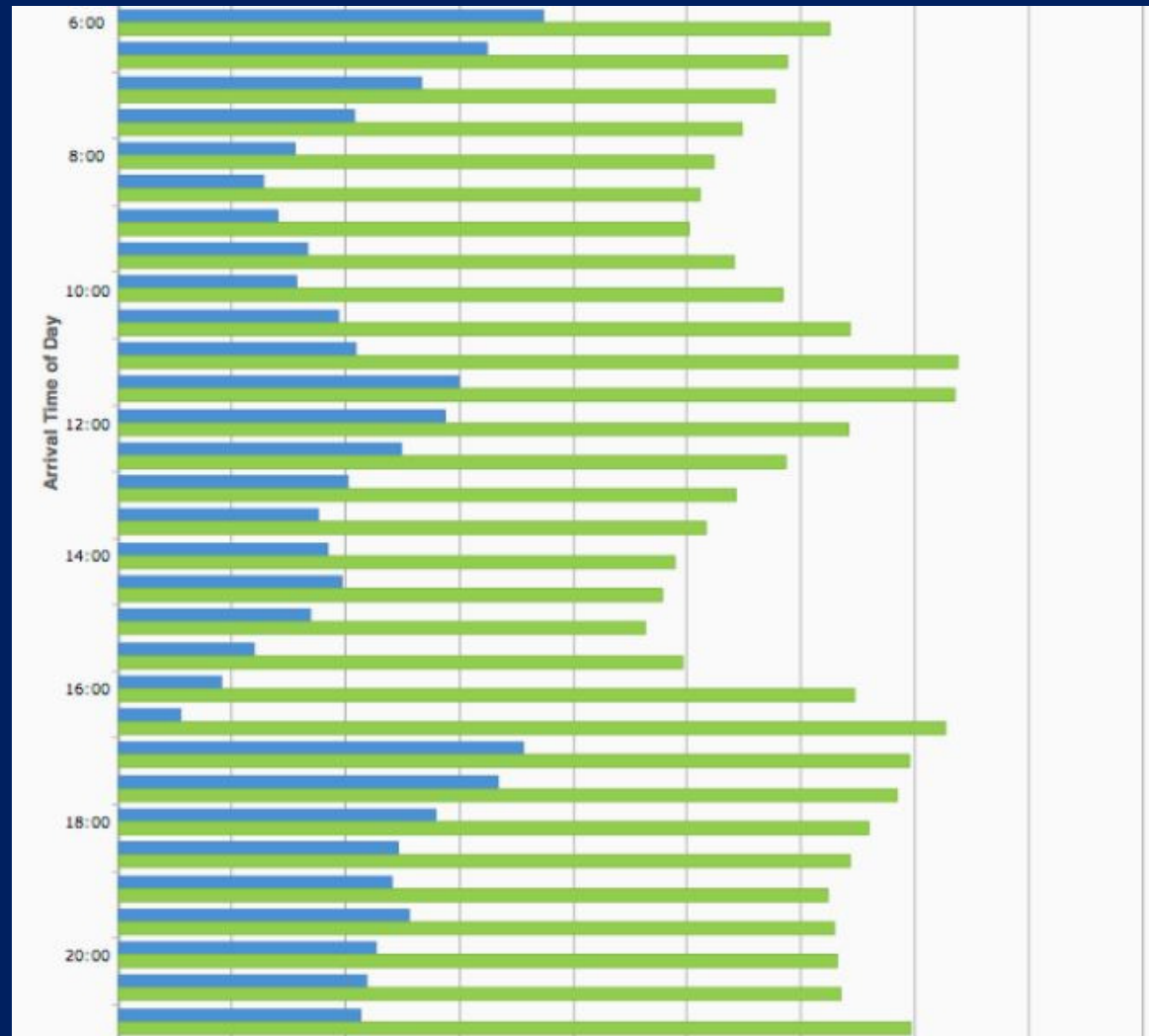
- Breakdown by time of arrival at terminal as shown below is consistent with pattern reported by Haverman in 2014.

Average Time Spent (minutes) by Time of Arrival



Data Analysis

Time Spent in Terminal by Arrival Time



Source: J.D. Haverman, 2014. Data for July 13-June 14, extracted from Harbor Trucking Association's Truck Mobility Project data.

Data Analysis

Time Spent in Terminal by Transaction Type

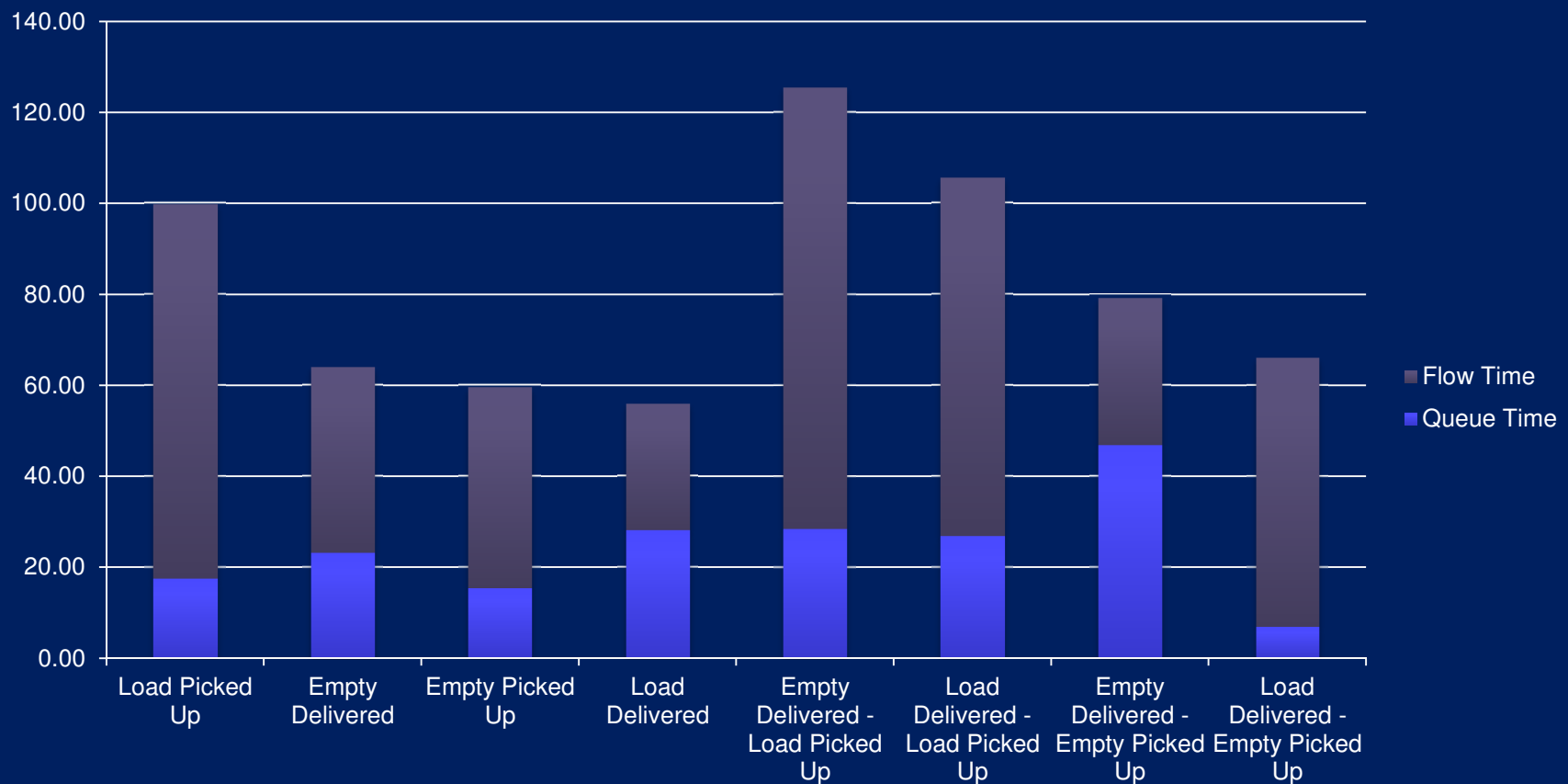
Average turn time, from longest to shortest

- For single transactions:
 - Load picked up
 - Empty delivered
 - Empty picked up
 - Load delivered
- For dual transactions:
 - Empty delivered – load pickup up
 - Load delivered – load picked up
 - Load delivered – empty picked up
 - Empty delivered – empty picked up
- “No Transaction” type includes chassis information but we excluded them due to inconsistency in logged data.

Data Analysis

Time Spent in Terminal by Transaction Type

Average Turn Time (minutes) by Transaction Type



Data Analysis

Frequency of Transaction Types

Transaction Type	Count
Load Picked Up	226
Empty Delivered	114
Empty Picked Up	7
Load Delivered	39
Empty Delivered - Load Picked Up	71
Load Delivered - Load Picked Up	7
Empty Delivered - Empty Picked Up	9
Load Delivered - Empty Picked Up	3

- Picking up load is the dominant type of work by the participating drivers.
- All transaction types that include load pickup account for 64%.
- Delivering empty has substantial count as well.

Data Analysis

Travel between Locations

	Average Time (min)	Average Distance (miles)	Average Speed (mph)	Min Speed (mph)	Max Speed (mph)
Heavy	22.74	7.35	19.40	3.40	33.30
Rail	17.72	6.42	21.74	4.00	43.46
Target	20.91	7.91	22.70	7.11	39.97
Store Delivery	57.84	33.74	35.00	12.05	55.41

- Vast majority of travels within 10 miles from ports.
- Roads within vicinity of ports much more congested.

Data Analysis

Productive vs Non-productive Travel

- Travel is considered productive when a truck is moving with a container.
- We consider a travel non-productive if it is not an initial or final leg, and the transaction prior to the travel is delivery of a container.
- Target delivery has the highest non-productive rate.
- Each driver is estimated to have wasted at least 57 miles per day in non-productive travel.

Data Analysis

Productive vs Non-productive Travel

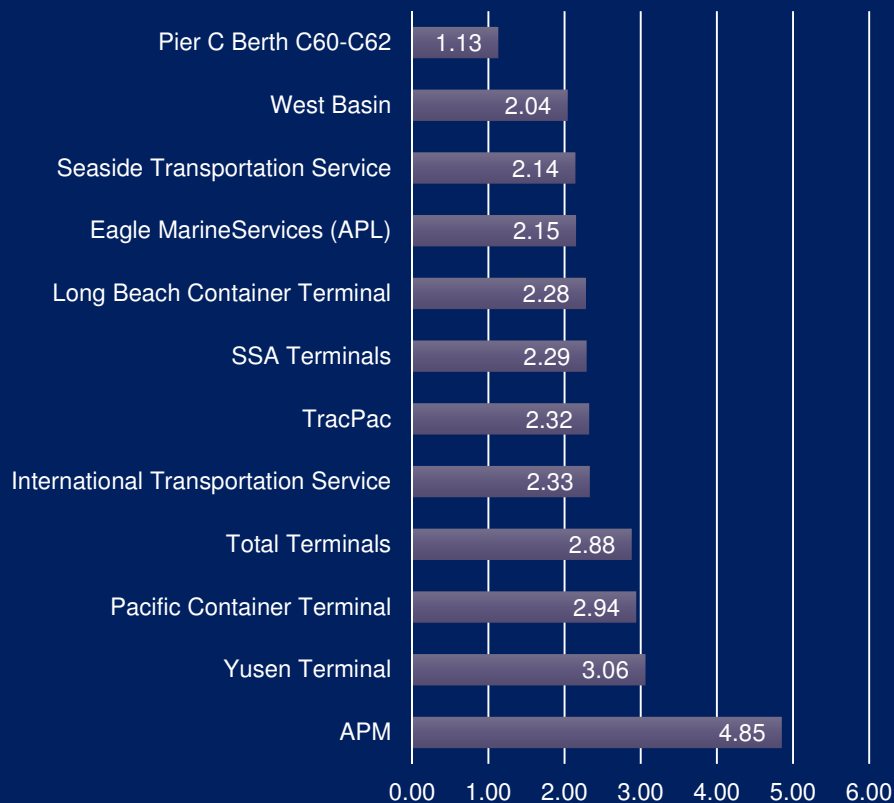
Work Type	Productive Travel (miles)	Non-productive Travel (miles)	Non-productive (%)
Target	839.80	722.53	46.25
Rail	1831.94	996.07	35.22
Heavy Tag	1172.24	258.72	18.08
Store Delivery	4808.70	655.01	11.99
All Types	8652.68	2632.33	23.33

- Highest: Target
- 2nd: Rail

Data Analysis

Cumulative Travels within Terminals

Average Distance (miles) Traveled within Each Terminal



- Truckers tend to drive more in large terminals, less in small ones.
- There are exceptions to the rule. Certain terminal is relatively small but has long travel in our data.
- If distance driven is large relative to a terminal size, it might be an indication of some issues, such as poor terminal design or system.

Our Experience

- Driver input errors found in collected data due to
 - Misunderstanding of procedure
 - Careless operations
 - Treat it at low priority
- Fixing errors and cleaning up data is time consuming, and sometimes not possible without collaborative data.
- Hence collection of event information should be automated.
- Had provided a “Voice Record” feature on mobile device for driver to record trouble tickets that lead to long delay. Feature rarely used, unfortunately.
- Not sure how the logging of trouble tickets can be automated.

Our Experience

- GPS location data are prone to inaccuracy in urban center with concentration of large or tall buildings. Inaccuracies are found in our logging of in/out of warehouse geofences. May be solved by an algorithm, such as the Kalman filter, with more data points, or technology using inertial sensors.
- For our data analysis need, not sufficient data after breakdown by arrival times, transactions, work types, etc. Longer tracking that requires driver input incurs too much overheads, hence hard to obtain willing participation.

Our Experience

- Cigarette lighters in almost all trucks are on regardless of the engine status. Hence our plan to use them and Bluetooth to trigger the start/stop of our mobile application did not pan out.
- Resolution
 - Have truck driver start/stop application manually (another source of errors due to missing data).
 - Alternatively, allow the application to stay on at all time and useless data filtered out prior to analysis.

Summary

- Average turn time is higher than previous studies on single terminal, but appears to be comparable to some recent statistics from Harbor Trucking Association data.
- Long queue time for 6:00 pm arrivals may be due to free entry after 6:00 pm under PierPass.
- Trucks mostly move under the traffic. More so for travels in the heavy container corridor and the Wilmington/Carson areas.

Summary

- Some work types (Target delivery & Delivery to rail in our case) have high % of non-productive travels. Possibly because these deliveries are either needed one-way or due to special arrangements.
- More data is needed to enable meaningful statistics after the breakdown into different categories. However, willingness for long-term driver participation can only be expected if tracking does not require driver input. Use weight sensors to detect container loading & unloading could be a solution.

Thank you!
Questions?