DRAYAGE OPTIMIZATION

Memphis, TN Deployment

Presented by

Sam Fayez

Agenda

- Project Overview
- System Architecture
- Optimization Algorithm
- Hardware Used
- Data Collection & Testing Plan
- Results

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Project Overview

- Drayage Optimization Proof of Concept Application
  - The project was directed to develop and test a drayage application that include two modules:
    - A Planning Module: Utilizing a sophisticated optimization algorithms that incorporate intermodal freight restrictive factors associated with drayage moves.
    - An Execution and Monitoring Module: Utilizing advanced tracking, tracing, and communication technology designed for the freight community
  - The application was deployed and tested in Memphis, TN

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Project Overview

- C-TIP Drayage Optimization Proof of Concept Application
  - The application is designed for drayage companies with the goal of enabling them to improve their drayage operations efficiency through:
    - Maximizing value added moves
    - Minimizing non-value added moves
    - Maximizing load matching & backhauls
  - The drayage operations improvement is envisioned to bring public benefits, through decreasing freight induced congestion and environmental impact.

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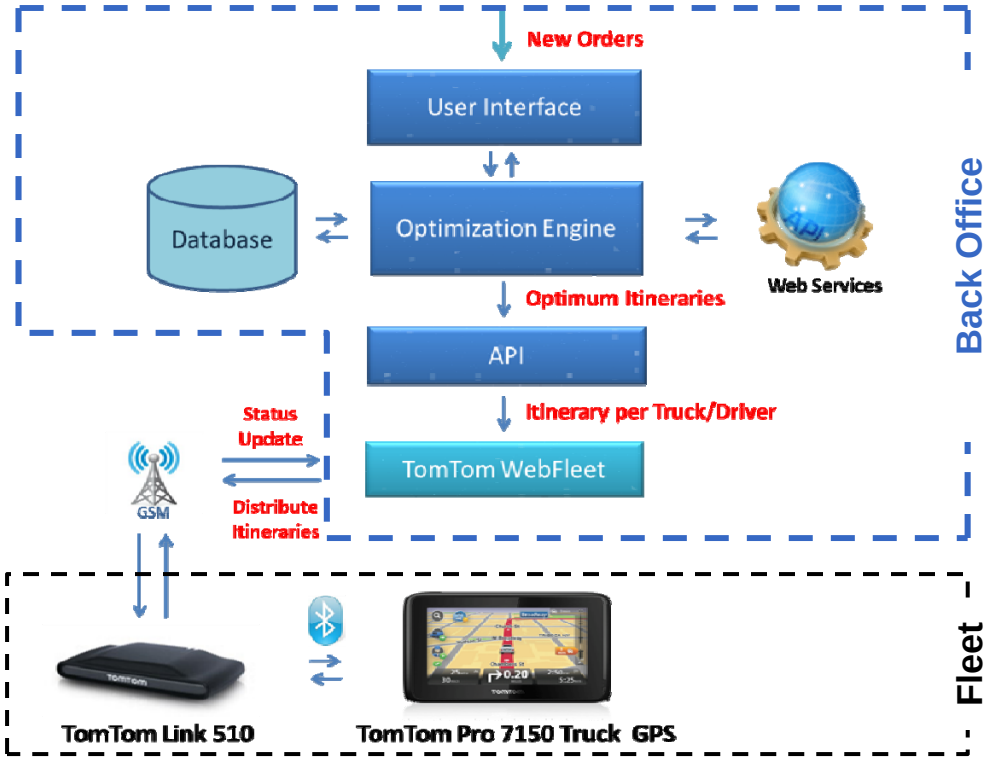
System Architecture



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Optimization Algorithm

- Objective Function:
  - Maximize Drayage Operations efficiency through:
    - Maximize value added moves
    - Minimize non-value added moves (e.g. Bobtail and Chassis)
    - Maximize load matching & backhauls
- Constraints
  - Locations
  - Stop time
  - Time Window at each Stop
  - Driver Hours of Service (HOS)
  - Equipment Ownership/Size/Availability

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Hardware Used

- Communicate with Link510 (Bluetooth)
- Fuel Consumption (OBDII Port)
- Carbon Foot Print (OBDII)
- Idling – wasted fuel (OBDII)

- Track Fleet 10sec/1min (GPS)
- Trace Fleet (GPS)
- 2-Way Communication with Back Office (GSM)
- 2-Way Communication with GPS unit (Bluetooth)
- Driving Behavior (IO cable)
- Driving and Idling time (IO cable)
- Ignition events (Power cable)

- Truck Navigation (GPS)
- Dynamic Routing Type 1
- 2-Way Communication with Link 510 (Bluetooth)
- 2 Way Text Messaging (Bluetooth)
- Work Menu
- HD Traffic
- IQ Traffic
- Weather
- Speed Cameras
- Safety (Driver Distraction)

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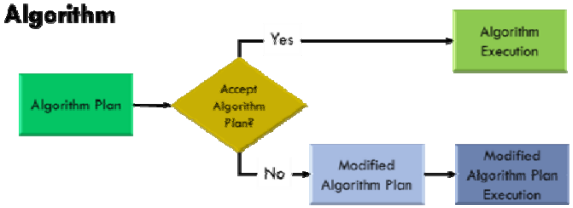
Data Collection & Testing Plan

Phase	Pre-Deployment	Post-Deployment
Actions	• Collect & Analyze Data (Orders, Plans, & Execution) • Deploy Data collection Excel sheet to Jamac • Train Trucking Company (Data Collection Sheet) • Install TomTom Link 510 • Deploy WebFleet (PAI team only)	• Collect & Analyze Data (Orders, Plans, & Execution) • Deploy the Drayage Application • Train Trucking Company team (Drayage Application) • Install Pro 7150 Truck and integrate with Link 510 • Deploy WebFleet • Provide Technical Support
Data Collection & Testing Components	**Manual** **Algorithm** 	**Algorithm** 

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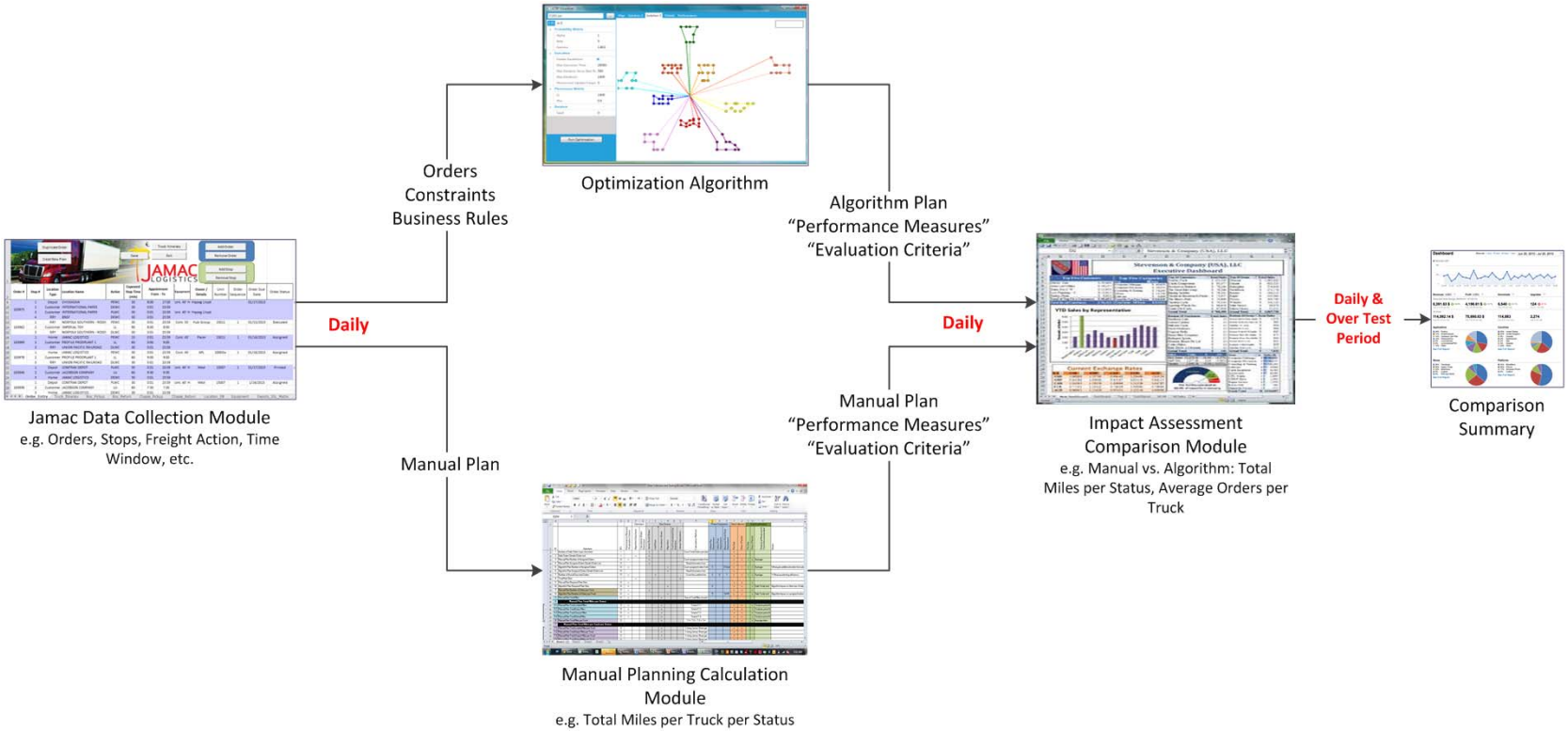
Pre-Deployment Manual vs. Algorithm Plans Comparison Methodology



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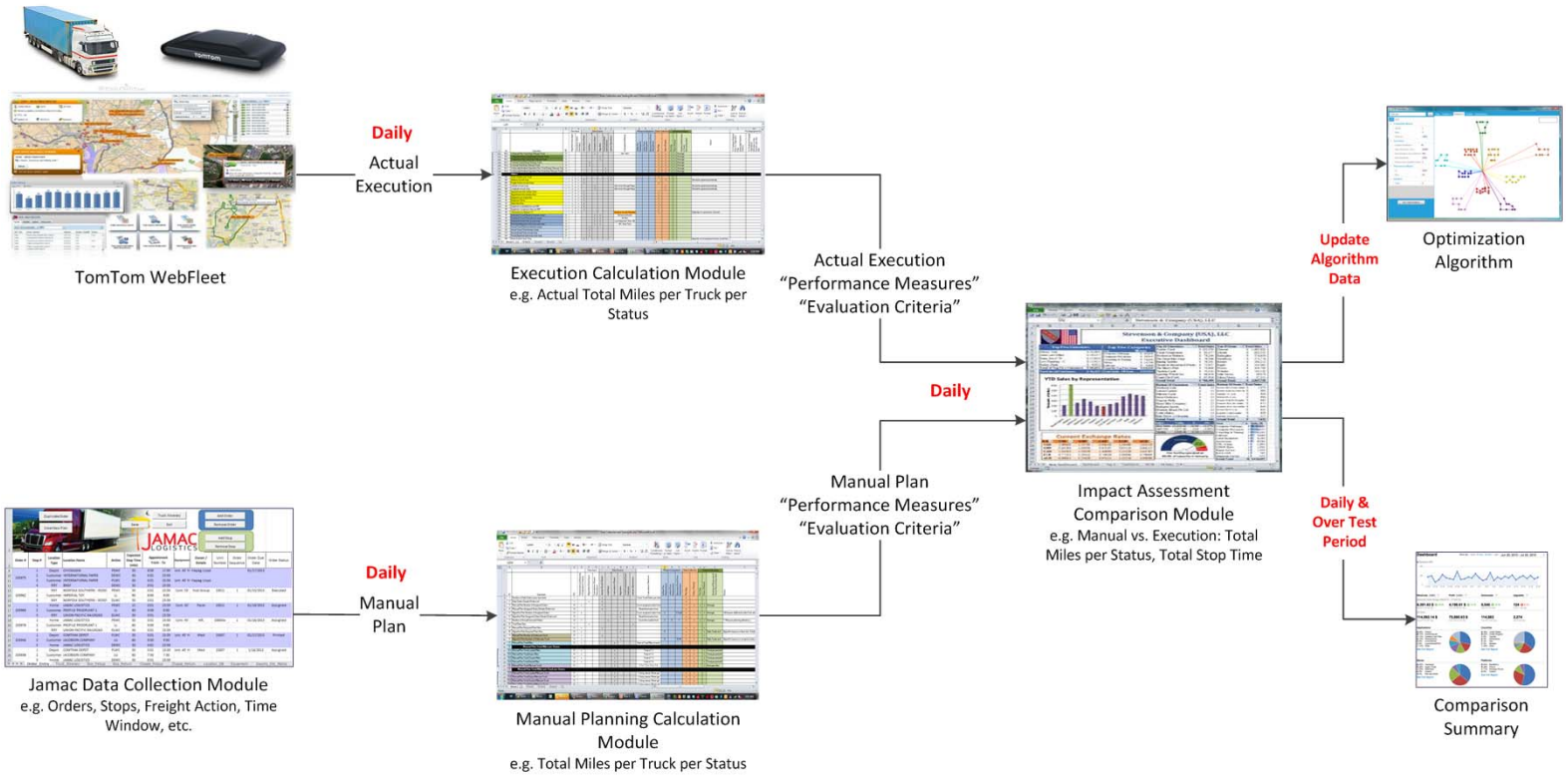
Pre-Deployment Manual Plan vs. Execution Comparison Methodology



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Pre-Deployment Data Collection & Testing Measures

- The Impact Assessment **Comparison Measures** include:
  - Counts (e.g. Number of Backhauls)
  - Total (e.g. Total Bobtail Miles)
  - Average (e.g. Average Orders per Truck)
  - Variability (e.g. Stop Time Std. Dev.)
  - Percentage (e.g. % Driver Utilization)
- The Measures will be compared **Daily** and/or over the **Test Period**
  - Daily Comparison Measure: e.g. Total Bobtail Miles in a given day
  - Over Test Period Measure: e.g. Average Bobtail Miles
- The Measures will be compared for the **Fleet** and/or **Per Truck**
  - Fleet: e.g. Total Bobtail Miles
  - Per Truck: e.g. Total Bobtail Miles per Truck

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Results

Average Improvements and Operational Impacts:

Fleet Productivity: **16%**

Orders/Truck Increase: **9%**

Total Miles Reduction: **1%**

Unproductive Miles Reduction (Bobtail Miles): **12%**

Fuel Consumption Improvement : **8%**

Emission Reduction: **10%**

Driving Time Improvement: **15%**

Total Time Improvement: **16%**

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Automated Enforcement in the ITS environment

Smart Roadside Initiative (SRI) Impacts Assessment

Presented by

Sam Fayez

Agenda

- Project Background
- Technologies Evaluated
- Sites Evaluated
- Objectives of Assessment
- Data Analysis Methodology
- Data Analysis of Sites
- Stakeholder Surveys
- Simulation
- Conclusion

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Project Background

- This is an independent assessment of the effectiveness and lessons learned from roadside motor carrier compliance technologies including testing of the smart roadside technologies
- The objective is to analyze the impact of automated tools on truck enforcement personnel productivity, effectiveness, and efficiency.
- This Project is supported by:
  - Federal Motor Carrier Safety Administration (FMCSA)
  - Federal Highway Administration (FHWA)
  - Intelligent Transportation System Joint Program Office (ITS JPO)

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Technologies Evaluated

- **Weigh in Motion (WIM) scales** – record axel weights and gross vehicle weights as trucks drive through a weigh station. There are both ramp and mainline WIMs
- **Kentucky Automatic Truck Screening (KATS)** – automated screening of trucks based on the license plate number and the USDOT number
- **Automated License Plate Reader (ALPR)** – captures license plate images and compares with safety databases
- **SRI Prototype (SRI Dashboard)** – integrated system to display WIM and static scale results and Safety and Fitness Electronic Records (SAFER) data to inspectors and drivers' mobile devices. This was developed the USDOT funded SRI Prototype Project
- **Other technologies at the test sites:**
  - **Static Scales**
  - **Infrared Cameras**
  - Pre-Clearance/Bypass Technologies: **PrePass; Drivewyze; NCPass**

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Sites Evaluated

State: **KENTUCKY**

Main Technology: Kentucky Automatic Truck Screening (KATS)

Sites:

- Weigh Station at Lyon County

- Weigh Station at Simpson County

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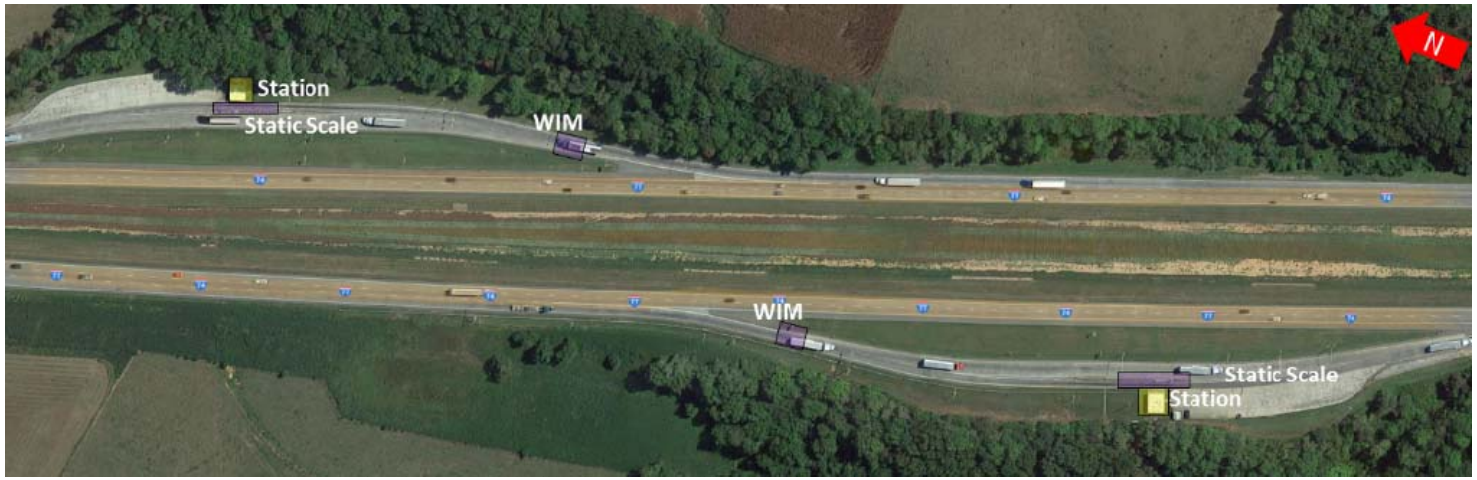
Sites Evaluated

State: **NORTH CAROLINA**

Main Technology: Weigh in Motion (WIM) scale and Automatic License Plate Reader (ALPR)

Sites:

- Mount Airy Weigh Station



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Sites Evaluated

State: **MARYLAND & MICHIGAN**

Main Technology: SRI Prototype

Sites:

- West Friendship Weigh Station

- Grass Lake Weigh Station

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Impact Assessment Methodology

1. Collect pre- and post-deployment data for each site
2. Produce a sound analysis of the relative performance metrics for each site
3. Determine qualitative and quantitative impacts to the operations of inspection stations
4. Identify key attributes or characteristics to be considered when applying test site findings to a broader environment

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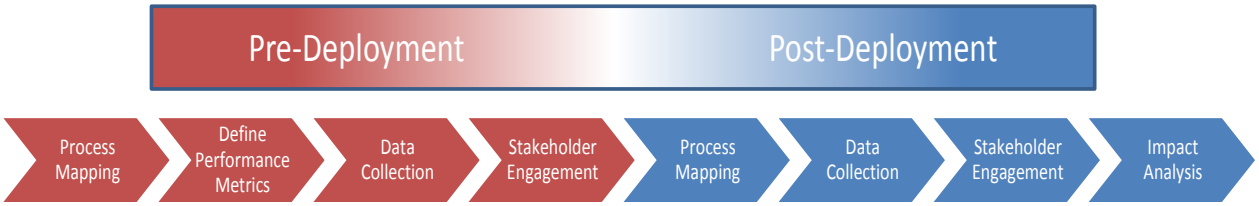
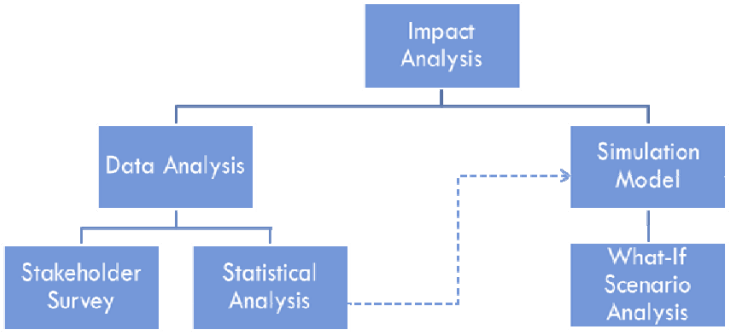
Impact Assessment Methodology





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Performance Measures

Goal	Performance Measures	Data	Quantitative/ Qualitative	Predominant Benefit
Increased Productive Inspections Time	Average proportion of time processing non-compliant vehicles (inspection and paperwork)	Inspection Duration, Inspection Start and End Time	Quantitative	Mobility; Agency Efficiency
		Inspection Duration, Inspection Start and End Time, Fuel Consumption Data, Emissions Data	Quantitative	Energy; Cost Savings
			Quantitative	Emissions
Increased Inspection Efficiency	Number of productive inspections per inspector (those with violations)	Inspections Results (Level I-V), Total Resources (Officers)	Quantitative	Agency Efficiency; Safety; Mobility
Increased Safety	Number of driver violations issued	Inspection Results (Level I-V)	Quantitative	Safety & Agency Efficiency
	Number of vehicle violations issued	Inspection Results (Level I-V)	Quantitative	Safety & Agency Efficiency
	Number of OOS assessments	Inspection Results (Level I-V), OOS counts	Quantitative	Safety & Agency Efficiency
User Acceptance	Number of satisfied users	Stakeholder Input	Qualitative	Agency Efficiency
Increased Revenue	Revenue generated through inspections	Financial metrics & historical data	Quantitative	Cost Benefit

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Data Collection

- Data was collected from commercial vehicle enforcement agencies, state DOTS, and Pre-screening companies
- Pre- and Post- deployment data from each site (3 - 6 months)

Examples of data records collected:

- WIM and Static Scale daily counts
- Daily inspections, inspection level, duration, results, type of violation
- Out of Service violations, totals, and per driver and vehicle
- Traffic counts near site location
- Monthly revenue data and permits collected

Used in:

- Site Data Analysis
- Simulation Model

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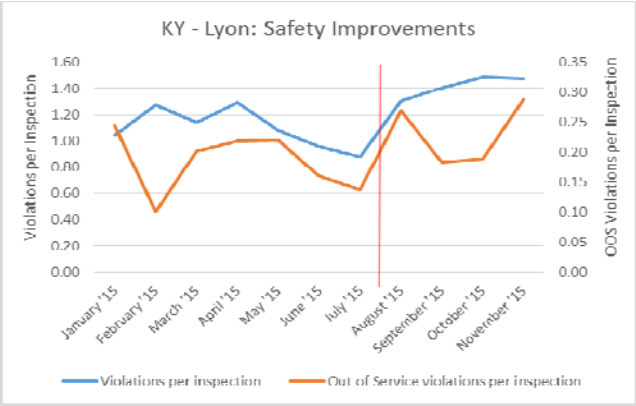
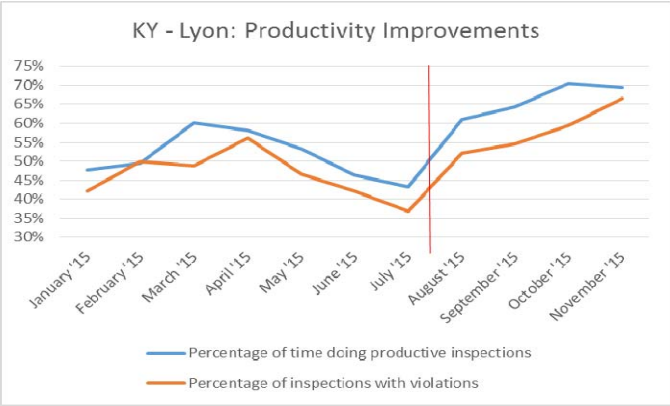
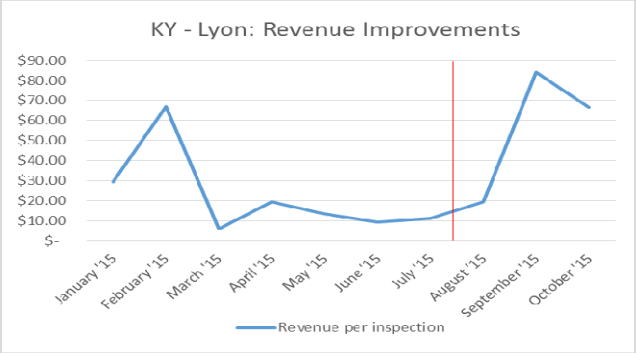
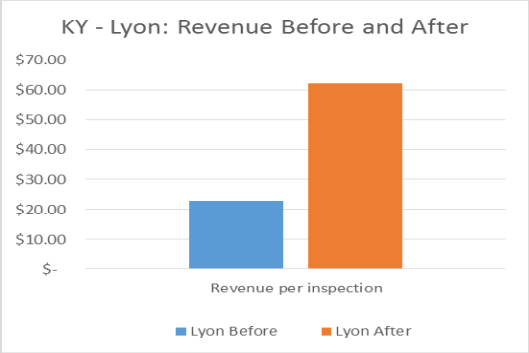
Data Analysis
Lyon, KY









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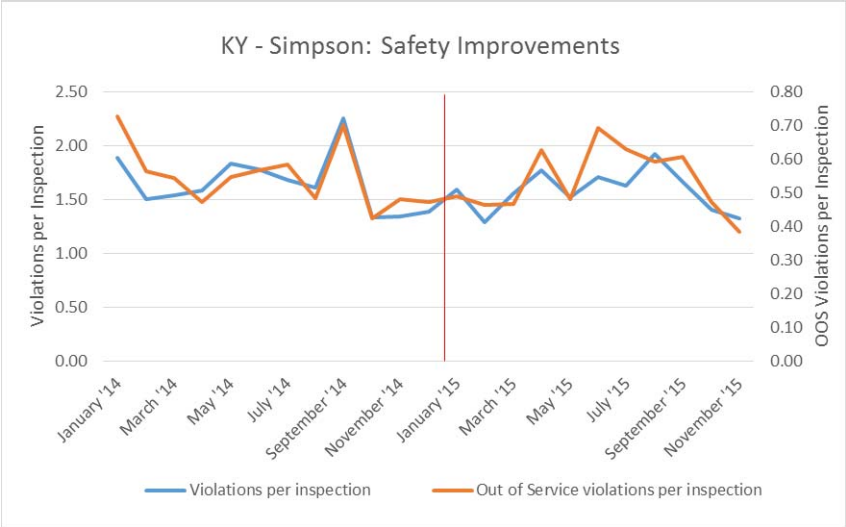
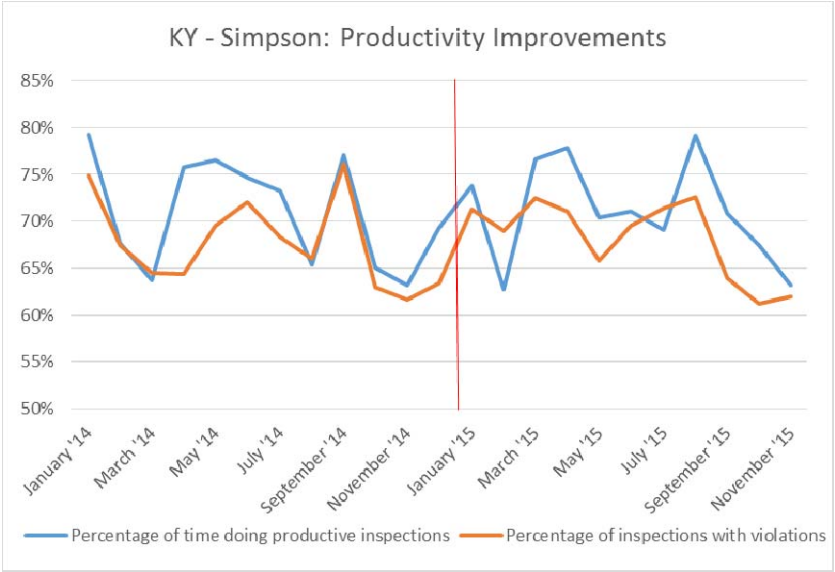
Data Analysis
Simpson, KY





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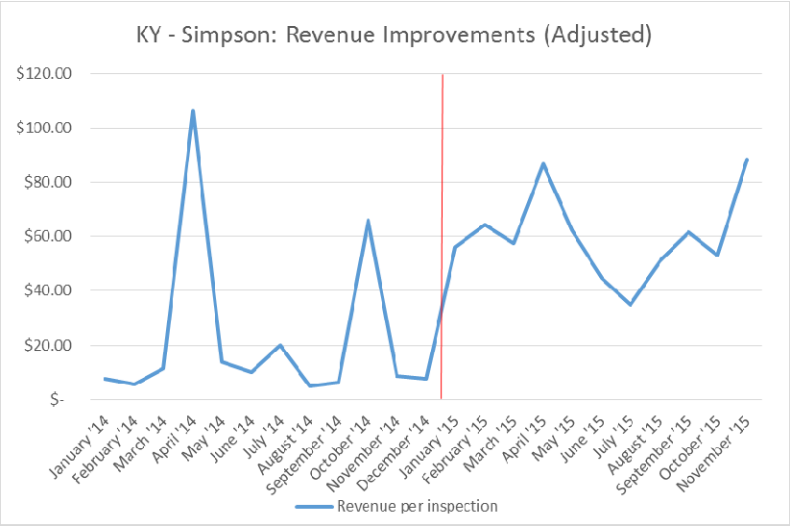
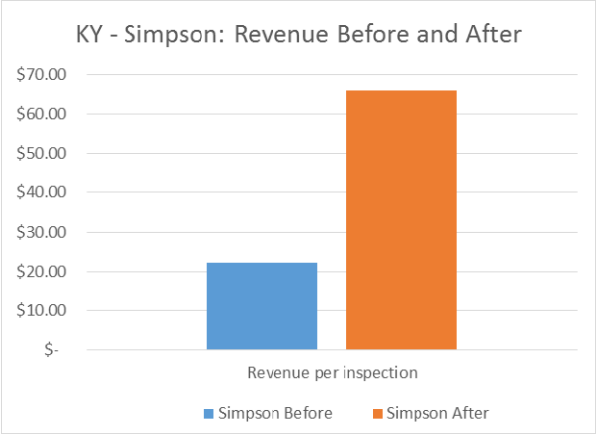
Simpson, KY (cont.)





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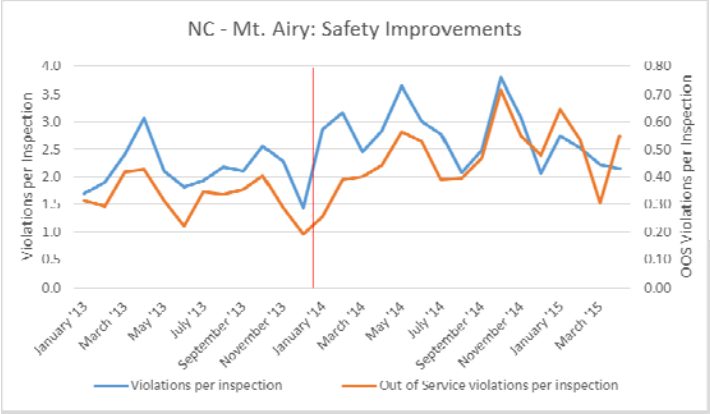
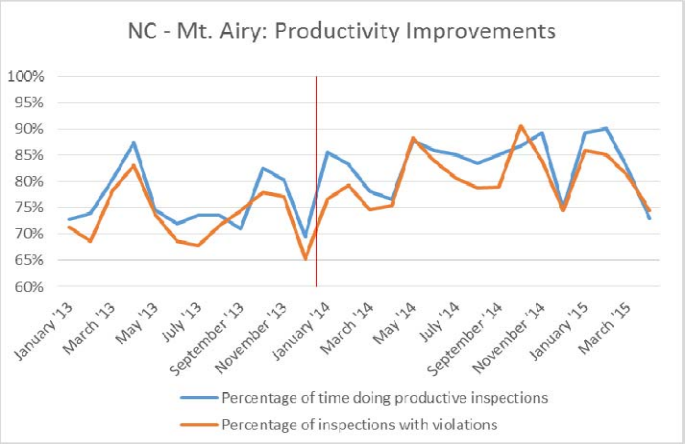
Data Analysis
Mt. Airy, NC





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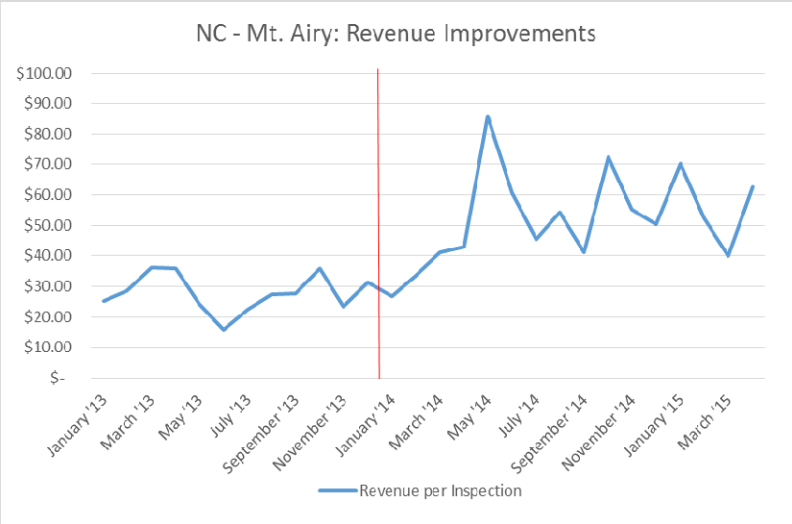
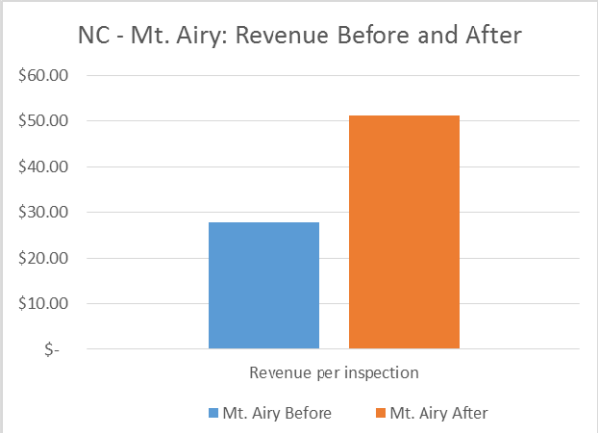
Mt. Airy, NC (cont.)





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Stakeholder Surveys

Commercial Vehicle Enforcement Perception Survey

Kentucky – 20 Respondents

Questions	Yes		No	
Have you used the KATS system to perform commercial vehicle inspections?	94.74%		5.26%	
Have you noticed a change in driver behavior during inspections after implementing KATS?	15.79%		84.21%	
Do you thinks KATS has changed drivers' attitude towards inspections?	26.32%		73.68%	
	Improved	Not Improved	Made Worse	Don't Know
To what degree has KATS improved your ability to identify commercial vehicle violations?	100%	0%	0%	0%
	Positively	No Impact	Negatively	Don't Know
To what degree do you believe KATS has impacted the safety of individual truck drivers?	47.37%	31.58%	0%	21.05%
To what degree do you believe KATS has impacted safety conditions in this corridor?	57.90%	31.57%	0%	10.53%

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Simulation Objective

To evaluate the impact of mainline WIM and By-Pass technologies on the number of vehicles inspected for a site similar to the Simpson, Kentucky Weigh Station

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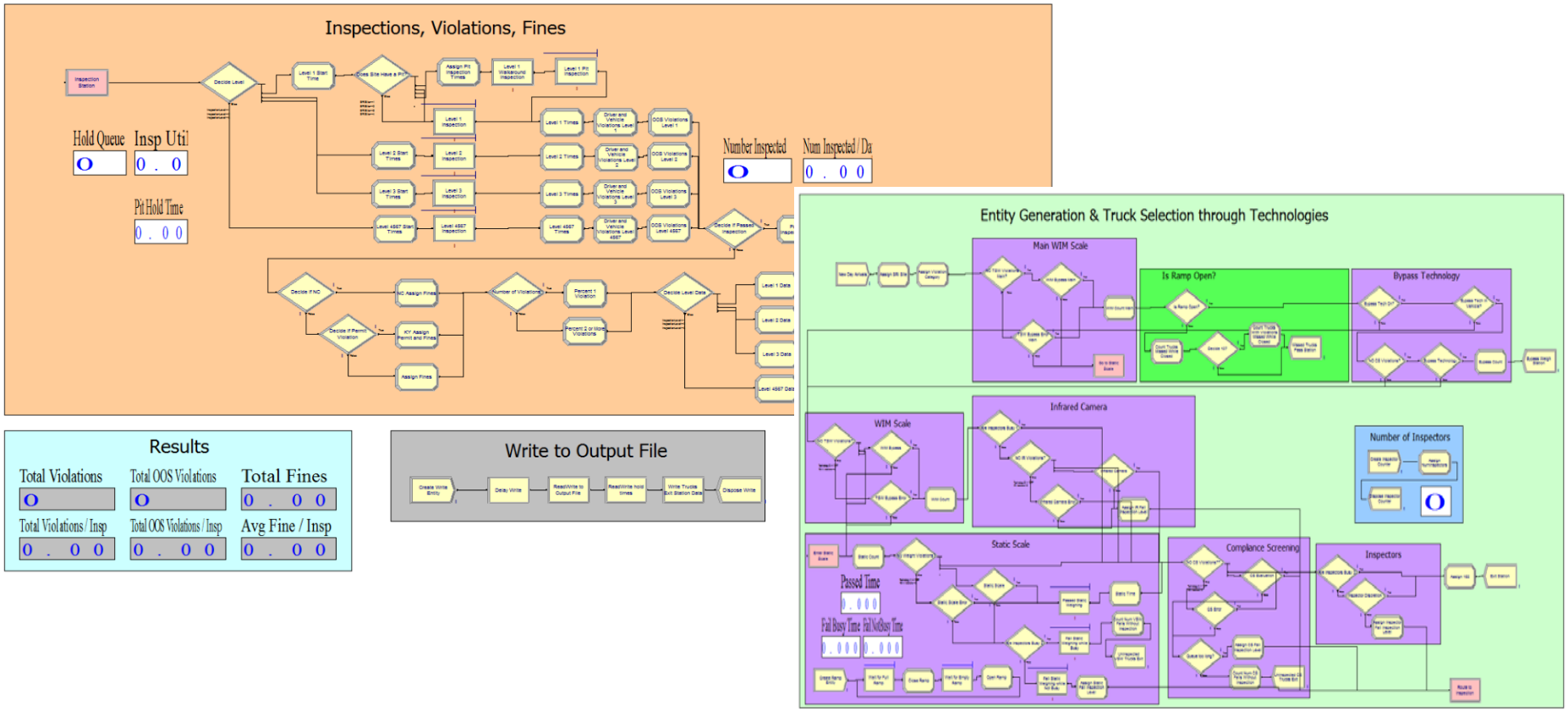
Simulation Model



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Model Assumptions and Data

- The technologies evaluated are 100% accurate and active
- There are no vehicles pulled based on inspector discretion
- There is only one inspection pit on each site
- The staff capacity is : 3 Inspectors and 1 Clerk
- There is one static scale only at the site
- The site is in operations for 10 hours a day
- The probability of having a violation is based on an analysis of two years of inspection records from the Kentucky Lyon and Simpson sites

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Simulation Analysis Scenarios & Results

	15% By-Pass 10% Random pull	15% By-Pass 20% Random pull	30% By-Pass 10% Random pull	50% By-Pass 15% Random pull
Trucks Exit Station Without Inspection	412.19	419.39	359.49	299.19
Trucks Exit Station With Inspection & With Violation	94.81	95.32	93.69	91.16

*In these scenarios: An increase in the percent of users with by-pass technology significantly reduces the number of trucks unnecessarily entering the weigh station, while inspecting the same average number of trucks with violations

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Conclusion (From In-progress Analysis)

- **Pre & Post Deployment Data Analysis:**
  - Technology improved productivity, effectiveness, and efficiency
  - Automated truck screening helped inspectors to better target level 3 violations

- **Surveys:**
  - All respondents agree that SRI technology improved the ability to identify commercial vehicle violations

- **Simulation:**
  - The technology helped inspectors to focus more on violators
  - The technology results in less non-violating trucks going into the weigh station

  (Based on the simulation analysis of the bypass technology)

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