Joint Transportation Research Program

Principal Investigator: Dan Koo, Indiana University Purdue University Indianapolis (IUPUI)
dankoo@iupui.edu, 317.278.1957

Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp

Sponsor: Indiana Department of Transportation, 765.463.1521

SPR-3650 2013

Roadway Striping Productivity Data Analysis for INDOT Greenfield and Crawfordsville Districts

Introduction

Roadway striping is a crucial component in maintaining public safety and managing traffic flow. It serves as an important informational tool for conveying official information to motorists, pedestrians, and cyclists. Roadway striping deteriorates over time due to heavy traffic, weathering, and other paint degradation factors. It therefore requires regular maintenance and restriping. The Indiana Department of Transportation (INDOT) is responsible for roadway striping throughout the entire state of Indiana, and the current annual cost of the INDOT roadway striping program is approximately $4.4 million. INDOT is seeking to improve roadway striping performance while minimizing overall costs. For this study, performance is defined as a combination of productivity and utilization improvement. Productivity indicates striping distance in an operation day and utilization refers to the number of operation days in a month. INDOT currently operates twelve striping trucks in six districts. Each district independently utilizes two striping trucks: one centerline truck and one edgeline truck. Each district is also responsible for executing its own striping scheduling and plans to meet the annual amount of striping work.

Telematics is defined as the integrated use of wireless telecommunication and operation data collection systems. In this study data was collected from telematics sensors and remotely transmitted via wireless technology to a database system on the web.

The main objective of this study was to provide an accurate overview of striping operations in the Crawfordsville and Greenfield districts to be used as a baseline for decision making aimed at improving striping efficiency. Telematics has proven to be an effective technology for providing real-time tracking and operational data to analyze current performance and a baseline for developing metrics to measure future performance.

Findings

Partial operational data from the 2011 striping operation was used to verify the system hardware configuration and setup. This process was required due to the complexity of the striping operation pattern and telematics device sensors. This study mainly used operation data collected from a single striping season between April 1, 2012, and November 30, 2012. Centerline and edgeline trucks have different patterns of operation. The centerline truck sprayed either single or multiple stripes using solid or skipped lines, while the edgeline truck sprayed a single stripe in a less complicated process.

The production algorithm was determined to measure only driving distance while striping. The average productivity (production rate) of a centerline truck was 18.3 miles/day in Crawfordsville and 17.1 miles/day in Greenfield. Crawfordsville and Greenfield districts operated on 66 and 80 days out of 244 calendar days, respectively, during the striping season. The centerline production rate ratio between total driving distance and striping distance is only approximately 15 percent. Productivity rates for the edgeline trucks are 29.5 miles/day in Crawfordsville and 30.6 miles/day in Greenfield. The edgeline trucks were operated only 46 days in Crawfordsville and 44 days in Greenfield. The edgeline production rate ratio between total driving distance and striping distance is only approximately 25 percent. The productivity analysis revealed that there was a significant opportunity to improve low productivity in terms of actual striping distance as compared to total driving distance.

Utilization is defined as the ratio between a number of operation days and calendar days, or weekdays, in a month. An operation day is counted whenever a truck stripes, regardless of the production rate. The Greenfield district operated with the highest centerline truck utilization rate at approximately 46 percent, and lowest edgeline truck rate at 25 percent over all weekdays. The Crawfordsville district operated with a centerline rate at 38 percent and edgeline rate at 26 percent over all weekdays.

Idling analysis provides a measurement of vehicle operation inefficiency in terms of excessive unnecessary fuel consumption and idling between striping operations. Idling is defined as cumulative time while the engine is running but a truck is not moving. A total of 268 idling hours were recorded by the telematics, and an estimated 268 gallons of diesel fuel, using a 1 gal/hour rate, could have been saved. Additional maintenance cost due to idling was estimated to be $892. Savings from this idling analysis seems insignificant. However, cumulative savings throughout the entire state, considering all supporting vehicles and trucks in all districts, would become significant.

Operational data obtained from the INDOT Work Management System (WMS) was compared to the telematics data. The study showed that potential human error occurred during the WMS manual input process. Materials analysis was conducted to provide a material consumption baseline. Centerline trucks primarily used yellow paint and some white paint. Edgeline trucks only used white paint. The analysis revealed that the Greenfield centerline truck applied more white striping paint than the Crawfordsville truck. Average paint and bead consumption for the striping trucks was approximately 17 gal/mile and 100 lbs/mile, respectively. Real-time GPS operation tracking is an advantage of using telematics. The geospatial operation tracking function has been successfully updated to present striping operation patterns on the webpage.

The existing operational boundary was examined to find any potential alternative operational boundaries for striping trucks. The results revealed that sub-district area striping operations from the center of a district location had the highest productivity as compared to other sub-districts in a district. Operational boundaries could possibly be reorganized to improve production rates by utilizing a smaller operational boundary in which a truck completes striping workloads within one sub-district before moving to the next sub-district.

Based on productivity and utilization analysis during the 2012 striping season, the study developed four alternative recommendations that improve overall productivity (striping mileage per operation day) and utilization (number of operation days in a month). The recommendations focused on (1) reducing the number of existing striping trucks, (2) modifying work schedules, and (3) possibly integrating administrative district boundaries. The maximum cost savings and striping production rate could be obtained from scenario 2 using a centerline truck and an edgeline truck in two districts. Scenario 4 might be the most plausible scenario smoothly transitioning from the current operation plan because it maintains district independency and provides an edgeline truck as a backup.

Performance metrics were developed as a baseline of future performance measurement. Performance metrics include productivity and utilization for the four striping trucks. Monte Carlo simulation was selected to develop productivity metrics. The main objective of Monte Carlo simulation was to simulate striping productivity based on 2012 striping operation data. The expected outcome of this method was to provide simulated population data for developing productivity metrics. The productivity metrics were divided into three categories: (1) low productivity—when the calculated value is less than or equal to 30 percent of the mean value derived from Monte Carlo simulation; (2) medium productivity—when the value is more than 30 percent and less than or equal to 70 percent; and (3) high productivity—when the value is over 70 percent.

Implementation

The striping operation data was obtained from actual observed operation for the four striping trucks in the two districts. Productivity and utilization analysis revealed that much higher daily production and monthly utilization were possible. The impact of the study is summarized in threefold: (1) the telematics data collection was proved to be effective in observing actual striping operations; (2) the data analysis shows there is significant opportunity for performance improvement; and (3) the study provides a baseline of the striping operation and performance metrics to measure future striping productivity and utilization. Currently, INDOT has already implemented one of the four scenarios, and considered a hybrid type of alternative operation plan, in the two districts. INDOT management expects to significantly reduce capital investment by maximizing the performance of existing striping trucks and optimizing the fleet size. Future study may be necessary to continue the efforts of improving performance in other INDOT roadway maintenance operations and to evaluate new striping operation plan implementations.

Recommended Citation

Koo, D. *Roadway Striping Productivity Data Analysis for INDOT Greenfield and Crawfordsville Districts*. Publication FHWA/IN/JTRP-2013/26. Joint Transportation Research Program, Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2013. doi: 10.5703/1288284315228.

View the full text of this technical report here:
http://dx.doi.org/10.5703/1288284315228

Published reports of the Joint Transportation Research Program are available at http://docs.lib.purdue.edu/jtrp/.