

# JOINT TRANSPORTATION RESEARCH PROGRAM

INDIANA DEPARTMENT OF TRANSPORTATION  
AND PURDUE UNIVERSITY



## Implementation of Continuous Improvement for INDOT Maintenance (Training and Tracking Process Improvements)



**Jon Padfield**

## **RECOMMENDED CITATION**

Padfield, J. (2018). *Implementation of continuous improvement for INDOT maintenance (training and tracking process improvements)* (Joint Transportation Research Program Publication No. FHWA/IN/JTRP-2018/19). West Lafayette, IN: Purdue University. <https://doi.org/10.5703/1288284316864>

## **AUTHOR**

**Jon Padfield, PhD**

Technical Assistance Program  
Purdue University

## **JOINT TRANSPORTATION RESEARCH PROGRAM**

The Joint Transportation Research Program serves as a vehicle for INDOT collaboration with higher education institutions and industry in Indiana to facilitate innovation that results in continuous improvement in the planning, design, construction, operation, management and economic efficiency of the Indiana transportation infrastructure. [https://engineering.purdue.edu/JTRP/index\\_html](https://engineering.purdue.edu/JTRP/index_html)

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

## **NOTICE**

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views and policies of the Indiana Department of Transportation or the Federal Highway Administration. The report does not constitute a standard, specification or regulation.

## **COPYRIGHT**

Copyright 2018 by Purdue University. All rights reserved.

## TECHNICAL REPORT DOCUMENTATION PAGE

<b>1. Report No.</b> FHWA/IN/JTRP-2018/19	<b>2. Government Accession No.</b>	<b>3. Recipient's Catalog No.</b>	
<b>4. Title and Subtitle</b> Implementation of Continuous Improvement for INDOT Maintenance (Training and Tracking Process Improvements)		<b>5. Report Date</b> October 2018	
		<b>6. Performing Organization Code</b>	
<b>7. Author(s)</b> Jon R. Padfield		<b>8. Performing Organization Report No.</b> FHWA/IN/JTRP-2018/19	
<b>9. Performing Organization Name and Address</b> Joint Transportation Research Program (SPR) Hall for Discovery and Learning Research (DLR), Suite 204 207 S. Martin Jischke Drive West Lafayette, IN 47907		<b>10. Work Unit No.</b>	
		<b>11. Contract or Grant No.</b> SPR-4158	
<b>12. Sponsoring Agency Name and Address</b> Indiana Department of Transportation State Office Building 100 North Senate Avenue Indianapolis, IN 46204		<b>13. Type of Report and Period Covered</b> Final Report	
		<b>14. Sponsoring Agency Code</b>	
<b>15. Supplementary Notes</b> Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.			
<b>16. Abstract</b> This is an applied research program. The research is a study of existing examples within INDOT to find examples of where LEAN tools and methodology have been successfully used to solve problems and improve efficiency. This research will be shared in a series of workshops where the participants will immediately apply the underlying principles to current problems / opportunities within INDOT to make similar improvements.			
<b>17. Key Words</b> LEAN, continuous improvement, problem solving, efficiency		<b>18. Distribution Statement</b> No restrictions. This document is available through the National Technical Information Service, Springfield, VA 22161.	
<b>19. Security Classif. (of this report)</b> Unclassified	<b>20. Security Classif. (of this page)</b> Unclassified	<b>21. No. of Pages</b> 11	<b>22. Price</b>

## EXECUTIVE SUMMARY

### IMPLEMENTATION OF CONTINUOUS IMPROVEMENT FOR INDOT MAINTENANCE

#### INTRODUCTION

LEAN process improvement methodology was derived from the Toyota Production System. The focus of LEAN is to identify and eliminate waste in business and operational processes by analyzing how work is done and how the value of the process is created and identifying activities that do not contribute to the value of the process.

Over the past two decades, LEAN methodology has adapted and migrated from manufacturing into healthcare, education, and other sectors. The tools used in LEAN methodology (inventory reduction, mistake proofing, continuous flow, TAKT time analysis, etc.) have application across many different industries.

The concepts involved in LEAN methodology are relatively easy to explain but more difficult to engrain in an organizational culture. Sending employees to a training class on LEAN methodology often produces disappointing results as the material is quickly forgotten if it is not promptly put into practice. Furthermore, while LEAN is a flexible methodology for improving processes, it is not a “one size fits all” approach. If LEAN is applied to the wrong projects, there is both a risk of disappointing project results and a loss of momentum in making LEAN thinking a part of the organizational culture because it creates a perception that “LEAN doesn’t work” when in reality LEAN was applied to an inappropriate problem.

In addition to LEAN tools and methodology, this project introduces entrepreneurship concepts that encourages workshop participants to think more like business owners. The goal is to encourage participants to continually look for opportunities to reduce non-value-added activities within their sphere of influence/control by challenging assumptions about the way they approach their daily activities. Examples will be drawn from common household situations where people may spend money on items of little value because their needs have changed. For instance, many people today are getting rid of landline telephones because everyone

in their home has a cell phone, or they may cancel their expensive cable TV package because they receive video entertainment from iTunes or Netflix at a lower monthly cost.

This project involved developing and delivering a series of on-site, 7.5-day LEAN workshops at four locations around the state.

#### FINDINGS

Two general themes emerged from the workshop series.

1. Numerous sub-district managers questioned the number and appropriateness of the Key Process Indicators (KPIs) used at INDOT at the beginning of this project. (Some adjustments were made to the KPI tracking during the course of this project.)
2. Equipment availability impacts productivity across all operations. There were numerous reasons cited for equipment being unavailable (e.g., equipment breaking down more frequently, shared equipment being used by another sub-district, not having the right amount of certain types of equipment available).

#### IMPLEMENTATION

This was an applied research project. The participants in these workshops were taught LEAN/process improvement tools, which they then applied to their work processes. In one case, an herbicide manager realized that when it came time to replace a tank on his truck, he could install a larger tank than the one he currently used. This change would increase the amount of liquid his truck could hold, thus reducing the time involved in refilling the tank. In another example, a sub-district manager recognized the amount of work time lost when traffic control was dispatched from a separate unit. With scheduling adjustments, employees arrived at the same time and the waste of “waiting” was reduced.

These are just a few small examples of how the workshops are impacting daily decisions to change the culture and drive small continuous improvements throughout INDOT Maintenance Operations.

## CONTENTS

1. INTRODUCTION . . . . .	1
2. PROBLEM STATEMENT . . . . .	1
3. OBJECTIVES . . . . .	1
4. METHODOLOGY . . . . .	1
4.1 Agenda by Day of Workshop . . . . .	2
5. ANALYSIS OF DATA . . . . .	3
5.1 General Themes from the Four Workshop Sites . . . . .	3
5.2 Project Selection . . . . .	3
5.3 Projects from Bloomington Workshop Site . . . . .	3
5.4 Projects from Columbus Workshop Site . . . . .	3
5.5 Projects from Monticello Workshop Site . . . . .	4
5.6 Projects from Kokomo Workshop Site . . . . .	4
6. RECOMMENDATIONS . . . . .	4
7. EXPECTED BENEFITS/RESULTS . . . . .	4

## LIST OF FIGURES

Figure	Page
<b>Figure 4.1</b> Schedule for workshop sessions	2
<b>Figure 4.2</b> Participants by workshop location	2

## 1. INTRODUCTION

The LEAN process improvement methodology was derived from the Toyota Production System. The focus of LEAN is to identify and eliminate waste in business and operational processes by analyzing how work is done, how the value of the process is created, and how to reduce or eliminate waste (all other activities that do not contribute to the value of the process).

Over the past two decades, LEAN methodology has adapted and migrated from manufacturing environments into healthcare, education and other sectors. The tools used in LEAN methodology (inventory reduction, mistake proofing, continuous flow, TAKT time analysis, etc.) have application across many different industries.

The concepts involved in LEAN methodology are relatively easy to explain but more difficult to engrain in an organizational culture. Often sending employees to a training class on LEAN methodology produces disappointing results as the material is quickly forgotten if not quickly put into practice. Furthermore, while LEAN is a flexible methodology for improving processes, it is not a “one size fits all” approach. If LEAN is applied to the wrong projects, there is a risk of both disappointing results on those projects and a loss of momentum in making LEAN thinking a part of the organizational culture (it creates a perception that “LEAN doesn’t work” when in reality LEAN was applied to an inappropriate problem).

In addition to lean, Entrepreneurship concepts will also be introduced to help participants think more like business owners. The goal of this portion of the workshop is to encourage participants to continually look for opportunities to reduce non-value added activities by challenging the assumptions about the way they approach their daily activities. Examples will be drawn from common household examples where people may spend money on items of little value because their needs have changed (i.e., today many people are getting rid of land line telephones because everyone in their home has a cell phone or people may cancel their expensive cable TV package and get their video entertainment from iTunes or Netflix at a lower monthly cost).

This project consists of two main parts:

1. Developing a five-day LEAN/Entrepreneurship workshop specifically for INDOT which uses transportation related examples rather than manufacturing, healthcare or other types of examples so it is obvious to all participants how the LEAN tools and methodology relate to their jobs & functions. ?
2. Delivering the five-day LEAN workshops on-site at four locations around the state. For each location there would be one day of planning in which the workshop participants would meet to select projects to be completed in

conjunction with the workshop. Each of the four locations around the state would have 12 to 15 participants working on a total of three to four projects. There would also be two days of mentoring/follow-up scheduled at each location after the five-day workshop to help ensure all projects are completed. The workshops would be scheduled for one day per week for five weeks.

## 2. PROBLEM STATEMENT

INDOT wants to improve the operational efficiency of their maintenance operations. To accomplish this, an INDOT specific workshop will be created which utilizes specific examples from INDOT and other states’ DOTs to illustrate how LEAN tools and methodology can be used to drive those efficiency improvements.

This information will be shared in a series of four hands-on workshops around the state where groups of 12 to 15 participants will lead a total of three to four projects to implement process improvements. Both Quality and Productivity metrics will be tracked and reported for these workshops. Follow-up sessions will be scheduled with each group of participants to help ensure the projects are successfully completed.

## 3. OBJECTIVES

This is an applied research program. The research is a study of existing examples within INDOT and other states’ Departments of Transportation to find examples of where LEAN tools and methodology have been successfully used to solve problems and improve efficiency. This research will be shared in a series of workshops where the participants will immediately apply the underlying principles to current problems/opportunities within INDOT to make similar improvements.

## 4. METHODOLOGY

A five-day workshop was planned and developed to allow INDOT employees to learn about and apply Lean/Continuous Improvement techniques and methodologies to their daily work. The five-day workshop was preceded by a half-day session to discuss and choose an appropriate project to work on in conjunction with the training provided in the workshops. There were also two follow up sessions provided after the five days of workshop to help mentor the projects that were being worked on during the workshop. The schedule of the planning sessions, workshops and follow up days is shown in Figure 4.1 and the participants in the workshops are shown in Figure 4.2.



	Bloomington	Columbus	Monticello	Kokomo
Planning (half day)	4/25	4/25	4/27	4/28
Day 1	5/2	5/3	5/17	5/18
Day 2	5/15	5/16	5/25	5/26
Day 3	5/22	5/24	6/7	6/8
Day 4	5/30	5/31	6/14	6/15
Day 5	6/12	6/13	6/21	6/22
Follow up 1	7/6	7/5	7/26	7/27
Follow up 2	8/8	8/9	8/18	8/25

Figure 4.1 Schedule for workshop sessions.

	Bloomington (15)	Columbus (13)	Kokomo (14)	Monticello (14)
Crawfordsville (9)	Gus Solomon			Randy Large
	Josh Woodrum			Scott Krintz
	Ed Batty			Vern Vanallen
	Paul Michael			Tim Levell
	Romora Ruffner			
Fort Wayne (10)			Tom Dull	Kevin Diehm
			Dennis Warnick	Wayne Orcutt
			Wayne Pavey	Roy Piercy
			Joe Ortiz	Gary Williams
			Ryan Messman	Mike Ritenour
Greenfield (8)		Doug Smith	Chad Ervin	
		Mark Anderson	Pat Szewczak	
		Mike Huffman	Tristan Ferguson	
		Coery Barrett	Greg Vaughn	
LaPorte (10)			Tyrone Hare	Jim Scheffer
			Milt McCoy	Bruce Sowell
			Bernard Rudd	Keith Norred
			John Claussen	John McIntire
			Tony Prentice	Gary Dick
Seymour (10)	Jeff Stephens	Jeremy McGuffey		
	Mike Ashby	Jason Caskey		
	Eric Fiddler	Marcus Monroe		
	Steve Holley	Julie Felner		
	Steve Muir	Jason Lowther		
Vincennes (9)	Mike Bastin	Dennis Barton		
	Chris Irvin	Randy Weikert		
	Gary Wampler	Phil Ivy		
	Brian Wilson	Kenny Coultas		
	Gordie Sollman			

Figure 4.2 Participants by workshop location.

#### 4.1 Agenda by Day of Workshop

##### Pre-work

Approximately 2 weeks prior to the first day of the workshop, the instructor met with the participants of the workshop to select appropriate projects for the participants to work on during the. Three to four participants were selected to work on each project to ensure we have enough manpower to complete each project in a timely manner.

##### Day 1

The focus of day 1 is Value Stream Mapping (VSM). Participants will learn how to create value stream maps and will get the chance to put that knowledge to immediate use with some Department of Transportation related exercises. Participants will then create a current state (or “as-is”) VSM for their project.

##### Day 2

The focus of day 2 was “pain points” and waste. Participants will learned about the 8 common forms of waste (waiting, over production, rework, excess motion, over processing, excess inventory, excess transportation, and underutilized people). Just as in day 1, participants practiced identifying waste in a series of Department of Transportation related exercises (based on real projects within INDOT and other state DOTs).

##### Day 3

The focus of day 3 was on creating “flow” within processes. Participants learned about push vs pull systems, “pull signals,” inventory management, and Kanban. Participants again worked on a series of Department of Transportation related exercises to reinforce these concepts and to ensure they know how to apply them correctly. Participants also completed a module on



innovation to help them learn to see alternatives to “the way we have always done it.”

#### *Day 4*

The focus of was on creating a future state (or “to-be”) VSM. This is a map of how the process would ideally work to eliminate as much waste as possible from the process each 3-4-person team is working on for their project.

#### *Day 5*

The focus of day 5 was on creating the action plan required to transform the current state (as-is) value stream map into the future state (to-be) value stream map. Participants learned some basic project management and change management skills to help ensure the success of their projects. Day 5 also focused on how to sustain the improvements made in these projects, so the processes improved do not regress back to their former state.

#### *Follow-up days 1 and 2*

After the completion of the five-day workshop, two additional days were scheduled with each group of workshop participants for follow up mentoring on their projects to help them remove barriers and to help drive accountability for completing the projects.

## 5. ANALYSIS OF DATA

### 5.1 General Themes from the Four Workshop Sites

Discussions during the workshops in Bloomington, Columbus, Monticello and Kokomo revealed a number of recurring themes regarding opportunities for improvement within Maintenance Operations at INDOT.

1. A number of participants commented on the number and level of detail required in their monthly tracking metrics. Some suggested moving to annual performance targets rather than monthly to allow sub-district managers more flexibility in prioritizing their tracked accomplishments (ditching, mowing, painting, etc.). One possible improvement might be moving to a “spider chart” or “radar chart” for tracking each sub-districts performance on a number of different activities.
2. Another common theme was equipment availability. The core of the issue is that INDOT has a significant amount of downtime with equipment due which limits the ability of operations to plan and complete their tracked activities. There are numerous contributing factors to this issue:
  - a. Aging equipment breaks down more frequently
  - b. Not having the right number of certain pieces of equipment
  - c. Not having the appropriate equipment (a lower cost bid for a less capable piece of equipment might be chosen over a piece of equipment that has higher capacity/capability)
  - d. Equipment shared and frequently moved between units/sub-districts/districts spend a fairly large

percentage of its time on the back of a flatbed trailer rather than actually being in use.

3. The final big, recurring theme expressed across multiple training sites was the high cost of employee turnover and employee training. Managers in areas of the state with unusually high employee turnover rates (areas where the Indiana economy was doing well) spent more time recruiting, interviewing, and training. There were also hidden cost in the form of “rookie mistakes” caused by the constant stream of low experience operators. The turnover rate seemed especially high among new INDOT employees shortly after they obtained the Commercial Driver’s License (CDL).

### 5.2 Project Selection

The half-day sessions to select projects occurred at the end of April, shortly after the State Highway Maintenance Director (the original business owner for this project) resigned from INDOT. The participants in the class were asked to select projects related to “pain points” (inefficiencies or process bottle necks) in their daily jobs. In hind-sight, the list of projects chosen should have been vetted through the District Highway Maintenance Directors and the then interim State Highway Maintenance Director to ensure the participants were working on the most appropriate projects.

Additionally, the actual workshops began the first week of May and ran through the end of July. Again, in hind-sight, this was not the optimal time for these types of workshops because aside from major winter/snow events, May through July tend to be the busiest time of the year for Maintenance Operations. The workshops in all four locations all launched with the half-day sessions at the end of April with 100% attendance among the participants. However, as the workshops progressed, attendance/participation dropped off due to the workshops competing with chip-seal operations and a variety of other tracked activities. If more workshops are scheduled for Maintenance Operations in the future, it would be best to avoid conducting the workshops in the summer.

### 5.3 Projects from Bloomington Workshop Site

Those from the Crawfordsville, Seymour and Vincennes districts met here. Among their findings was that inefficiencies were prevalent in the form of traffic control from one unit being sent a long distance to support shallow patchwork being performed by another unit. This practice often led to delayed starts of 45-plus minutes each for eight to 10 crew members in the morning because of the wait for traffic control to show up. A concentrated effort to assign traffic-control members from the same sub-district would be ideal.

### 5.4 Projects from Columbus Workshop Site

The site was represented by those from the Greenfield, Seymour and Vincennes districts. They deduced that having to hit monthly accomplishment goals sometimes

led to poor decision-making. An example was a sub-district that had already hit its accomplishment goal for ditching, so it moved on to another activity to finish the month. The crew's motivation was to not be too far over on one activity or under on a different activity. But, in some instances, this led to the unnecessary movement of equipment or tying up equipment longer than needed by switching activities toward the end of the month. The employees also made the suggestion to switch to a radar chart, also called a spider chart, to track activities. This type of chart uses concentric circles representing 25, 50, 75 and 100 percent of an annual accomplishment goal and a series of straight lines drawn from the center of the inner circle, extending outward; the length of the line represents the percent of the annual goal that has been accomplished.

### **5.5 Projects from Monticello Workshop Site**

This site was represented by those from the Crawfordsville, Fort Wayne and LaPorte districts. They concluded that lack of training is causing issues. For instance, they said too many unit foremen give up on a day's planned activities if they encounter unforeseen problems such as equipment breakdown. They advocated for practice sessions for planning; such exercises were conducted in 2014 during the statewide INDOT Maintenance Conference. The group also agreed that there are opportunities to provide field-level training on pipe replacement, ditching, mowing, shallow patching and bridge cleaning.

### **5.6 Projects from Kokomo Workshop Site**

Those from the Fort Wayne, Greenfield and LaPorte districts met here. They investigated the use

of larger-capacity trucks for bridge-deck cleaning, so the trucks don't have to be returned as often for more water. Another way to keep INDOT trucks on-site to clean instead of being driven back for more water would be to work out agreements with local communities for access to water via volunteer fire departments.

## **6. RECOMMENDATIONS**

The majority of the participants in these workshops were intentionally chosen to be mid-level managers (unit foremen and sub-district managers) who had visibility of both the "big picture" (District and State level plans and goals) as well as visibility to daily activities of individual, front line employees. The participants provided positive feedback regarding the value of the materials taught and applied in the workshops. The participants recommended the workshops be repeated again and offered to senior leadership with INDOT and other areas including the QA Group, Tech Services, Highway Maintenance Directors, and Procurement/Logistics. The participants also suggested offering the workshops to crew leaders, specialty crews and additional unit foremen.

## **7. EXPECTED BENEFITS/RESULTS**

Approximately INDOT 50 employees directly participated the workshops and Lean/Continuous improvement activities within their sub-districts. This group of employees will be valuable in helping to make Lean/Continuous Improvement methodology a part of INDOT's culture.

## About the Joint Transportation Research Program (JTRP)

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. That collaborative effort was called the Joint Highway Research Project (JHRP). In 1997 the collaborative venture was renamed as the Joint Transportation Research Program (JTRP) to reflect the state and national efforts to integrate the management and operation of various transportation modes.

The first studies of JHRP were concerned with Test Road No. 1—evaluation of the weathering characteristics of stabilized materials. After World War II, the JHRP program grew substantially and was regularly producing technical reports. Over 1,600 technical reports are now available, published as part of the JHRP and subsequently JTRP collaborative venture between Purdue University and what is now the Indiana Department of Transportation.

Free online access to all reports is provided through a unique collaboration between JTRP and Purdue Libraries. These are available at: <http://docs.lib.purdue.edu/jtrp>

Further information about JTRP and its current research program is available at: <http://www.purdue.edu/jtrp>

## About This Report

An open access version of this publication is available online. This can be most easily located using the Digital Object Identifier (doi) listed below. Pre-2011 publications that include color illustrations are available online in color but are printed only in grayscale.

The recommended citation for this publication is:

Padfield, J. (2018). *Implementation of continuous improvement for INDOT maintenance (training and tracking process improvements)*. (Joint Transportation Research Program Publication No. FHWA/IN/JTRP-2018/19). West Lafayette, IN: Purdue University. <https://doi.org/10.5703/1288284316864>