

# e-Ticketing Implementation Plan

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## FOREWORD

Highway construction projects produce massive amounts of valuable data. Historically, information collected in highway construction projects was communicated via paper. The practice of solely using paper tickets, such as those collected from truck drivers to document the weight of every truckload of materials delivered at a job site, is cumbersome, inefficient, and outdated.

As transportation agencies are advancing faster toward paperless workflows for construction administration and management, electronic ticketing (e-Ticketing) automates the process of collecting paper tickets. e-Ticketing is a market-ready digital innovation that automates the recording and transfer of information in real time for materials as they are moved from the plant to the job site.

This report is an implementation plan developed to assist the Federal Highway Administration (FHWA) with the planning of deployment activities for e-Ticketing under round six of the Every Day Counts initiative. The Every Day Counts program works with State departments of transportation, local agencies, and other stakeholders to identify and rapidly deploy proven and underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce traffic congestion, and integrate automation.

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Director, Office of Innovation Implementation

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16. Abstract Historically, on highway construction projects, truck drivers collect paper tickets for every truckload they haul to a job site from a material plant. This practice of paper tickets is cumbersome and outdated. Electronic ticketing (e-Ticketing) automates the process. e-Ticketing is a market-ready digital innovation that automates the recording and transfer of information in real time for materials as they are moved from the plant to the site.  This report is the implementation plan developed to assist FHWA with the planning of e-Ticketing deployment activities under the sixth round of the Everyday Counts initiative (EDC-6).			
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<b>SI* (MODERN METRIC) CONVERSION FACTORS</b>				
<b>APPROXIMATE CONVERSIONS TO SI UNITS</b>				
<b>Symbol</b>	<b>When You Know</b>	<b>Multiply By</b>	<b>To Find</b>	<b>Symbol</b>
<b>LENGTH</b>				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
<b>AREA</b>				
in <sup>2</sup>	square inches	645.2	square millimeters	mm <sup>2</sup>
ft <sup>2</sup>	square feet	0.093	square meters	m <sup>2</sup>
yd <sup>2</sup>	square yard	0.836	square meters	m <sup>2</sup>
ac	acres	0.405	hectares	ha
mi <sup>2</sup>	square miles	2.59	square kilometers	km <sup>2</sup>
<b>VOLUME</b>				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft <sup>3</sup>	cubic feet	0.028	cubic meters	m <sup>3</sup>
yd <sup>3</sup>	cubic yards	0.765	cubic meters	m <sup>3</sup>
<b>NOTE: volumes greater than 1,000 L shall be shown in m<sup>3</sup></b>				
<b>MASS</b>				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2,000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
<b>TEMPERATURE (exact degrees)</b>				
°F	Fahrenheit	$5 (F-32)/9$ or $(F-32)/1.8$	Celsius	°C
<b>ILLUMINATION</b>				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m <sup>2</sup>	cd/m <sup>2</sup>
<b>FORCE and PRESSURE or STRESS</b>				
lbf	poundforce	4.45	newtons	N
lbf/in <sup>2</sup>	poundforce per square inch	6.89	kilopascals	kPa
<b>APPROXIMATE CONVERSIONS FROM SI UNITS</b>				
<b>Symbol</b>	<b>When You Know</b>	<b>Multiply By</b>	<b>To Find</b>	<b>Symbol</b>
<b>LENGTH</b>				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
<b>AREA</b>				
mm <sup>2</sup>	square millimeters	0.0016	square inches	in <sup>2</sup>
m <sup>2</sup>	square meters	10.764	square feet	ft <sup>2</sup>
m <sup>2</sup>	square meters	1.195	square yards	yd <sup>2</sup>
ha	hectares	2.47	acres	ac
km <sup>2</sup>	square kilometers	0.386	square miles	mi <sup>2</sup>
<b>VOLUME</b>				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m <sup>3</sup>	cubic meters	35.314	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	cubic meters	1.307	cubic yards	yd <sup>3</sup>
<b>MASS</b>				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2,000 lb)	T
<b>TEMPERATURE (exact degrees)</b>				
°C	Celsius	$1.8C+32$	Fahrenheit	°F
<b>ILLUMINATION</b>				
lx	lux	0.0929	foot-candles	fc
cd/m <sup>2</sup>	candela/m <sup>2</sup>	0.2919	foot-Lamberts	fl
<b>FORCE and PRESSURE or STRESS</b>				
N	newtons	2.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in <sup>2</sup>

\*SI is the symbol for International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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## SECTION I: OVERVIEW AND INNOVATION DESCRIPTION

### BACKGROUND

Paper-based load delivery tickets on highway construction projects have been used for many years. The use of paper tickets is a cumbersome, inefficient, and outdated practice. The possibility of using an electronic or digital process simplifies handling and integration of material data into construction management systems (CMS), or document management systems (DMS) for acceptance, payment, and source documentation.

Electronic ticketing (e-Ticketing) is a market-ready innovation that digitally enables the exchange of information in real time as material deliveries are moved from the materials plant to the construction site. Implementing this paperless process may occur in various configurations where technology solutions can create, share, track, document, and archive material information, such as material type, quantities, and delivery information, in electronic or digital format. This e-ticketing process typically pushes data to a cloud database for immediate access by multiple users, via mobile devices or desktop/laptop computers, for material verification, information, and real-time operational decisions. Although applicable to larger components, such as structural members, e-Ticketing is especially suited to complement information exchange of bulk material delivery.

### CHALLENGES

Collecting paper tickets from hauling vehicles exposes construction inspectors and contractor personnel to safety hazards in work zones. Paper-based ticketing is a linear and resource-intensive practice that entails multiple “touchpoints” for handoff and the recordation of information through manual entry. The paper-based approach provides little traceability for materials, and the data have fewer downstream uses. Lost or damaged tickets are also common.

Both transportation agencies and the private sector spend considerable resources producing, sorting, recording, and archiving paper tickets. Furthermore, with State transportation agencies facing a chronic shortage of skilled inspectors, the paper-based practice requires an in-person “ticket taker” to collect tickets from drivers, record tonnage and location, calculate yield, and report daily summary quantities.

To meet Federal-aid Highway Program (FAHP) policies, State transportation agencies must collect, retain, and verify haul tickets for the projects that serve as source documentation. The source documentation serves as the basis of payment for materials incorporated into the completed work. Regardless of whether an electronic or digital process is used, e-Ticketing must provide reconstruction of the chain of events that occurs on the projects and must be acceptable from engineering, auditing, and legal standpoints (Federal Highway Administration (FHWA) 1989).

### BENEFITS

e-Ticketing mitigates the challenges of paper tickets through a safer, faster, less resource-intensive, sustainable, and streamlined process that uses technology for information and

data transfer. e-Ticketing data can be transmitted in real time to a cloud or storage system, then become easily accessible by mobile devices, and thus, enabling operational decisions. This electronic cloud approach creates a single source of truth that can be exchanged via application program interfaces (APIs) directly into department of transportation (DOT) information management systems, such as construction management or financial systems, for data mining, payment, or other purposes. e-Ticketing facilitates integration with complementary technologies, such as intelligent compaction, dielectric profiler systems, and pavement-mounted thermal profilers. This integration offers a unique opportunity to access and analyze quality and productivity data that are otherwise difficult to capture until after the completion of construction.

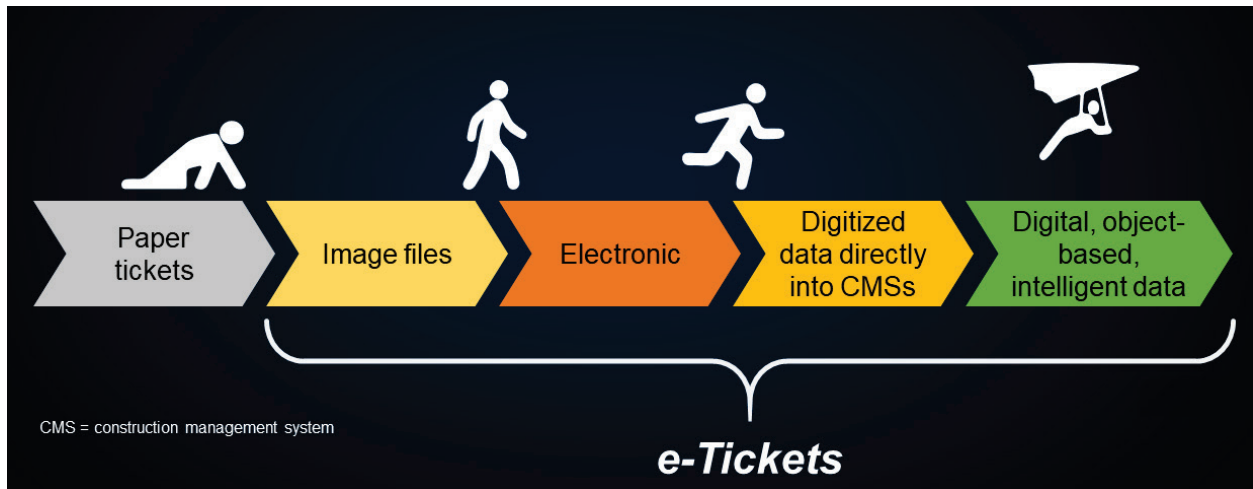
With the implementation of e-Ticketing, transportation agencies can provide solutions to overcome pressing challenges and achieve the following benefits:

- Improved worker safety through reduced human-to-human interaction during ticket handoffs, because construction inspectors no longer must climb on delivery trucks to retrieve tickets while physically near moving traffic or construction equipment.
- Increased efficiencies with e-Ticketing over a paper-based process that include automating routine activities such as collecting and summarizing paper tickets, reducing the workload of construction inspectors and allowing them to prioritize more critical inspection elements; conserving resources associated with paper printing, storage, and archiving records; and streamlining the payment process for fewer delays and lost tickets.
- Streamlined data management with e-Ticketing through electronic capture of data and opportunities for automated transmission and archiving. e-Ticketing also eliminates lost or damaged tickets; reduces handoffs involving paper tickets; eliminates manual or multiple data entries; and automatically generates, transmits, and stores data in a consistent, reliable, and usable format.
- Enhanced applications of digitalized e-Ticketing data, enriched with complementary data that allows material placement to be traced, compliance assessed, and further investigations conducted for forensics, asset management, and other data-mining purposes.
- Enriched data access through a single source that is available instantly to multiple users via web- or cloud-based interfaces and mobile devices in the field to enable automated tracking of material delivery and real-time operational decisions.

## **PARTNERS**

Both agency and industry partners have contributed to this innovation through participation in a technical working group (TWG). The TWG prepared and presented materials at the summits and worked together to develop this implementation plan. Section F identifies the members of the TWG.





Source: FHWA.

**Figure 2. Maturity of e-Ticketing technologies.**

While image-based files are convenient for electronic transmittal and human readability, the original paper ticket is still needed to serve as the source document and must eventually be delivered to the project or retained by the contractor or supplier. Because the image files contain unstructured data that are not machine readable, the information must still be manually extracted and entered into the agency's business information systems.

In the "walk" stage, the tickets are produced in an electronic format that is machine readable with some structure to the data, such as comma-separated values, extensible markup language, and JavaScript Object Notation. The electronic tickets are transmitted in real time from load-out systems to field inspectors directly or through a server. The State transportation agencies who have implemented commercially available or in-house-developed e-Ticketing solutions have achieved this maturity stage. The electronic ticket serves as a source document and must be securely transmitted, stored, and archived in electronic form.

The "run" stage indicates the maturity level where the electronic tickets are digitalized into semi-structured data using a standard data schema for transmittal and exchange. The data fields are automatically extracted, transformed, and loaded, via API, into an agency's CMS, or alternatively, DMS or geographic information system (GIS), for further applications and archived under the CMS's protocol.

The final "fly" stage envisions the use of object-based data. The ticket data are structured as defined elements that are grouped intelligently, organized hierarchically, and linked with other datasets using GIS or building information modeling file formats, such as shapefiles, file geodatabase, InfraGML encoding standard, or IFC alignment. The object-based ticket enforces data quality rules to validate data attribute and relationship requirements. The object-based ticket also allows some operations, such as data retrieval or updating, to be automated using a set of procedures. The object-based ticket makes the data easier for use in extensive data mining applications. In the object-based approach, payment can be automated based on the e-Ticket data transfer.

## IMPLEMENTATION TEAM AND KEY STAKEHOLDERS

The implementation team included technical experts from FHWA, State DOTs, academia, and industry associations. Table 1 identifies the members of the core implementation team, their affiliation, and their roles.

**Table 1. Core implementation team.**

Name	Agency	Role Assignment
Kathryn Weisner	FHWA	e-Ticketing team lead
Dennis Dvorak	FHWA	e-Ticketing team co-lead
Matthew Corrigan	FHWA	Research
Antonio Nieves	FHWA	Headquarters construction
Jeff Withee	FHWA	Quality assurance
Brian Lawrence	FHWA	FHWA division office
Rob Elliott	FHWA	EDC-6 e-Ticketing and digital as-builts coordinator
Rick Bradbury	Maine DOT	Lead State champion
Cedric Wilkinson	Iowa DOT	Lead State champion
Rebecca Embacher	Minnesota DOT	Lead State champion
Jon Myler	Pennsylvania DOT	Lead State champion
Ken Talbot	Utah DOT	Lead State champion
Alexander Harris	Alabama DOT	Lead State champion
Jacob Blanchard	Indiana DOT	Lead State champion
Marco Foster	Washington State DOT	Lead State champion
Hao Chen	West Virginia DOT	Lead State champion
Roy Sturgill	Iowa State University	e-Ticketing champion
Gabe Dadi	University of Kentucky	e-Ticketing champion
Richard Willis	National Asphalt Pavement Association	Industry representative
Greg Mulder	Iowa Ready Mix Concrete	Industry representative
Tom Yielding	National Stone, Sand and Gravel Association	Industry representative

EDC-6 = Every Day Counts Round 6.

## **SECTION II: MISSION STATEMENT**

To facilitate the adoption of e-Ticketing to increase safety, efficiency, and responsible use of resources using cost-effective digital collaborative tools while saving lives, time, and taxpayer funds.

### SECTION III: GOALS

The e-Ticketing implementation team has identified several team, national, and innovation goals to achieve through the EDC-6 initiative.

#### TEAM GOALS

- Increase the number of State transportation agencies and local agencies institutionalizing e-Ticketing from 0 to 12 in 2 yr.
- Support all State transportation and local agencies in advancing their base-level implementation to the development, demonstration, assessment, or institutionalization stage.
- Support the development of standard operating procedures, guidance on effective practices, sample or provisional specifications, and data standards for e-Ticketing.
- Increase the number of State transportation agencies expanding the application of e-Ticketing to at least one additional use case (hot mix asphalt/warm mix asphalt ready-mix, aggregate, salt, or other) beyond their baseline usage in tracking, recording, and verifying material information.

#### NATIONAL GOALS

- Increase the number of State transportation agencies that have advanced the innovation, including proper independent verification techniques, in 2 yr.
- Increase the knowledge and acceptance of e-Ticketing among all target audience members.
- Increase the number of State transportation agencies to expand the application of e-Ticketing to at least one additional material type.

#### INNOVATION GOALS (OR BENEFIT GOALS)

- Minimize worker exposure to reduce near-miss events, work-related injuries, and fatalities. Reduce time, resources, environmental impact, and financial expense associated with production, reproduction, distribution, exchange, and archiving of paper-based tickets.
- Streamline construction contract administration by integrating electronic and digital workflows through efficient data gathering and sharing.
- Improve timeliness and accuracy of payments through electronic submission of quantity data and independent verification of the data for contract items paid by weight.



## SECTION IV: TARGET AUDIENCE

The target audiences for implementing e-Ticketing are identified as primary and secondary stakeholder groups:

### *Primary stakeholder group*

The primary stakeholders, who are the users and solution providers of the e-Ticketing technology, include:

- Transportation agencies (i.e., State transportation agencies, Federal Lands Highways, local public agencies). The State transportation agency stakeholders include executives; managers; engineers; inspectors of construction, materials, maintenance, and asset management programs; and the offices handling information technology, contract administration, financial management, audits, and economic opportunity (e.g., compliance with disadvantaged business enterprises and the Davis-Bacon Act of 1971) (Public Law 71–798).
- Highway contractors (i.e., prime contractors and subcontractors).
- Operators of asphalt concrete and ready-mix concrete plants, manufacturers of other construction and maintenance materials (e.g., aggregate, salt, millings) and products (e.g., reinforcing steel, pipes), and materials suppliers.
- Third-party haulers.
- Technology solution providers (i.e., vendors).

### *Secondary stakeholder group*

The secondary stakeholders, who are the users of the information created using the e-Ticketing technologies, include:

- Construction engineering and inspection (CEI) firms.
- Law enforcement (State and local).
- FHWA division offices.
- Federal Motor Carrier Safety Administration (FMCSA) or other State motor carrier agencies.

Table 2 provides a summary of the target audience segments and associated characteristics identified by the team.

**Table 2. Target audience descriptors.**

Target Audience (TA)	Characteristics	Opportunities and Needs	Obstacles and Issues	Targeted Message	Messenger	Strategies
TA-1 State transportation agencies	Contract administrators Project owners Specification writers Asset managers Data managers and users	Improved safety Reduced paper usage Improved compliance Improved efficiencies through streamlined processes Material traceability Transparency Data-mining Validation of permit/ overweight trucks/ haul routes Workforce development	Impedance with technology adoption File formats and data standardization Many vendor solutions Lack of specifications Increased project cost Lack of supporting technologies (e.g., mobile devices in the field) Training IT concerns Mobile device access to non-DOT systems Data ownership and data sharing Privacy laws Data verification	Saves lives, money, time Work zone safety Value added work Save money (paper creation and storage) Save time and effort Engage inspection staff for higher priority work Accuracy of quantities and payment Attract young people to technology-oriented work	FHWA Contractor Suppliers Vendors Industry associations Early State DOT adopters. AASHTO committees Internal champion	Contract and pilot requirements Webinar Peer exchanges FHWA EDC events AASHTO coordination Fact sheet Magazine and trade articles STIC groups Focus groups User producer groups Regional AASHTO conferences

Target Audience (TA)	Characteristics	Opportunities and Needs	Obstacles and Issues	Targeted Message	Messenger	Strategies	
TA-2 local agencies	Contract administrators	Improved safety	Impedance with technology adoption	Saves lives, money, time	FHWA	Contract and pilot requirements	
	Project owners	Reduced paper usage	File formats and data standardization	Work zone safety	Contractors	Webinar	
		Specification writers	Improved compliance	Many vendor solutions	Value added work	Suppliers	Peer exchanges
	Asset managers	Improved efficiencies through streamlined processes	Lack of specifications	Save money (paper creation and storage)	Vendors	FHWA EDC events	
	Data users and managers	Material traceability	Dependence on State agency systems, processes, procedures, and specifications	Save time and effort	Industry associations	Early State agency adopters	AASHTO coordination
		Transparency	Increased project cost	Engage inspection staff for higher priority work	Internal champion	AASHTO committees	Fact sheet
	Data-mining	Lack of supporting technologies	Accuracy of quantities and payment	Attract young people to technology-oriented work	Internal champion	Magazine and trade articles	
	Workforce development	Training	IT concerns			STIC groups	
	Local agency certifications	Mobile device access to non-State agency systems	Data ownership and data sharing			Focus groups	
	Faster reimbursement by State/Federal agencies	Privacy laws				User producer groups	
		Data verification				Regional AASHTO conferences	

Target Audience (TA)	Characteristics	Opportunities and Needs	Obstacles and Issues	Targeted Message	Messenger	Strategies
TA-3 contractors	Prime contractors	Improved safety	Many vendors	Higher ROI	State/local agencies	Contract requirements
	Subcontractors	Improved profits	Too many influencers (plant, placement contractor, State agency and material types) driving choices	Competition	Contractor	Training
		Fewer disputes over payment		Quicker payment for work	Manufacturers	Webinar
	Technology adopters	Less paperwork and fewer delays	ROI is yet to be demonstrated or not convinced	Efficiency of work, not losing time and money in tracking down paper tickets	Suppliers	Peer exchanges
	Data providers	Less storage needs for paper		Safety is not “apparent”	Way to measure efficiency of sub to award work	Vendors
		No lost or damaged tickets	Data security	FHWA		AGC, NAPA and association meetings
		Billing efficiency	Limitations on data sharing by third parties	AGC, NAPA, and other professional associations	User producer groups	
		Transparency between parties	Position in supply chain and share of business from government work			
		Connectivity in remote and high-elevation areas, while alternatives are expensive	Workforce development			
		Lack of uniform requirements when working across multiple States				

Target Audience (TA)	Characteristics	Opportunities and Needs	Obstacles and Issues	Targeted Message	Messenger	Strategies
TA-4 manufacturers  plant operators and material suppliers	Operators of asphalt concrete mix, Portland cement concrete mix, and prefabrication plants  Suppliers of aggregates, steel, and other materials  Technology adopter, vendor selector and data creator  Serves multiple customers with varied needs	Improved safety  Delivery efficiencies  Better data, faster and accurate payments  Less paper produced and stored	No direct contract with State agency  Integration with legacy systems  Added cost for plant upgrades  Different specifications when working across multiple States  Wireless connectivity  Data security  Training	Higher ROI through efficiency  Improved safety  Payments more accurate and faster  Efficiency of operation  Competitive advantage  Workforce development	Contractors.  State/local agencies  Vendors  Industry associations	Contract requirements  Training  Webinar  Peer exchanges  FHWA EDC events  AGC, NAPA and association meetings  Trade articles  User producer groups
TA-5 e-Ticketing vendors	Providers of technology solutions  Trainers  Change agents	Increased market adoption	Intellectual property  Interoperability  Competition  Market changes  Lack of uniform requirements	Growth opportunities for everybody in market	State agencies  Contractor  Plant operators and materials suppliers  Industry groups  Other technology providers	Contract and pilot requirements  Webinar  Peer exchange  Training  Focus groups  AASHTO and FHWA EDC events  Trade association meetings

Target Audience (TA)	Characteristics	Opportunities and Needs	Obstacles and Issues	Targeted Message	Messenger	Strategies
TA-6 third-party truck haulers and individual owner operators	Fleet operators for pay and profit Users of delivery and logistics data	Efficiencies with fleet management No lost or damaged tickets invoice streamlined Law enforcement compliance Global Positioning Service (GPS) tracking	Limited technology exposure and training Buy-in with ROI demonstration Privacy concerns All the different vendors by contract or project or within the same project	Improved safety Billing ease and accuracy Compliance Fleet management Workforce development	State/local agencies Contractor Material suppliers Plant operators	Partnering to get buy-in YouTube and on-demand videos Trade articles and trade conferences (ConExpo-Con/Agg World of Concrete).
TA-7 law enforcement	Enforcement	Improved safety Real-time data validation and verification	Lack of knowledge or acceptance of technology Local laws requiring paper Wireless connectivity	Educating on technology Ease of use Security and validity	State agencies FHWA	Educational materials YouTube and on-demand videos Pilot involvement
TA-8 CEI firms	Users of e-Ticketing data	Better allocation of resources Ability to focus on other critical activities Reduced need for duplication and multistep data entry	Access to mobile devices and privileges Training Need for delivery and data verification	Demonstrating the benefits Workforce development	State/local agencies Contractor Plant operators/supplier	Contract requirements Training Webinar Peer exchanges FHWA EDC events YouTube and on-demand videos

Target Audience (TA)	Characteristics	Opportunities and Needs	Obstacles and Issues	Targeted Message	Messenger	Strategies
TA-9 FHWA division offices	Program oversight, including quality assurance, records management, payments, and compliance with Federal requirements  Stewards of Federal funding	Improved safety  Reduced paper use  Increased efficiency for project documentation and payments  Improved compliance  Improved efficiencies through streamlined processes  Material traceability  Transparency	Federal IT challenges (e.g., firewall, security)  Higher project cost  Maturity of technology adoption  Lack of mobile devices and access to non-DOT systems  Need for delivery and data verification	Demonstrating the benefits – saves costs, efficiencies, safety  Workforce development  Accuracy of quantity and payment	Early State Agency Adopters  AASHTO Committees  FHWA Internal Champions	Pilot requirements  Webinar  Peer exchange  FHWA EDC events  AGC/  ARTBA coordination  AASHTO coordination
TA-10 FMCSA or other State motor carrier agencies	Compliance with Federal and State regulations	Improved driver safety  Compliance with truck weight regulations  Compliance with driving daily limit and breaks of truck operations	Lack of knowledge or acceptance of technology  Laws requiring paper	Educating on technology  Ease of use  Security and validity	State agencies  FHWA	Educational materials  YouTube and on-demand videos  Pilot involvement

AASHTO = American Association of State Highway and Transportation Officials; AGC = Associated General Contractors of America; ARTBA = American Road and Transportation Builders Association; NAPA = National Asphalt Pavement Association; ROI = return on investment; STIC = State Transportation Innovation Councils.

## SECTION V: MARKET RESEARCH

### GENERAL MARKET RESEARCH APPROACH

The team identified several marketing research tools to gather information on the use of e-Ticketing from target audiences. The team will capitalize on existing information and supplement it with additional tools, such as surveys, professional and trade events, listening sessions, and research. These tools will be used to gather information on current deployments, costs, and benefits to make a business case, stakeholder needs and challenges, and implementation barriers. Table 3 presents a list of tools identified for each target audience group. The table further describes what information can be gathered using these tools and why these tools are effective for information gathering.



**Table 3. Innovation market research.**

<b>Target Audience</b>	<b>Name of Data Collection Tool</b>	<b>Information to Be Gathered by Tool</b>	<b>This Tool Is an Effective Choice Because...</b>
TA-1: State agencies.	Stakeholder engagement, regional summits, direct call, professional organizations, listening sessions, EDC events, web polls and surveys, research, vendors, contractors, FHWA process reviews, AID and STIC grants.	Use cases, standards, specifications, research, requirements, success factors and lessons learned from pilots.	It helps to collect information from current deployments and stakeholders to assist with implementation needs.
TA-2: Local agencies.	Stakeholder engagement, regional summits, direct call, professional organizations, listening sessions, EDC events, web polls and surveys.	Use cases, standards, specifications, research, success factors and lessons learned from pilots, requirements.	It helps to collect information from current deployments and stakeholders to assist with implementation needs.
TA-3: Contractors.	Stakeholder engagement, regional summits, direct call, professional organizations, listening sessions, EDC events, web polls and surveys, research, vendors.	Use cases, standards, specifications, success factors and lessons learned from pilots, requirements, costs, ROI, vendors, custom solutions.	It helps to collect information from current deployments and stakeholders to assist with implementation needs. It also helps to gather costs and benefits to make a business case for contractors.

Target Audience	Name of Data Collection Tool	Information to Be Gathered by Tool	This Tool Is an Effective Choice Because...
TA-4: Manufacturers, plant operators and material suppliers.	Stakeholder engagement, regional summits, direct call, professional organizations, listening sessions, web polls and surveys, research.	Systems, standards, success factors and lessons learned from pilots, requirements, capabilities, costs, ROI, vendors.	It helps to collect information from current deployments and stakeholders to assist with implementation needs. It also helps to gather costs and benefits to make a business case for plant operators and material suppliers.
TA-5: e-Ticketing vendors.	Stakeholder engagement, regional summits, direct call, professional organizations, listening sessions, EDC events, web polls and surveys, research, literature review, salespersons, and sales information.	Use cases, standards specifications, success factors and lessons learned from pilots, requirements, costs, ROI, products, services, clients.	It helps to collect information from current deployments and stakeholders to assist with implementation needs.
TA-6: Third party truck haulers and individual owner operators.	Stakeholder engagement, direct call, professional organizations, listening sessions, web polls and surveys, site visits.	Use cases, success factors and lessons learned from pilots, requirements, costs, vendors, contracts and relationships.	It helps to collect information from current deployments and stakeholders to assist with implementation needs.
TA-7: Law enforcement.	Stakeholder engagement, regional summits, direct call, professional organizations, listening sessions, EDC events.	Use cases, laws, regulations, compliance, success factors and lessons learned from pilots, requirements.	It helps to collect information on receptivity of law enforcement personnel and understanding of laws and regulations causing implementation barriers.
TA-8: CEI firms.	Stakeholder engagement, regional summits, direct call, professional organizations, listening sessions, EDC events, web polls and surveys, research.	Use cases, success factors and lessons learned from pilots, requirements, costs, ROI, vendors, custom solutions.	It helps to collect information from current deployments and stakeholders to assist with implementation needs.

Target Audience	Name of Data Collection Tool	Information to Be Gathered by Tool	This Tool Is an Effective Choice Because...
TA-9: FHWA division offices.	Stakeholder engagement, regional summits, direct call, EDC events, web polls and surveys, FHWA process reviews, AID and STIC grants.	Use cases, standards, specifications, success factors and lessons learned from pilots.	It helps to collect information from current deployments and stakeholders to assist with implementation needs.
TA-10: FMCSA or other State motor carrier agencies.	Stakeholder engagement, regional summits, direct call, professional organizations, listening sessions, EDC events.	Use cases, laws, regulations, and compliance, success factors and lessons learned from pilots, requirements.	It helps to collect information on receptivity of law enforcement personnel and understanding of laws and regulations causing implementation barriers.
TA-11: e-Ticketing subject matter experts group.	LNC homework sessions, listening sessions, WSP survey.	Use cases, standards, specifications, research, success factors and lessons learned from pilots, requirements.	It helps to collect information from current deployments and stakeholders to assist with implementation needs.

AID = Accelerated Innovation Deployment; LNC = Leap Not Creep; ROI = return on investment.

## OBSTACLES, OPPORTUNITIES, STRATEGIES, TOOLS AND TACTICS

To provide a clear path forward, the team evaluated potential obstacles along with opportunities, strategies, tools, and tactics for mitigating the barriers to deployment and implementation of the innovation. Table 4 through table 6 summarize the team's evaluation

**Table 4. Strengths, weaknesses, opportunities, and threats.**

<b>Strengths (Internal)</b>	<b>Weaknesses (Internal)</b>
Proof of concept and supporting research. Tangible safety improvements. Ability to progressively advance deployment through maturity levels. Diverse and engaged implementation team. Vendor involvement and energy.	Lack of uniform specifications across agencies. Many pilots but slow to institutionalize. Vendor involvement and energy. Disruptive technology. Need to advance through multiple levels of maturity.
<b>Opportunities (External)</b>	<b>Obstacles/Threats (External)</b>
Single-source-of-truth in electronic and digital formats. Progressions of deployment through maturity levels. Leveraging advances in e-Construction sets a low threshold for entry. Safer and contactless delivery.	Plethora of vendors. Lack of data standardization. Resistance to change. Lag in e-Construction technologies might hinder e-Ticketing deployment.

Table 5. Heat map.

Risk Type	Primary Impact	Threat or Opportunity	Likelihood	Impact	Response Strategy Type	Response Strategy
State DOT's over-reliance on old means and methods.	Delayed adoption of e-Ticketing resulting in processing delays, and lost and damaged tickets.	Threat	Possible	High	Mitigate	Educate users on benefits of tools and technology via in-person and just-in-time training. Business process review of current practices.
Limited deployment of mobile devices in the field.	Stakeholders are unable to access the e-Ticketing data in the field in real time.	Threat	Possible	High	Accept	Co-promote EDC-3/4 e-Construction tools, techniques, and strategies to encourage mobile devices deployment, such as through small-scale deployment under STIC.
Limited deployment of e-Ticketing data with a CMS or DMS.	Stakeholders are unable to receive, access, manage, and archive the e-Ticket information and/or data.	Threat	Possible	Moderate	Accept	Co-promote EDC-3/4 e-Construction tools, techniques, and strategies to encourage CMS/DMS deployment, such as through small-scale deployment under STIC.
Limited connectivity in the field office, jobsite, and supplier plant.	Stakeholders are unable to receive, access, and transmit the e-Ticketing data in the field in real time.	Threat	Almost certain	High	Accept	Encourage the deployment of wired or wireless technologies through business process specifications, via phone line, cable, fiber optic, cellular, satellite, or fixed internet options as part of project field office or supplier/plant equipment. Educate stakeholders to ensure that e-Ticketing solutions have "off-line" capabilities and load-out computers with internet connectivity.
Multiple e-Ticketing technological solutions on one project. Construction personnel are likely to struggle with training on handling multiple e-Ticketing solutions.	Lack of data standardization causes challenges in ingesting data into the State agency CMS/DMS and missing fields.	Threat	Possible	Moderate	Accept	Create and promote business-process specifications. Train State agency staff on e-Ticketing data maturity and standardization.

Risk Type	Primary Impact	Threat or Opportunity	Likelihood	Impact	Response Strategy Type	Response Strategy
Inadequate data verification process for source documentation, acceptance, and payment.	Inconsistencies cause compliance issues with FAHP.	Threat	Almost Certain	High	Mitigate	Create and promote business-process specifications. Guidance on the review of agency specifications, process and procedures for source documentation, acceptance, and payment and update them to reflect e-Ticketing tools and technologies.
GPS/GNSS	Bread crumbing is opposed by some stakeholders and may be a violation of various State and local privacy laws.	Threat	Almost Certain	High	Mitigate	Create and promote best practices, specifications. Educate stakeholders on alternative uses of GPS/GNSS tracking data that provide user benefits (labor compliance, work hours, prevailing wages, disadvantaged business enterprises utilization, haul route compliance). Encourage on-demand only per State agency formal request from contractor for specific need due to potential waste, fraud, or abuse. Encourage development and deployment of alternative delivery verification methods (e.g., license plate readers).
Data ownership: Lack of clarity on when and where the State DOT takes possession of the data.	Lack of clarity on data ownership is likely to cause data access, privacy, accountability, and security issues.	Threat	Possible	Moderate	Accept	Create and promote best practices, specifications, contract language that emphasizes data requirements for only those elements that are needed.
Training to stakeholders on various e-Ticketing technology solutions.	Provides education to users on tools and technology via in-person and just in time (JIT) training.	Opportunity	Almost Certain	High	Enhance	Develop educational materials and conduct virtual and in-person training events.

Risk Type	Primary Impact	Threat or Opportunity	Likelihood	Impact	Response Strategy Type	Response Strategy
Allowing workers access to e-Ticketing in real time remotely	Provides education to users on tools and technology via in-person and JIT training to encourage safer practices for vehicle and social distancing.	Opportunity	Almost Certain	High	Enhance	Conduct virtual and in-person training events, such as workshops, peer exchanges, webinars, etc.
Prioritizing staffing to critical items of work instead of chasing down trucks for paper tickets.	Provides education to users on tools and technology to encourage resource management and allocation.	Opportunity	Almost Certain	High	Enhance	Conduct virtual and in-person training events, such as workshops, peer exchanges, and webinars.
Some agencies have implemented practices that have questionable validity for source documentation, verification, acceptance, and payment on Federal-aid projects.	Questionable practices create compliance issues with FAHP.	Threat	Almost Certain	High	Mitigate	Survey State DOTs of level of maturity (crawl, walk, run, fly). Create and promote business-process specifications. Guidance on the review of agency specifications, process, and procedures for source documentation, acceptance, and payment and update them to reflect e-Ticketing tools and technologies.
Data management and transfer.	Establishing standards streamlines data management process.	Opportunity	Almost Certain	High	Enhance	Support AASHTO and industry standard formats for data (fields, file type) and use beyond project. Create awareness through AASHTO Committees and vendor workshops. Encourage bringing IT and GIS into e-Ticketing deployment process. Provide training on data usage, data mining, and archiving.

Risk Type	Primary Impact	Threat or Opportunity	Likelihood	Impact	Response Strategy Type	Response Strategy
Unsecure e-Ticketing software and data.	Unsecure e-Ticketing software and data create waste, fraud, and abuse.	Threat	Possible	Moderate	Accept	Encourage involving IT staff in the development and deployment of tools and technologies.
User buy-in and acceptance of a new disruptive technology.	Lack of buy-in impedes deployment.	Threat	Possible	High	Mitigate	Educate users on benefits of the tools and technologies via in-person and virtual training and outreach events to encourage increased awareness, input, and utilization. Encourage early and frequent stakeholder outreach and involvement.
Small operators of quarries, pits, and plants.	e-Ticketing implementation may cause financial burden on small operators.	Threat	Almost Certain	High	Accept	Work with transportation agencies to encourage but not require e-Ticketing for small operators. Work with industry associations to identify incentives for small operators. Educate “small” users on benefits of the tools and technologies via in-person and virtual training and outreach events to encourage increased awareness, input, and utilization.
Upgrade load out software.	Upgrading incurs additional costs and may be met with resistance.	Threat	Possible	Moderate	Accept	Educate users on benefits of tools and technology via in-person training and outreach events. Conduct vendor outreach on compatibility and upgrades, and education on savings and other efficiencies.
Vendor support.	Vendors provide roll-out and training to DOTs.	Opportunity	Certain	Moderate	Enhance	Work with vendors to create roadmap on educational objectives. Work with State transportation agencies to create a timeline on their deployments for planning purposes.



Risk Type	Primary Impact	Threat or Opportunity	Likelihood	Impact	Response Strategy Type	Response Strategy
Disparate technology solutions due to existence of multiple vendors and contractor-built solutions in the market.	Lack of standardization.	Threat	Possible	Moderate	Mitigate	Conduct vendor outreach for a discussion on standardizing requirements and solutions. Include contractors who have built their own systems.
Maturity level definitions.	Maturity levels help State transportation agencies plan their implementation pathways.	Opportunity	Almost Certain	Minor	Enhance	Work with State transportation agencies and AASHTO committees to recognize the levels of maturity and encouragement to advance up the maturity levels for their agency.
Weighmaster certifications and suppliers' standard data.	Lack of standard practice.	Threat	Possible	Moderate	Accept	Develop guidance on certifications, standards, and best practices. Promote AASHTO provisional standards for nationwide compatibility.

GNSS = Global Navigation Satellite System; IT = information technology.

**Table 6. Marketing tools and tactics.**

<b>Marketing Tool or Tactic</b>	<b>Estimated Cost</b>	<b>Level of Priority</b>
Peer-to-peer exchanges (virtual and in-person) with reports for posting on FHWA website.	NA	High
Regional workshops with reports for posting on FHWA website.	NA	High
Industry day, virtual event for vendors to showcase technologies.	NA	Medium
Webinars with recordings posted on FHWA websites.	NA	High
Articles in FHWA and national publications.	NA	Medium
Presentation and informational booths at industry events.	NA	High
Marketing materials, fact sheets, short case studies, techbriefs and how-to guides and other similar informational materials for distribution (electronically and hard copy) and posting on FHWA website.	NA	Low
Federal-aid Essentials and YouTube Videos for posting on FHWA website.	NA	Medium
Update (6-mo intervals) innovation matrixes for FHWA website.	NA	High
Develop and maintain a State-by-State map of maturity (crawl, walk, run, fly) for posting on FHWA website.	NA	High
Technical and SME support for EDC-6 CAI events and deliverables.	NA	High
SME support for data standards development with industry and AASHTO.	NA	High
Technical and SME support for EDC 3/4 e-Construction to enable EDC-6 e-Ticketing.	NA	High

CAI = Center for Accelerating Innovation; NA = Not Available; SME = subject matter expert.

## SECTION VI: PERFORMANCE MEASURES

The success of the implementation plan will be ensured through closely tracked and measured deployment goals. For each goal, specific objectives will be achieved through focused strategies and activities with quantifiable and achievable performance metrics.

The implementation plan will be evaluated at several interim stages by the e-Ticketing team during implementation, and measurable targets will be established as a means of assessing progress. The feedback provided at several stages throughout the schedule will provide accountability for the team, highlight early success, and show progress toward implementation goals.

Table 7 provides an overview of performance measurements—a consistent series of data describing progress over time toward a desired outcome or outcomes. The table defines each goal and the associated tools for monitoring progress toward achievement and overall performance.

**Table 7. Performance measurement.**

Goals	Progress Monitoring Measurement Tools	Performance Evaluation Measurement Tools
Team goals	Communication within TWG routine meetings.	Diverse webinar, peer exchanges, industry day, and summit presentations by all members of the group.  Technical assistance from lead States.  Summit and webinar involvement.  Capability maturity matrix.
National goals	Polling of States during webinars to determine interest and extent-of-use feedback during summits to establish a realistic baseline.  Regular reporting through the division offices.	Number of States that have made progress.  Cost, life, and time savings experience based on pre- and post-evaluation of benefits.  Capability maturity matrix.
Innovation (benefit) goals	Gather feedback from States/agencies as they implement the innovation.	Cost, life, and time savings experienced based on pre- and post-evaluation of benefits.

## SECTION VII: WORK PLAN

Table 8 provides a detailed matrix of the identified activities, cost, audience, and messaging essential to deploying e-Ticketing. Responsibility is assigned for each activity, and completion dates are identified.

Table 8. Work plan.

Activity	Cost	Audience	Message	Responsibility	Due	Comments
Virtual summits with reports for posting on the FHWA website.	\$	State/local agencies, contractors, plant operators and material suppliers	SMEs to share experience for the transfer of knowledge to facilitate adoption of practices.	FHWA	NA	NA
Peer-to-peer exchanges (virtual and in-person) with reports for posting on the FHWA website.	\$	State/local agencies	Experience of lead States who have adopted e-Ticketing shared with other agencies for the transfer of knowledge to facilitate adoption of practices.	FHWA and lead States	NA	NA
Regional workshops (in-person) with reports for posting on the FHWA website.	\$	State/local agencies, contractors, plant operators and material suppliers	Leveraging the collective knowledge of a region to advance the state of the practice among all participants, and provide technical assistance.	FHWA and lead States	NA	NA
Webinars with recordings for posting on the FHWA website.	\$	State/local agencies, contractors, suppliers, vendors	Experience of agencies who have adopted e-Ticketing shared with other agencies for the transfer of knowledge to facilitate adoption of practices.	FHWA	NA	NA
Articles in FHWA and national publications.	\$	State/local agencies, contractors, plant operators and material suppliers, vendors	Information demonstrating the adoption of e-Ticketing uses.	FHWA and lead States	NA	NA
Presentation and information booths at industry events.	\$	Contractors, plant operators and material suppliers, vendors.	SMEs share experience for the transfer of knowledge to facilitate adoption of practices.	FHWA and lead States	NA	NA

Activity	Cost	Audience	Message	Responsibility	Due	Comments
Technical and SME support for EDC-6 CAI events and deliverables.	\$	State/local agencies, contractors, plant operators and material suppliers, vendors	SMEs share experience for the transfer of knowledge to facilitate adoption of practices.	FHWA	NA	NA
Marketing materials, fact sheets, short case studies, techbriefs, how-to guides, and other similar informational materials for distribution and posting on FHWA website.	\$	State/local agencies, contractors, plant operators and material suppliers, vendors	Quick guides for specific use cases to allow for the quick implementation of new e-Ticketing uses.	FHWA and lead States	NA	NA
Federal-aid essentials and YouTube videos for posting on FHWA website.	\$	State/local agencies	Guidance on Federal-aid regulations and policies.	FHWA	NA	NA
Industry day (leverage with local industry events where contractors and plant operators participate).	\$	State/local agencies, contractors, plant operators and material suppliers, e-Ticketing, and State agency information system vendors	Showcase of vendor technologies and create synergy among public agencies, highway construction industry, and vendor representatives.	FHWA	NA	NA
SME support for data standards development with AASHTO and industry.	\$	State/local agencies, e-Ticketing, and DOT information system vendors	Collaborative forum to facilitate exchange of experiences on open standards, interoperability, and integration opportunities.	FHWA and lead States	NA	NA

Activity	Cost	Audience	Message	Responsibility	Due	Comments
Capability maturity framework/self-assessment.	\$	State/Local agencies	Guidance on various maturity levels to guide implementation and expand it to additional materials and use-cases.	FHWA and lead States	NA	NA
State of practice database.	\$	State/local agencies	Development and maintenance of a State-by-State map of maturity. Update innovation matrices every 6 mo for FHWA website.	FHWA	NA	NA
Community of practice (webconference).	\$	State/local agencies, contractors, plant operators and material suppliers, e-Ticketing, and DOT information system vendors	Knowledge sharing among stakeholders on implementation aspects.	FHWA	NA	NA
Technical assistance.	\$	State/local agencies	Continuation of technical and SME support provided for EDC-3/EDC-4 e-Construction to enable e-Ticketing.	FHWA and lead States	NA	NA
Implementation tools.	\$	State/local agencies, contractors, plant operators and material suppliers, vendors	Development of tools to facilitate pre- and post-assessment of benefits and costs such as ROI.	FHWA	NA	NA

## SECTION VIII: CONTINGENCY PLANNING

The current excitement around e-Ticketing can be leveraged to generate interest. As many as 24 agencies have piloted some form of e-Ticketing as of December 2020. Approximately one-half of those agencies swiftly took advantage of contactless delivery offered by this technology in response to the 2020 construction season. Some agencies, however, may not see the need to continue this practice in the future or may need to modify their procedures to provide an audit trail.

Our goal is to meet that excitement with a clear implementation plan to ensure agencies that implemented e-Ticketing during the 2020 construction season as well as those yet to pilot them see value in the practice. Similarly, getting buy-in from industry stakeholders, including small contractors, manufacturers, and suppliers, is key.

Leveraging expertise from State DOTs can also prove extremely valuable to demonstrate and showcase real benefits and how these benefits were achieved on construction projects. Holding webinars, summits, workshops, and peer-to-peer exchanges are opportunities for State DOTs and subject matter experts to share their knowledge and experience. Additionally, capturing and communicating how the States are using e-Ticketing data for construction management, asset management, and data mining applications is key to making a robust business case for agencies. The key to success is capitalizing on quick-start guides, such as TechBriefs and case studies, to ensure that agencies are prepared to adopt this technology.

The marketplace of e-Ticketing is diverse. Many technology solutions, either agency developed, contractor/manufacturer/supplier developed, or commercial off-the-shelf products are available. Ensuring the use of standardized and interoperable data are essential to the realization of e-Ticketing's long-term benefits. To address these potential challenges, bringing stakeholders together for an "industry day with vendors" or "data integration" forums to discuss the state of the practice for a better understanding of challenges, success factors, and lessons learned will help increase the adoption and application of e-Ticketing broadly.



## CONCLUSION

e-Ticketing has been gaining significant traction across the country for its ability to enhance material delivery operations and information management via improved safety, increased efficiency, improved quality, and reduced costs for use in cases that span multiple facets of transportation agencies and the private sector. The greater implementation of this innovation has wide-reaching benefits to both taxpayers and transportation agencies. This implementation plan's strategies provide a targeted approach to facilitate information dissemination to target audiences and stakeholders.

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