Current State of Department of Transportation Mobile Information Technology Use in the Field

October 5th, 2016
Today’s Presenters

- Moderator: David Esse, Innovation Officer - WisDOT

- Use of Mobile IT Devices in the Field
  Gabriel Dadi, Assistant Professor, University of Kentucky

- Addressing the Challenges and ROI for Paperless Project Delivery
  - Richard Duval, Construction and Project Management Engineer - Federal Highway Administration
  - Jagannath Mallela, Vice President and Director of Research & Innovation Solutions - Parsons Brinckerhoff
NCHRP is...

- A state-driven, national program that leverages AASHTO’s Standing Committee on Research
- Practical, ready-to-use results that focus on applied research and implementation
- A partnership that provides a wide range of approaches and products including:
  - NCHRP reports, IDEA program, Domestic Scans
Today’s First Presentation

Use of Mobile IT Devices in the Field

Gabriel Dadi, Assistant Professor

University of Kentucky
Today’s Second Presentation

Addressing the Challenges and ROI for Paperless Project Delivery

Richard Duval
Construction & Project Management Engineer
Federal Highway Administration

Jagannath Mallela
V.P./Director of Research & Innovation Solutions
Parsons Brinckerhoff
Current State of Mobile IT Use in the Field

Gabe Dadi, Ph.D., P.E., LEED AP
Assistant Professor

University of Kentucky
Demand

• Reduced staffing & productivity demands
  – 4.1% more miles managed by 9.78% fewer employees (Taylor and Maloney, 2013)

• Increased documentation

• EDC-3 and EDC-4 Innovation (e-Construction)
Mobile IT Devices

• Saves time and money
  – Field inspection and data collection
• Improves communication
  – On-demand email, text, Facetime/Skype
• Michigan DOT e-Construction
  – Saved $12M in added efficiencies
  – Saved 6M pieces of paper
  – Reduced average change order processing from 30 days to 3 days
Objective

• To identify the current state of practice in STAs for:
  1. Mobile IT devices and their applications
  2. Agency policies for mobile IT use
  3. Evaluation of mobile IT devices performance
Procedure

• Electronic survey created in Survey Gizmo
• Sent to AASHTO Standing Committee on Finance and Administration Subcommittee on Information Systems
• Requested distribution to design, construction, IT, and maintenance
Survey Response

100 total responses
To what degree has your agency adopted/implemented mobile IT

All respondents

- High level implementer: 10%
- Medium level implementer: 38%
- Low level implementer: 52%

IT respondents

- High level implementer: 9%
- Medium level implementer: 37%
- Low level implementer: 54%

End user respondents

- High level implementer: 11%
- Medium level implementer: 37%
- Low level implementer: 52%
What mobile IT device(s) does your agency issue (not including personally-owned devices) for use in the field?

- Smartphone
- Laptops
- Tablet
- Digital camera
- Hand-held multi-functional data collectors
- GPS equipped digital camera
- Mini-laptops
- Laser Rangefinder
- Other
- RFID readers
What is (are) the main purpose(s) for your current use of mobile IT?

- Access & send emails
- Make phone calls/texts
- Record entry
- Access standards & manuals
- Take/view geo-tagged photos
- GPS/GNSS coordinates
- View and edit plans
- Collect spatial geometry
- GIS viewing
- Take/view geo-tagged videos
- RFID/Barcode scanning
- Other
- View 3D models
Does your agency standardize mobile IT devices to be used across multiple business areas?

According to IT respondents:
- Yes: 73%
- No: 21%
- Unsure: 6%

According to End User Respondents:
- Yes: 47%
- No: 6%
- Unsure: 47%
How does your agency deploys its devices?

- Informal process ("give and go")
- Software specific training and deployment
- Project specific training and deployment
- Formal training process
- Other
What level of training do your employees receive for the mobile IT devices that are issued to them?

- Brief overview of device: 50%
- Software specific training: 40%
- Overview of functions, rules and regulations, and expectations of use: 30%
- No training provided: 20%
- I do not know: 10%
- Overview of functions and how they have been used on other projects: 5%
- User groups that share knowledge: 3%
How is data shared in your agency?

- Device is synced to land-based servers
- Shared on projects with other stakeholders
- Stays within agency project
- Centralized for reference to entire agency
- Synced to a cloud server
- Incorporated in project lessons learned
- Stays with individual data collector
- Other
What do you believe is the overall return on investment (ROI) from your agency's mobile IT use?

**IT**
- Negative ROI 15%
- >0-25% 15%
- >25-50% 25%
- >50-75% 22%
- >75-100% 4%
- 100%+ 19%

**End Users**
- Negative ROI 13%
- >0-25% 25%
- >25-50% 13%
- >50-75% 19%
- >75-100% 30%
- >100% 30%
# Top Selection Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>IT Overall Rank</th>
<th>End User Overall Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security of data</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Cost</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Ease of use</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Agency standard</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Interoperability</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Durability</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Operating system</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Available native applications</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>
### Most Significant Challenges

<table>
<thead>
<tr>
<th>Challenge</th>
<th>IT Overall Rank</th>
<th>End User Overall Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connectivity Issues (loss of cell signal)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Device maintenance and user support</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Application maintenance and support</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Cost effectiveness</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Poor/ineffective applications</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Interoperability Issues (software incompatibility)</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Lack of security of collected data</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Poor Durability/Lack of Ruggedness</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Electronic signatures/approval</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Quality of collected data</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>End-user resistance</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Training requirements</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Battery life</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Deploying devices to employees</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>
Case Studies
## Case Studies

<table>
<thead>
<tr>
<th>Score</th>
<th>Mobile Devices</th>
<th>Mobile IT Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Low)</td>
<td>Laptops, mini-laptops, smartphones</td>
<td>Access standards and manuals, email, phone calls, text messages, etc.</td>
</tr>
<tr>
<td>2 (Medium)</td>
<td>Tablets, digital cameras</td>
<td>View/edit plans, take photos, view 3D models, and record entry</td>
</tr>
<tr>
<td>3 (High)</td>
<td>Handheld multi-functional data collectors, GPS cameras, RFID readers, and laser range finders</td>
<td>Take/view geotag photos &amp; videos, RFID scanning, GPS/GNSS coordinates, GIS viewing, and collecting spatial geometry</td>
</tr>
</tbody>
</table>

### State Average Innovation Score

- **Judicious** 16%
- **Following Majority** 23%
- **Leading Majority** 26%
- **Believers** 26%
- **Innovators** 9%
## North Carolina

### Innovator

<table>
<thead>
<tr>
<th>Device Selection</th>
<th>Standard spec used for bid; have BYOD with reimbursement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile IT Uses</td>
<td>Automated maintenance management system, tracking operations, equipment, and personnel. Use GPS tablets for geolocating assets with automatic syncing to databases</td>
</tr>
<tr>
<td>Application Development</td>
<td>Develops or adapts apps with either consultant or in-house expertise</td>
</tr>
<tr>
<td>Data Sharing and Storage</td>
<td>Using data management group for consistency</td>
</tr>
<tr>
<td>Challenges</td>
<td>Supporting multiple devices on multiple OSs</td>
</tr>
<tr>
<td>Benefits</td>
<td>Time savings</td>
</tr>
</tbody>
</table>
| Unique Product(s)      | • Highway Construction Materials System (HiCAMS)  
                          • Xamarin and AgileAssets for app development |
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device Selection</strong></td>
<td>Business units request purchase to IT for final decision</td>
</tr>
<tr>
<td><strong>Mobile IT Uses</strong></td>
<td>Uses videotelephony and talk-to-text features. Sign inventory,</td>
</tr>
<tr>
<td></td>
<td>pavement condition evaluations, and maintenance rating program.</td>
</tr>
<tr>
<td><strong>Application Development</strong></td>
<td>Mostly in-house customization of commercially available apps</td>
</tr>
<tr>
<td><strong>Data Sharing and Storage</strong></td>
<td>Enterprise Data Branch monitors systems and has security but no</td>
</tr>
<tr>
<td></td>
<td>documented standards</td>
</tr>
<tr>
<td><strong>Challenges</strong></td>
<td>Rural connectivity, resistance to technology</td>
</tr>
<tr>
<td><strong>Benefits</strong></td>
<td>Time savings, connectedness, reducing erroneous and redundant</td>
</tr>
<tr>
<td></td>
<td>data</td>
</tr>
<tr>
<td><strong>Unique Product(s)</strong></td>
<td>• AASHTOWare/Trns.port</td>
</tr>
<tr>
<td></td>
<td>• Carrymap/Esri</td>
</tr>
</tbody>
</table>
CarryMap/Esri

Pavement Evaluation iOS Application
<table>
<thead>
<tr>
<th>Device Selection</th>
<th>Used some Apple, moving to MS with IT support.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile IT Uses</td>
<td>iPhones as hotspots for laptops. Use ArcGIS for snow/ice condition reports</td>
</tr>
<tr>
<td>Application Development</td>
<td>Primarily off the shelf</td>
</tr>
<tr>
<td>Data Sharing and Storage</td>
<td>Storage managed through VPN, moving to cloud-based solution</td>
</tr>
<tr>
<td>Challenges</td>
<td>Rural connectivity, relying on users to update devices and apps</td>
</tr>
<tr>
<td>Benefits</td>
<td>No longer using landlines, communication in emergencies</td>
</tr>
<tr>
<td>Unique Product(s)</td>
<td>• XenServer by Citrix for file sharing</td>
</tr>
</tbody>
</table>
## Idaho

Following Majority

<table>
<thead>
<tr>
<th>Device Selection</th>
<th>No process in place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile IT Uses</td>
<td>Conference calls for reacting to emergencies, 511 mobility index</td>
</tr>
<tr>
<td>Application Development</td>
<td>Using commercially available applications</td>
</tr>
<tr>
<td>Data Sharing and Storage</td>
<td>Use remote wiping for lost or stolen devices, Androids require antimalware</td>
</tr>
<tr>
<td>Challenges</td>
<td>Standardization is difficult with various devices and OSs. A lot of BYOD with legal issues with personal data</td>
</tr>
<tr>
<td>Benefits</td>
<td>Real-time information transfer, quicker responses to emergencies</td>
</tr>
</tbody>
</table>
| Unique Product(s) | • ProjectWise/Trns.port  
                     • Esri |
<table>
<thead>
<tr>
<th>Device Selection</th>
<th>DOT does not supply smartphones but does use laptops.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile IT Uses</td>
<td>None reported. Just a construction management system.</td>
</tr>
<tr>
<td>Application Development</td>
<td>Only use one developed for a different DOT with small modifications</td>
</tr>
<tr>
<td>Data Sharing and Storage</td>
<td>Some issues with synching data. Store data on web-based applications.</td>
</tr>
<tr>
<td>Challenges</td>
<td>Rural connectivity, devices getting rotated out</td>
</tr>
<tr>
<td>Benefits</td>
<td>Time savings, project information available to all</td>
</tr>
<tr>
<td>Unique Product(s)</td>
<td>• Exevision for daily records, change orders, and construction management</td>
</tr>
</tbody>
</table>
Field Design Uses

- Limited
- Geo-locating project and physical features
Field Construction Uses

- Issue resolution through video
- Georeferenced documentation
- Complete mobile construction administration systems
- Access to plans and specs
Field Maintenance Uses

- Geospatially identified inventory
- Geospatially collected and reported asset conditions
Conclusions

• Many STAs are using mobile IT devices but there’s a large gap between high level and low level adopters
• Few transportation specific applications exist
• STAs need more guidance
• Solutions require collaboration across the STA
Future Needs

• Formal cost/benefit methodology
• Guidebook that includes implementation of mobile IT devices in current practices
Acknowledgements

Thank you to the following individuals and organizations that made this research happen:

• Roy E. Sturgill, Research Engineer, Kentucky Transportation Center
• Elsie Wang, Graduate Research Assistant, University of Kentucky
• NCHRP
• Panel members of Synthesis Report 491
Thank You

Any products/services mentioned are for information purposes only and are not intended to be recommendations or endorsements by the authors or the University of Kentucky.
Addressing the Challenges and the Return on Investment for Paperless Project Delivery (e-Construction)

FHWA Contract DTFH61-14-C-00045

Richard Duval, P.E.
Highway Research Engineer
Federal Highway Administration
&
Jagannath Mallela, Ph.D.
Vice President, Research & Innovation Solutions
WSP|Parsons Brinckerhoff
Presentation Outline

• e-Construction Research Overview
• Areas of Automation
• State of the Practice
• Estimated Savings
• Case Studies
• Looking into the Future
e-Construction Research Overview
FHWA e-Construction Definition

“e-Construction is defined as the collection, review, approval, and distribution of highway construction contract documents in a paperless environment.”

- Paperless environment includes:
  - Electronic capture of construction data
  - Electronic submission of construction documentation
  - Increased use of mobile devices
  - Increased automation of document review & approval
  - Use of electronic signatures throughout project delivery
  - Secure electronic document and workflow management
  - Accessibility of information through mobile devices
FHWA e-Construction

- Definition encompasses all steps of the project delivery process
e-Construction Research Objectives

- Our research focuses on e-Construction:
  - Review e-Construction practices nationwide
    - Document successes, challenges and opportunities
  - From project advertisement to final project acceptance
    - Includes central office, field offices and jobsite processes
  - Product: Implementation guidance for e-Construction
    - Identify common barriers and strategies to address them
    - Document benefits, costs and return on investment
Business Case Approach

Planning-level benefits and costs estimate
- Team knowledge

Benefits and costs from state highway agencies
- Iowa DOT
- Michigan DOT
- Missouri DOT
- Utah DOT
- Others from survey

Business case for each improvement area
- Business case template
- Benchmark data

Implementation guidance
Feasibility Criteria

- Benefits to agency (qualitative)
- Likelihood of success
- Complexity of current process
- Ability to leverage existing resources/processes/systems
- Quantitative benefits
- Costs
Benefit Cost Analysis Framework
Components

- Quantitative benefits
- Costs
- 7-year timeframe
- Net benefits
- Cumulative benefits
- Breakeven year
- Return on Investment over a 7-year timeframe
Benefit (Qualitative) Examples

- Streamlining of key processes (e.g., digital review, approvals, contractor payments, etc.) to reduce overall project and program schedule
- More consistent and better quality data
- Collaboration
  - Increased collaboration through digital review process
  - Increased communication
- Increased transparency and reduced claims with audit trails
- Standardized reporting
- Easier/better reporting on performance data
Benefit (Quantitative) Examples

• Reduced use of paper, printing, and mailing
• Reduced data entry
• Self-service options for contractors, reducing manual data entry
• More complete and competitive bid documents
• Productivity and process efficiencies
  • Increased utilization and productivity of existing staff
  • Time savings from accelerated business processes and contractor payments
  • Reduced trips between the jobsite, field office, and central office
  • Faster document access, distribution, submission, review, and approval
Cost Examples

• Software licensing/development
• Software maintenance
• System implementation/integration
• Ongoing software maintenance and upgrades
• Hardware maintenance
• Internal agency staff time
• Contractor compliance
• Training
• Others
Areas of Construction Automation
### Areas of Construction Automation

- Electronic bidding and contract award
- Digital review of project documents
- Project construction management
- Digital management of construction documentation using a project collaboration tool
- Automated machine guidance (AMG) for construction operations
- Requirement of digital as-builts
- Use of Digital signatures (including electronic document routing and electronic approvals)
- Mobile devices
# e-Construction State of the Practice

<table>
<thead>
<tr>
<th>Category</th>
<th>Application/Service/Software</th>
<th>Project Elements</th>
</tr>
</thead>
</table>
| Plan Set Review and Preparation   | **Adobe Acrobat/Reader**  
*PDF solution for creating, editing, and managing documents; used for plan set review and signing and sealing plan sets* | • PS&E           |
|                                  | **AutoCAD**  
*CAD software for 2D and 3D design*                                                      | • PS&E           |
<table>
<thead>
<tr>
<th>Category</th>
<th>Application/Service/Software</th>
<th>Project Elements</th>
</tr>
</thead>
</table>
| Electronic Bidding and Contract Award | **Bid Express**  
*Internet bidding service that enables an agency and contractors to communicate with each other; it is used to submit the bid, view and download project information, and access plans and bid data online; this service is often used in conjunction with the Expedite Bid software.*  
**Expedite Bid Software**  
*Software used to prepare, validate, and analyze an electronic bid and is often used in conjunction with the Bid Express service* | • PS&E  
• Electronic Bidding and Contract Award |
| Digital Signatures               | **DocuSign**  
Digital signature product to securely access and sign documents to complete approvals and agreements | • PS&E  
• Electronic Bidding and Contract Award  
• Project Construction Management |
## e-Construction State of the Practice

<table>
<thead>
<tr>
<th>Category</th>
<th>Application/Service/Software</th>
<th>Project Elements</th>
</tr>
</thead>
</table>
| **Project Collaboration** | **Doc Express**  
*Paperless contracting service that enables document exchange during construction projects; also allows for electronic signatures* | • PS&E  
• Project Construction Management |
|                        | **ProjectSolve**  
*Internet-based collaboration tool that allows project teams to communicate and collaborate with each other* | • Project Construction Management |
|                        | **ProjectWise**  
*Suite of software used for information management to manage, share, and distribute project materials in a single platform* | • Project Construction Management |
|                        | **SharePoint**  
*Web application framework used for collaboration to centralize access to project information* | • Project Construction Management |
## e-Construction State of the Practice

<table>
<thead>
<tr>
<th>Category</th>
<th>Application/Service/Software</th>
<th>Project Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Construction Management</td>
<td><strong>AASHTOWare Project – SiteManager</strong></td>
<td>• Project Construction Management</td>
</tr>
<tr>
<td></td>
<td><em>Enterprise software suite that includes modules used to manage contract administration, contract records, daily work reports, contractor payments, materials management, and laboratory inventory management</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>AASHTOWare Project – FieldManager</strong></td>
<td>• Project Construction Management</td>
</tr>
<tr>
<td></td>
<td><em>Tool that enables data to be entered once and shared electronically between the field office and central office</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Primavera P6</strong></td>
<td>• Project Construction Management</td>
</tr>
<tr>
<td></td>
<td><em>Project management software to assist with planning, scheduling, and controlling project resources</em></td>
<td></td>
</tr>
<tr>
<td>Mobile Devices</td>
<td><strong>Android tablet, Apple iPads, Windows tablets</strong></td>
<td>• Project Construction Management</td>
</tr>
<tr>
<td></td>
<td><em>Mobile devices enable inspectors to collect data, access documents and applications from the field, and collaborate with office staff.</em></td>
<td></td>
</tr>
</tbody>
</table>
Mobile Information Technology
Foundation for mobility and accessibility

- Construction management
- Back-office extension, integration and/or capability
- Intuitive/user friendly interface
- Sustainable and supportable
- Triggered alerts/automated workflows
- Offline capabilities

- Long battery life
- OS must be a common platform
- Anti-glare/less glare
- Durability
- Keyboard capable
- Market share/top name brand
- Proper infrastructure for connectivity

- Search, query and filter
- Reporting
- Geospatial integration (GIS)
- Publish and add layers (map)
- Control access
- Asset inventory management
Estimated Savings
## Estimated Savings

<table>
<thead>
<tr>
<th>DOT</th>
<th>Estimated Savings</th>
<th>Origin of Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>$12 million</td>
<td>Cost avoidance focused on bidding system</td>
</tr>
<tr>
<td>North Carolina</td>
<td>$1 million</td>
<td>Paper printing and time savings (trips avoidance) from mobile technology</td>
</tr>
<tr>
<td>Texas</td>
<td>$11 million</td>
<td>Mobile inspection technology</td>
</tr>
<tr>
<td>Minnesota</td>
<td>$4.3 million</td>
<td>Mobile inspection technology</td>
</tr>
<tr>
<td>Washington</td>
<td>$10 million</td>
<td>Mobile inspection technology</td>
</tr>
<tr>
<td>Michigan</td>
<td>$12 million</td>
<td>Reduction in paper, printing and mailing</td>
</tr>
<tr>
<td>Florida</td>
<td>$22 million</td>
<td>Paper printing and job site travel for in-person meetings</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>$23.4 million</td>
<td>Elimination of paper-based methods Time savings of staff from reduced driving</td>
</tr>
<tr>
<td></td>
<td></td>
<td>between field and office, and transcribing data from field books to electronic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>systems, etc.</td>
</tr>
</tbody>
</table>
Case Studies
Participating Agencies e-Construction Maturity
Pilot Agencies

- Iowa DOT | Michigan DOT | Missouri DOT | Utah DOT
- Collected detailed benefits and cost data for various improvement opportunities
  - Project level data, for pilot projects
- Data collected for pilot projects
- Benefits and costs vary due to many factors
  - Agency (size, current practices, urban/rural setting)
  - Existing maturity in e-construction
  - Project scope (new construction, major rehab, minor rehab)
  - Project location (close to a central/urban location, remote)
  - Tools used (enterprise tools where costs are divided among projects, or a software purchased as a service for the project)
## Participating Agencies

<table>
<thead>
<tr>
<th>Agency</th>
<th>Project/Type</th>
<th>Area of Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utah DOT</td>
<td>SR-13 620 North to I-15 (Minor Rehab)</td>
<td>• Mobile Devices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Digital Signatures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Project Construction Management</td>
</tr>
<tr>
<td></td>
<td>Mountain View Corridor 5400-4100 (New Construction)</td>
<td>• Digital Review</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Project Collaboration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mobile Devices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Digital Signatures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Project Construction Management</td>
</tr>
<tr>
<td></td>
<td>SR-20 (Widening)</td>
<td>• Digital Review</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mobile Devices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Digital Signatures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Project Construction Management</td>
</tr>
</tbody>
</table>
## Participating Agencies

<table>
<thead>
<tr>
<th>Agency</th>
<th>Project Type</th>
<th>Area of Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iowa DOT</td>
<td>Alice’s Road Interchange (New Construction)</td>
<td>• Digital Review&lt;br&gt;• Project Collaboration&lt;br&gt;• Mobile Devices&lt;br&gt;• Digital Signatures&lt;br&gt;• Project Construction Management</td>
</tr>
<tr>
<td>Michigan DOT</td>
<td>¾ Mile Full-Depth Pavement Reconstruction and Bridge Painting</td>
<td>• Project Collaboration&lt;br&gt;• Project Construction and Management</td>
</tr>
<tr>
<td>Missouri DOT</td>
<td>Laffayette Interchange – New Construction</td>
<td>• Digital Signatures</td>
</tr>
</tbody>
</table>
Areas of Automation

- Electronic bidding and contract award
- Digital review of project documents
- Project construction management
- Digital management of construction documentation using a project collaboration tool
- Automated machine guidance (AMG) for construction operations
- Requirement of digital as-builts
- Use of Digital signatures (including electronic document routing and electronic approvals)
- Mobile devices

Benefits
Costs
Breakeven year
ROI

Each improvement opportunity/area will have its own Benefit Cost Analysis (BCA) framework.
BCA Framework Example
Project Construction Management

• Input sheet:
  • Annual construction program $
  • FTE unit cost
  • Phasing of benefits by year over planning horizon
  • Costs by year over planning horizon

• Benefit and cost analysis calculation sheet:
  • Total benefits
  • Total costs
  • Net benefits
  • Cumulative benefits
  • Breakeven year
  • Return on Investment (ROI)

Table 1. Agency Costs and % of Estimated Annual Savings

<table>
<thead>
<tr>
<th>Agency Cost</th>
<th>Cost</th>
<th>% of Estimated Annual Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual construction program</td>
<td>$ 800,000,000</td>
<td>0.5%</td>
</tr>
<tr>
<td>Total value of claims annually</td>
<td>Reduction in claims annually</td>
<td></td>
</tr>
<tr>
<td>Claims</td>
<td>$ 16,000,000</td>
<td>5%</td>
</tr>
<tr>
<td>Change orders</td>
<td>Eliminated average pages printed per project</td>
<td></td>
</tr>
<tr>
<td>Total value of change orders</td>
<td>Reduction in change orders annually</td>
<td></td>
</tr>
<tr>
<td>$ 5,000,000</td>
<td>Number of projects bid per year</td>
<td></td>
</tr>
<tr>
<td>Annual materials budget (i.e., paper, printing, mailing, and scanning) for all</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$1,000</td>
<td>1.00</td>
</tr>
</tbody>
</table>
## BCA Framework Example

### Project Construction Management

<table>
<thead>
<tr>
<th>Benefits (Quantifiable)</th>
<th>Total</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
<th>Year 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in the overall efficiency and effectiveness of the delivery of the agency’s</td>
<td>$ 14,000,000</td>
<td>$ -</td>
<td>$ -</td>
<td>$ 1,000,000</td>
<td>$ 2,000,000</td>
<td>$ 3,000,000</td>
<td>$ 4,000,000</td>
<td>$ 4,000,000</td>
</tr>
<tr>
<td>agency’s construction program by streamlining and standardizing key processes (e.g.,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>faster review and approvals) and integration of material testing and laboratory functions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction in claims</td>
<td>$ 2,800,000</td>
<td>$ -</td>
<td>$ -</td>
<td>$ 200,000</td>
<td>$ 400,000</td>
<td>$ 600,000</td>
<td>$ 800,000</td>
<td>$ 800,000</td>
</tr>
<tr>
<td>Reduction in change orders</td>
<td>$ 875,000</td>
<td>$ -</td>
<td>$ -</td>
<td>$ 62,500</td>
<td>$ 125,000</td>
<td>$ 187,500</td>
<td>$ 250,000</td>
<td>$ 250,000</td>
</tr>
<tr>
<td>Reduced use of paper, printing, mailing, faxing, scanning</td>
<td>$ 1,050,000</td>
<td>$ -</td>
<td>$ -</td>
<td>$ 75,000</td>
<td>$ 150,000</td>
<td>$ 225,000</td>
<td>$ 300,000</td>
<td>$ 300,000</td>
</tr>
<tr>
<td>Total Benefits</td>
<td>$ 16,800,000</td>
<td>$ -</td>
<td>$ -</td>
<td>$ 1,200,000</td>
<td>$ 2,400,000</td>
<td>$ 3,600,000</td>
<td>$ 4,800,000</td>
<td>$ 4,800,000</td>
</tr>
</tbody>
</table>

| Costs                                                                                   |             |        |        |        |        |        |        |        |
| Pre-implementation planning consultant                                                   | $ 225,000  | $ 225,000 | $ -    | $ -    | $ -    | $ -    | $ -    | $ -    |
| COTS software licenses                                                                  | $ 1,268,946| $ -    | $ 196,000 | $ 196,000 | $ 201,500 | $ 201,500 | $ 236,973 | $ 236,973 |
| COTS software maintenance                                                                | $ -        | $ -    | $ -    | $ -    | $ -    | $ -    | $ -    | $ -    |
| Systems integration services                                                             | $ 1,200,000| $ 575,000 | $ 625,000 | $ -    | $ -    | $ -    | $ -    | $ -    |
| Managed services support                                                                 | $ -        | $ -    | $ -    | $ -    | $ -    | $ -    | $ -    | $ -    |
| Hardware and other technical infrastructure                                             | $ 200,000  | $ 200,000 | $ -    | $ -    | $ -    | $ -    | $ -    | $ -    |
| Hardware and infrastructure maintenance                                                 | $ 135,000  | $ 15,000 | $ 15,000 | $ 15,000 | $ 45,000 | $ 15,000 | $ 15,000 | $ 15,000 |
| Hardware refresh                                                                        | $ 110,000  | $ -    | $ -    | $ -    | $ -    | $ -    | $ 110,000 | $ -    |
| Agency staff cost during project                                                        | $ 1,020,000| $ 510,000 | $ 510,000 | $ -    | $ -    | $ -    | $ -    | $ -    |
| Agency staff cost to support system ongoing                                             | $ 600,000  | $ -    | $ -    | $ 120,000 | $ 120,000 | $ 120,000 | $ 120,000 | $ 120,000 |
| Systems integration services for upgrade                                                | $ 350,000  | $ -    | $ -    | $ -    | $ -    | $ -    | $ 350,000 | $ -    |
| Total Costs                                                                            | $ 5,108,946| $ 1,525,000 | $ 1,346,000 | $ 331,000 | $ 716,500 | $ 446,500 | $ 371,973 | $ 371,973 |

| Net Benefit (positive indicates benefit)                                               | $11,691,054 | $(1,525,000) | $(1,346,000) | $869,000 | $1,683,500 | $3,153,500 | $4,428,027 | $4,428,027 |

| Cumulative Benefit                                                                     | $(2,871,000) | $(2,002,000) | $(318,500) | $2,835,000 | $7,263,027 | $11,691,054 |

| Breakeven Year, not accounting for qualitative benefits                                | Year 5      |

| 7-Year ROI                              | 229%        |
Looking into the Future
Looking into the Future

• Digital data for construction inspection
  • Using digital design data for inspection of machine control activities, field verifications, and calculation of pay quantities.
  • Updating processes to support the use of digital data while ensuring compliance with federal regulations for QA
  • Finding the right mix of tools and processes to support digital inspection

• Remote sensing technologies
  • Use of unmanned aircraft systems (UAS) in construction inspection and documentation
  • Data fusion from multiple remote sensing technologies for payment and creating 3D as-builts

• Digital as-builts for asset management
  • Determine the type of data and features needed for asset management
Questions?