AASHTO Innovation Initiative

[Proposed] Nomination of Innovation Ready for Implementation

Sponsor

Nominations must be submitted by an AASHTO member DOT willing to help promote the innovation. If selected, the sponsoring DOT will be asked to promote the innovation to other states by participating on a Lead States Team supported by the AASHTO Innovation Initiative.

1. Sponsoring DOT (State): Indiana Department of Transportation

2. Name and Title: Zach DeLoach, Statewide Maintenance Operations Director

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Innovation Description (10 points)

The term "innovation" may include processes, products, techniques, procedures, and practices.

3. Name of the innovation:

Salt Monitoring and Reporting Technology Implementation

4. Please describe the innovation.

The SMART system utilizes LiDAR devices to estimate the volume of road salt that is present in INDOT storage facilities across the State.

5. What is the existing baseline practice that the innovation intends to replace/improve?

The baseline practice for road salt inventory management is to track inbound weight tickets at time of delivery and deduct estimated expenditures from that total. For example, throughout the summer a facility may receive 100 tons of road salt. During a winter event road salt is loaded into plow trucks with a front-end loader. A full front-end loader bucket is assumed to be three tons of road salt. If I use ten front-end loader buckets during a storm, I would assume that I have approximately 70 tons of road salt remaining in the facility.

These quantities are verified by having experienced personnel visually inspect the remaining road salt and estimate in their best opinion how many tons of salt are in a particular stockpile.

6. What problems associated with the baseline practice does the innovation propose to solve?

The current baseline practice leaves a tremendous amount of opportunity for error. The precise, on-demand ability of a LiDAR system capable of estimating stockpile volumes within a 1-2% margin of error eliminates:

- Overreliance on accuracy of delivery tickets, with no economical means of on-site verification
- Discrepancies in consumption reporting based on the difference in how each front-end loader operator fills their bucket (heaping, flat, partial-fill, etc.)
- Eliminates need for visual estimation, and replaces these estimates with precise, data-driven quantities.

7. Briefly describe the history of its development.

This project originally began in February of 2021. Over the course of the project a combination of sensors was tested to track and inventory stockpile quantities in salt facilities. The team looked at camera solutions, drone solutions, and LiDAR solutions. Over the course of this research project, the research team found cameras were heavily dependent on lighting within the facility, drones were restricted by GPS signal and obstacles in the facility, leading the team towards LiDAR as most of those restrictions were eliminated. At the beginning of the 2021-2022 winter season a portable prototype system was deployed at 30 unique facilities using LiDAR, and a camera. This system captured almost 90 unique scans and provided insight for a larger scale deployment. These efforts were further expanded for the 2022-2023 winter season with modifications made to the original prototype and 5 more prototypes were developed and deployed in both a portable and permanent model. Over 120 facilities were inventoried twice over the winter season and two permanent systems monitored salt inventories before, during, and after a winter storm event or refill activity. This equated to a total of approximately 300 scans statewide. Due to the success of the project a more scalable and permanent solution was desired by the agency to monitor stockpile inventories statewide.

In early 2023, INDOT and Purdue were made aware of a solid-state LiDAR vendor known as Blickfeld. During exploratory discussions, Blickfeld expressed interest in providing an all-in stockpile measurement service encompassing hardware, software, data collection, and analysis. INDOT's intent is to enter into a

contract with Blickfeld this winter to test their proposed system at 15 locations over the coming winter season, and Purdue will act as an impartial third-party validation of data collected.

8. What resources—such as technical specifications, training materials, and user guides—have you developed to assist with the deployment effort? If appropriate, please attach or provide weblinks to reports, videos, photographs, diagrams, or other images illustrating the appearance or functionality of the innovation (if electronic, please provide a separate file). Please list your attachments or weblinks here.

Article discussing SMART Salt Development:
https://www.purdue.edu/newsroom/releases/2022/Q3/portable-tech-platform-monitors-volume-of-bulk-material-stockpiles-in-timely,-cost-effective-method.html
Video discussing SMART Salt Development: https://www.foxweather.com/watch/play-60e69b0c100004b
2021 Remote Sensing Journal publication: https://doi.org/10.3390/rs14010231
2022 Remote Sensing Journal publication: https://doi.org/10.3390/rs14194802
Purdue's final paper is still under review, but will be presented at this year's Transportation Research Board Annual Meeting.

Blickfeld will provide training resources once they are under contract with INDOT.

Attach photographs, diagrams, or other images here. If images are of larger resolution size, please provide as separate files.

a) SMART Permanent Install b) SMART Unit and Operating System

Figure 1. Permanent installation of Prototype system.

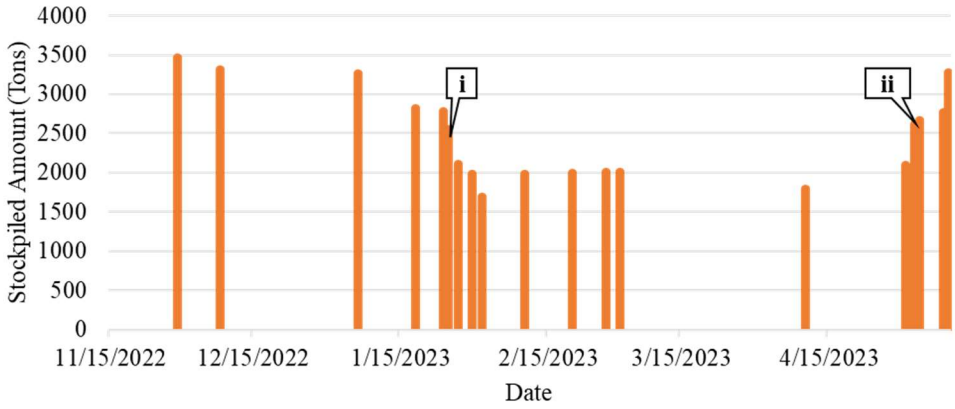

Figure 2. Monitoring of inventory during Winter 2022-2023.

a. Permanent Installation in a Dome b. Permanent Installation in a Barn

Figure 3. Installation and testing of Blickfeld sensors.

State of Development (40 points)

Innovations must be successfully deployed in at least one State DOT. The AII selection process will favor innovations that have advanced beyond the research stage, at least to the pilot deployment stage, and preferably into routine use.

9. How ready is this innovation for implementation in an operational environment? Please select from the following options. Please describe.

☐ Prototype is fully functional and yet to be piloted

☐ Prototype has been piloted successfully in an operational environment

☒ Technology has been deployed multiple times in an operational environment

☐ Technology is ready for full-scale implementation

The collection methods and algorithm created by Purdue University have been field tested multiple times. Purdue's algorithm and expertise will be used to validate the accuracy and validity of Blickfeld's off-the-shelf system.

10. What additional development is necessary to enable implementation of the innovation for routine use?

It is our belief that Blickfeld's methods and procedures are accurate in salt barns, with some opportunity for further development in salt domes. Blickfeld will be responsible for improving their own system, but Purdue's validations will serve to highlight the opportunities for improvement.

11. Are other organizations using, currently developing, or have they shown interest in this innovation or of similar technology?? ☒ Yes ☐ No

If so, please list organization names and contacts. Please identify the source of this information.

Organization	Name	Phone	Email
Illinois, Michigan, Tennessee DOTs have all expressed interest.	Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.
Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.
Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.

Potential Payoff (30 points)

Payoff is defined as the combination of broad applicability and significant benefit or advantage over baseline practice .

12. How does the innovation meet customer or stakeholder needs in your State DOT or other organizations that have used it?

Road salt is the lifeblood of winter operations. Knowing how much salt the DOT has on-hand is vital to ensuring that winter operations can continue uninterrupted, providing safe travel to road users. Additionally, having accountability of resources that are procured with taxpayer funds is a must.

13. Identify the top three benefit types your DOT has realized from using this innovation. Describe the type and scale of benefits of using this innovation over baseline practice. Provide additional information, if available, using quantitative metrics, to describe the benefits.

Benefit Types	Please describe:
Improved Operation Performance	Allows for more timely ordering, visibility into inventory.
Organizational Efficiency	Creates confidence in planning inventory and ordering across the entire State, and breaks down ordering silos.
Cost Savings	Will allow salt to be ordered in a more efficient manner, maximizing taxpayer funds.

Provide any additional description, if necessary:

Click or tap here to enter text.

14 How broadly might this innovation be deployed for other applications. in the transportation industry (including other disciplines of a DOT, other transportation modes, and private industry)?

Once this system is proven out, it can easily be applied to stockpiles of any type of material. This will provide a level of stockpile accuracy to DOTs and private industry both that has never been attainable at scale.

Market Readiness (20 points)

The AII selection process will favor innovations that can be adopted with a reasonable amount of effort and cost, commensurate with the payoff potential.

15. What specific actions would another organization need to take along each of the following dimensions to adopt this innovation?

Check boxes that apply	Dimensions	Please describe:
☐	Gaining executive leadership support	Click or tap here to enter text.
☒	Communicating benefits	Field and material personnel will need to be trained on why accuracy of inventory levels is important.
☒	Overcoming funding constraints	There is a substantial up-front cost to buy into this system.
☒	Acquiring in-house capabilities	Network accessibility in salt buildings to transmit LiDAR measurements.
☐	Addressing legal issues (if applicable) (e.g., liability and intellectual property)	Click or tap here to enter text.
☐	Resolving conflicts with existing national/state regulations and standards	Click or tap here to enter text.
☐	Other challenges	Click or tap here to enter text.

16. Please provide details of cost, effort, and length of time expended to deploy the innovation in your organization.

Cost: We estimate that full implementation, including hardware and installation, will be in the range of $1MM to $2MM.

Level of Effort: This will be a medium level-of-effort implementation.

Time: Three to five years for full statewide implementation.

17. To what extent might implementation of this innovation require the involvement of third parties, including vendors, contractors, and consultants? If so, please describe. List the type of expertise required for implementation.

This implementation will require partnership between INDOT, Purdue University, and Blickfeld for installation, training, validation, and ongoing maintenance.