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Guide to Life-Cycle Data and Information Sharing Workflows for Transportation Assets

tech transfer summary

The guidelines and recommendations resulting from this research
can help transportation professionals more efficiently and
effectively manage and share project data throughout the life cycle
of a transportation asset.

Objective

The purpose of this work was to capture industry knowledge and
experience with digital data and information sharing throughout the life
cycles of different transportation assets, develop business process maps
and data sharing maps for various project types, and offer guidance to
practitioners on better ways to collect, manage, and store project data.

Background

Transportation project data are increasingly available in digital formats
due to the adoption of such advanced computerized technologies
as three-dimensional (3D) modeling and project administration
systems. These technologies offer an opportunity to improve data and
information sharing significantly between project participants and
across various project development stages.

Problem Statement

In current practice for much of the highway sector, different project
participants collect, use, and manage digital data and information
independently in proprietary formats. Moreover, data exchange
processes still rely on paper or electronic document-based formats
rather than digital data sets.

Research Description

Key tasks for this research were as follows:

• Review literature, manuals, project documents, and software
applications and benchmark vertical construction industry practices
to identify lessons learned and practices that could be adapted to the
transportation industry

• Conduct focus group discussions with industry professionals for each
type of transportation asset covered in this research (signs, guardrails,
culverts, pavements, and bridges)

• Develop process maps and data maps for each of the transportation
assets to describe workflows for new construction, reconstruction,
repair, and maintenance

For the literature review, the researchers studied information delivery manuals (IDMs). An IDM aims to define (1) processes through the life cycle of a building project in which information exchange is required, (2) the actors that send and receive information for each process, and (3) definitions and descriptions for the information to be shared.

For the focus groups, a working group for each type of transportation asset was formed that included industry professionals with varied expertise from the Iowa Department of Transportation (DOT), including central office staff, maintenance staff, and district engineers, and contractors. The focus group discussions helped identify and document the data exchange scenarios, data flows, data requirements, data formats, and supporting software applications.

Based on the focus group discussions, a process map and a data map were developed for each transportation asset scenario. The process maps showed the data exchange processes throughout a project's life cycle, and the data maps presented the data that must be shared, the stakeholders required to share the data, the stakeholders who receive the data, and the times when data must be shared.

Key Findings

In total, 15 process maps and five exchange requirement matrices were developed for the five types of transportation assets and the different project scenarios. The following scenarios were covered:

- Sign construction/reconstruction
- Sign replacement
- Sign maintenance
- Guardrail construction/reconstruction
- Guardrail maintenance
- Culvert new construction/reconstruction
- Culvert maintenance
- New pavement construction
- Pavement reconstruction
- Resurfacing, restoration, or rehabilitation (3R) projects
- Pavement maintenance
- New bridge construction
- Bridge reconstruction
- Programmed bridge repair projects for letting
- Emergency bridge repair projects for letting

Based on the focus group discussions, several limitations were identified within the current data workflow for many projects:

- The digital life of asset data officially ends after the design phase. Although designers send both digital files and PDF plans to the Office of Contracts for letting, the digital files are only used for reference.

- Cost estimation is primarily made manually. Unit prices of bid items are estimated based on historical data from the last 12 months.

- Mobile light detection and ranging (LiDAR) sees limited use only in survey work and mostly for Interstate projects.

- After collecting survey data in the field, surveyors must hand-pick point clouds to map survey features by using mapping software to create terrain models.

- Designers do not use the digital files they receive from the survey team in their design efforts. Rather, they use the input data and start work in a new file.

- The digital files that contractors receive from the Office of Contracts are just for reference, so in many cases those files are incorrect. Contractors need to spend time and money to correct the files for use in automated machine guidance. Moreover, the corrected files are not stored for further use.

- As-built data are created by adding red-line markups to the design plan PDFs. This document-based format is not machine-readable and creates challenges for asset managers to translate into a useful format.

- In addition to as-built documents, inspection daily reports (IDRs) are a great potential source from which to extract as-built data for an asset. However, in current practice IDRs capture very limited geometric or geolocation-related data.

- Data transfer from the construction phase to the asset management phase is lacking.

Conclusions and Recommendations

- Designers should use MicroStation files and Excel spreadsheets for construction and maintenance plans.

- Official digital files should be used for letting, and they should be carefully coordinated with the PDF plans shared with contractors.

- Survey work should rely on mobile LiDAR results and use automated data processing.

- Cost estimation should be done digitally, not manually.

- Digital terrain models created by the survey team should be directly leveraged by designers when developing design plans and then be updated by contractors and inspectors.

- As-built plans in MicroStation files should be required as part of the plans submitted by contractors.

- IDRs should capture the locations of construction activities using global positioning system (GPS) devices rather than the linear referencing system (LRS).

- Formal communication channels should be established to share information between the construction and asset management phases.

Implementation Benefits and Readiness

The 15 process maps developed in this research can provide practitioners with a clear understanding of the activities and data sharing requirements throughout the life cycles of different types of projects (new construction, reconstruction, repair, and maintenance) and assets (signs, guardrails, culverts, pavements, and bridges).

Additionally, the five exchange requirement matrices clearly show the participants who need data at different stages, the data that must be exchanged, and the actors that can provide the data.

An ideal process map and suggestions for improvement have been proposed to further streamline the workflow throughout the project life cycle and reduce duplicate data collection efforts in the operation and maintenance phases. Properly transferring the necessary asset data in the appropriate format can help enhance productivity and reduce operation costs.

Ideal digital data workflow