A Synthesis Study on Collecting, Managing, and Sharing Road Construction Asset Data

Introduction

Transportation infrastructure asset management is a data-driven process. Accurate and complete in-place data of assets, i.e., the construction records and as-built data, are the key prerequisite to the effective management, operation, and maintenance of infrastructure assets. Many states, including Indiana, spend a decent portion of their ever-shrinking budget on asset inventory to obtain data regarding asset location, materials, dimensions, and condition.

The construction phase is the best time for collecting in-place data of infrastructure assets. Unfortunately, in the current practice, the construction data collection (for the purpose of construction inspection and documentation) and asset data collection (for asset management) are two separate processes. This isolated approach creates a blockage that prevents the flow of asset data collected during construction into asset management information systems, leading to duplicate efforts in data collection—a magnificent waste. To eliminate this waste, there is a need to create mechanisms to leverage the construction documentation process to collect asset data during the construction phase and to automate the flow of asset data into corresponding asset management information systems.

To eliminate duplicate asset data collection efforts, a framework was created in this study to leverage the construction inspection and documentation practice to collect asset data that are needed in operations and maintenance (O&M) during the construction phase. The framework uses specific pay items—construction activities that result in physical structures—as the bridge to connect plan assets (i.e., physical structures specified in the design documents) to their corresponding counterparts in the asset management systems. The framework is composed of (1) a data needs component for determining the information requirements from the O&M perspective, (2) a construction documentation module, and (3) a mapping mechanism to link data items to be collected during the construction documentation to data items in the asset management systems. The mapping mechanism was tested and validated using four priority asset classes—underdrains, guardrails, attenuators, and small culverts—from an INDOT construction project.

Findings

Data needs at INDOT vary across types of assets and business units. A total of 91 assets/asset components were identified in this study. Despite the variance in data needs, essential data items remain the same: location, dimensions, materials, and condition. The examination of the construction documentation practice and process revealed that all these essential data items are being collected during the construction phase for the construction documentation purpose. This finding forms the prerequisite for the methodology in this study: to create a mechanism that links asset data collected in construction documentation to their counterparts in asset management systems.

A data needs assessment framework was created to assess the data needs for seven major assets: road pavement sections, underdrains, guardrails and attenuators, utilities crossings and relocations, culverts, ditches and outfalls, and signs. Rounds of meetings were conducted to determine the data needs for these assets from nine business units. Resulting data needs are graphically illustrated in Figures 5.4 to 5.14 and Appendix D in the report. Data items are organized under asset and asset component and their type is categorized as location, geometry, physical attributes, condition/performance, administrative, or construction and maintenance. For every data item, its current hosting database and suggested hosting database are spelled out. In addition, users (business units that expressed their need/interest for specific data items) are listed out for every data item.

A survey of state highway agencies (SHAs) regarding their practice on collecting, managing, and sharing construction asset data was conducted. The survey questions were organized into four groups: construction, asset management (during operation and maintenance), road inventory, and information technology. A total of 42 valid responses were received. The asset management group had the largest number of responses (15). The other three groups had roughly equal numbers of responses. Survey results show that the paper-based format is still the dominant format in data exchange, which causes severe data interoperability and exchangeability issues and major blocks to the flow of data from design into construction and operation and maintenance, and

to the update of electronic files to reflect the as-designed, as-constructed, as-built, and as-maintained conditions throughout the infrastructure life cycle. Survey results also show that while many SHAs recognize the data blockage issue and some are taking initiative, there are no existing mechanisms in the current practice to leverage the construction documentation process to collect asset data for the asset management purpose in the future phase of O&M.

A framework was created to leverage the construction documentation for collecting and sharing road construction asset data. This framework follows the construction inspection process and, as illustrated in Figure 5.30 in the report, eliminates the need to manually link construction activity, pay item, and plan asset, thus allowing the flow of necessary information regarding the plan assets being inspected to construction engineers to enhance their work efficiency. The framework includes a mapping mechanism to link plan assets to assets in the asset management system based on matching pay items. Such a mechanism works because (1) every single plan asset is associated to pay items in the contract information book (CIB), (2) every asset in the asset management system is associated with a list of relevant pay items, (3) pay items have unique numbers that facilitate the matching process, (4) plan assets are connected to specific assets in the asset management system based on matching pay items, and (5) consequently, data collected in the construction documentation for plan assets automatically flow into the asset management system for the corresponding assets.

The framework was tested and illustrated for four priority assets—underdrains, guardrails, attenuators, and small culverts—using real INDOT construction project data. The testing results show that the newly developed framework is viable and solid for collecting asset data during the construction phase for O&M use without adding extra work for construction crews. The framework can reduce/eliminate INDOT's duplicate data collection efforts, leading to long-term savings and efficiency gains.

Implementation

The newly created framework and guideline are viable and solid for eliminating the data collection waste caused by the isolated approach in the current practice—separate processes for construction documentation and in-place data collection for assets—and the predominance of paper-based data exchange among applications. Recommendations for the implementation of the newly developed framework and guideline are listed as follows:

- Replace the paper-based format with electronic files—electronic design files are passed on to construction engineers; electronic files are marked, modified, and commented on during the construction phase to reflect the as-constructed and as-built condition; electronic construction records and as-built data automatically flow into asset management information systems for their usage during the O&M phase (and they are also continuously updated to reflect the as-maintained condition).
- Use the data needs assessment framework (Figure 5.1 in Section 5.1.2 of the report) to identify the data needs from INDOT business groups for all infrastructure assets to create a comprehensive view of what data items are needed by which business groups. The result forms the base for guiding the flow of asset data collected during construction into relevant asset management information systems and maintaining the data integrity across all INDOT information management systems.
- Retain the association between plan assets and pay items as a part of the design documents to be included in the contract documents. The one-to-one relationship between a plan asset and a pay item allows bringing relevant information to construction engineers in real time.
- Adopt the guideline, especially its mapping mechanism, in the mobile construction documentation app. As illustrated in Section 5.6.4 of the report, the mapping mechanism integrates the collection of asset data items into the construction documentation process and the guideline enables the flow of these asset data items collected during the construction documentation process into suitable places in the corresponding asset management information systems.
- The adoption needs to be gradual: starting with the four priority assets, expanding to the seven major assets, and eventually covering all assets.
- Conduct a pilot study with early involvement to test before rolling out the new approach to all construction projects.

Recommended Citation for Report