

## Project Information

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## Research Administration

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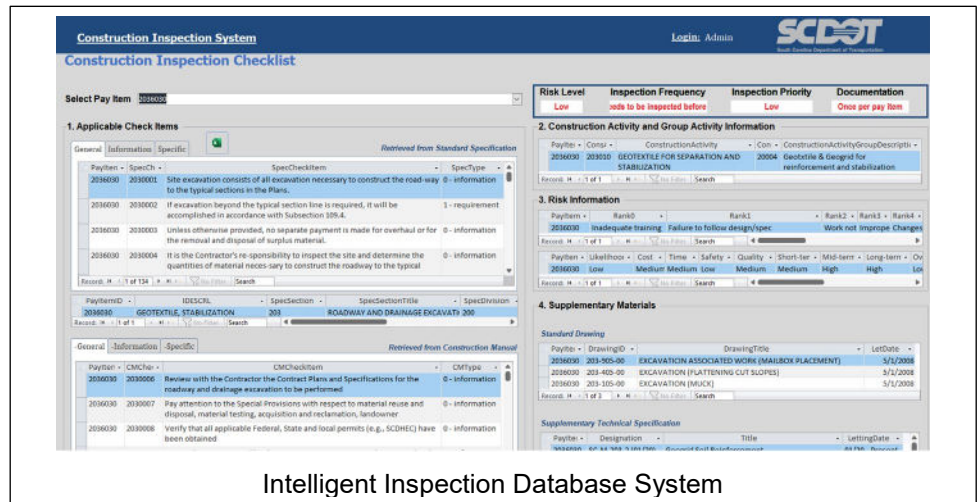
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<http://www.scdot.scltap.org/projects/completed/>

## Risk-based Inspection

Construction inspection is a critical component of the quality assurance/quality control (QA/QC) program at the South Carolina Department of Transportation (SCDOT). A pressing challenge SCDOT has been facing is to balance the increasing demand to rebuild the statewide transportation systems with declining resources available for inspection. This project aims to address this critical issue by developing a risk-based inspection program that includes (1) the identification and assessment of risks associated with construction activities at SCDOT, (2) the development of inspection strategies that correspond to the level of risk, (3) the identification of quality requirements and inspection activities that are applicable to pay items, and (4) the design and implementation of a digital, risk-based inspection system.



Intelligent Inspection Database System

### Problem

Construction inspection is a critical component at the SCDOT to ensure the quality and long-term performance of the resulting infrastructures (e.g., roads and bridges). In the current practice, SCDOT has been facing the challenge of balancing the inspection resource shortage (attributed to staff downsizing and the retirement of experienced construction inspectors) with the increasing demand for rebuilding and maintaining the statewide infrastructures. The growing number of transportation projects and complexities in modern construction projects further aggravate the challenges. Therefore, there is still a critical need for SCDOT to seek alternative strategies to more effectively allocate its limited

inspection resources to ensure the construction quality and life cycle performance of infrastructure

### Research

In order to assist SCDOT in effectively allocating limited resources to the most critical areas, this research aims to develop a risk-based inspection program by focusing mainly on risks associated with SCDOT's current construction activities. This research consists of four objectives: (1) identification and assessment of risks associated with construction activities at SCDOT, (2) the development of inspection strategies that correspond to the risk level, (3) identification of quality requirements and inspection activities associated with construction activities,

and (4) the design and implementation of a digital, risk-based inspection system. This project consists of eight tasks. Task 1 aims to identify construction activities and requirements at SCDOT by identifying pay items associated with construction activities, developing a work breakdown structure (WBS), and linking pay items to applicable sections and divisions in related construction documents (e.g., standard specification). Task 2 aims to understand the current inspection practices at SCDOT by conducting surveys and aligning pay items with construction processes. Task 3 aims to identify the availability and cost of inspection resources at SCDOT by conducting surveys and analyzing materials provided by the SCDOT. Task 4 aims to identify risks associated with construction activities and assess corresponding risk levels by compiling a list of risks, developing risk breakdown structure (RBS) and risk breakdown matrix (RBM), determining the risk likelihood and consequence severity, and computing the composite risk score based on risk assessment matrix (RAM). Task 5 aims to determine inspection priority, inspection frequency, and documentation requirements for construction activities based on the risk level. Task 6 aims to identify critical inspection information from construction documents and develop a digital inspection system by retrieving quality requirements from construction documents (e.g., standard specification) using deep learning approaches. Task 7 aims to summarize a list of inspection requirements. Task 8 aims to develop a toolbox to accompany the inspection system designed in Task 6.

## Results

[Task 1] Identification of construction activities and construction requirements at SCDOT:

- A total of 7,024 pay items were found to be associated with the construction activities at SCDOT.

- The 7,024 pay items can be organized into the developed WBS in which the hierarchical structure consists of 1,276 construction activities, 142 activity groups, and 7 construction areas.
- For each construction activity, construction requirements were identified.

[Task 2] Current inspection practice at SCDOT:

- The focus of the construction inspection at SCDOT is on 6 areas (asphalt, earthwork, concrete, traffic control, structures, and erosion control and survey).
- The SCDOT inspection process consists of 4 steps [(1) notification, (2) requirements retrieval and planning, (3) inspection, and (4) documentation], and a significant amount of time is spent on requirements retrieval, inspection, and documentation.

[Task 3] Availability and cost of inspection Resources:

- In the current inspection practice, SCDOT mainly uses in-house staff and CE&I contracts.
- CE&I contracts have relatively higher average hourly rates on all the positions compared with in-house staff.

[Task 4] Risk identification and assessment for construction activity:

- The RBM, which was developed based on WBS and RBS in this research, can be used to identify risks for construction areas, construction activity groups, or even construction activities.
- The risk level for each of the 142 construction activity groups and the overall risk level of the 7 construction areas were assessed.

[Task 5] Recommendation of inspection priority, inspection frequency, and documentation based on risk:

- Three levels of inspection priority were designed: high, medium, and low.

- Three levels of inspection frequency were proposed: full-time, intermittent, and end of production
- Three levels of documentation were developed: daily/per segment, per pay item, and once per pay item.

[Task 6] Inspection documentation for database:

- The sentence classifier can correctly classify requirements in standard specifications with an average accuracy of 91% and those in the construction manual with an average accuracy of 90%.

[Task 7] Inspection summary:

- The inspection summary containing inspection objectives and inspection activities at the section level was developed.

[Task 8] Toolbox for inspectors:

- The intelligent inspection database system can (1) automatically generate applicable check items for the selected pay item from standard specification and construction manual, (2) retrieve corresponding construction activity and group, (3) display associated risk information, (4) retrieve applicable supplementary materials and (5) generate inspection forms as a checklist format.

## Value & Benefit

SCDOT can make risk-informed decisions based on inspection information (e.g., risk factors). For example, within the project, SCDOT can prioritize construction activities based on risk level and organize limited inspection resources accordingly. Also, inspection frequency (e.g., continuous and intermittent) can be set based on the varying risk level of construction activities and used for efficient inspection. As such, this research can facilitate the efficient allocation of available inspection resources, reduce the workload of construction inspectors, ensure consistency in the QA/QC practice, and support the documentation of construction inspection.