

GEORGIA DOT RESEARCH PROJECT 17-13

FINAL REPORT

**DEVELOPMENT OF IMPLEMENTATION
PLAN FOR GDOT E-CONSTRUCTION
PROGRAM**



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16. Abstract: Transportation agencies are constantly seeking new methods for engineering, construction, and administration in order to improve project efficiency and quality. The Georgia Department of Transportation (GDOT) seeks to improve its administrative processes with new e-Construction initiatives, including electronic submission and distribution of all construction documentation. By updating its e-Construction program, GDOT hopes to increase efficiency throughout the entire life cycle of state projects with improved communication, document tracking, and transparency. This study identifies the limitations of GDOT's current construction administration processes and establishes an implementation framework for department-wide improvements.			
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Final Report

DEVELOPMENT OF IMPLEMENTATION PLAN FOR
GDOT E-CONSTRUCTION PROGRAM

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The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views of the Georgia Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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EXECUTIVE SUMMARY

One of the innovations encouraged by the Federal Highway Administration (FHWA) as a part of its Every Day Counts (EDC) Initiative is e-Construction, a paperless construction administration method. While the Georgia Department of Transportation (GDOT) already implements several software programs and technologies to support e-Construction methods, the Department is interested in improving certain processes as well as introducing new innovations into its standard of practice. The primary study objective was to determine the current limitations of GDOT's e-Construction program and develop an implementation framework for improvements.

In addition to in-house software programs, GDOT currently employs three major types of software: Bentley's ProjectWise Software, AASHTOWare Project SiteManager, and e-Builder. This study determined that several of GDOT's software programs have overlapping capabilities while others are not being used to their full potential. From this study, it is recommended that GDOT focus on improving three aspects of its e-Construction program: accelerate implementation of AASHTOWare Project 4.1 and its suite of software products, increase software training, and assess the use of mobile inspection. Rather than investigating enterprise application integration of GDOT's current software programs, this research proposes to accelerate the Department's implementation of the AASHTOWare Project 4.1 software, which will allow for improved communication and integration among current construction processes. The accelerated adoption of the AASHTOWare Project 4.1 software will help GDOT to automate processes and workflows, which is the most common challenge among Departmental offices. With the goal of receiving federal funding to implement these improvements, the research team has developed a draft proposal for the FHWA AID Demonstration program using the information collected in this study.

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1. INTRODUCTION

With new software programs and technologies arising, the Georgia Department of Transportation (GDOT) has become interested in improving its e-Construction program. The Federal Highway Administration (FHWA) introduced the Every Day Counts Initiative in 2015 to implement new design and construction methods as well as administrative innovations with the purpose of reducing project delivery time, enhancing safety, and protecting the environment [FHWA, 2016b]. One of these FHWA innovations is e-Construction, a paperless construction administration method. E-Construction includes electronic submission and distribution of all construction documentation as well as electronic document approvals and signatures. The traditional paper-based system used today by most departments of transportation (DOTs) requires extensive documentation, which involves postal delivery, hand note-taking, stamped plan sets, design and construction submittals, and physical signatures on multiple copies of several documents.

The e-Construction initiative aims to improve the construction management process by employing document technologies available on mobile devices. The FHWA believes e-Construction will save money by decreasing paper usage, printing, and document storage. In addition, it will eliminate communication delays and extended transmittal times, which translates to more savings. This management method improves communication among all parties involved with a DOT construction project. Electronic submissions and approvals allow for enhanced document tracking and transparency [FHWA, 2017a]. By updating its e-Construction program, GDOT expects to increase efficiency throughout the entire life cycle of state projects.

2. PROBLEM STATEMENT

2.1 Research Significance

This research was aimed at improving GDOT's e-Construction program. On September 1, 2016, the Federal Highway Administration published a new Notice of Funding Opportunity for the Accelerated Innovation Deployment (AID) Demonstration. The AID Demonstration is authorized under the Fixing America's Surface Transportation (FAST) Act, which continued the Technology and Innovation Deployment Program (TIDP). The purpose of the AID Demonstration was to provide incentive funding for qualified highway transportation projects in order to compensate for the risk of implementing an innovation. The FHWA plans to provide \$10 million of funding each fiscal year from 2016 to 2020, with approximately \$9 million going to state departments of transportation. GDOT is interested in applying for funding to implement more advanced e-Construction initiatives beginning in October of 2018. To GDOT's advantage, e-Construction is one of the innovations encouraged by the FHWA as a part of its Every Day Counts Initiative [FHWA, 2016b]. This study assisted GDOT with creating a proposal for AID Demonstration funding.

2.2 Research Objectives

The objective of this study was to identify the current limitations of GDOT's construction administration processes and to establish an implementation framework for a more advanced, department-wide e-Construction program. The end goal was to develop a proposal for the FHWA AID Demonstration with the hopes of acquiring federal funds to transition into a completely paperless communication and document transfer process.

Prior to developing the AID Deployment proposal, departmental coordination was identified and other state DOT e-Construction practices were reviewed.

3. LITERATURE REVIEW

3.1 FHWA AID Demonstration

Since September 2014, the AID Demonstration program has provided 69 awards with a sum of \$47,870,115. The program has funded innovations such as three-dimensional (3D) modeling, geospatial data collaboration, geosynthetic reinforced soil-integrated bridge systems, high friction surface treatments, intelligent compaction, prefabricated bridge elements, slide-in bridge construction, structural health monitoring, and work zone safety [FHWA, 2017b]. Figure 1 shows the locations of agencies that have received funding through the AID Demonstration. Figure 2 shows the total dollar amount of funding over time. These agencies include state departments of transportation, federal land management agencies, and tribal governments. GDOT has not received funding through this program.

The AID Demonstration award is based on the cost of the innovation in a project, not the total cost of a project. The full cost of the innovation may be awarded, but the maximum award is \$1 million. The funds are available at an 80 percent federal share and require a minimum 20 percent cost share [Thompson, 2016]. The Kansas Department of Transportation (KDOT), Ohio Department of Transportation (ODOT), and Utah Department of Transportation (UDOT) have all received funding for the e-Construction innovation. KDOT received the maximum \$1,000,000 in 2015 for updating its construction management system using electronic processes. ODOT received \$511,762 in 2015 to improve document management and workflow throughout the design and construction of two state projects. UDOT received \$626,229 to implement e-Construction as a means of improving business practices [FHWA, 2017b].

To be considered for an AID Demonstration grant, the project must be eligible for assistance under Title 23 of the United States Code. In addition, the applying agency must be prepared to initiate the project within 6 months of applying for the funding. The funding may be used for resources related to planning, financing, operation, structures, materials, pavements, environment, or construction. The project must involve an innovation that is applied to the highway transportation industry but not routinely implemented by the applicant. The application must include evidence that the innovation is more beneficial than the applicant's conventional processes. A cost estimate reflecting the requested funding should be included. Additionally, the application must include performance goals for deployment of the innovation, and these goals should reflect the following goals of the TIDP:

- “Significantly accelerate the adoption of innovative technologies by the surface transportation community;
- Provide leadership and incentives to demonstrate and promote state-of-the-art technologies, elevated performance standards, and new business practices in highway construction processes that result in improved safety, faster construction, reduced congestion from construction, and improved quality and user satisfaction;
- Construct longer-lasting highways through the use of innovative technologies and practices that lead to faster construction of efficient and safe highways and bridges;
- Improve highway efficiency, safety, mobility, reliability, service life, environmental protection, and sustainability;

- Develop and deploy new tools, techniques, and practices to accelerate the adoption of innovation in all aspects of highway transportation” [Dawoud, 2016].

An FHWA evaluation team composed of technical and professional staff reviews AID Demonstration applications and determines whether they are qualified based on specified selection criteria. In addition to the requirements discussed previously, the team measures the technology readiness level (TRL) of the innovation, as defined in Table 1. The project must be at a readiness level of seven or higher.

TABLE 1
Technology Readiness Levels [Dawoud, 2016]

Phase	TRL	3.5
<i>Basic Research</i>	1	Basic principles and research
	2	Application formulated
	3	Proof of concept
<i>Applied Research</i>	4	Components validated in laboratory environment
	5	Integrated components demonstrated in laboratory environment
<i>Development</i>	6	Prototype demonstrated in relevant environment
	7	Prototype demonstrated in operational environment
	8	Technology proven in operational environment
<i>Implementation</i>	9	Technology refined and market ready

If the application is deemed qualified and the applicant acquires funding, then the award recipient is required to submit a progress report to the FHWA within 6 months of completing the project. The purpose of that report is to document the benefits, lessons learned, and methods for implementing the innovation as standard practice [Thompson, 2016]. The applicant must be prepared to assess the effectiveness of the innovation,

accept FHWA oversight of the project, conduct a customer satisfaction survey before and after implementation of the innovation, and commit to implementing the innovation as standard practice. The application process includes submitting the Standard Form 424 and a project narrative attachment [Dawoud, 2016].

3.2 State DOT Implementation of e-Construction

Most states are employing at least some aspect of e-Construction, but they are at varying levels of implementation. The Michigan Department of Transportation (MDOT), a leader in e-Construction, has successfully applied e-Construction to design–bid–build projects since 2015. The department rates their construction administration process as 99 percent paperless. Material tickets are the only item delivered on paper [FHWA, 2016a]. MDOT estimates savings of \$12 million and 6,000,000 pieces of paper annually due to electronic construction administration. The department reduces its average contract modification processing time from 30 days to 3 days [FHWA, 2017a]. MDOT uses software such as FieldManager for collecting field data, Mobile Inspector for daily reports, and ProjectWise for document storage. The department’s technology of choice was the iPad after a comparison to Windows devices [FHWA, 2016a].

The Florida Department of Transportation (FDOT), another leader in e-Construction, has successfully applied e-Construction to design–build projects since September of 2015 [FHWA, 2017a]. FDOT uses software such as SiteManager for field project management, ProjectSolve as a collaboration platform, Electronic Document Management System (EDMS) for final archiving of project files, Hummingbird for document storage, IdenTrust for digital signatures, and Bluebeam for as-builts and field

changes. FDOT believes ProjectSolve increases efficiency of communication between district administrators and consultants. FDOT added an e-Construction specification to its contract documents, which requires electronic signatures. The department's technology of choice is iPads using Citrix as the interface for accessing its other programs [FHWA, 2016].

One of the most popular software programs for document storage is ProjectWise by Bentley. Currently, the program is used as a tool for e-Construction by at least nine state departments of transportation: Georgia, Michigan, Missouri, Oregon, Texas, Utah, Virginia, Washington, and West Virginia [FHWA, 2016a]. A case study was published by Bentley describing a highway construction project in Austin, Texas, that was completed with the use of ProjectWise Integration Server, ProjectWise Passports, and ProjectWise Caching Servers. AECOM, a top transportation engineering firm, was contracted by Central Texas Highway Constructors to provide estimates, specifications, and plans for two segments of a 27-mile, four-lane state highway. The required project timeline was 18 months, which is 50 percent faster than the average project of this size. Using Bentley ProjectWise, AECOM was able to distribute information simultaneously to a team of 120 employees from 20 different offices throughout the United States and Canada. In addition, there were six contractors working with AECOM on the project. ProjectWise allowed the team to minimize the need for travel and to maintain an updated set of design documents. The AECOM project manager noted that Bentley was available to assist the team with training and ongoing support for issues such as large data transfers, server maintenance, and user access management. ProjectWise was used for computer-aided design (CAD) file management, quality control, quality assurance, and

document control with accelerated information sharing and communication. Overall, AECOM saved \$600,000 in travel costs and another \$250,000 in management costs. As a result, AECOM saw a return worth 12 times the original investment in ProjectWise. Additionally, the company increased its productivity by about 12 percent. This increase in productivity can be attributed to a decrease in travel time, less time spent locating and validating files, and the elimination of duplicated work by maintaining a single version of design documents [Bentley System, Inc., 2012].

AASHTOWare is another popular e-Construction platform and is currently used by several states, including Arkansas, Minnesota, Oregon, Virginia, and West Virginia [FHWA, 2016a]. AASHTOWare Project, in particular, enables DOTs to manage information throughout both the preconstruction phase and construction phase. The software includes modules to assist with cost estimation, proposal preparation, letting bids, construction and material management, and data collection. AASHTOWare Project allows users to create a consistent, integrated view of the contract process during each phase.

Additionally, it is common for state DOTs to incorporate different products provided by Adobe. For example, Iowa's DOT utilizes Adobe Connect, which is a web conferencing software. As previously mentioned, online meetings can save a significant amount of time and money by eliminating the need for travel. The Oregon and Washington state departments of transportation use Adobe Acrobat for accessing and annotating PDF (Portable Document Format) documents. The Minnesota DOT uses Adobe Reader to create electronic contract documents for inspectors. The Missouri DOT uses the same program for document management and providing digital signatures on

construction plans. Although it is not a product exclusive to the implementation of e-Construction, Microsoft Office is noted as an important program by several state DOTs. This software includes applications such as Word, Excel, PowerPoint, Outlook, OneDrive, Project, and SharePoint. Georgia, Florida, Missouri, Pennsylvania, Texas, Utah, Virginia, and Washington State use SharePoint for project collaboration and workflow as well as document storage.

Employees of state DOTs typically use a virtual private network (VPN) connection to create a secure connection from mobile devices (i.e., laptops, tablets, smartphones, etc.) in the field to their network. This private connection is especially beneficial when using public Wi-Fi. Alternatively, Citrix Receiver is used by a least five states: Florida, Minnesota, Texas, Virginia, and West Virginia. This product is free of charge and allows access to personal applications, desktops, and data from mobile devices [FHWA, 2016a].

3.2.1 Benefits of e-Construction

An increasing number of state DOTs is becoming interested in implementing more aspects of e-Construction due to its abundant benefits. Figure 3 shows the phases of construction and examples of paperless processes created by e-Construction. In general, e-Construction provides savings in time, project cost, fuel, printing, and postage. Some of these savings then correlate to a reduced environmental impact. In addition, e-Construction creates greater accessibility, transparency, and accountability in the workplace. Having a single electronic version of construction documents increases productivity and submitting and approving administrative documents electronically.

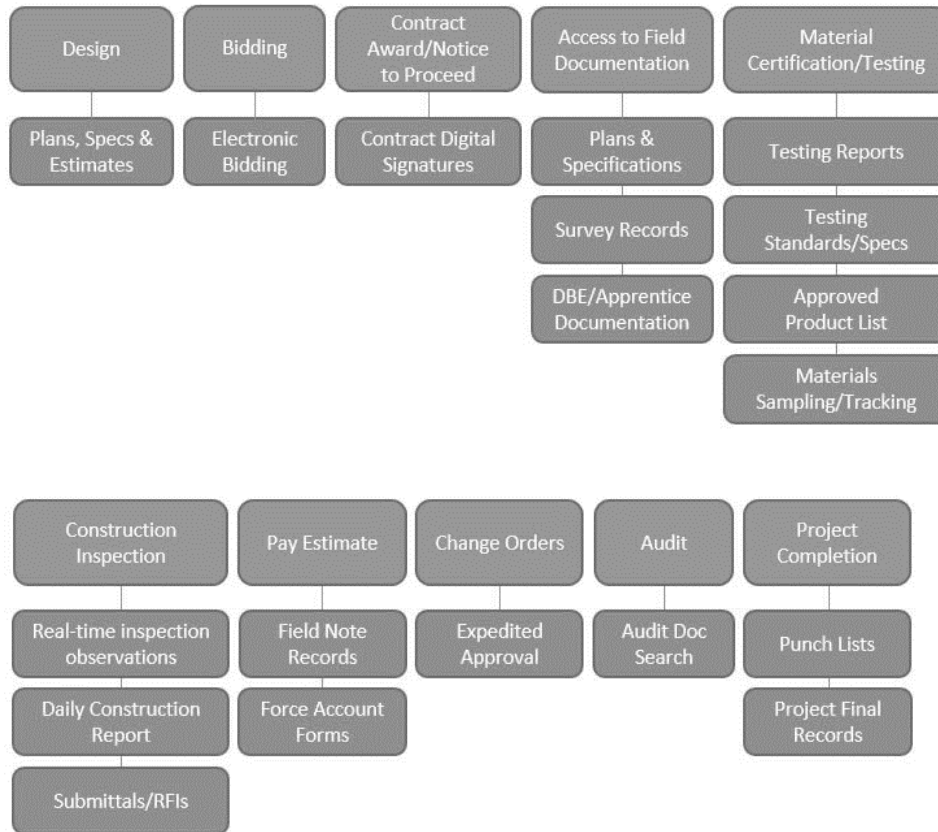


FIGURE 3

Paperless Processes Created by e-Construction [Pavement Interactive, 2016]

3.2.2 Challenges of e-Construction

It is beneficial for state DOTs to address possible challenges associated with implementing e-Construction and to learn from successful solutions. One of the first and greatest challenges is selling the idea to state decision-makers and other stakeholders. A common concern is that introducing new processes will create unnecessary stress among employees and contractors. Another concern is the up-front costs of implementing the changes. There are relatively high costs associated with e-Construction due to the required technology infrastructure, licensing software, and electronic signature management. However, it should be noted that savings in time, travel, postage, printing,

and scanning accumulate if e-Construction is implemented as standard practice. Prior to going paperless, it is beneficial to develop a memorandum of understanding between the state and construction industry leaders in order to establish common goals and to ease the transition. The Florida Department of Transportation recommends providing state leaders with an estimate of time and money savings.

Another obstacle of implementing e-Construction is a lack of resources, including hardware, software, licenses, portable devices, and personnel. With the help of information technology (IT) personnel, it is important to determine required resources and their associated costs. To save money throughout the research and implementation phases of this innovation, it is possible to find employees who are passionate about the transition and available to contribute additional hours of work. Neither Michigan nor Florida hired additional personnel to implement e-Construction [FDOT, 2015].

Additionally, state DOTs have discovered several information technology limitations while implementing e-Construction. First, state leaders must determine the most efficient hardware, software, and devices to provide to personnel. Despite selecting the appropriate technology, connectivity might become a problem in remote locations. FDOT states that the best solution to this issue is to have IT personnel improve the network whenever possible. Furthermore, data storage might become a concern considering any one transportation project could have hundreds of documents that will require storage in digital format. One solution is to utilize a vendor-supplied software specifically for document storage; however, this solution comes with the cost of a hosting fee. Alternatively, documents may be archived on state systems if IT personnel are able to devise a solution to create sufficient storage space. Mobile device deficiencies,

including compatibility issues between devices and software, GPS data connectivity, and low battery life, could become a concern. According to FDOT, the best way to overcome this obstacle is to research available devices in relation to e-Construction needs [FDOT, 2015].

In regard to IT security concerns, IT personnel need to determine whether conventional security policies and procedures will be sufficient for the new hardware, software, and devices. In 1989, the Federal Highway Administration distributed a memorandum on the computerization of construction records. According to the administration, there are three important provisions for the collection and retention of electronic records: security of records, reliability of records, and storage of records. In terms of security, only authorized personal should have access to electronic records, and appropriate personnel should be trained to maintain its safeguard. There should be no unauthorized alteration or erasure of electronic records; however, there should be backup and recovery methods in place for accidental errors. To ensure the reliability of records, a procedure should be established for inputting, editing, and updating all records, including procedures for proofreading and validating data entry. The state should be able to provide evidence of program testing and computer malfunctions in order to protect its reliability. Additionally, providing an audit trail of data processing steps can enhance the reliability of electronic records. Lastly, it is paramount to maintain appropriate storage and easy retrieval of electronic records throughout their life cycle [Van Ness, 1989]. Unfortunately, these information technology obstacles could possibly require additional IT personnel or vendor support to overcome training and unexpected issues.

The issue of departmental coordination requires sufficient planning to overcome. A cross-functional team representing all stakeholders should be appointed to efficiently update policies and procedures. The members of this team may include members from the IT, CAD, finance, and legal groups. FDOT recommends selecting individuals from each department that are excited about the transition and being involved in the process. State leaders should establish common goals in order to prevent competing interests among stakeholders.

There will be several legal concerns associated with implementing e-Construction, particularly involving electronic and digital signatures. An electronic signature is “a version of an actual signature that is electronically embedded in a document” [FDOT, 2015]. Examples of an electronic signature include a scanned image of a written signature or a signature created using a finger or stylus on a touch-screen device. Typing initials, checking a consent box, or recording a voice or video approval are other examples of electronic signatures. The Michigan Department of Transportation utilizes this type of signature. A digital signature, however, is a more secure way to sign documents electronically. A digital signature includes signer authentication, which provides a secure connection between the signer and the signatures. Additionally, if someone changes a document after it was digitally signed, the signature would be invalidated. This process ensures data integrity. The Florida Department of Transportation utilizes digital signatures.

Regardless of which type of signature is used, it is important for state officials to determine where their state is authorized to perform such actions. If a state has signed the Uniform Electronic Transactions Act (UETA), it is approved to use electronic or digital

signatures. IT personnel can determine which type of signature they feel more comfortable using based on security and data integrity. The use of digital signatures might require a licensing fee. In addition, it is important for state personnel to determine whether their state statutes and professional engineering board allow the use of electronic PE stamps. State statutes, policies, and procedures must be reviewed to determine if a fully paperless e-Construction system is feasible. If current policies and procedures require hard copies of construction documents, steps will need to be taken to amend them.

Lastly, a reluctance to accept change and a lengthy learning curve should be expected among personnel. Some employees will see no deficiencies associated with the current system and not realize the benefits of e-Construction. This is why it is helpful to take the time to get the buy-in of all stakeholders associated with transportation projects. Additionally, informational material can be distributed to employees to describe the benefits of e-Construction and justify the transition. All employees will require at least some training regarding the transition to paperless construction administration. FDOT suggests testing the implementation with a small group of employees who are well suited for the e-Construction process. Their experience will provide valuable feedback to other employees and stakeholders prior to making e-Construction standard practice. All changes in policies, procedures, and processes should be well documented before the implementation process begins. If a vendor-supplied solution is implemented, the vendor might be able to provide useful documentation and training to state employees [FDOT, 2015].

4. EXPERIMENTAL PLAN

This study was conducted by first identifying the required departmental offices and documentation that need to be incorporated into GDOT's e-Construction program. To document current construction management software systems and field data collection within the context of GDOT's workflow processes as described by the Plan Development Process (PDP), meetings were conducted with various GDOT offices. The meeting schedule is shown in Table 2. Each office identified technical and organizational barriers within the current processes.

Additionally, a thorough review of other state DOT e-Construction practices was conducted to identify their paperless status, software used, field data collection technologies, and workflow processes. Both challenges and benefits seen by other transportation agencies were recorded. Following this research, a proposal for the FHWA AID Demonstration was drafted. The project team contacted other state DOTs that have previously received funding for e-Construction through the AID Demonstration program, including KDOT and ODOT, to gather information regarding their successful submissions and implementation of their e-Construction programs. Using the collected information as reference material, the required FHWA AID proposal Project Narrative draft was completed and submitted to GDOT. The Project Narrative included the following sections: Project Abstract, Project Description, Innovation Performance, Application Information and Coordination, Funding Request, Eligibility and Selection Criteria, and Additional Attachments. Ultimately, the draft proposal will be submitted for funding consideration.

TABLE 2
GDOT Office Meeting Schedule

No.	Meeting Date	Office	Division
1	November 13, 2017	Construction	Construction
2	March 16, 2018	Materials and Testing	Construction
3	April 18, 2018	Roadway Design	Engineering
4	April 18, 2018	Program Control	Program Delivery
5	April 20, 2018	Construction Bidding Administration	Construction
6	April 24, 2018	Bridge Design and Maintenance	Engineering
7	April 26, 2018	Design Policy and Support	Engineering
8	April 26, 2018	IT Application Support	Information Technology
9	April 30, 2018	Environmental Services	Engineering
10	May 7, 2018	Planning	Planning
11	May 8, 2018	Engineering Services	Engineering
12	May 9, 2018	Right-of-Way	Engineering
13	May 9, 2018	IT Infrastructure	Information Technology
14	May 14, 2018	Program Delivery	Program Delivery
15	May 23, 2018	Innovative Delivery	P3

5. EXPERIMENTAL RESULTS

5.1 GDOT e-Construction Processes

A series of meetings was conducted with GDOT office representatives to investigate the current state of e-Construction at GDOT and to determine how to implement a more efficient program across the entire department. The research team gained an understanding of the needs of each office based on coordination with other GDOT offices and consultants. At the conclusion of each meeting, the study team summarized each office's software usage, communication needs, and challenges through the submission of meeting minutes. A summary of findings from each office meeting is included within this section.

5.1.1 Bidding Administration

The Office of Construction Bidding Administration (CBA) is responsible for guiding projects through the contract letting process in accordance with applicable laws and specifications. The office publishes an annual letting schedule for processing projects and prepares bidding proposals. The CBA then publishes an advertisement for bid to contractors and requests eligibility to bid. After a list of eligible bidders is published and project amendments have been advertised, the bids are received, processed, and evaluated. Finally, a contractor is awarded, and the contract is processed.

5.1.1.1 Software

At the initiation of a project, the project manager from Program Delivery uploads final specifications, plans, and other documents to ProjectWise. The CBA then retrieves the

documents necessary to build a proposal and advertise the project to contractors. Web Trns•port, an older AASHTOWare Project software, is used to enter pay items and quantities into the AASHTOWare Project Cost Estimation System (CES). Contractors do not have access to CES because it is a desktop software. Web Trns•port generates reports as PDFs, which can be edited using Adobe Acrobat.

The proposal file is uploaded to Bid Express (BidX), where contractors are able to download using Expedite. Expedite is a desktop software used in coordination with BidX. As a result, contractors are required to have a BidX account. A database engine file (.dbe file) can be downloaded for each letting, containing pay items and quantities for each project. Contractors then upload their unit price to BidX. Prior to gaining access to projects in BidX, the contractor must submit a Request for Eligibility specifying which projects they would like to bid on for each letting. The CBA then approves contractors to see project information and specifies the approvals in BidX. Contractors are able to submit questions through BidX, which are sent to the CBA through email. The questions are then answered with the help of the project manager, and the answers can be viewed by all contractors.

The CBA plans to transition to AASHTOWare Project 4.1, which will automate the bidding eligibility process. Web Trns•port has the ability to support this process, but the required documentation has to be printed out and re-uploaded. AASHTOWare Bids, which is a web-based program, will replace Expedite. It will allow the CBA to receive an email with a request to bid, which they can approve electronically. It will also make it easier to post amendments to a proposal after it has been advertised. In addition,

Trns•port and CES will be retired with the implementation of AASHTOWare Project 4.1. There will be a new estimating feature within the software.

5.1.1.2 Communication

The CBA communicates with the Office of Financial Management to ensure projects are authorized and funding is available prior to posting proposals. Contracts are routed through the Contracts Authorization Tracking System (CATS), an internal software. Questions regarding contract times are directed to Beau Quarles, assistant state construction engineer, at the Office of Construction. The office also communicates with project managers or the Office of Construction regarding questions during project advertisement. The questions are downloaded to an Excel file and emailed to the project manager, as well as to Beau Quarles and other relevant offices. The project manager is then able to send design-related questions to the appropriate consultant or office.

5.1.1.3 Challenges

The CBA is not able to display contracts for early availability in BidX. Since the CBA creates a call number for each proposal during each letting, there is nowhere to place the files prior to letting. To overcome this challenge, the CBA posts the documents on vendor sites and displays a notice on BidX that directs contractors to the site. With the use of CATS, there is a limitation on document size. The maximum allowable envelope size in CATS is 250 megabytes. Contracts have to manually be separated into 25-megabyte segments using Adobe. Currently, the prequalification of contractors is not conducted electronically. Georgia regulation and GDOT specifications require contractors to be registered and have a certificate of qualification to work as a primary contractor or

subcontractor. Primary contractors must submit a Form 477 and a hard copy of a financial statement with original signatures. Subcontractors must submit a Form 478 with original signatures and letters of reference. The CBA then sends the forms to the Office of Audits for approval and emails the contractor a certificate. The CBA is interested in completely automating this process and transitioning to digital signatures. The office has been working with the Office of Information Technology for 6–8 months to develop a new electronic process that will be tested in July.

5.1.2 Bridge Design and Maintenance

The Office of Bridge Design is responsible for the hydraulic and structural design of highway bridges, culverts, and retaining walls. The Office of Bridge Maintenance conducts inspections of all bridge structures and determines load ratings, and also designs and details bridge repairs.

5.1.2.1 Software

The Office of Bridge Design uses MicroStation and in-house software for design. ProjectWise is used for document management and storage. Documents are stored in folders within ProjectWise based on Project Identification (PI) number. Additionally, each GDOT office has its own folder. A timestamped, record set of final plans is stored in ProjectWise for bridge projects. The Office of Design Policy and Support determines access to the software. At some point, consultants might be granted access to specific project folders. The long-term goal is for everything to be stored in ProjectWise, but documents are still being distributed through email. The Office of Bridge Design is in the

process of transitioning from hard copies to electronic documentation and developing standardized e-Construction processes.

ProjectWise Deliverables Management is a web-based application that locates files in ProjectWise and uploads them to the cloud for retrieval. It allows for document distribution between GDOT employees and consultants. The Office of Design Policy and Support provides ProjectWise training sessions from Bentley staff for both GDOT and its consultants. The Office of Bridge Design recently used a project with E.R. Snell as a pilot study for deliverables management. Overall, ProjectWise is still only used for document storage.

The Office of Innovative Delivery uses e-Builder to manage and store documents for design-build projects in the P3 division. Documents in e-Builder include plans, submittals, shop drawings, and RFIs. E-Builder is highly customized compared to ProjectWise. The Office of Bridge Design believes e-Builder should be simplified and have improved accessibility.

5.1.2.2 Communication

The Office of Bridge Design receives requests for bridge design from the project manager or road design engineer through email. The office is working toward providing a PDF version of final plans through a link, which can then be distributed to contractors for bidding. That consultant must stamp plans that she/he prepares. If the Office of Bridge Design creates the plans, the cover sheet is signed by the chief engineer and scanned into the record set plans.

Shop drawings and other submittals are received from contractors through email for quick review and submission. However, these documents are not tracked and can get lost.

Shop drawings move between the contractor, the Office of Materials and Testing (OMAT) Lab, the area engineer, and others. Plan development documents are distributed to the District Roadway Design Office, OMAT, the Office of Utilities, and sometimes the Offices of Environmental Services or Right-of-Way. Problems in the field are relayed by telephone call or email. The Office of Bridge Maintenance is the program manager for bridge projects. Bridge replacements are programmed and then turned over to the Office of Program Delivery.

5.1.2.3 Challenges

An Encroachment Permit is required to perform work in GDOT right-of-way (ROW) (e.g., bridge over highway). When the district receives a permit, they communicate with the necessary offices through email. These permits, shop drawings, etc. need to be uploaded into ProjectWise, but they do not have a PI number or project manager to correspond to.

Plans often specify for a contractor to design certain components of a project, such as overhead signs, traffic signals, strain poles, and lighting. The contractor sends shop drawings to GDOT for review. These documents often do not have a PI number, so they are managed manually and have no place to be stored. They are scanned and stored in a standalone ProjectWise folder, which is difficult to locate later if change is required.

5.1.3 Construction

The Office of Construction is responsible for communicating with the construction industry and developing timely problem resolutions. The office reviews and approves

contract modifications and conducts construction compliance audits, project field inspections, and contract compliance investigations.

5.1.3.1 Software

The Office of Construction becomes involved with a project during the Field Plan Review. The district offices are involved from the beginning of a project. The Offices of Planning, Environmental Services, and Right-of-Way currently use ProjectWise for documentation. Their documents are sent to the District Office of Construction. ProjectWise is a secure network for filing contracts and allows a single continuously revised document to be shared. All internal offices have access to ProjectWise; however, some offices are restricted to read-only access, which is controlled by the Office of IT Application Support. SiteManager is currently employed as a server-based software, but it will be soon transformed to a web-based system. It is used to document daily work reports from the field.

CATS is used for contract modifications. When the Office of Construction receives documents, they mark them up if necessary and provide input through email. Some of these changes are documented on ProjectWise, as well. Sometimes other offices will provide a link to the document on ProjectWise through email or provide a hard copy. Payments documented in SiteManager are electronically transferred to Accounting through PeopleSoft. GDOT's CES is the internal database for estimating. The Office of Design Policy and Support is heavily involved with the Office of Construction during preconstruction. During construction, the Office of Construction works closely with OMAT and district offices.

GDOT is currently conducting two project pilots using ProjectWise with contractors. Submittals and other documents are being passed to contractors through the web-based interface and returned to the server. The documents pass through IT security before being transferred. Currently, all field engineers have a tablet for using Bluebeam and other software on-site. If service is unavailable in the field, the engineers use their cell phones to retrieve information. Contract liaisons are expected to have tablets by the end of November 2018. The Office of Construction believes there is currently no need for more mobile technology.

5.1.3.2 Challenges

Designers are not able to incorporate ideas from the Offices of Planning, Environmental Services, and the Right-of-Way in their plans. The Office of Construction often does not see documents until something goes wrong and “all easy answers are wrong.” Offices involved with preconstruction, consultants, and contractors do not have direct access to ProjectWise. Some GDOT projects have not been upgraded to electronic document management. By December 2018, GDOT hopes to be using ProjectWise for all projects. Project managers need access to both ProjectWise and SiteManager; however, these programs function separately. Documents are being stored in various locations, and it is difficult for users to know how up-to-date these documents are. Additionally, the Office of Construction is currently unable to respond to emails outside of the office due to a firewall issue.

The Office of Construction suggests it would be beneficial to have an easy way to retrieve specific reports from ProjectWise, including a way to download documents from the same contractor across multiple projects. It is critical to the Offices of Construction,

Financial Management, and Bidding Administration to see milestone dates quickly and easily. All documents in the software should be timestamped. The Office of Construction sees a need for more efficient communication between ProjectWise and SiteManager, as well as more efficient document transfer among offices. Alternatively, GDOT would benefit from having one central database for document management, such as AASHTOWare. The disadvantage of implementing a new software is the training it would require.

The Office of Construction sees opportunities for new e-Construction innovations in the future, such as e-Ticketing. The overall goal of improving GDOT's e-Construction program is to decrease the amount of time spent on document management and to increase the amount of time spent on quality control.

5.1.4 Design Policy and Support

The Office of Design Policy and Support (ODPS) is composed of three divisions: Engineering Systems Support, Roadway Design Policy, and Location Bureau. Engineering Systems Support is responsible for supporting the department's engineering software systems and visual engineering. During preconstruction, Roadway Design Policy is responsible for defining and interpreting policy and litigation for roadway design, lighting, and water resources. The division is also responsible for conducting QA/QC of engineering deliverables. The Location Bureau is responsible for statewide aerial mapping and ground surveying. Overall, the office supports and enhances all aspects of program delivery.

5.1.4.1 Software

ODPS maintains several programs from Bentley, including ProjectWise, MicroStation, InRoads, OpenRoads, and hydraulics/hydrology software. The office does not support SiteManager.

5.1.4.2 Engineering Systems Support

This division coordinates with district IT staff across the state. The frontline support staff handles software installation. Engineering Systems Support also leads document management for the electronic letting process and electronic construction revisions. In the case of a consultant being required to use a specific software, it is up to that consultant to have it.

ProjectWise is a flexible software that allows all files within the department to be centrally located. Some consultants have ProjectWise in their office and can be connected to GDOT project information; however, issues can be encountered if the consultant has a slow connection speed. ProjectWise Deliverables Management, the cloud-based application, is recommended. Deliverables Management improves communication and exchange of data with external consultants. When a consultant uploads a package to Deliverables Management, the receiver at GDOT is notified. The package is electronically reviewed, and the appropriate files are sent back. The consultant will then be notified to download the documents from the cloud.

5.1.4.3 Roadway Design Policy

The Roadway Design Policy division of ODPS is required to communicate with the Offices of Traffic Operations, Bridge Design and Maintenance, and Roadway Design

regarding policy. Questions about deviating from standard policies are directed to the Offices of Program Delivery or Innovative Delivery. During the conceptual design phase, concept reports are produced and reviewed by the necessary offices. Comments and approvals are provided electronically, and a hard copy of the final report is sent to management.

During construction, the Roadway Policy Group in the Roadway Design Policy Division reviews shop drawings for structures that deviate from standard construction drawings. They prepare construction plans for specialty maintenance projects, including erosion control and flooding. The Roadway Lighting Group reviews and approves relevant designs and shop drawings, as well. The Water Resources Group manages water quality from concept to letting of the project, coordinating with the Office of Construction.

Once ODPS completes a request, the Office of Construction is responsible for documentation and proceeding. While some PDFs and questions are sent through email, a lot of documentation is distributed as paper copies. These documents could be distributed electronically with ProjectWise Deliverables Management.

5.1.4.4 Location Bureau

Aerial mapping and ground surveying information is combined to create 3D models and sent to the Office of Roadway Design. The files are uploaded to a folder in ProjectWise, and the Office of Roadway Design and the project manager from the Office of Program Delivery receive a link to access the documents. GDOT uses proprietary survey software by Trimble. Consultants might use different survey software than GDOT, but they are still required to provide an InRoads Survey file. If consultants do not have access to

ProjectWise, the Office of Program Delivery project manager uploads the file. If the project manager does not have access to the folder, the Office of Design Policy provides assistance.

The process could be quicker if everyone involved had access to the necessary ProjectWise folders. ProjectWise Deliverables Management is currently being tested on a couple of pilot projects under construction. Deliverables Management has automated alerts through email and document tracking. The Location Bureau is moving toward requiring external consultants to submit deliverables through this software. In addition, ODPS and consultants are in the process of implementing OpenRoads for designing 3D models.

5.1.4.5 Challenges

Older civil design software (e.g. GDOT's CAiCE) has limited support. The office emphasizes that the only way to convert projects designed with older software would be to recreate all design work.

5.1.5 Engineering Services

The Office of Engineering Services authorizes preliminary engineering (PE), right-of-way, and construction funds and provides project cost estimates. This office reviews plans and facilitates field plan reviews (FPRs). In addition, the Office of Engineering Services manages standard specifications and GDOT's Value Engineering Program. They also ensure environmental compliance and conduct post construction evaluations (PCEs). In general, this office oversees federally funded projects.

5.1.5.1 Software

The Office of Engineering Services has its own folders within specific project folders located in ProjectWise. The office uploads reports to ProjectWise, which are accessed through an emailed link. In the very rare case that a document does not have a PI number, it is emailed as a Word document to the project manager.

The Office of Engineering Services receives hard copies of the plan set for reviews (i.e., Design Review Section, Preliminary FPR/Final FPR/Corrected Final FPR) and developing an estimate (i.e., Estimating Section, Corrected Final FPR only). In addition, the plans are uploaded to ProjectWise for others to access. Although the district construction offices, district utilities offices, and district environmental offices still receive hard copies, the number of hard copies has decreased to approximately 25 percent of the number from 10+ years ago. However, the Office of Engineering Services suspects that many people who do not receive a hard copy print their own. When consultants perform reviews for the Office of Engineering Services, they receive hard copies. The Office of Engineering Services is moving toward fully implementing electronic document distribution with ProjectWise Deliverables Management. Engineering Services uses TPro, Primavera, and occasionally PCCommon. The office only uses e-Builder to compile comments for Office of Innovative Delivery design–build projects.

Within the Office of Engineering Services, documents are shared through network drives. Confidential information from estimators used to develop the Engineer’s Estimate is stored here. Engineer’s Estimate prices are entered into AASHTO Trns•port. Trns•port is also used by the Office of CBA to develop the Letting Proposal and other letting documents. Within Trns•port, the Office of Engineering Services can find historical data

of final estimates. Within the network, the office can find Excel sheets that were used to build Engineer's Estimates. Trns•port CES is used to develop the designer cost estimate. AASHTO Trns•port is becoming an unsupported software, and GDOT is transitioning to AASHTOWare Project.

5.1.5.2 Communication

The Office of Engineering Services mostly interacts with the Office of Program Delivery to facilitate design review meetings, field plan reviews, etc., which are coordinated by the project manager. The Office of Engineering Services coordinates with district construction offices through email for coordinating meetings. When the project manager requests a review, she/he brings a hard copy of the request letter and plans to the Office of Engineering Services. The reviewer emails the project manager, district construction engineer, and designer to determine a date for the review. Once the date is set, a schedule letter is sent through email. A link to the letter and project package in ProjectWise is included in the email. Before the meeting, a draft report with comments is distributed to the team. After the report is reviewed at the meeting, it is distributed through email with the ProjectWise link, as well. The designer sends responses through email, and the project manager distributes the report with accepted responses through email and ProjectWise.

5.1.5.3 Challenges

The process of assigning reviews to consultants could become more efficient by distributing plans electronically with ProjectWise Deliverables Management. However, some people who review the plans might not have access to a plotter to print them. Many

estimators are in area offices, and they do not always have the availability to print documents. Overall, the Office of Engineering Services sees a lack of knowledge regarding the functionality of ProjectWise. Training was provided for ProjectWise, but it was provided a year or more before it was implemented. Workflows with step-by-step processes are provided online, but not everyone knows they are available.

5.1.6 Environmental Services

The Office of Environmental Services (OES) obtains environmental approvals and permits for all projects according to applicable laws, rules, and regulations. The office coordinates with design teams to avoid, minimize, or mitigate harm to the environment. OES identifies environmental resources and assesses project effects to these resources.

5.1.6.1 Software

During concept development, OES receives a layout for resource identification from the Office of Program Delivery. This document is accessed through a link to ProjectWise, which is sent via email. Folders in ProjectWise are sorted by PI number, and OES has its own folder. The Office of Program Delivery manages the folders.

Final administrative records are stored in ProjectWise, but it is not typically used for document distribution. Most documents are mailed as hard copies or emailed. If documents need to be sent to outside agencies or if they are too large for email (e.g., policy updates, project reports), they are distributed through SharePoint or the FTP site. Geographic information system (GIS) files slow down ProjectWise, so GIS maps are created outside of the software. A final copy is then saved to ProjectWise. Noise Models

cannot be opened in ProjectWise, which complicates the review process if documents are submitted for review through ProjectWise.

PCCCommon is a department-wide internal server that is used to share draft documents. PCCCommon contains an alphabetical list of files. The framework for TPro was created a decade ago, so it is not structured to meet today's needs. For example, TPro does not have the ability to track permit applications, but SharePoint does. OES needs to be able to track the quality of the documents they are receiving. GDOT's databases do not talk to each other, so it is difficult to ensure everyone has the most up-to-date version of documents throughout the life of a project.

5.1.6.2 Communication

Within GDOT, OES communicates most often with the Offices of Roadway Design, Program Delivery, and Innovative Delivery. Additionally, OES communicates with external agencies, such as the U.S. Army Corps of Engineers and the Board of Regents for the University System of Georgia. OES creates a document that publicly discloses the environmental impacts of a project, which is then distributed to FHWA on federally funded projects. OES believes they are at 80 percent of their full e-Construction potential. Some document reviews are still distributed to agencies as hard copies. In terms of signatures, it is mostly a personal preference between electronic signatures and signing a hard copy and scanning the document.

Contractors may make changes during construction, which require them to reapply for permits and surveying. Once a special provision transitions from an environmental commitment to a construction commitment, it may or may not be conveyed properly. The FHWA Georgia Division does not have access to ProjectWise, but they do have access to

GeoPI. OES sends electronic documents to FHWA, but OES prints hard copies for archival. Locally, there seems to be a disconnect regarding e-Construction processes.

5.1.6.3 Challenges

Document management in ProjectWise requires staff training, and OES expresses that its staff does not have the time to learn a new software that is not implemented on all projects. They are already updating several databases throughout a project. It is inconvenient to download and re-upload documents in ProjectWise, so it is only used to store final records. In addition, it is difficult to use ProjectWise with documents outside of the PI structure or for external agencies. A lot of processes could probably be automated, but every project is unique. OES mentioned that it would be ideal to fully implement ProjectWise if it could accommodate all projects and all non-project document coordination.

OES works with multiple outside agencies who have different preferences for processes and document access. The office is moving toward using SharePoint to share documents with consultants. In addition, OES finds it challenging to work with Innovative Delivery because they use e-Builder instead of ProjectWise. Files must be transferred from one software to the other, and personnel have to be trained before using e-Builder.

5.1.7 Innovative Delivery

The Office of Innovative Delivery is responsible for planning and management of Public–Private Partnerships (P3), Design–Build, and other alternative delivery projects. For these projects, the Office of Innovative Delivery conducts the procurement of the

contract and becomes the project manager/construction manager until project closeout. P3 projects have different procurement rules, making it a longer process. The procurement of a P3 project typically lasts 18 months compared to 6 months for a regular project. Rigorous document control and confidentiality are important for Best-Value Alternative Technical Concept (ATC) Evaluations.

The Office of Innovative Delivery partners with the State Road and Tollway Authority (SRTA) to sign contracts for P3 projects. The contract states that GDOT will fund and manage the project, and SRTA will pay the contractor. Inter-agency relations such as this require software that facilitates external communication. The Office of Innovative Delivery uses software that helps reinforce policies and timelines as well as preserve documents.

The number of Office of Innovative Delivery contracts per year varies since there is no quota. Overall, it is a small percentage of GDOT projects. Over the last 10 years, the average contract value of Innovative Delivery projects is \$100 million per year. Currently, there are \$2 billion of Innovative Delivery projects under construction, with even more in the preconstruction phase.

5.1.7.1 Software

The Office of Innovative Delivery uses TPro for preconstruction information and Primavera for project scheduling. The office retrieves concept reports from ProjectWise. SiteManager is used for standard pay request processes, and SharePoint is used to share Reference Information Documents outside of contracts with proposers. Requests for Proposal are posted on SharePoint, as well. Assure-IT by Aster is used for material testing data. The Office of Innovative Delivery uses CATS to process agreements,

following legal financial steps. A modification was added to CATS to replace manual routing of contracts with external agencies (e.g., FHWA, contractors, etc.). DocuSign is used in conjunction with CATS for e-signatures. Contracts with SRTA are created in e-Builder.

The Office of Innovative Delivery acquired an unlimited license for e-Builder in 2012 or 2013. It is used to distribute, review/approve, and store documents, including submittals, RFIs, and pay requests. Processes within e-Builder are customizable. The software audits all processes by tracking ball-in-court, user comments, when documents are approved, and who approved them. In addition, the Office of Innovative Delivery can see statistics from the software, including information about its users. Customized access can be created for contractors. The office is not currently using all of e-Builder's capabilities. It has enhanced its e-Builder license to interface the software with Primavera; however, e-Builder is not connected to PeopleSoft or TPro.

Approximately 4000 submittals have been completed in e-Builder to date. The software was purchased to avoid having to hire more people to manage documents. It was selected with adaptability and scalability in mind. The program manager provides training for e-Builder.

5.1.7.2 Communication

Concept reports are processed the same way as any other project. They are submitted to the Office of Design Policy and Support and distributed electronically through ProjectWise. Concept reports can be signed electronically. The ATC process often involves review, comments, and approval from Office of Bridge Design personnel, so they have access to e-Builder.

5.1.7.3 Challenges

E-Builder does have some querying capabilities, but typically requires going into the file structure. The software is not compatible for uploading material testing data. The Office of Innovative Delivery is currently working with OMAT to solve this issue. OMAT favors using Assure-IT for material certifications. The software allows certifications to be completed every 3 months throughout a project, which shortens the time to finish certifications after project completion. The software is customizable, which is beneficial for materials quality assurance and design-build projects. Office of Innovative Delivery projects usually have a large amount of material being tested by a complex team. Material test data can be entered into Assure-IT in the field, and it is integrated and organized into the software. The software can be used for materials document management and as a repository. E-Builder and Assure-IT do not feed information to each other. E-Builder has the documents, but it does not have all the data required for analysis and decision-making. The Office of Innovative Delivery is not currently creating 3D models. The office creates 2D plans, which are then converted to 3D models.

While some processes for submittal tracking have been implemented in ProjectWise, the functionality of ProjectWise does not match that of e-Builder. The GDOT could benefit from using e-Builder (or a similar software) to create standardized processes for all project managers. E-Builder can be viewed as a tool for submittal management, which is extremely important for Office of Innovative Delivery projects. New processes can be tested in e-Builder without interfering with the rest of the Department.

5.1.8 IT Application Support

The Office of IT Application Support is composed of two divisions: Applications Development and Applications Support. The Development Division manages the development of new applications and coordinates the Department's Geographic Information System (GIS). The Support Division maintains the department's computer applications and shared resources to support the Plan Development Process. The Office of IT Application Support is responsible for the historical archiving and retention of records. This office is the contact for application troubleshooting, end-user access, and other user needs.

5.1.8.1 Software

Applications that are supported by this office include TPro, Primavera, SiteManager, and ProjectWise. The engineering support team throughout construction provides support for ProjectWise. Data are made accessible online for those who do not have access to ProjectWise. Additionally, plans reflecting the latest revisions are available on GeoPI. ProjectWise contains information from TPro through the use of metadata. The Office of IT Application Support suggests focusing less on the folder structure of ProjectWise and more on using metadata for searching and retrieving documents. There are too many folders within ProjectWise, and it is up to the user to determine if documents are in the right folder and who has access to these folders. It was suggested that files be stored in a manner in which the information could be more easily queried. The Office of Design Policy and Support approves public access to the software.

The Primavera P6 software has not been changed since it was received from the vendor, and it is not being used to its full capability. SiteManager is an AASHTOWare software with modules for preconstruction, bidding (Expedite), civil rights and labor management, construction, and materials and testing. The Office of Construction primarily uses this software, and other offices pull information as needed. The Office of IT Application Support created the standardization of project IDs. Additionally, the office has worked to create interoperability between TPro and AASHTOWare Trns•port.

5.1.8.2 Challenges

There are some gaps in the coordination of applications. For example, design–build P3 projects are performed by consultants and are not part of GDOT’s internal system. Consultants do not use the same technology as GDOT, so their projects are managed outside of the department. For example, while GDOT moved to Primavera, the P3 division uses e-Builder. Data are transferred to GDOT information systems and vice versa.

PeopleSoft is used as the financial record system within the state of Georgia. The Office of IT Application Support has not been given approval to have direct access to PeopleSoft. GDOT inputs a large amount of data into PeopleSoft and does not always back up the data to the database. If the Office of IT Application Support did receive all of the necessary information, more extensive financial analysis could be conducted. It would also improve synchronization with the project programming software, TPro. The Office of IT Application Support is currently working with GoldenGate to improve data integration.

The Office of IT Application Support fulfills the business needs of GDOT. Although the office does not actively look for inefficiencies, it believes processes could be simplified by workflows. The Office of Bridge Design, for example, is starting to implement workflows to help route documents to the appropriate individuals for review, approval, and acceptance of contracts and permits. Documents in ProjectWise with the correct metadata can be pulled by IT and shared with other applications. Some information is duplicated on SharePoint and ProjectWise. GDOT 411 is a separate reporting function used to access information. Oracle Business Intelligence Enterprise Edition (OBIEE) also has reporting capabilities. After updates, OBIEE will be able to support Primavera reporting and PeopleSoft data. At this point, there are two separate instances of data.

5.1.9 IT Infrastructure

The Office of IT Infrastructure is responsible for the operation and management of the department's computer hardware and software. The office consists of Database Support, Server Support, Network Support, Client Support, and the Solutions Center. The Office of IT Infrastructure deals with domain information, security, firewall protection, internet proxy work, support and maintenance to all end devices (i.e. printers, computers, etc.), and quality assurance for applications developed internally. The office maintains a data repository for all department software purchases and site licenses. The Office of IT Infrastructure backs up all of GDOT's software data.

5.1.9.1 Software

The Office of IT Infrastructure provides back-end support for the GIS application but does not deal with the application's functionality. The Office of Design Policy and Support manages the implementation of ProjectWise. GDOT offices reach out to the Office of IT Infrastructure to request external access to applications. The office can either publish web-based applications externally or provide VPN access for external agencies, depending on what the office is comfortable with and what the technology will support. A routine audit validates all external accounts.

The Office of IT Infrastructure is always looking for ways to reduce the number of applications within the department. That number has dropped to about 65 percent of the total applications in use 10 years ago. GDOT's internal data warehouse has access to the information within TPro, PeopleSoft, and other applications. GDOT 411 pulls data from the warehouse to be shared across applications. The implementation of e-Builder was more of an add-on than an integration.

The Office of IT Infrastructure is involved with providing connectivity to remote sites. The office conducts testing and routing of devices when a vendor installs them. The Office of IT Infrastructure took care of everything from a hardware standpoint for field applications. The office participated in the selection of laptops and tablets and the creation of hotspots. Last year, the office conducted a pilot study with construction engineers and different types of devices (e.g., Surface Pro, Apple). From a field perspective, usability was the main concern, including screen brightness, ruggedness, and connectivity via 4G or hotspots. Cost was considered, as well.

PCCCommon is the only network share location that everyone in the department can access. Every office and each individual has her/his own folder within PCCCommon. It is considered an easy way to share information, since permission is not required for access. However, several offices use SharePoint instead to share documents internally and externally in order to have more control/protection over information. PCCCommon is not managed, and the Office of IT Infrastructure does not guarantee that files will not be deleted.

Workflows have been created in Remedy, SharePoint, and ProjectWise. The Office of IT Infrastructure uses Remedy, a ticketing system, to track tasks. Offices can send a ticket request to the Office of IT Infrastructure through Remedy that can be picked up by an employee and closed out when it is complete. The system keeps a record of tasks, how long it took to complete each task, and when each task was completed. The Offices of Human Resources and Procurement, Customer Service, and executives use Remedy, as well.

5.1.9.2 Challenges

Devices have been provided for field personnel, but the office has indicated it is difficult to keep up with advancements in technology. In addition, document sharing internally and externally is a challenge. Every entity has their own cloud storage (i.e., iCloud, Dropbox, etc.), and having files in several different locations makes document management difficult. Finally, the Office of IT Infrastructure notes that the local area networks available to district offices do not always have the connectivity required to support the use of document management through ProjectWise.

5.1.10 Materials and Testing

The Office of Materials and Testing provides expertise and testing for materials used in construction and maintenance projects. In addition, OMAT manages the qualified products list, specifies material requirements, and provides geotechnical services.

5.1.10.1 Software

During preconstruction, OMAT is involved with concepts and preliminary field plan reviews. This includes payment evaluations and site reports. Currently, pavement evaluations are electronically submitted and reviewed through ProjectWise. The approved report is distributed through an emailed link. OMAT is working toward electronically processing reports for geotechnical applications, as well, including soil surveys, retaining walls, and bridge foundation investigations (BFIs). In the bidding phase, material testing is requested from the field. These test reports are conducted through GDOT 411, and there is no physical delivery of these documents. In addition, field auditing is an electronic process. Everything is reviewed through email and ProjectWise. Both pavement evaluations and material certifications use electronic signatures.

The software utilized in the preconstruction phase includes internal software for payment evaluation and others for geotechnical applications. SiteManager Materials (the Laboratory Inventory Management System [LIMS] function) contains all material data. However, raw data cannot be retrieved from SiteManager directly. Reports are created through GDOT 411 and are distributed through an automated email to individuals from

the area office. The reports are only created for completed samples, so there is no issue of having duplicate versions or not having the most up-to-date report.

Currently, tonnage for concrete and asphalt based on plant production is recorded in SiteManager Materials. Actual tonnage and pay items for these materials are recorded in SiteManager Construction. Overall, the pay quantity in SiteManager Construction should not exceed the value in SiteManager Materials. Daily work reports for material temperature, time of truck arrival, etc. are entered in SiteManager Construction. Materials certificates recently started being saved in ProjectWise. Moving forward, documents for all new projects will be stored in ProjectWise. Information in SiteManager Materials is not duplicated in ProjectWise.

Each unit (e.g., testing management, geotechnical, pavement, etc.) has its own access to relevant information in ProjectWise and SiteManager. Access is not restricted to only that folder. The software has a tracking component, so it records who adds or deletes a document or where a document has been moved. Vendors and consultants of contractors have the same access to their project on the software. GDOT consultants see the same information as a GDOT employee. OMAT is an advocate for an increased use of ProjectWise throughout all GDOT offices. OMAT estimates it is at 35 percent of its full e-Construction capability.

5.1.10.2 Communication

OMAT communicates through district construction personnel. This communication is usually through email or hand delivery of a sample card rather than through ProjectWise. OMAT only contacts personnel from the Office of Construction (i.e., John Hancock, Beau Quarles) if there is an issue in the field. Technical Assistance Bureau requests come

in through email, and OMAT responds through email. Waivers are saved in an electronic folder. It is assumed that the district has been uploading information to ProjectWise since December 2017.

5.1.10.3 Challenges

OMAT is interested in e-Ticketing, but feels more research should be conducted prior to implementation. In addition, OMAT is working toward implementing an electronic process for tagging concrete cylinders. This process, also known as e-Tagging, will timestamp each cylinder with a barcode to specify break times. Construction personnel will use a hand scanner to create the barcode, and IT Application Support is currently working on the script and looking at third-party software. OMAT is currently using sample cards for materials in the lab, but they are interested in implementing an electronic process for material samples (similar to e-Tagging).

GDOT has not yet moved to the web-based version (i.e., 3.18) of SiteManager, and the current version is not user-friendly. There are many steps required to input information. Additionally, OMAT heavily relies on the Office of IT Application Support to create GDOT 411 reports. The reports are auto-generated and distributed to people who might not be interested in seeing the report. Geotechnical processes are currently being refined. They will no longer do paper reviews after they get tablets and monitors. OMAT would like full electronic submission, review, and approval of all submittals (i.e., Primavera P6 activity schedules) from the project management side during preconstruction using ProjectWise. These submittals are required to finalize bids and will help with OMAT performance metrics. It would be helpful to have all documentation from older projects in an electronic format so everyone can have access.

5.1.11 Planning

The Office of Planning manages the state transportation-planning program. The office is responsible for developing the Statewide Transportation Plan (SWTP), State Transportation Improvement Program (STIP), Statewide Strategic Transportation Plan (SSTP), Congestion and Mitigation/Air Quality (CMAQ) coordination, and Georgia Scenic Byways Program.

5.1.11.1 Software

The Office of Planning has its own folder in ProjectWise. Historical data and planning studies can be stored here, but currently this is not common practice. The office is working to develop a planning package that can be sent electronically to the Office of Program Delivery and stored in ProjectWise based on PI number. Once a project has a PI number, there are standard practices for other offices. Other offices transfer documents from the internal server to ProjectWise. Overall, the Office of Planning uses ProjectWise as a central location for project information for the department to access.

For cost estimating, the Office of Planning uses a tool that is an extension of the AASHTO Cost Estimation System or the Right of Way and Utility Relocation Cost Estimate Tool (RUCEST). There is a handbook for these estimating tools in the office. A statewide travel demand model is used to assist MPOs with estimation of future travel demand as well as provide the ability to test various project alternatives.

5.1.11.2 Communication

The Office of Planning is responsible for acquiring additional funding outside of PE funding, ROW funding, and construction funding. The project manager sends documents

for initiation to the Office of Planning through email, and responses are distributed electronically. The Office of Planning primarily communicates with the Office of Financial Management, Program Delivery, and Innovative Delivery. The Office of Planning reviews concept reports from Innovative Delivery. Attachments are sent through email to the project manager. Externally, the Office of Planning communicates with metropolitan planning organizations (MPOs). External organizations have access to project information through GeoPI.

The Office of Planning sends an initial cost estimate to the Office of Financial Management to receive funding and a PI number for the project. This communication is through email, and a copy of the documentation is stored on an internal department-wide server. If everything goes as planned, there is no communication between the Offices of Planning and Construction after a project is let. The only interaction the Office of Planning might have with the Office of Construction is in regard to construction engineering and inspection (CEI) funding, which is not project-specific. Questions from the public are directed to the project manager.

5.1.11.3 Challenges

Within the Office of Planning, a lot of data is generated prior to a project receiving a PI number. The office indicates that if a project does not have a PI number, the corresponding documents are labeled with the county or state route name.

5.1.12 Program Control

The Office of Program Control monitors, controls, and reports on project status. The office houses the department's project scheduling software and project status reports. The

Office of Program Control leads the PDP training course and the Local Administered Project (LAP) training, emphasizing the importance of collaboration. Additionally, the office maintains a balanced Construction Work Program, providing monthly letting list recommendations, and reviews project concept reports.

5.1.12.1 Software

TPro is the statewide project management database, which is used for reporting and scheduling. Everyone within the department has access to TPro. The Office of Program Control determines specific privileges for each office depending on its role. Further, it is possible to have different tiers of access among the same office (e.g., Right-of-Way). There are additional standalone software programs that are interfaced at the data warehouse, GDOT 411. If someone enters information in TPro, it is automatically updated in other programs through GDOT 411.

Primavera is the software used for project scheduling. Documents are shared through this software, and everyone has access to its content. ProjectWise is used for the approval and distribution of final plans and critical milestones, but not all active files are stored in ProjectWise. The Office of Program Control is currently updating the PDP Manual, which is tracked and stored in ProjectWise. All PDP committee members have access to the software, but there are limitations on who can post and edit documents. Additionally, the Office of Program Control utilizes Microsoft Office applications (e.g., SharePoint, etc.).

5.1.12.2 Communication

The Office of Program Control is generally on the receiving end of information. The Office of Project Delivery is required to report to the Office of Program Control and the chief engineer regarding changes in schedule and other critical information. The office facilitates monthly status meetings to ensure the Office of Project Delivery is on schedule. All offices, including the Office of Construction, are represented at these meetings. The Office of Program Control provides project status updates, including changes, risks, and goals. Project status is compared to the baseline schedule, which is based on the approved letting schedule established by the Office of CBA. Project managers deliver schedule, budget, and invoices. Everyone has access to the P6 schedule, and it is expected to be continually updated.

Currently, consultants conduct about 86 percent of GDOT's design. Consultants have the same expectations and access to software programs as GDOT project managers. The bridge program and traffic operations program are gaining more consultants, while the BFI program has limited consultants. The Office of Program Control has no oversight over consultants in other offices.

5.1.12.3 Challenges

Project Change Request Forms for schedule changes are now created and approved through SharePoint. The project manager distributes forms as a PDF to the Office of Program Control. The form is then emailed to the director of the Office of Program Delivery and the chief engineer. Using SharePoint allows for better tracking of documents, but the office desires a more efficient long-term solution that can be

supported by IT. The processes and policies within the Office of Program Control require flexibility. The Office of Program Control receives requests regarding different projects from several different offices, including the Offices of Program Delivery, Bridge Design and Maintenance, Traffic Operations, and Local Grants. Requests are either sent through email or SharePoint. The office noted it would be helpful to be able to organize what requests need to be acted upon; information that is older than 30 days is lost.

The Office of Program Control sees a need for modifications to TPro on the preconstruction side. They are still using paper to print reports, schedules, etc. for status meetings, and could benefit from utilizing monitors, laptops, or tablets to access PDFs during meetings. In addition, the office would find it helpful to have an automated process for posting reports to reduce the number of emails during concurrent projects. Lastly, real-time information exchange is a challenge for the Office of Program Control. The office distributes information on a monthly basis, while continually working behind the scenes. In order to increase efficiency, the P6 schedule needs to be updated constantly. Although Primavera has the capability of connecting to Outlook, the function is not being utilized.

5.1.13 Program Delivery

The Office of Program Delivery (OPD) communicates with department offices, MPO staff, local government, business and community stakeholders, and other government agencies to ensure effective project development and delivery. Project managers within the Office of Program Delivery are responsible for critical project delivery tasks, including scope, schedule, budget development, resource management, and risk analysis.

5.1.13.1 Software

OPD uses ProjectWise as a centralized server system for document management and storage. Documents related to in-house projects have been migrated from other server sources to ProjectWise, and documents related to consultant projects are currently being migrated. Documentation for new projects moving forward will be stored on ProjectWise, but historical data are not. Since the data migration process is ongoing, OPD has not yet explored the full functionality of ProjectWise. The office estimates it will be using ProjectWise on a broader level in preconstruction within another year and a half. The construction staff has tablets with access to ProjectWise but is still being trained on how to access files. OPD communicates with external entities that do not have access to ProjectWise. PDF documents from ProjectWise are shared externally on GeoPI. OPD does not plan to use e-Builder outside of Office of Innovative Delivery projects.

Additional software programs used by OPD include cost estimating software, invoicing software, Remedy, Microsoft Office products, Primavera P6, and TPro 4.01. Primavera is used for scheduling. TPro is used to store data in a way that allows OPD to conduct queries. The new version, TPro 5.0, will allow data to be linked together in a centralized system for more efficient reporting. Pre-let data are stored in Primavera, TPro, and MS Word and Excel documents. The software programs communicate well, but there are not enough modules within TPro for proper query and data storage. OPD has made a request to IT to update TPro with additional modules. OPD would like the ability to use TPro for additional tasks. For example, tasks that might be of interest include: looking up projects that are within a mile from an airport; searching for

documents associated with the Corps of Engineers; and looking up data associated with an individual, regardless of consulting firm.

OPD prefers to have some level of redundancy for safety of documents. Since ProjectWise is not able to run queries, OPD considers ProjectWise to be a backup to TPro. Each office has its own TPro modules, and project managers can query this information. GDOT 411 is the querying software across all metadata from TPro, Primavera, etc., which allows the creation of customized reports.

5.1.13.2 Communication

ProjectWise is used for document distribution, as well. OPD includes a ProjectWise link in transmittal letters and links in emails to let people know information is available for retrieval. OPD does not want the system to notify people automatically because they conduct quality control checks on product information, field plan reviews, etc. OPD encourages other offices to save information in ProjectWise.

OPD usually sends consultants to GeoPI for project budget information, scheduling information, and status reports. The office controls what information is available externally, which does not include draft documents. Review agencies, such as the Corps of Engineers, usually want hard copies and send back hard copies of approvals. Larger documents are distributed to consultants through email or the FTP site.

5.1.13.3 Challenges

OPD finds that oftentimes it is easier to distribute documents through email because people are not always comfortable using a dashboard like ProjectWise.

5.1.14 Roadway Design

The Office of Roadway Design is responsible for the design of state transportation projects, including the development of conceptual layouts, preliminary and final construction plans, and right-of-way plans. This office focuses on quality assurance, quality control, and consultant oversight.

5.1.14.1 Software

The design software used by the Office of Roadway Design is InRoads with Bentley MicroStation used for computer aided drafting. ProjectWise is used officewide as a document management and distribution system for PDFs. For example, final plans are posted in ProjectWise, and a link is emailed to those who need access. The following categories have a folder in ProjectWise: environmental surveys, concept reports, geometry, quality assurance, preliminary field plan review, ROW plans, final field plan review, permitting, and letting plans. Plan sets are printed, and the cover sheet is signed one time by the chief engineer.

Specified user groups have different privileges to access folders in ProjectWise. These groups are determined by the Office of Design Policy and Support and must be established each time GDOT has a new consultant. In some cases, however, other people might be interested in looking at documents, such as submittals. An original copy of each document is stored separately in case something is modified or deleted. ProjectWise is occasionally used for historical plans research. The Office of Roadway Design supports the use of ProjectWise as a department-wide document management system. Unfortunately, some offices are not currently taking advantage of the software's full

potential. The Office of Roadway Design does not work with SiteManager. Although they are using components of e-Construction, such as PDFs and emails, they believe there is room for improvement.

By January 1, 2019, the Office of Roadway Design plans to provide contractors with pre-bid models electronically. The Office of Roadway Design or the district design office currently does 3D modeling to replace cross sections, but the software is not being used to its full advantage. This new process is expected to reduce cost, eliminate risk, and increase trust in plans.

5.1.14.2 Communication

Before a project is awarded, the Office of Roadway Design communicates with the Office of Construction and the CBA. During construction, the office communicates with both the state Office of Construction and district construction offices. In addition, they receive questions from the contractor via telephone call or email. Field conditions might lead to a request for evaluation of design or redesign. Post-construction, there is communication between the district office liaison, project manager, and construction engineer through email and telephone calls.

5.1.14.3 Challenges

Generally, the Office of Roadway Design does not have issues with document transfer due to the folder structure and milestone tracking in ProjectWise. There are duplicate files of concept reports, final plans, etc., but they are meant to document changes during design. For the most part, ProjectWise eliminates the mistake of looking at the wrong version of a document.

One challenge the Office of Roadway Design faces is resolving problems in the field as quickly as possible. Oftentimes, this process requires coordination with several different offices, while being filtered through the project manager. The office notes that it can be difficult to determine who is responsible for what. Furthermore, the design team might be working on a solution, while people in the field have not received any updates.

5.1.15 Right-of-Way

The Office of Right-of-Way acquires the property necessary for transportation projects. This office is responsible for design review and approval of plans, appraisals, relocation assistance, condemnation, negotiation, and property management.

5.1.15.1 Software

TPro is the database used to store right-of-way data and track property disposals. The database can be used to run queries, and it is tailored for specific ROW tasks (i.e., relocation packages, appraisals, condemnation, etc.). Other software programs used by the Office of Right-of-Way include ProjectWise, e-Builder, PeopleSoft, the file transfer site, and GeoPI. ProjectWise is used for document storage. PCCCommon and SharePoint are used to share documents with other offices. GDOT 411 is a database that stores data from TPro but not ProjectWise and provides querying capabilities.

ROW plans are submitted to the Office of Right-of-Way electronically through ProjectWise. The plans are reviewed on Bluebeam, and the office communicates through email and ProjectWise regarding corrections. The plans are then approved in ProjectWise. The ROW authorization process begins upon approval of the plans. A hard copy of Form 1625 is sent to the Office of Financial Management for final approval.

Although the Office of Right-of-Way still communicates through email, documents are always stored and accessed through ProjectWise. Projects that do not have a PI number are assigned a number beginning with H. Those ROW files are stored on a CD. All new projects that come to the Office of Right-of-Way now have PI numbers.

When the Office of Right-of-Way receives ROW plans, the project is assigned to a district ROW team manager. All activities and acquired assets are tracked in TPro. It shows timelines for appraisals, as well. TPro is a comprehensive database for storing metadata, while ProjectWise is a storage unit and is not able to run queries. Office of Innovative Delivery projects are still documented in TPro, but they also require the use of e-Builder internally and externally. E-Builder is even more comprehensive and captures great detail; however, it does not track all milestones in the parcel acquisition life cycle. E-builder requires TPro, but TPro does not require e-Builder. The Office of Right-of-Way has a flowchart explaining the functionality of e-Builder. The district ROW offices do not use e-Builder because they are not usually involved with design–build projects.

The Office of Right-of-Way requests checks and financial information through PeopleSoft, the state accounting system. Few people in the Office of Right-of-Way work with this program. CATS is the software used to route contracts and documents that require a commissioner’s signature, such as deeds. However, CATS only tracks signatures, so the documents are still kept as hard copies. Team Market Place is where supplies are ordered.

The Office of Right-of-Way is working toward using ArcGIS as an interactive system for all state and federal routes. The office is working with IT and Arcadis to make a comprehensive program that can be used with Citrix. A consultant helped the office

plot all parcels. The office feels it would be ideal to have TPro interfaced with the new GIS software.

5.1.15.2 Communication

The Office of Right-of-Way communicates with the Offices of Program Delivery, Innovative Delivery, and Environmental Services, and the district Right-of-Way teams (which are extensions of the Office of ROW). Consultants do not currently have access to TPro or Deed Writer. The Office of Environmental Services is running a pilot to test consultant access to TPro. The Office of Right-of-Way uses SharePoint or the FTP site to share large files with consultants. The Office of Design Policy is currently going through the process of providing access to ProjectWise to consultants in each office.

5.1.15.3 Challenges

The Office of Right-of-Way feels it is using too many applications with overlapping capabilities. Every time a new program is implemented, everyone has to be trained, including people in the district offices. For example, training for ProjectWise was provided 6 months before it was implemented. The office indicates there is a lot of repetition of documents, and that processes could be automated. One solution they suggest is to implement one central software that combines the capabilities of ProjectWise, TPro, and e-Builder. Another solution would be to continue using TPro and have it interfaced with ProjectWise and other software programs. The Office of Right-of-Way feels it is possible that the software solution for GDOT is to establish better interfaces rather than implementing one overarching software, as offices are more comfortable using their own software.

5.2 GDOT Software Usage and Challenges

Based on the information the researchers collected in the meetings with GDOT office representatives, two types of diagram were created to illustrate GDOT's construction administration software usage. The first illustration is a web-based, interactive mapping tool displaying GDOT's software usage in relation to office, project phase, and task. The diagram includes all GDOT offices that were interviewed, as well as the software programs that were discussed. These software programs were then connected to corresponding tasks and phases of construction (i.e., Programming and Scheduling, Concept Stage, Preliminary Design, Final Design, and Construction Phase). This mapping tool allows the user to scroll over any item and view the connections within each category. This tool is helpful in determining what software programs the department uses most frequently and which ones have overlapping capabilities. For example, Figure 4 shows the connections that are displayed when "ProjectWise" is selected. As the diagram shows, almost every office uses ProjectWise during all phases of construction. Figure 5 shows the connections that are displayed when the task "Share Documents Externally" is selected. The diagram demonstrates that several GDOT offices share documents with consultants, contractors, and other external agencies using four different software programs. This illustrates inconsistencies among offices and might suggest that some of these programs are unnecessary. This mapping tool can be continually updated to reflect any changes GDOT makes to its e-Construction processes.

The second type of illustration, shown in Figure 6, is a mapping diagram displaying GDOT's software usage in relation to office and task. The inner level contains the software programs mentioned in the meetings. The middle level shows the offices that

use each program, and the outer level shows what tasks they are used for. The size of each colored section indicates how common each software program is among the offices that were interviewed. Again, ProjectWise is the most commonly used software. SiteManager, TPro, Primavera, GDOT 411, GeoPI, CES, SharePoint, and CATS are other common programs. Although the diagram shows that e-Builder is used just as often as those programs, it is only used for Innovative Delivery projects. The appendix provides larger versions of the interactive mapping tool and the mapping diagram.

The meetings with the GDOT offices revealed common challenges regarding e-Construction processes, which are summarized in Table 3. Several offices mentioned the need for automating processes and creating workflows and a plan for where to store documents that do not have a project number. In addition, the offices see a need for improved electronic document distribution and software training, specifically for ProjectWise. There is a common issue of having documents in several locations and too many software programs with overlapping capabilities. Further, some programs might need to be modified to accommodate certain tasks and improve functionality. These challenges can later be used to assess the effectiveness of new e-Construction innovations.

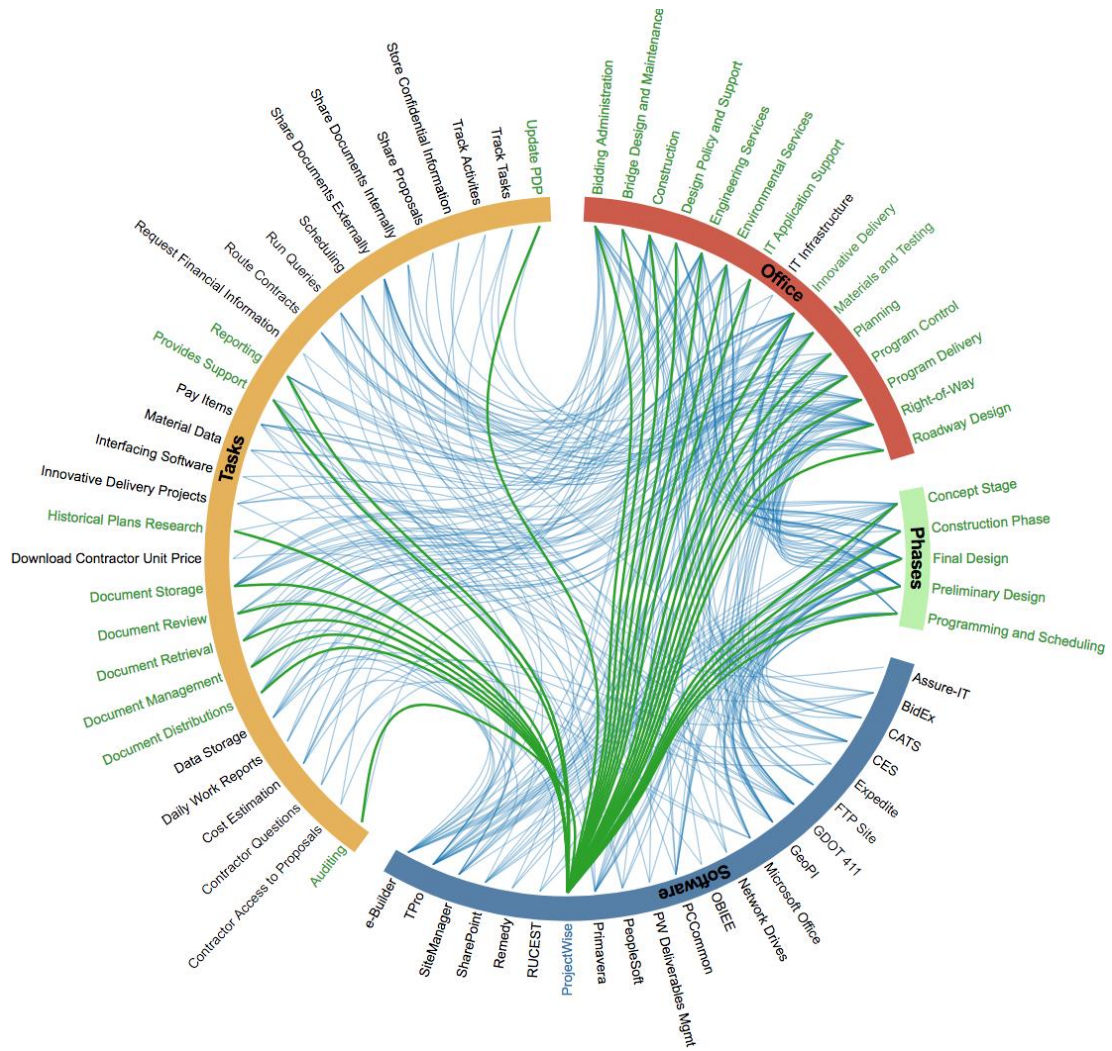


FIGURE 4

Interactive Mapping Tool of GDOT Software Usage (ProjectWise)

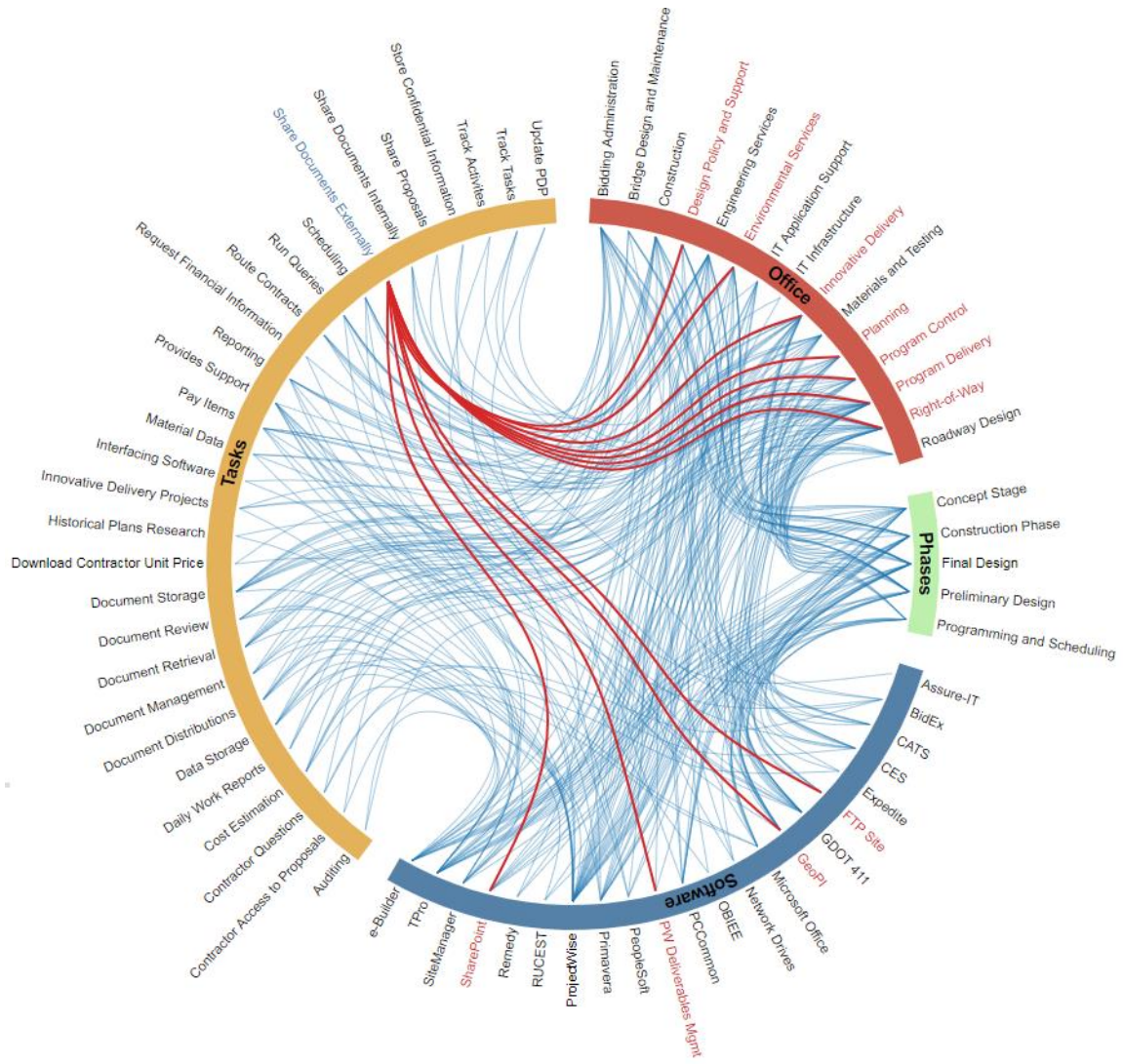


FIGURE 5

Interactive Mapping Tool of GDOT Software Usage (External Document Sharing)

**TABLE 3
 GDOT e-Construction Challenges**

Challenge	Frequency	Offices
Automating processes/workflows	5	Bidding Administration Environmental Services IT Application Support Program Control Right-of-Way
Documents without a PI number	4	Bidding Administration Bridge Design Environmental Services Planning
Electronic document distribution	4	Bidding Administration Engineering Services OMAT Program Control
ProjectWise training	4	Engineering Services Environmental Services Program Delivery Right-of-Way
Real-time information exchange	3	Construction Program Control Roadway Design
External access to ProjectWise	3	Construction Environmental Services Program Delivery
Converting old projects documents to electronic versions	3	Construction ODPS OMAT
Duplicate documents in various locations	3	Construction IT Application Support Right-of-Way
Unable to query in ProjectWise	2	Construction IT Application Support
Too many software programs with overlapping capabilities	2	Environmental Services Right-of-Way
Too many document-sharing programs among external agencies	2	Environmental Services IT Infrastructure

**TABLE 3 (Continued)
 GDOT e-Construction Challenges**

e-Builder	2	Environmental Services Program Delivery
TPro modifications	2	Program Control Program Delivery
Document size limitation in CATS	1	Bidding Administration
Interoperability of SiteManager and ProjectWise	1	Construction
Unable to respond to emails outside of the office	1	Construction
Clear milestones/timestamps	1	Construction
Availability to print plans	1	Engineering Services
Certain files cannot be created/opened in ProjectWise	1	Environmental Services
Too many folders in ProjectWise	1	IT Application Support
IT access to PeopleSoft	1	IT Application Support
Connectivity	1	IT Infrastructure
Keeping up with advances in technology	1	IT Infrastructure
Functionality of SiteManager	1	OMAT
Heavy reliance on IT	1	OMAT
Unnecessary automatic distribution	1	OMAT
Organization of requests	1	Program Control

5.3 FHWA AID Demonstration Project Narrative

Using the information collected from the meetings with the GDOT offices, the research team developed a draft Project Narrative on GDOT’s behalf. In the narrative, funding is requested for three major e-Construction initiatives: (1) accelerate implementation of AASHTOWare Project 4.1 and its suite of software products, (2) increase software training, and (3) assess the use of mobile inspection technology.

5.3.1 Project Abstract

Since December 2016, the Georgia Department of Transportation (GDOT) has been assessing the performance and process for carrying out e-Construction and preparing for full deployment of current e-Construction initiatives by December 2018. However,

GDOT Research Project 17-13 “Development of Implementation Plan for GDOT e-Construction Program” was conducted in 2017–2018 and determined technical and organizational barriers within the department and among external agencies related to the agency’s e-Construction program. All of GDOT’s offices currently employ e-Construction processes to some degree; however, the department sees a need for improved communication and document sharing through the adoption and accelerated integration of AASHTOWare Project 4.1 and its suite of software products. Furthermore, GDOT would like to invest in additional training for recently employed (i.e. ProjectWise) and future (i.e. AASHTOWare Project 4.1) software programs and assess new e-Construction technologies such as mobile inspection. This project is intended to improve GDOT’s planning and construction processes by developing and deploying “new tools, techniques, and practices to accelerate the adoption of innovation in all aspects of highway transportation.”

5.3.2 Project Description

The goal of this project is to implement more efficient e-Construction practices to be adopted by the state’s transportation community and used regularly on all projects. GDOT currently utilizes several software programs to facilitate electronic processes throughout all phases of construction. ProjectWise Construction Management, which was purchased in 2013, is currently the program most widely used by the department. This software is mostly used for document distribution, review, and storage. GDOT utilizes AASHTOWare Project Cost Estimation System for cost estimation and AASHTOWare Project SiteManager for daily work reports, material data, and pay items during

construction. BidEx and Expedite are used to facilitate the bidding process electronically. In addition, the department employs a number of in-house software programs, including TPro for data storage and reporting, Primavera for project scheduling, GeoPI to share documents externally, CATS to route contracts, PeopleSoft for financial information, and GDOT 411 to run queries among software programs. Some offices use SharePoint to share documents with contractors and other external agencies. Since GDOT's design-build projects are procured, regulated, and managed differently than other projects, the Office of Innovative Delivery uses e-Builder to distribute, review, and store documents for these projects. Field Construction Supervision Staff have been provided with the necessary equipment and technology to allow for access to electronic data in the field.

GDOT currently employs a multitude of software programs, several of which have overlapping capabilities. The department is interested in improving interfaces and data integration for more efficient information management throughout all phases of construction. Rather than investigating the potential for enterprise application integration of GDOT's numerous software programs, this proposal aims to accelerate the Department's implementation of AASHTOWare Project 4.1 suite of software products by replacing currently used GDOT programs that duplicate efforts and/or are inoperable with one another. Ultimately, the Department wishes to implement a software system that will allow for improved communication and integration among current construction processes. The accelerated adoption of the AASHTOWare Project 4.1 software will help GDOT achieve this by automating processes and workflows, which is the most common challenge among Departmental offices. By fully adopting AASHTOWare Project 4.1 suite of software products will provide a real-time and automated platform for data and

information exchange. Timing of data and information exchange are essential in facilitating and expediting project development. One of the greatest challenges is the nature of GDOT's Plan Development Process, which is not necessarily sequential. Often, related tasks are concurrent, which makes efficient information exchange key to the success of the project. Despite the capabilities of GDOT's current software programs, construction documents are still distributed through email and sometimes mailed as hard copies.

Automating processes and creating workflows are challenges GDOT hopes to address with this proposal. There is currently a need for more efficient communication and document transfer among offices. The implementation of the full suite of AASHTOWare Project 4.1 software products will allow the Department to automate document sharing, simplify document storage, and assist in better managing information throughout a project's life-cycle, thereby improving GDOT's ability to increase efficiency of document transmittal, review, and approval as well as enhance workflow management among all involved parties. Additionally, GDOT is interested in developing a robust training program for its employees and consultants for its newer software programs. Several software programs within the department are not being used to their full advantage, particularly ProjectWise. Advanced software training will further improve the buy-in and implementation of GDOT's e-Construction program.

GDOT has been aggressive in evaluating new e-Construction technologies such as e-Ticketing, e-Tagging, and 3D engineered modeling. These efforts are currently underway. However, one e-Construction innovation that the Department wishes to assess is the use of mobile inspection technology. GDOT's Construction Manual details the

requirements of the construction manager in completing Daily Work Reports (DWRs) and diaries. The DWR is a record of daily work activities, contractors, and subcontractors on the site. These reports typically include detailed descriptions of daily work, station numbers, measurements/quantities of materials and details for payment of work items. The Department seeks to identify opportunities to increase efficiency and improve the data quality through the project inspection process. An objective of this proposal is to complete a thorough review of GDOT's current business process for conducting project inspections and identify methods for supplementing current technology employed by the department (i.e. tablets) through the evaluation of mobile tools (i.e. software/applications) that have the capability of capturing and readily sharing the documentation required for project administration. To accomplish this, a review of GDOT's current business processes for project inspections will be completed with recommendations made for improvements. New mobile tools (software/applications) that provided the capabilities to incorporate the required and timely documentation for project administration will be evaluated while confirming their operability and compatibility of mobile tools with AASHTOWare Project and Projectwise.

5.3.3 Innovation Performance

The performance goals for the deployment of this innovation reflect the goals of the TIDP. Specifically, this study will lead to improved efficiency throughout the construction process, thereby resulting in a cost savings to GDOT through the elimination of document printing, transmitting, and storing with reduction in communication delays and transmittal time. These performance goals will be monitored, assessed, and

documented throughout several projects in relation to similar completed projects. Additionally, the department will track overall usage of AASHTOWare Project 4.1 software products and ProjectWise and user proficiency of the software before and after training.

A timeline for the project is as follows:

- 6 months for project planning phase regarding the accelerated adoption of AASHTOWare Project 4.1 (October 2018 – March 2019);
- 12 months for integration and transition to AASHTOWare Project 4.1 (April 2019 – March 2020);
- 6 months concurrently developing and implementing robust training program (April 2019 – September 2019); and
- 12 months concurrent assessment of mobile inspection technology (April 2019 – March 2020).

5.3.4 Applicant Information and Coordination

This application is being submitted on behalf of the GDOT Office of Construction along with the Office of Performance-Based Management and Research. The point of contact for this project is:

John Hancock, Office of Construction Administrator

Address: Georgia Department of Transportation
One Georgia Center
600 West Peachtree St NW, 11th Floor
Atlanta, GA 30308
Email: jhancock@dot.ga.gov
Phone: (404) 631-1971

The implementation of this project will require internal coordination with other GDOT offices, as well as external coordination with consultants and contractors. The GDOT offices involved with this process include Bridge Design and Maintenance, Construction Bidding Administration, Design Policy and Support, Engineering Services, Environmental Services, Innovative Delivery, Materials and Testing, Planning, Program Control, Program Delivery, Right-of-Way, and Roadway Design. The Offices of IT Application Support and IT Infrastructure will be involved with the development, operation, and management of computer hardware and software.

5.3.5 Funding Request

The Georgia Department of Transportation requests \$875,000 of available funding to streamline its current e-Construction practices as well as facilitate the assessment of new e-Construction technologies. The research conducted under GDOT Research Project 17-13 critically examined the current state of utilization of different software systems and technologies related to e-Construction at GDOT and identified needs for advancing the department's e-Construction program. The requested AID Demonstration funding will assist the Department in adopting AASHTOWare Project 4.1 software, improving software training provided to its employees, and assessing innovative mobile inspection technologies.

5.3.6 Eligibility and Selection Criteria

- As a state department of transportation, GDOT is eligible to apply for funding. The Georgia Department of Transportation has not previously received any

AID Demonstration funding. This project is eligible for assistance under Title 23 USC. GDOT is prepared to initiate the project within 6 months of applying for the funding.

- The project demonstrates an innovation with a technology readiness level in the development phase as defined by Table 1 of the Notice of Funding Opportunity. GDOT considers the Basic Research and Applied Research phases to be completed by RP 17-13 and other state DOT results. E-Construction is an EDC-3 (2015–2016) innovation and directly applies to the highway transportation industry, benefiting aspects of planning, financing, operation, structures, materials, pavements, environment, and construction. E-Construction has been proven in real-world applications, and documented benefits have been provided by the FHWA and state DOTs. Although GDOT currently employs aspects of e-Construction, it has not implemented a department-wide electronic document management capable of being integrated throughout the entire life-cycle of the project.
- GDOT accepts FHWA oversight of the project and will participate in monitoring and assessment activities regarding the effectiveness of the innovation. Additionally, GDOT will conduct a customer satisfaction survey before and after implementation of the innovation as standard practice. GDOT is committed to deploying this innovation as standard practice for the future of the department. GDOT will submit a report assessing the effectiveness of the project to the FHWA within 6 months of completion.

6. FUTURE WORK

Presented in this study is an e-Construction implementation plan based on discussions with representatives from GDOT offices interviewed in this study. The findings from this research can be used by GDOT to finalize a schedule for the planning, development, and implementation of more advanced e-Construction initiatives.

GDOT and other transportation agencies should discover ways to integrate information among their most commonly used software programs for more efficient project administration. In addition, transportation agencies can greatly benefit from robust training programs and workflows for new document management software. Future studies should be conducted to further explore new e-Construction technologies, such as mobile inspection, e-Ticketing and e-Tagging. It is important to research the experiences of other state DOTs and conduct pilot studies before implementing new innovations department-wide. After any new e-Construction innovation is implemented, assessments should be conducted to determine how it has affected project efficiency.

7. CONCLUSIONS AND RECOMMENDATIONS

The findings of this study revealed the limitations of GDOT's current e-Construction program by providing insight into the software usage and communication among its internal offices. In addition to in-house software programs, there are three different types of software frequently being used at GDOT: Bentley's ProjectWise Software, AASHTOWare Project SiteManager, and e-Builder. The most widely used software program is ProjectWise, which is used for document distribution, retrieval, storage, and management. In some cases, it is used for historical plans research, updating the PDP, sharing documents externally (with ProjectWise Deliverables Management), or reporting. AASHTOWare Project SiteManager is primarily used for daily work reports, pay items, and material data during construction. E-Builder is the software used by the Office of Innovative Delivery throughout the entire life cycle of a project.

Overall, it is recommended that GDOT focus on improving three aspects of its e-Construction program: (1) accelerated adoption of AASHTOWare Project 4.1, (2) increased software training, and (3) assessment of new technologies. Through the adoption of AASHTOWare Project 4.1 software, the Department will help automate processes and workflows, which is the most common challenge among GDOT offices. Software training and new e-Construction technologies will have a lasting impact on the efficiency of the department's construction administration processes.

REFERENCES

Bentley System, Inc. (2012, September 24). *AECOM Uses ProjectWise to Complete a Complex State Highway 50 Percent Faster and Under Budget*. Case Study.

Dawoud, M. (2016, September 1). "Notice of Funding Opportunity for Accelerated Innovation Deployment Demonstration." U.S. Department of Transportation, Federal Highway Administration.

Federal Highway Administration. (2017a, February 9). "e-Construction." U.S. Department of Transportation. Retrieved from <https://www.fhwa.dot.gov/innovation/everydaycounts/edc-3/econstruction.cfm>.

Federal Highway Administration. (2017b, September 28). "AID Demonstration Projects." U.S. Department of Transportation.

Federal Highway Administration. (2016a). *e-Construction Lead State Profiles*. U.S. Department of Transportation.

Federal Highway Administration, Office of Federal Lands Highway. (2016b, February 23). "Every Day Counts Initiative (EDC)." U.S. Department of Transportation. Retrieved from <https://flh.fhwa.dot.gov/programs/ttp/edc.htm>.

Florida Department of Transportation. (2015, July 13). *e-Construction How-To Guide*. Transportation Research Board.

Pavement Interactive. (2016, February 1). "What is e-Construction?"

Thompson, F. (2016). *AID Demonstration: Accelerated Innovation Deployment*. U.S. Department of Transportation, Federal Highway Administration.

Van Ness, N. (1989, September 21). "Computerization of Construction Records Memorandum." U.S. Department of Transportation, Federal Highway Administration.

APPENDIX:
MAPPING OF CURRENT GDOT SOFTWARE USAGE

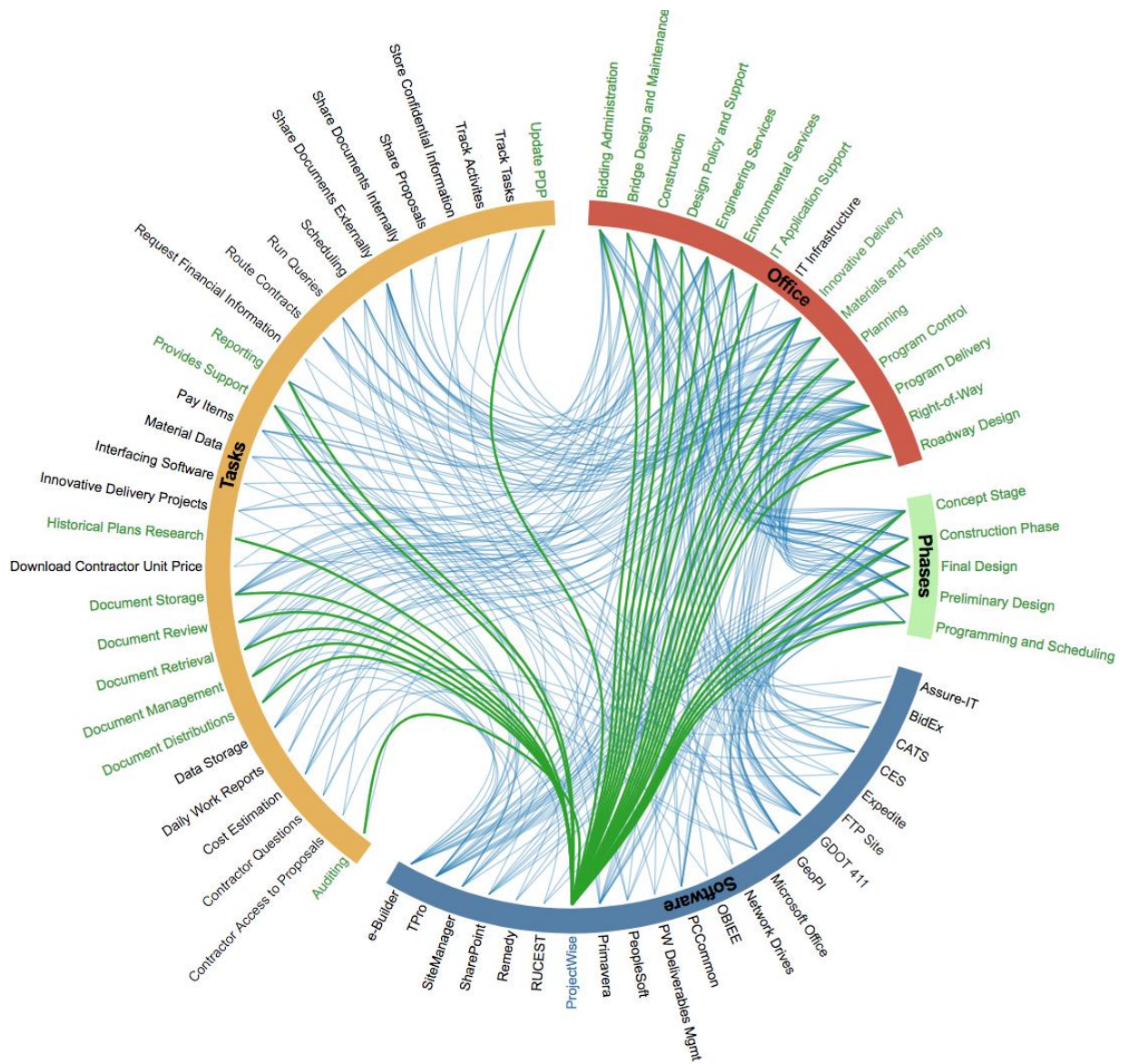


FIGURE 7

Interactive Mapping Tool of GDOT Software Usage in Relation to Office, Project Phase, and Task

