Research Management Database Business Analysis, TPF-5(181)

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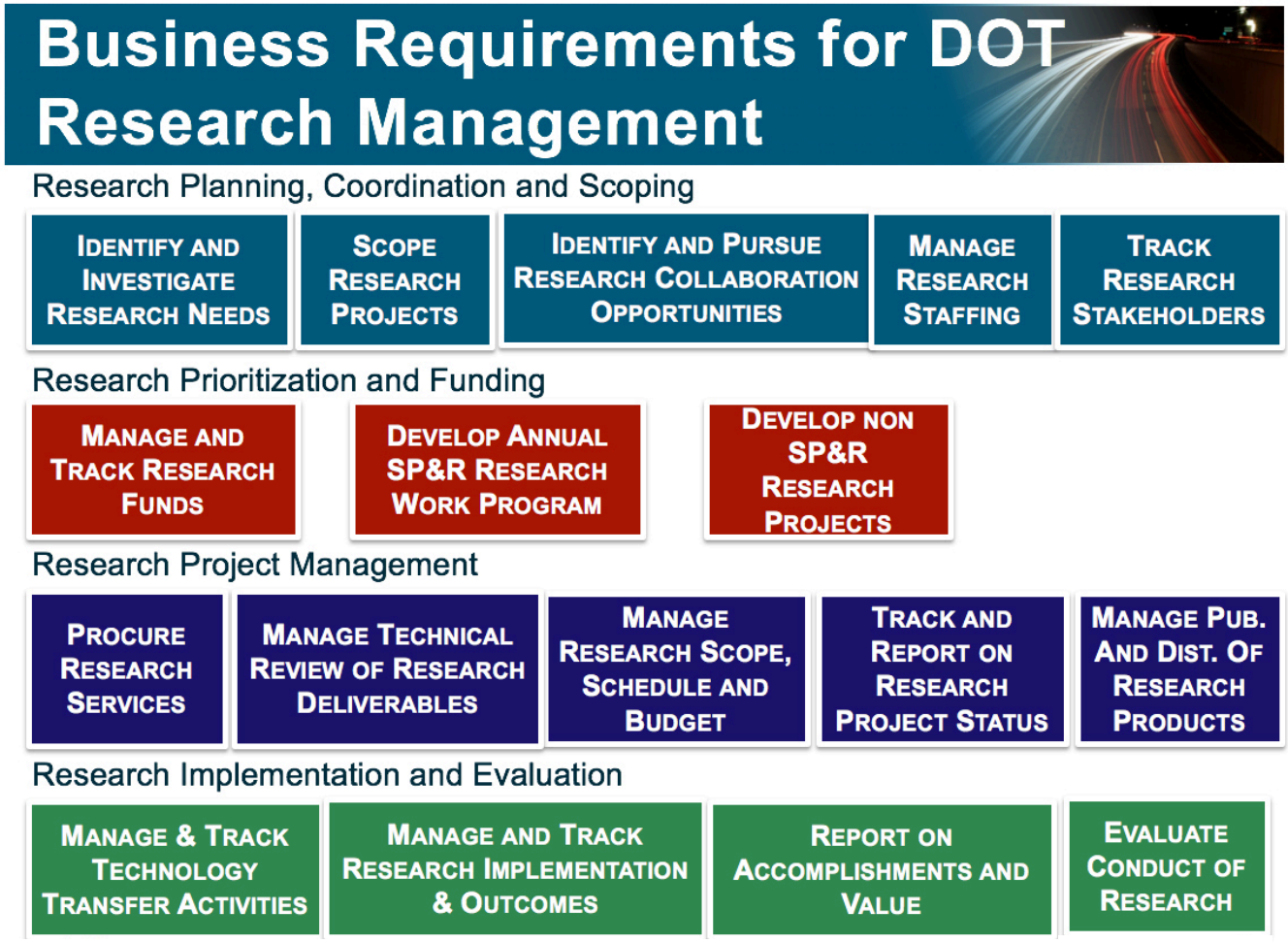

Washington State Department of Transportation
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WSDOT Research Report

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TPF-5(181)
Research Management Database Business Analysis
Final Report

Spy Pond Partners, LLC
Arlington, MA

July 2018

Transportation Program Management Database [TPF-5(181)]

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16. Abstract

This report presents the results of an analysis of business needs for state department of transportation (DOT) research project and program management databases. DOTs currently track their research information in a variety of ways. While a few agencies have implemented full featured research program and project management database systems (RPMDs), many are using spreadsheets or simple desktop databases to manage their information. Many agencies – particularly those with smaller research programs -- seek improvements to research data management and reporting capabilities but are constrained by staffing and information technology resource limitations. This research was conducted to provide a common base of foundational information for agencies wishing to develop or improve an existing RPMD and to explore options for future collective RPMD development activities that could benefit multiple agencies. The research involved synthesis of business, functional, data and transition requirements for an RPMD. Requirements development was based on review of existing research manuals, RPMD documentation, and interviews with research stakeholders at DOTs, universities, the Transportation Research Board (TRB) and the Federal Highway Administration (FHWA). Based on the requirements, the research identifies several future initiatives for consideration to improve research data management and sharing practices. These initiatives include development of a research data exchange standard, creation of a model research data mart, and collaborative development of a basic, web-based RPMD through a collaborative effort by interested agencies.

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1. Introduction

1.1 Background

State Departments of Transportation (DOTs) manage research programs supported by State Planning and Research (SP&R) Part 2 and other funding sources. Each agency follows a similar process of identifying research needs, selecting and managing projects, reporting on progress, disseminating results and facilitating implementation. Some DOTs have developed Research Program and Project Management Databases (RPMDs) to track information about research projects and provide reporting functions. Others use spreadsheets and manual paper processes to manage information. While RPMD needs vary across agencies based on program size, many DOTs are looking to improve and streamline their research information management capabilities. There may be opportunities to save DOTs time and effort by creating common reference requirements for RPMDs – or potentially, common RPMD software modules that could be adapted to different agency needs. Adoption of managed vocabularies (term relationships) and data elements could also facilitate information sharing about research needs and activities across DOTs, leading to enhanced collaboration and an improved understanding of the value of State Planning and Research (SP&R) funded research at the national level. The report presents the results of a contract undertaken as part of a Transportation Pooled Fund Study TPF-5(181) to conduct an analysis of RPMD business needs and recommend future development options to meet these needs.

1.2 History of TPF-5(181)

Initial Pooled Fund Project (2008)

Recognizing the common need for a robust state DOT research program and project database management capability, in 2008, seven DOTs (Alaska, California, Indiana, Michigan, Nebraska, New York, and Washington) initiated TPF-5(181): Transportation Research Program Management Databases. The original purpose of this project was to adapt and enhance an existing research program management database (RPMD) developed by the California Department of Transportation (Caltrans) to meet the needs of the participating states.

This project was a partial success – Caltrans' RPMD was implemented at the Washington State Department of Transportation (WSDOT). However, plans to enhance the original RPMD with additional modules and migrate it from a desktop database system (FileMaker Pro) to a web-based system (.NET) were not completed.

Several challenges were identified with the project. Adapting the Caltrans program for other DOTs proved more difficult than anticipated due to the size and complexity of Caltrans' research program relative to other DOTs, as well as agency differences in reporting needs and environments. The project's Technical Advisory Committee concluded that "modifying the RPMD was not the most feasible strategy for development of state DOT research databases as both modification of the system for other agencies and the development of new modules is more difficult with a more complicated schema than most state DOTs need." Another challenge was that new requirements within Caltrans

for the RPMD emerged which added scope and costs. Changing priorities and limited Information Technology (IT) staff resources made it difficult to absorb these changes without impacting the research project scope and budget.

A key lesson learned through the project was the importance of having "a clear business need and functional outline before pursuing database development." Subsequent activities related to TPF-5(181) therefore shifted focus to business analysis rather than software development.

State DOT Practice Survey (2013)

The American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee (RAC) commissioned a survey of state DOT research databases in 2013, updating a prior similar survey conducted in 2008. CTC & Associates conducted the survey and summarized its results. Forty-six agencies responded to the 2013 survey. Findings were as follows:

- 40% of respondents used spreadsheets; 60% used databases.
- 24% of spreadsheet users and 19% of database users were satisfied with their current system.
- 46% of database users used Microsoft Access; others included Oracle, SQLServer, SharePoint, FileMaker Pro.
- 51% of database users considered their system very transferable or moderately transferable to other states; 27% didn't know.
- 27% of database users reported that their system was integrated with other DOT systems (e.g. financial system.)
- Databases included: SP&R-funded, state-funded, pooled fund studies, University Transportation Center (UTC) projects, Innovative Bridge and other Federal Highway Administration (FHWA) projects, Experimental Features projects, and other types of research projects.
- Information included in databases varied and included: problem statements, requests for proposals (RFPs), proposals submitted, oversight committee members, research topic areas, investigator contact information, contracts and amendments, quarterly progress reports, invoices, detailed financial information, implementation information, and email notifications.
- Reports included: problem statements, project summaries, annual FHWA work programs, annual reports of completed and in-progress projects, quarterly progress reports, financial summaries, and implementation status reports.

2015 WSDOT Information Compilation

Building on the initial work of TPF-5(181) and the 2013 practice survey, WSDOT - the lead agency for the pooled fund study - requested detailed information from state DOTs on their current research databases. Forty-one agencies responded to the request; 33 provided detailed information (e.g. databases, screen shots, lists of data elements, etc.)

The key business purposes of an RPMD were summarized as follows:

- Collect research need statements
- Support project selection
- Manage contract and financial data for projects
- Manage program contributions
    - National Cooperative Highway Research Program (NCHRP)

  - Transportation Research Board (TRB) Core Services
  - AASHTO Technical Service Programs
  - Transportation Pooled Fund (TPF)Program)
- Manage all types of research projects (SP&R, TPF, other national, university, state, or local programs)
- Manage problem statements submitted to national programs
- Manage matching funds
- Manage people associated with state and national projects
- Provide program and project alerts
- Collaboration support for research project management

Detailed information on specific attributes maintained by each state was compiled and synthesized. Common attributes were grouped into seven categories:

- General (Project)
- Problem Statements
- Contracts – agreements, amendments/modifications
- Funding (Budget) – budgets, invoices, payments
- Schedule – events, project tasks/milestone tracking
- People (Groups) – researchers, agency staff, committees
- Results (Product) – deliverables/reports, performance measures/outcomes, implementation activities

Key observations were:

- There are several common/similar attributes in transportation research management databases.
- There are similar interests in research management but varied levels of functionality.
- There is variation in what is tracked, how it is tracked, and what things are called.
- Generally, there is little automation of workflow and reporting (though opportunity to improve efficiency by doing so).
- There is opportunity to improve the efficiency of research program and project management with technology.
- The majority of States are not satisfied with their current RPMD solution.
- Most states do not have financial support to develop/improve their research management databases.

The next iteration of TPF-5(181) was initiated in January 2017 to build on the information gathered by WSDOT and produce a business analysis supporting future development of enhanced state DOT RPMDs. The remainder of this report describes the results of this latest (and final) portion of TPF-5(181).

1.3 Project Objectives and Scope

The objective of this project was to establish a clear understanding of business needs and potential State Department of Transportation (DOT) Research Program Management Database (RPMD) functions to manage research projects across their entire lifecycle.

Project tasks included:

- Analysis of research program and project management business processes at different state DOTs to understand commonalities;
- Identification of current and desired information inputs and outputs associated with different research business activities – and distinguishing common and unique data requirements,
- Identification of functional requirements for an RPMD to support the business processes,
- Consultation with key stakeholders to validate and augment RPMD requirements,
- Identification of options for developing a new RPMD (or RPMD components) that would serve the needs of multiple state DOTs, and
- Development of recommendations for how state DOTs might transition from their current RPMD solutions to a new solution.

1.4 Report Organization

Chapter 2 of this report presents business requirements for research program and project management.

Chapter 3 identifies associated functional requirements for an RPMD system to support these business requirements.

Chapter 4 identifies data requirements for research program and project management – and distinguishes items needed for external reporting requirements.

Chapter 5 discusses options that were considered in this project for future improvements to state DOT research databases and to national-level databases. It presents the results of interviews conducted to discuss these options and document transition requirements – i.e. what it would take for DOTs to implement enhanced RPMD capabilities.

Chapter 6 presents recommendations for future consideration.

Appendix A presents results of an updated survey of state DOT RPMD systems.

Appendix B provides information about a set of RPMD data models developed for this project that are available as a resource for agencies.

2. Research Program and Project Management Business Requirements

2.1 Purpose and Approach

Business requirements for research program and project management describe what DOT research offices need to do, which provides the foundation for identifying functional and data requirements for a research database (RPMD) system. A set of DOT research business requirements were identified based on minimum federal requirements for State Planning and Research (SP&R) funding (outlined in Section 2.2), input from interviews with stakeholders and a review of DOT research manuals. Requirements are organized into four high-level categories, illustrated in Figure 1.

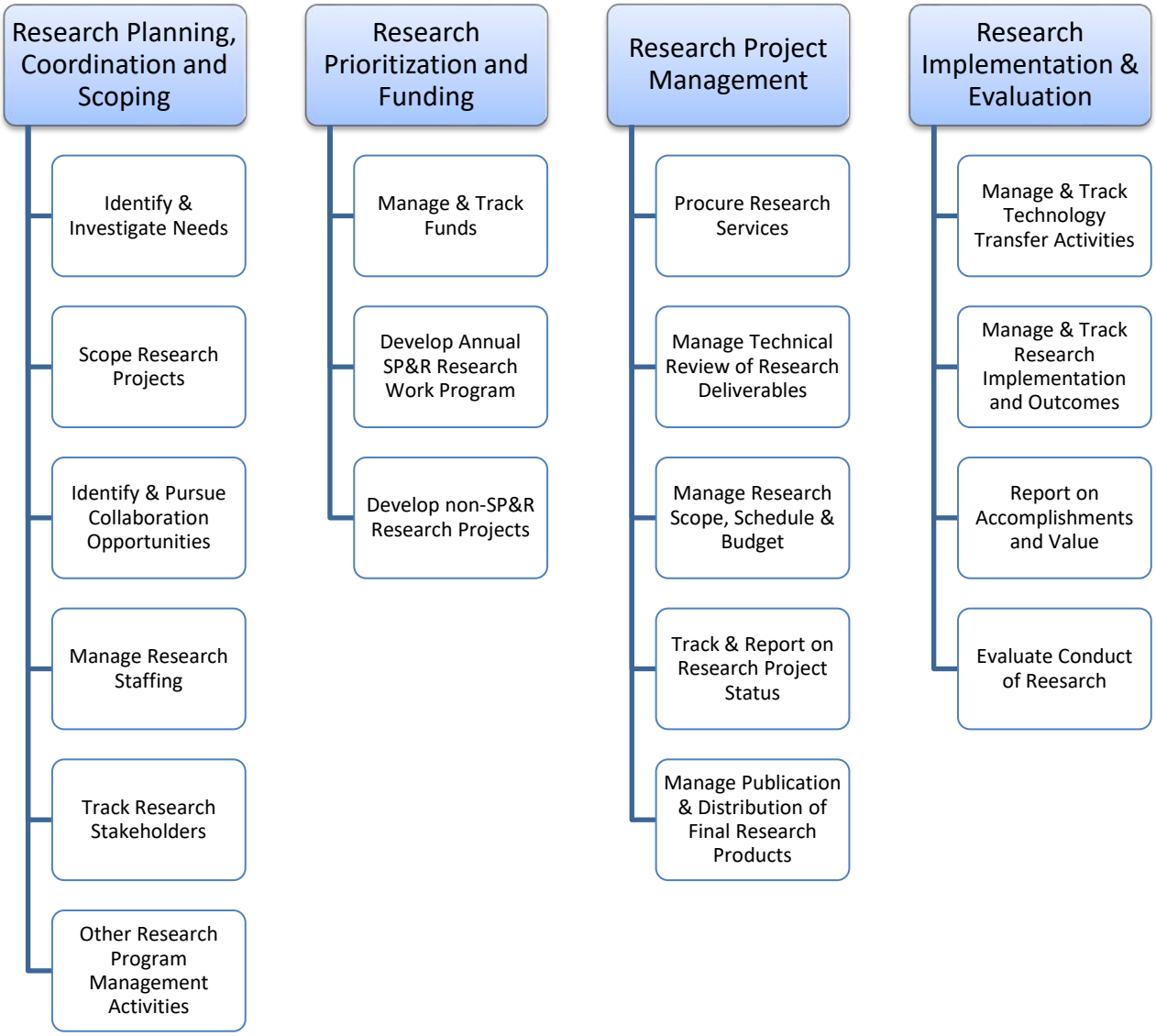

Figure 1. Research Program and Project Management Business Requirements

These business requirements cover the full cycle of defining research needs, scoping, and programming prioritizing research for funding, managing research projects, and then pursuing implementation and technology transfer activities to realize the value of research. Every data element and function of an RPMD should address a business requirement. However, each business requirement does not necessarily need to be addressed by an RPMD function. Smaller research programs may choose to focus their RPMD on research project management only whereas larger programs may pursue a more comprehensive approach.

It should be noted that the specific state practices highlighted in this document represent a snapshot in time and are continuously evolving. For current information on research practices in a given state, it is advisable to contact the research office directly.

The following section outlines the federal requirements that DOT research offices must meet; subsequent sections cover each of the individual business requirements shown in Figure 1.

2.2 Federal Requirements

In order to maintain eligibility for SP&R funds, DOT research offices must establish and implement a management process that ensures effective use of available Federal Highway Administration (FHWA) planning and research funds for Research, Development and Technology (RD&T) activities on a Statewide basis. This process must meet the following minimum requirements, as established in 23CFR 420.207 (FHWA):

1) An interactive process to identify and prioritize RD&T activities for inclusion in an RD&T work program.
2) Use of all FHWA planning and research funds set aside for RD&T activities, either internally or for participation in transportation pooled fund studies or other cooperative RD&T programs, to the maximum extent possible.
3) Procedures for tracking program activities, schedules, accomplishments, and fiscal commitments.
4) Support and use of the Transportation Research Information Service (TRIS) database for developing programs, reporting active RD&T activities, and inputting final report information.
5) A process to enter new research into the Research in Progress (RiP) database.
6) Use of TRIS and the RiP databases to search for duplicative or complementary research conducted previously.
7) Procedures to determine the effectiveness of the State DOT's management process in implementing the RD&T program, determine the utilization of the State DOT's RD&T outputs, and facilitate peer exchanges of its RD&T program on a periodic basis.
8) Procedures for documenting RD&T activities by preparing final reports. At a minimum, the documentation must include the data collected, analyses performed, conclusions, and recommendations. The State DOT must actively implement appropriate research findings and should document benefits.
9) Participation in peer exchanges of its RD&T management process and of other State DOT programs on a periodic basis.
10) The State DOT must develop documentation that describes its management process, including the procedures for selecting and implementing RD&T activities, and submit this documentation

to the FHWA Division office for certification. State DOTs also must submit significant changes in the management process to FHWA for certification. The management process certification should be included in the State RD&T work program.

2.3 Research Planning, Coordination and Scoping

This first category of business requirements involves managing the early stages of the research life cycle, as well as performing supporting research program management activities including staff management, stakeholder tracking, peer exchange tracking and research manual updating.

Identify and Investigate Research Needs

This involves processes to identify research needs and vet ideas that are suggested to determine which to pursue further. Specific activities may include:

- Establish research program objectives & priorities
- Solicit and compile research needs from stakeholders
- Investigate research needs through literature reviews and/or expert consultation
- Develop research roadmaps or multi-phase research plans
- Determine whether to proceed with development of research candidate projects

Some agencies approach this in a highly formalized manner through defining research program tracks and developing roadmaps to guide the process. For example:

- Caltrans has 12 Program Steering Committees (PSCs) that identify program level research priorities and annually approve multiyear research roadmaps.
- Ohio DOT establishes research focus areas to identify the topics of interest in which the agency intends to invest its research efforts and funds. These are re-evaluated every two years to ensure alignment with the agency's business plan.

Some agencies track research needs identified by others through the TRB RNS, AASHTO Center for Environmental Excellence (CEE) Transportation Environment Research Ideas (TERI) database, resources posted to the AASHTO/TRB Research Program and Project Management (RPPM) Website and through available Google custom search tools[1]. This facilitates communication, coordination, and collaboration, as well as preventing reinventing the wheel.

Other agencies do not have formalized research planning processes but rely on a periodic solicitation process to gather ideas within general categories of interest.

The process of soliciting new research needs typically involves a multi-faceted approach. DOTs may have established internal committees organized by topic area who develop research needs. In addition, many agencies have established relationships with universities involving discussion of research needs and ideas. A formal solicitation for research problem statements is often conducted as part the research work program development cycle.

[1] See: https://www.wsdot.wa.gov/NR/rdonlyres/8C50229D-FF27-4350-927E-0DE592BF6447/0/Mining_hyperlinks.pdf

There are variations across states in the scope of research needs solicitation, the role of the research office, whether the solicitation is internal only or open to external stakeholders, and the format and level of detail requested for research needs statements.

For example:

- In Florida, an annual solicitation is sent to 11 research coordinators representing substantive areas (maintenance, construction, materials, safety, structures, etc.) and to each district secretary. The research coordinators and district contacts are responsible for gathering research needs within their areas.
- In Louisiana, the research work program is developed by the Louisiana Transportation Research Center (LTRC), administered jointly by the Louisiana Department of Transportation and Development (DOTD) and Louisiana State University (LSU). LTRC accepts research problem statements at any time, but conducts a formal biennial solicitation from LTRC, DOTD, universities, and transportation industry representatives.
- In Montana, the research programs manager conducts an annual open solicitation for research topics.
- In New Hampshire, suggestions for research may be submitted at any time to the Bureau of Materials & Research using an online Research Project Suggestion Form. In addition, the Research office periodically solicits ideas from Department personnel and other appropriate organization.
- In North Carolina, the research manager sends an annual solicitation for specific research needs to all NCDOT staff every spring. A separate solicitation is sent to university researchers.
- In Ohio, there is an annual internal solicitation for research ideas to divisions, districts, and offices. An online "Idea Form" is provided to gather problem statements.
- In Washington, Research Advisory Committee (RAC) members identify research needs and are encouraged to hold workshops with stakeholders (including Regions, Modes, Universities, federal and local partners, etc.) as part of this process.

Once research ideas are received, they are typically vetted to determine whether they merit further advancement. This process will typically involve a literature review to determine whether there is already existing similar or related research available, as well as consultation with subject matter experts. There is variation across DOTs with respect to who performs the vetting and when, the level of effort involved, the nature of the output.

For example:

- In California, a Preliminary Investigation (PI) is required to establish the need for new or additional research. The PI involves a literature review and identification of best practices in a specific field and function of the transportation system. Preliminary Investigations may be performed by agency staff or external consultants and involve a standard set of management and oversight activities. The product is a detailed report summarizing the literature, state of the practice and gaps. Program Steering Committees and Technical Advisory Panels review the results and determine which projects to move forward. See: www.dot.ca.gov/research/researchreports/preliminary_investigations/.

- In Montana, submitted research topic statements must have a champion and a sponsor, and must be approved by a Research Review Committee. Approved topics are assigned to a Technical Panel for further review. The Technical Panel determines the need for the project based on their expertise and a review of the literature.
- In New Hampshire, a preliminary literature review is conducted by Materials and Research Bureau staff for each submitted problem statement. Problem statements that are found to have prior potentially duplicative research are referred to sponsors for review and revision.
- In Ohio, there is an expectation that research project statements will be vetted by the sponsoring office prior to submittal for funding consideration.
- In Washington, research needs are vetted first as part of the solicitation process through stakeholder input, and again as part of problem statement development by functional areas.

Scope Research Projects

This involves processes to turn research needs or ideas into problem statements that can be evaluated and prioritized for funding – and identification of potential funding sources for the projects. For example, a problem statement may include a list of tasks, anticipated research products and a rough cost estimate.

Once a candidate research project is approved for further development, the initial scope is typically refined. This may occur through a Request for Proposal (RFP) process if the work is to be contracted out, or through an internal scoping activity. States vary with respect to how much scoping occurs prior to selection of projects for funding. For example:

- In California, once a candidate project or task passes the initial vetting process by the Program Steering Committees, it is passed along to a Project Panel, whose members are responsible for developing a detailed Project Plan that specifies scope, schedule and budget. Initial Project Plan development occurs prior to final approval of the research portfolio. Once a project is approved and initiated, the Project Plan is updated during the course of the project.
- In North Carolina, vetted research problem statements are made available to university researchers, who may then submit preliminary proposals. These proposals are a maximum of seven pages, and include preliminary task descriptions, budgets, and schedules, along with proposed Principal Investigator qualifications. Research Technical Subcommittees evaluate the preliminary proposals and invite selected researchers to submit full proposals. The full proposals are then prioritized for funding by the Research Executive Committee.
- In New Hampshire, a Technical Advisory Group (TAG) is formed to draft a work plan and set a budget for an approved SP&R project. The TAG conducts an in-depth literature review to inform this process.
- In Ohio, sponsoring offices provide a list of tasks and products on the Idea Form. Selected research ideas are scoped in the RFP development process, which is carried out by the Research Section and the sponsoring office.
- In Washington, scopes are developed by selected Principal Investigators once the final SP&R project selections are made.

Identify and Pursue Research Collaboration Opportunities

DOT research offices seek to take advantage of opportunities to collaborate and pool resources with partner agencies, and advance project ideas for national research funding programs.

DOTs may pursue a variety of avenues for research funding, including:

- The FHWA-administered Transportation Pooled Fund Study program allows agencies to pool funds and jointly sponsor research that is of interest to multiple agencies. One agency takes the lead and assumes project management responsibilities; others participate in project oversight.
- The TRB-administered National Cooperative Research programs (NHCRP, TCRP, ACRP, etc.) conduct annual solicitations for research problem statements.
- The TRB-administered Innovations Deserving Exploratory Analysis (IDEA) program funds investigations of promising but unproven innovations for highways, transportation safety, and transit.

DOT research offices may coordinate submittal of problem statements to these programs and track the status of the problem statements that have been submitted. They may also participate in prioritization and selection of research through AASHTO RAC.

Typical activities include:

- Consult with peer agencies, universities and other partners to identify collaboration opportunities;
- Evaluate requests for Pooled Fund Project participation;
- Develop, review and vote on NCHRP problem statements; and
- Investigate other collaboration opportunities.

Manage Research Staffing

DOT research offices range in size from a single individual responsible for 5-10 projects to a staff of 5 or more managing 50-100 projects. Larger research offices need to keep staffing and project workloads in balance by anticipating staffing needs for anticipated projects and managing staff assignments to distribute workload.

Track Research Stakeholders

At the Program Management level, research offices track, refresh, and communicate with membership on agency committees involved in research program development and oversight. They conduct outreach at both the research need solicitation stage and again at the research dissemination stage. This outreach extends to individuals and groups inside the DOT as well as to external stakeholders.

As part of research project management, research offices track and communicate with sponsors, managers, and members of panels or technical teams for specific research projects.

Research offices also maintain contacts with participants in national research programs – to propose research problem statements for funding, to identify opportunities for DOT staff to participate in national research panels, and to ensure that relevant national research findings are disseminated internally within the agency.

Key research stakeholders include:

- DOT executives and managers who make decisions about research priorities and funding allocation;
- DOT staff who participate in activities to define, vet and prioritize research needs;
- DOT staff who implement and/or benefit from research products;
- DOT staff who serve as sponsors or managers of research projects;
- DOT staff who participate in research project scoping, researcher selection, technical product review and implementation planning;
- FHWA division office staff who review and approve SP&R work programs and progress reports;
- Researchers at universities, other public research institutions, and private companies;
- TRB and AASHTO committee chairs and members who develop and advance research needs statements;
- Members of NCHRP research panels; and
- FHWA Pooled Fund Study sponsoring and participating agency representatives

Research stakeholder tracking supports several activities across the research life cycle:

- Soliciting research ideas;
- Identifying research sponsors and customers;
- Pursuing and managing agency representation on national research committees and panels;
- Identifying and involving reviewers for research problem statements and proposals; distributing requests for proposals (RFPs) to qualified vendors;
- Assembling technical panels with specific areas of expertise;
- Managing project team communication and review processes;
- Planning research implementation activities; and
- Disseminating information about completed research.

Other Research Program Management Activities

In addition to the above, research offices must, at a minimum:

- Participate in periodic peer exchanges related to the RD&T management process and
- Document the research management process (typically in the form of a research manual) and obtain FHWA certification of the process (and re-certification when significant changes are made.)

2.4 Research Prioritization and Funding

This second requirements category involves selection, approval and programming of funds for individual research projects and activities; and keeping available funds in balance as project costs and schedules shift. These are program management activities; project management activities are covered in the next section.

Manage and Track Research Funds

This involves assessing available research funding, tracking funding commitments to determine what funds are available for new research activities, and managing matching funds. Research budgeting considers costs of research program administration, commitments to local technical assistance programs (LTAP), commitments to external programs (TRB, NCHRP, AASHTO Technical Services Program, other special programs such as Long-Term Pavement Performance, Strategic Highway Research Program); commitments for Pooled Fund Studies, and commitments for internally managed research projects.

In some states, research budgeting and funding management is a relatively straightforward task; in others there may be greater complexity due to availability of different types and sources of funding and the ability to carry over funds across fiscal years. The level of involvement and role of the research office in budgeting varies across DOTs – in some agencies, this function is partially handled by other business units with more general budget or program management responsibilities. The budgeting process establishes the financial constraints under which the programming process is carried out.

Activities may include:

- Tracking available funding by source (SP&R, State Funds, Grants, etc.) by state and federal fiscal year;
- Obtaining and tracking federal obligation authority;
- Tracking cumulative expenditures and future commitments for each funding program and year;
- Developing the research program budget – including both administrative and project cost components;
- Transferring and obligating federal funds for research projects;
- Managing matching funds for federally funded research projects; and
- Tracking how available funds are leveraged (e.g. through in-kind and/or other contributions)

Develop Annual SP&R Research Work Program

Each DOT research office is responsible for developing an annual SP&R work program that lists continuing and new projects for the upcoming federal fiscal year, with proposed funding amounts. This involves prioritizing and selecting projects for SP&R funding, drafting the work program, obtaining management approval of the work program, and obtaining approval of the work program from the FHWA Division office.

The SP&R project prioritization and selection process will typically involve evaluation of candidate problem statements by one or more technical experts and research customers, and some type of scoring or rating process. Many agencies have a standing research advisory committee that makes final recommendations for funding, with final approval by an executive management team. However, processes for prioritizing and selecting candidate projects for funding vary with respect to the complexity of the approval process, the prioritization methods, the nature and role of committees involved, and the timing of approvals for funding. In some agencies, final funding approval does not actually occur until projects are contracted; in others it happens earlier. Some agencies follow an annual cycle of program development activities; other agencies have a bi-annual cycle.

For example:

- In Florida, research coordinators are responsible for prioritizing research needs within their areas and obtaining functional area management review and approval. They submit ranked research funding requests to the Research Center. The Research Center reviews the requests with respect to their prioritization, potential impact/benefit, and potential for duplicating available or ongoing work, and in light of the research workload and past performance of the proposed project managers and principal investigators. They prepare a package of prioritized research needs for management review and approval. Management determines which projects are approved for funding.
- In New Hampshire, candidate research projects are rated and then ranked by the NHDOT Research Advisory Council (NH-RAC). The Bureau of Materials and Research develops the SP&R Part II Work Program based on the rankings and the available funds. The proposed program is submitted through the Director of Project Development to the Assistant Commissioner for approval. It is then submitted for FHWA approval to the Division Office. The NH-RAC includes voting members (primarily Bureau Administrators) from each of the major Divisions within the Department. Non-voting members participate from the FHWA Division Office and partner research and technology transfer organizations.
- In North Carolina, Research Subcommittees in five technical areas (Pavement, Maintenance and Material; Structures, Construction and Geotechnical; Environment and Hydraulics; Traffic, Safety and Roadway Design; and Planning, Programming, Policy and Transit) are responsible for recommending projects for funding to the Research Executive Committee (REC). The REC determines which projects will be funded.
- In Ohio, research ideas are assigned priority levels by the DOT's internal Standing Committee on Research (OSCOR) based on the agency business plan and needs. Recommended ideas are then forwarded to Executive Leadership for approval. Approved ideas are advanced for development of Requests for Proposals (RFPs). Executive Leadership reviews the RFPs and selects which ones are to be included in a solicitation.

Some states have established sub-programs within the SP&R work program. For example, Washington State DOT has a small set aside within its SP&R program for quick response projects to meet high-priority, opportunistic or emergent research needs.

Develop non-SP&R Research Projects

Project selection processes for the SP&R work program are typically separate from those for other research funding programs. Other processes for research project selection and approval may be in place for:

- Pooled-fund projects – state lead
- Pooled-fund projects – state participant
- 100% state funded projects (where applicable)
- Other federally funded research projects
- University research projects
- Projects funded through other sources

2.5 Research Project Management

This third requirement category involves activities to manage research projects from procurement of services through publication and distribution of research products.

Procure Research Services

Research procurement varies by DOT and by project. Some research activities are conducted by internal agency staff and do not require procurement. State law provides the foundation for procurement practices such as whether a state can obtain services from organizations in other states. DOTs use a variety of procurement methods; some involving open solicitation for proposals, others involving direct selection of a researcher based on existing contract agreements. Many DOTs have established partnerships with universities for conducting research, with master agreements in place for facilitating the contracting process.

Examples:

- In California, a Task Manager (TM) is assigned with responsibility for overseeing the research task from task execution to close-out. Research may be conducted internally or via contract with a university or consultant. Several different types of contract vehicles are available, with varying processes and requirements.
- In Montana, the project panel may choose to give the work to another governmental agency, such as a Montana university. Alternatively, the panel may choose to obtain proposals through the request for proposal (RFP) process. If the first option is selected, the agency is asked to submit a proposal. The panel recommends the best proposal to the Research Review Committee for funding approval. Once approved, an agreement for the research is executed.
- In North Carolina, the DOT has Master Agreements with several universities. Once a full proposal from a university is selected for funding, a Project Authorization document is prepared, serving as the contract for the research project.
- In Ohio, once RFPs are selected by executive leadership, the Research Office issues an open solicitation to the research community by posting the RFPs on the Research website. ODOT does not prequalify researchers. Proposals are reviewed and evaluated by research and technical liaisons. Final selections are approved by Executive Leadership.
- In Washington, once projects are approved for SP&R funding, a Request for Qualification (RFQ) is sent to government research organizations who provide qualifications for proposed Principal Investigators (PIs). If a suitable PI is not identified through this process, the RFQ is issued to other research organizations. After PIs are selected, they are asked to develop draft proposals. Draft proposals are circulated for review and comment. Based on the comments, the PIs submit final proposals. These are used to develop the research project contracts.

Typical procurement activities include:

- Develop description of the research objective
- Issue requests for proposals
- Respond to vendor questions
- Evaluate proposals and select vendor
- Negotiate scope of work and execute contract or task order

- Initiate research

Manage Technical Review of Research Deliverables

Once a research project is underway, the agency research manager is generally responsible for managing technical review of interim and final deliverables. In many DOTs, research projects are managed by agency staff outside of the research office; but research staff may play an oversight or coordination role. Typical technical management activities include:

- Distribute draft deliverables to reviewers for comment
- Synthesize and communicate comments to researchers
- Review revised deliverables and verify that comments are addressed

Manage Research Scope, Schedule and Budget

Management of scope, schedule and budget are essential project management activities and at the core of what many current RPMD systems support. Typical activities include:

- Notifying project managers and researchers of upcoming or past due milestones
- Tracking planned versus actual delivery dates for project deliverables and other milestones
- Processing requests for direct cost expenditures
- Reviewing invoices to determine whether to approve, reject or hold
- Processing invoices for payment
- Negotiating and processing contract amendments for changes to project scope, schedule and budget

Track and Report on Research Project Status

Agencies are required to report periodically on their SP&R research to FHWA. Some report on an annual basis; others on a quarterly basis. Pooled fund projects require quarterly status reporting. Some agencies produce a single annual report to meet both internal and external needs for status updates. Progress reporting involves obtaining and compiling information about completed and planned work, accomplishments, changes in project scope, schedule or budget, and issues encountered. Project managers will generally work with Principal Investigators to update this information.

Agencies are required to enter new research projects into the TRB Research in Program (RiP) system. Some agencies update RiP more frequently (e.g. annually) to reflect project completion or other significant status changes. These updates may be done by research office staff, library staff, or contractors.

Manage Publication and Distribution of Final Research Products

Research projects will generally be documented in a final report – for SP&R funded projects, this report must include at a minimum, a description of data collected, analyses performed, conclusions, and recommendations. Some research offices manage editing and production of research reports – this may be done by internal staff or by contractors.

Reports may be published in electronic form only; in hard copy, or both. Once publication is complete, research offices disseminate information about the report via web pages, email or social media announcements, RSS feeds and/or other communication methods. For SP&R reports, they are

required to submit it for inclusion in the Transportation Research International Documentation (TRID) (which creates a metadata record for the report) and in the National Transportation Library's digital repository (ROSA-P).

Research reports are also distributed to the FHWA Library, the FHWA Office of Corporate Research, Technology, and Innovation Management, Northwestern University Library and NTIS. Individual state DOTs have other distribution lists for reports – for example, to the DOT library (if one exists) and the state library. Reports produced by universities may also be posted on university websites and included in university libraries or archives.

2.6 Research Implementation and Evaluation

This final category of requirements covers tracking communication and outreach (to spread awareness and understanding of research findings and products), research implementation (changes made to practices based on research), and outcomes or benefits (time savings, safety improvements, etc.) resulting from research implementation. It also includes evaluations of the research process at the programmatic level and at the project level – in order to identify and pursue improvements.

Manage and Track Technology Transfer Activities

Technology transfer activities to facilitate awareness and adoption of research products may be conducted throughout the research life cycle. Activities may include: one on one meetings; stakeholder surveys to learn about concerns, level of awareness, and implementation barriers; group presentations; peer exchanges; and so on.

Tracking these activities can serve multiple purposes: accountability for the research office; keeping a recorded history of contacts and decisions for future follow up or reference; and providing the basis for future evaluation of what activities are most effective. Activities can be tracked at the project level (i.e. as part of the project implementation record) or collectively across the research program.

Various products may be produced to spread awareness of research – including newsletters, research briefs, research web pages, brochures, and videos. These products need to be managed and tracked as well so that they can be distributed, updated (as needed) and potentially, used as models for future products.

Manage and Track Research Implementation and Benefits

This involves activities before, during and after the project to develop and refine a plan for research implementation, to define what outcomes are anticipated, and to follow up with post-project studies to assess implementation status, activities and outcomes.

Research implementation activities are identified during the research project and final recommendations are discussed at close-out. However, tracking and reporting of activities extends beyond the project close-out. In some states, the panel formed to oversee the project continues to play a role in implementation once the research contract has been closed out. More commonly, research office staff conduct implementation tracking and post-project follow ups. Example processes are:

- In California, Project Plans identify the anticipated deployable products from the research. During the project, the research project manager works with the project panel and the

researchers to produce a detailed Implementation Plan that "provides the means for the customer to identify and document the necessary resources, processes, and requirements that will be needed to implement the product of the research." Customers are engaged during the research process to ensure that "resources will be available to implement the new policy, practice, product, or service." The Division of Research, Innovation and System Information produces an annual report for FHWA summarizing research project outcomes, benefits, and deployable products and services.

- In Montana, the project Technical Panel is responsible for evaluating the validity of the implementation recommendations from the PI and reporting its findings. Findings are made available to MDT Administrators, through the Research Review Committee. Administrators review and modify the recommendations and take responsibility for their implementation. Implementation actions are documented by Research in an annual report.
- In North Carolina, research implementation activities are identified and discussed during the course of projects, and a post-project implementation follow up is conducted. R&D unit staff conduct outreach to disseminate research findings, support training activities, and track implementation activities on a semi-annual and annual basis.
- In Ohio, an initial implementation assessment is discussed at the research project startup meeting. This assessment is reviewed and updated throughout the project and at close-out meetings. Implementation plans are prepared (where appropriate) by the Research Section (working with the Technical Panel) to identify actions to be taken beyond the research project, individuals/parties responsible for those actions and the timeline for ensuring the steps necessary to implement the results occur. The sponsoring office and the Technical Panel are responsible for monitoring implementation, but the Research Section conducts a post project follow-up. The Research Section produces an annual implementation report and maintains a historical record of research project implementation activities.

Report on Research Activities, Implementation and Value

This involves producing reports on research program activities, accomplishments and value. For SP&R projects, this may take the form of an annual SP&R accomplishments report. Some agencies produce separate internal reports for management review and public distribution.

- AASHTO RAC issues a solicitation each year asking states to identify and document recently completed for "high value research" projects. Criteria include demonstrated need, answers specific questions or deals with documented problems relating to the state transportation agencies and its practices;

Research results and implementation activities:

- The project addresses a demonstrated need, answers specific questions or deals with documented problems relating to the state transportation agencies and its practices;
- Research results and implementation activities display innovation;
- Project implementation has led to significant changes in agencies, positively impacting the conduct of business;
- Implementation of research results will lead to defined benefits (quantitative or qualitative) that outweigh the cost of research and implementation.

- The state or other appropriate agencies are making demonstrated progress in implementing the results of the research or otherwise following the project recommendations

For agencies wishing to submit projects and gain recognition, this information must be compiled and provided.

Evaluate Conduct of Research

One of the SP&R funding requirements is to have a "process to determine the effectiveness of the State DOT's management process in implementing the RD&T program." Research management effectiveness may be assessed primarily through post-project evaluations or approached at a more systemic level. Activities may include post-project evaluations of Principal Investigator or consultant performance, conducting surveys of research customers to determine level of satisfaction and suggestions for improvement, and reviewing research outputs and outcomes to identify potential improvements to research management efficiency and effectiveness.

A recent research peer exchange (Kirsten Seeber and Brian Hirt, 2018) and associated survey identified the following performance tracking activities related to conduct of research:

- Montana Transportation Department does exit surveys at project closeout that go to the project panel and the consultant. The survey measures satisfaction with the researcher and the Research staff. Results are passed along to researchers.
- Minnesota DOT does an exit interview for each project, and tracks results in their research database system (ARTS).
- Ohio DOT, Texas DOT, Utah DOT do periodic research customer surveys.
- New Jersey DOT has a Research Implementation and Closeout Risk Assessment Survey that must be completed by the customer and Research Project Manager within 60 days of accepting the final report package from the Principal Investigator. They also document projects every 5 years in an implementation report which includes all project implementation efforts.
- Missouri DOT tracks research projects completed on-time.
- New Hampshire DOT tracks the number of research projects funded/completed and how recognizable the program is by the Department through a survey.
- DC DOT tracks multiple performance measures for the research program, including:
    - Number of research results and best practices implemented.
    - Percentage of projects completed on time and within budget.
    - Number of research needs statements submitted. (annual call)
    - Number of presentations to or meetings with prospective external partners.
    - Number and type of research collaborations with internal and external partners.
    - Problem statements submitted to national research programs.
    - Number of NCHRP and other external research program results implemented at DDOT.
    - Number of presentations to DDOT units to foster engagement in RDT services.
    - Percent of DDOT divisions/branches participating in essential functions of the RDT program: problem statement submission, project panel participation, evaluations, and research results implementation.

3. Functional Requirements

3.1 Purpose and Approach

RPMD functional requirements were identified based on the business requirements presented in Chapter 2, as well as a review of existing RPMD system functions. Functional requirements address the question: "what should an RPMD system do to support the business requirements of a DOT research office?"

Requirements are organized into four major categories:

- **Information tracking** – storing and managing research program and project information
- **Workflow support** – tracking status of research management activities, issuing notifications and reminders about pending or past due actions
- **Reporting and information delivery** – producing reports for FHWA, research program and project managers; updating research project web pages; pushing information about projects and reports out to stakeholders; updating TRB RiP and TRID
- **Analysis support –** summarizing project cost data to obtain program financial status; calculating standard research performance measures; managing code lists used to standardize categorical data element values – and maintaining crosswalks from these code lists to enable translation to categories used by RiP and TRID

Different verbs are used to indicate requirement importance or priority:

- Requirements use "shall" where the capability is considered to be mandatory – an essential function of an RPMD.
- Requirements use "should" where the capability is considered to be a highly desirable function of an RPMD.
- Requirements use "may" where the capability is considered to be an optional function of an RPMD.

Following presentation of functional requirements for state DOT systems, functions of national systems maintained by TRB and AASHTO that also support the DOT research function are briefly described.

3.2 Information Tracking Functions

Types of Data to Track in an RPMD

Specific types of information that agencies may wish to track in an RPMD are covered in Chapter 4-Data Requirements. Briefly, these include:

- **Research Needs Information** – Problem Statements
- **Research Project Information** – Identification and Classification, Description, Project Status, Project Schedule and Milestones
- **Research Stakeholders and Roles** - Project Team Members, Research Group Members, Stakeholder Contact Information

- **Research Program Funding and Budget** – Program Budget and Expenditures by funding source and fiscal year
- **Research Project Financial and Contract Information** – Project Costs and Funding, Project Budget Detail, Funding and Expenditure Detail by fiscal year, Contract Detail, Contract Modifications, Task Detail, Invoice Detail, Contract Deliverable Detail
- **Activities and Events** – Comment Log, Communication and Event Log
- **Research Products and Results** – Research Publications, Report Production and Distribution Tracking, Research Outcomes, Research Performance Measures, End User Products
- **Program and Project Document Links –** links to general research program documents (such as the research manual, literature reviews, research road maps, etc.); links from projects to a variety of documents such as RFPs, proposals, contracts, and amendments

Note that this is a fairly comprehensive list of what might be included – a basic RPMD for a small to medium sized research program would likely cover only a portion of these.

Data Maintenance

An RPMD shall have the capability to create new data records, update existing data records, and delete existing data records.

An RPMD should have the capability to manage permissions to allow users to view, add, update and delete data records.

An RPMD may have the capability to manage permissions to restrict updates to particular projects to individuals responsible for those projects.

Interfaces with Agency Systems

An RPMD may have the capability to interface with financial, contract, program and project management systems in order to *pull* data into its database.

An RPMD may have the capability to interface with financial, contract, program and project management systems in order to *push* data from its database to these other systems.

Document Links

An RPMD should have the capability to associate documents or document links to database records.

Search and Query

An RPMD shall have the capability to search for a project based on agency project number or project title.

An RPMD should have the capability to query for a list of projects meeting filter criteria based on project type, subject category, project status, project manager, PI or research implementation status.

An RPMD should have the capability to search for stakeholder contact information by last name and first name.

An RPMD may have the capability to search for a problem statement based on problem statement ID or title.

An RPMD may have the capability to query for a list of problem statements meeting filter criteria based on target funding category, subject category, status, and submitting organization.

3.3 Workflow Support Functions

Research Needs Collection

An RPMD may include the ability to create an email list and/or send out emails for solicitation of research needs or research problem statement submittals from a specified set of stakeholders.

An RPMD may include the ability for internal stakeholders to submit research needs or problem statements using a web form.

An RPMD may include the ability for external stakeholders to submit research needs or problem statements using a web form.

An RPMD may include the ability to view research needs or problem statement submittals and assign them to reviewers.

Review and Comment

An RPMD may include the capability to request input about a research need or problem statement from a specified set of stakeholders in the form of a questionnaire.

An RPMD may include the capability to maintain comment logs on problem statements, scopes of work, and project deliverables, including the ability to track comment resolution.

Balloting/Voting

An RPMD may include the capability to request votes on research problem statements from a specified set of stakeholders.

Notifications

An RPMD may include the capability to send notifications to selected stakeholders when a particular condition is met – for example:

- A funding decision has been made on a submitted problem statement
- A decision has been made on contractor selection for an RFP
- FHWA approval has been obtained on a project
- A final report has been published

An RPMD may include the capability to send notifications to PIs or other project team members when a specified condition is met – for example, a deliverable is due within 2 weeks.

Other

An RPMD may include the capability to assign tasks to research staff.

An RPMD may include the capability for research staff to mark tasks as complete

3.4 Reporting and Information Delivery Functions

Research Problem Statement Reports

An RPMD shall include the capability to produce a listing of research problem statements by status.

Project Reports

An RPMD shall include the capability to produce project status reports for individual projects or a selected set of projects.

An RPMD shall include the capability to produce project management reports that include information about project schedule and budget status for an individual project or a selected set of projects.

An RPMD may include the capability to produce a report showing accomplishments and results for a selected set of projects.

Project Web Pages

An RPMD may include the capability to update Project Web Pages with information managed in the RPMD database.

Program Financial Reports

An RPMD may include the capability to produce a report showing planned and current estimated research program costs by fiscal year and funding source.

External Interfaces

An RPMD shall include the capability to produce a report that with information needed to update the TRB RiP database.

An RPMD may include the capability to produce a file that can be directly uploaded to update the TRB RiP database.

An RPMD may include the capability to produce a file that can be directly uploaded to update the TRID database.

3.5 Analysis Support Functions

Performance Measure Computation

An RPMD may include the capability to calculate a set of standard research performance measures.

Program Budget Tracking

An RMPD may include the capability to compute anticipated and actual program expenditures by funding source from project expenditures.

Management of Coded Values

An RPMD shall include the capability to manage lists of values for coded attributes.

An RPMD should include the capability to convert agency project status codes to TRB RiP status codes.

An RPMD should include the capability to convert agency subject categories to TRB subject areas.

3.6 National Information Tools

Several national information tools support DOT research business requirements. These are described below to highlight and acknowledge the important role that they play in complementing internal DOT RPMD functions.

TRB RiP

This database is used to conduct literature reviews and investigate suggested research needs or problem statements to determine whether they may duplicate or complement already ongoing research. It is also updated by DOT research offices to reflect new research projects or changes in project status. (See: https://rip.trb.org/)

TRB RNS

This database is used to post research needs statements developed by TRB Technical Activities standing committees for use by practitioners, researchers, and others. (See: https://rns.trb.org/)

TRID

This database is used to conduct literature reviews to investigate research needs and ensure that proposed new research builds upon already completed research products. DOT research offices submit information on completed research reports for inclusion in the TRID database. (See: https://trid.trb.org/)

TPF Website

The transportation pooled fund website is used to evaluate requests for participation in pooled fund projects. It is used by lead states on pooled fund projects to post project status reports and deliverables, and by participating states and other interested parties to review this information. (See: http://www.pooledfund.org/)

TRB and AASHTO Directories

The TRB directory includes contact information for members of TRB committees and research panels. AASHTO committee web pages include listings with committee member contact information. Both of these resources are used by DOT research offices to manage and track DOT staff involvement in national research activities. They are also used to support collaboration and communication activities. (See: https://www.mytrb.org/DirectorySearch.aspx and https://www.transportation.org)

TRB Research Funding Website(s)

TRB web pages provide information on the timing and status of research funding programs including NCHRP and NCHRP Synthesis programs. These are used to guide internal DOT efforts to develop and submit problem statements to these national programs. (See: http://www.trb.org/Projects/FindaProject.aspx)

AASHTO RAC High Value Research Website

The High Value Research website supports tracking of research accomplishments and value. It showcases information submitted by states on completed research projects that meet established criteria. Each state has its own dashboard for tracking/viewing their projects. States can import project information from RiP, upload project information from a spreadsheet, or enter it directly. (See: https://research.transportation.org/High-Value-Research-Projects/)

AASHTO RAC Research Program and Project Management Website

The RPPM website is a resource for anyone involved in transportation research planning and coordination. It provides a space to share documents related to research program and project management – across the entire research life cycle. Documents may include research roadmaps,

research problem statements, research manuals, procedures, and sample forms. (See: http://rppm.transportation.org/Pages/default.aspx)

4. Data Requirements

4.1 Purpose and Approach

RPMD data requirements were identified based on the business requirements presented in Chapter 2, as well as a review of existing RPMD database contents. Data requirements address the question: "What data elements should be maintained within an RPMD?"

Section 4.2 describes the different data entities that could be included in an RPMD and the relationships across these entities. In this section, the verb "shall" is used to indicate a required entity for inclusion in an RPMD; "should" is used to indicate a recommended entity, and "may" is used to indicate an optional entity.

Sections 4.3-4.10 list individual data elements that could be included in an RPMD. These sections designate data elements that are required for external reporting, as well as additional data elements that are recommended for inclusion in a basic RPMD system.

A modular approach was used. Rather than listing all data elements pertaining to research projects together, data elements are segmented into groups representing different categories of information.

It should be noted that while these data requirements are intended to provide input to a database design; more detailed logical and physical data modeling would be required for design of an RPMD based on these requirements. Appendix B describes a set of three data models (including required, recommended and optional data elements respectively) developed as part of this project that can be used as a resource by agencies wishing to implement an RPMD based on the requirements in this chapter.

4.2 Data Entities and Relationships

Data Entities

An RPMD *shall* store information about the following types of entities:

- Research Projects – these are projects that are scoped for programming (commitment of funding) and implementation.
- Research Publications – these are publications that are produced by research projects.
- Research Contacts – these are individuals that participate in research project teams, research groups, or others with whom the research office communicates.
- Project Team – these are members of the research project team. Principal investigator and Project Manager need to be tracked; Champion should be tracked; other roles are optional to track.
- Research Organizations – these are organizations that perform research. A research organization can be an outside organization that performs research through contractual agreements, or it can be the DOT itself if the research is conducted internally.

- Lead Organizations – these are organizations that take on the primary responsibility for research management.

An RPMD *should* store information about the following types of entities:

- Research Problem Statements – these are research ideas that have been defined and described enough to be vetted and evaluated but not yet fully scoped for programming or implementation.
- Research Contracts or Task Orders– these are agreements between an agency and a contractor for delivery of a research product or service. Multiple task orders may be executed under a single contract.
- Research Products – these are the final products produced by the research project. One type of research product is a research publication.
- Implemented Products – these are products that are put into practice as a result of agency research projects, such as new standards or guidelines, data sets, applications or training materials.
- Performance Measures – these are measures used to evaluate research projects for purposes of continuous improvement or accountability.
- Research Documents – these are documents related to a research problem statement, project or the research program in general.
- Research Milestones – these are significant events during the life of the research project that are tracked.

An RPMD *may* store information about the following types of entities:

- Research Contract Modifications – these are amendments to research contracts to change scope, schedule or budget.
- Partner Organizations – these are organizations that sponsor research or serve in an advisory role on research projects.
- Project Advisory Groups – these are groups established to provide advice or oversight for a research project.
- Program Advisory Groups – these are generally standing committees that support the research program through establishing objectives, emphasis areas and priorities, and guiding research project development and selection.
- Research Deliverables – these are well-defined, trackable products provided as a result of performing research tasks.
- Master Agreements – these are contract agreements that establish a contractual relationship between two parties for future execution of task orders for specific services.
- Research Invoices – these are documents transmitted by research organizations requesting payment for services rendered or products delivered.
- Research Tasks – these are research work activities that have a schedule and result in one or more deliverables.
- Research Activities and Events – these are communication, dissemination or collaboration activities related to a project or to the research program in general.

- Research Comments – these are comments on Research Documents (e.g. problem statement or draft research deliverable) that requires tracking and resolution.
- Research Program Budgets – these are records of budgeted and actual (or estimated) research program costs by program category, budget line item, funding source and fiscal year.

Relationships Across Data Entities

An RPMD should maintain the following relationships across data entities:

- A Research Problem Statement can be related to zero or more Projects (e.g. to track the fact that a project recommended further research, which resulted in drafting of the problem statement.)
- A Research Project can be related to zero or one Research Problem Statements (e.g. the project was developed in response to the problem statement.)
- A Research Project can be a parent of another Research Project – for example, a Project can represent a multi-step stream of research with several child projects to carry out each part of the research.
- A Research Project can be associated with zero or more Research Contracts.
- A Research Project can be associated with zero or more Implemented Products.
- A Research Project produces one or more Research Products.
- A Research Publication is a type of Research Product.
- A Research Contract has one or more Research Deliverables.
- A Research Document can be associated with zero or more Research Projects.
- A Research Document can be associated with zero or one Research Problem Statements.
- A Research Project has one or more Research Tasks.
- A Research Contract can have zero or more Contract Modifications.
- A Research Contact can be associated with zero or more Research Projects.
- A Research Contract can have zero or more Research Invoices.
- A Research Invoice must be associated with one Research Contract.
- A Research Project can be associated with zero or more Research Activities & Events.
- A Research Document can have zero or more associated Research Comments.

Figure 2 illustrates the different data entities that may be included in an RPMD. It shows the relationships across entities, and indicates which should be considered required, recommended and optional.

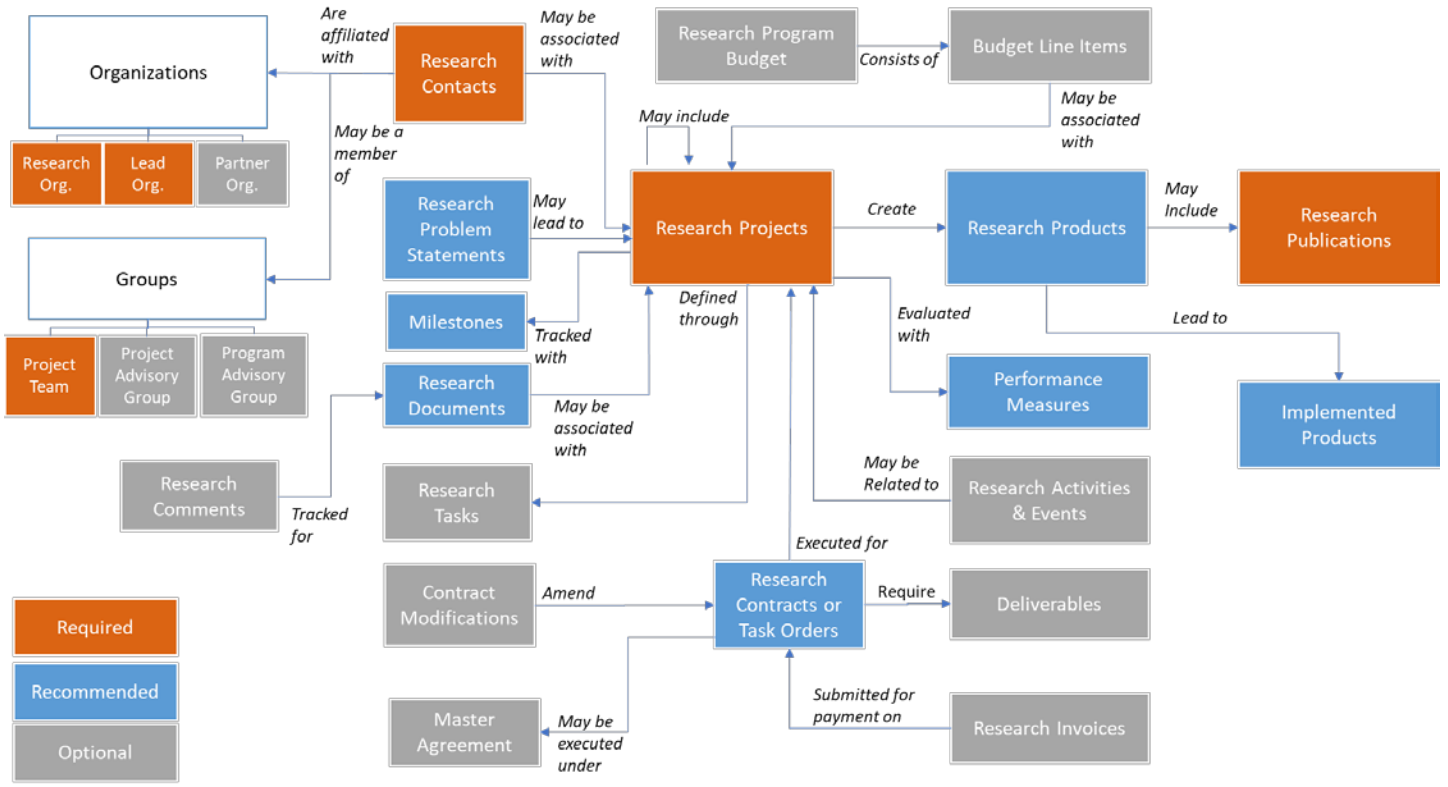

Figure 2. RPMD Data Entities and Relationships

4.3 Research Needs

Data requirements for managing research needs consist of a single table storing information about Research Problem Statements, with information that can be used to vet and prioritize them for funding. Data elements identified for inclusion in this table are listed below.

Research Problem Statements

Attribute	Required or Recommended?	Comments
Problem Statement ID	Required	Internal unique ID
Title	Recommended	
Description	Recommended	
Background/Objectives		
Scope/Tasks		
Urgency and Anticipated Benefits		
Related Research		
Implementation Opportunities		

Attribute	Required or Recommended?	Comments
Implementation Responsibility		
Implementation Barriers		
Target Funding Source	Recommended	See code lists
Cost Estimate		$
Time Estimate		# Months
Anticipated Start Date		Date
Agency Subject Categor(ies)	Recommended	See code lists
Submitting Organization	Recommended	
Submitting Individual	Recommended	Link to Contacts
Author		Link to Contacts
Champion		Link to Contacts
Sponsor		Link to Contacts
Submittal Date	Recommended	Date
Modification Date		Date
Rating		Agency defined – e.g. 1-5
Status	Recommended	See code lists

4.4 Research Project Information

Research project information is the core of an RPMD. Several different types of information may be stored about projects, as indicated in the tables below.

Identification and Classification Information
This provides basic information used to identify and classify the project, supporting reporting, search and query capabilities, and linkage to other agency systems.

Attribute	Required or Recommended?	Comments
Project ID	Required	Internal unique ID
Federal Project Number		
Parent Project Number		
Project Title	Required	
Sponsor/Lead Organization	Required	Default to agency name (for RiP)
Customer Business Unit		Division, section or office that is the primary customer for the research
Agency Project Number	Recommended	
TPF Number (for pooled-fund projects)	Required	If applicable

Attribute	Required or Recommended?	Comments
Associated Contract/Grant Number	Required	
Project Phase		#
TRB Subject Areas*	Required	See code lists If possible, derive from Agency Subject Categor(ies)
Agency Subject Categor(ies)		See code lists
Agency Goal Linkage		See code lists
Project Type	Recommended	See code lists
Procurement Type	Recommended	See code lists
Technical Review Panel?		Y/N
Spatial Reference		Format to be defined by agency – e.g. route-MP, lat/long, jurisdiction, etc.)
URL		URL for the project web page
Related Problem Statement ID		Link to Research Problem Statements
Remarks		

Project Description

This provides basic descriptive information about the project for inclusion in RiP, project reports and the project web site (if applicable).

Attribute	Required or Recommended?	Comments
Description	Required	Abstract to be used for RiP, Status Reports
Project Objectives/Purpose		
Background		
Anticipated Benefits	Recommended	
Methodology		
Implementation Plan	Recommended	Descriptive information about how the results of the project will be implemented – drafted at project initiation and augmented throughout the life of the project.

Project Status Information

This information supports progress reporting – it provides both a snapshot of current status and a report of activities for a reporting period (e.g. quarter). The data structure supporting this information could be designed to store historical status information (a set of records for each status period) or it could just include a single status period in order to generate status reports. For the second option, the historical status reports could be linked to the project as documents.

Attribute	Required or Recommended?	Comments
RiP Status	Required	See code lists. If possible, derive from Agency Project Status
Agency Project Status	Recommended	See code lists
Research Implementation Status	Recommended	See code lists
Begin Status Time Period	Recommended	Date
End Status Time Period	Recommended	Date
Status Time Period Label		e.g. FY, Quarter
Project Percent Complete	Recommended	%
Task Percent Complete		List or sub-table for each task
Funds Expended		$
Funds Obligated		$
Accomplishments	Recommended	
Next Period Planned Activities	Recommended	
Project Issues		
Status Change Comments		Any comments related to a recent change in project status – e.g. "project is now on hold due to XYZ…"

Research Milestones

This information supports research project management activities to monitor the project schedule and deliverables against plans. It includes several items required by RiP. Note that a more flexible, customizable implementation for most of this information could consist of a table with two items – milestone name and milestone date.

Attribute	Required or Recommended?	Comments
Project Start Date	Required	Date
Original Estimated Completion Date		Date
Current Estimated Completion Date	Required	Date. This will be the same as the actual completion date once the project has been completed.
Actual Completion Date	Required	Date
Scope/RFP Approval Date		Date
Scope/RFP Approved By		
RFP Publication Date		Date
Contractor Questions Due Date		Date
Contractor Questions Posted Date		Date

Attribute	Required or Recommended?	Comments
Proposal Due Date		Date
Contractor Selection Date		Date
Notice to Proceed Date		Date
TRB RiP Entry/Update Date	Recommended	Date
Final Report Approval Date		Date
Final Report Assigned to Editor Date		Date
Final Report Edit Completion Date		Date
Final Report Print Date		Date
Final Report Publication Date	Recommended	Date

4.5 Stakeholders and Roles

An RPMD can be used to track people and groups associated with research projects – and with the research program as a whole. Four distinct groups of stakeholder information have been identified: information about research project team roles, information about research organizations, information about research group membership, and detailed contact information.

Project Team Information

This includes reference information on the project team to support project management and communication. It includes several items required by RiP. For efficient data management and reporting, detailed contact information for project team members is maintained within the Research Contacts entity.

Attribute	Required or Recommended?	Comments
Project ID	Required	Internal unique ID
Project Role	Required	See code lists – Principal Investigator and Project Manager are required; others are optional.
Contact ID	Required	Link to Contacts

Organization Information

This includes information about research organizations that perform work for the DOT, partner organizations that collaborate in research (through funding contributions or technical participation), or other stakeholder organizations that are customers for research.

Attribute	Required or Recommended?	Comments
Organization ID		Internal unique ID
Organization Name		

Attribute	Required or Recommended?	Comments
Agency Vendor ID		Link to agency procurement system information (if applicable)

Project Organizations

This includes information about organizations associated with specific research projects

Attribute	Required or Recommended?	Comments
Project ID		
Organization ID		
Project Organization Role		See code lists

Research Group Members

This includes information about the membership in various research standing committees as well as project advisory groups.

Attribute	Required or Recommended?	Comments
Group ID		Internal unique ID
Group Name		
Group Type		See code lists
Project ID (optional - if associated with a project)		Link to Research Projects – only included if the group was associated with a project.
Contact ID		Link to Research Contacts.

Stakeholder Contact Information

This includes detailed contact information for project team members and other research stakeholders

Attribute	Required or Recommended?	Comments
Contact ID	Required	Internal unique ID
ORCID		Persistent digital identifier for researchers. See: Http://www.orcid.org
First Name	Required	
Last Name	Required	
Organization		
Title		
Address 1		
Address 2		
City		
State		

Attribute	Required or Recommended?	Comments
Zip		
Phone		
Email		

Stakeholder Distribution Lists
This includes information about mailing or email lists for conducting targeted outreach

Attribute	Required or Recommended?	Comments
List ID		Internal unique ID
Description		

Stakeholder Distribution List Members
This includes information about stakeholders included in each contact list.

Attribute	Required or Recommended?	Comments
List ID		Link to Contact Lists
Contact ID		Link to Research Contacts

Stakeholder Disciplines
This includes information about the expertise of different stakeholders.

Attribute	Required or Recommended?	Comments
Contact ID		Link to Research Contacts
Discipline ID		Link to Disciplines

4.6 Program Funding and Budget

An RPMD can be used to support the process of developing and managing research program budgets. One approach is to manage program budget and funding information in a spreadsheet and use the RPMD to produce reports that aggregate project cost information for use in the budgeting process. Another approach is to build in data structures for managing program-level budget information – as illustrated below.

Research Program Funding and Budget Information
This includes information about research program budget line items and associated costs, by fiscal year. As noted in the Functional Requirements under Analysis Support, an RPMD may include logic to

update this information based on project data – for example, calculate amount expended for all SP&R projects for each fiscal year.

Attribute	Required or Recommended?	Comments
Fiscal Year		YYYY
Federal or State		Indicates whether the record pertains to the federal fiscal year or the state fiscal year
Research Budget Category		See code lists
Research Line Item Description		
Amount Proposed		$
Amount Approved		$
Date Approved		Date
Amount Expended		$
Expenditures Updated Date		Date

4.7 Project Financial and Contract

An RPMD may be used to manage detailed financial and contract information for research projects. In many cases, this information will be included in agency financial, project management and procurement systems, and the research office can utilize reports from those systems in lieu of managing this information in the RPMD.

Project Costs and Funding

This includes high level information about the project's budget and funding sources.

Attribute	Required or Recommended?	Comments
Project ID	Required	Internal unique ID
Total Project Cost	Required	$
Vendor Cost		$
Federal Funding Share	Recommended	%
Federal Funding ($)		$
State Funding ($)		$
Other Funding ($)		$
Leveraged Funds		$
Value of In-Kind Contributions		$
Funding Approval Date		Date
FHWA Project Authorization Date	Recommended	Date

Project Budget Detail

This provides a finer breakdown of the project budget.

Attribute	Required or Recommended?	Comments
Project ID		Internal unique ID
Salary/Labor		$
Overhead		$
Consulted Services		$
Travel		$
Equipment		$
Materials		$
Profit		$
Indirect Costs		$

Project Funding and Expenditure Detail

Attribute	Required or Recommended?	Comments
Project ID		Internal unique ID
Fiscal Year		YYYY
State or Federal		Indicates whether the record pertains to the federal fiscal year or the state fiscal year
Funding Source		See code lists
Amount Estimated		$
Amount Approved		$
Date Approved		Date
Amount Expended		$
Expenditures Updated Date		Date

Contract Detail

This provides detailed information about research contracts or individual task orders within a master contract agreement.

Attribute	Required or Recommended?	Comments
Project ID	Recommended	Link to Research Project
Contract ID	Recommended	Link to Contract
Vendor ID	Recommended	Link to agency vendor information
Contract/Grant Number	Recommended	Note this is a required item for RiP – included under Project Identification and Classification information above for agencies that don't want a separate contract detail table.

Attribute	Required or Recommended?	Comments
Purchase Order Number		
Payment Terms		
Contract Status	Recommended	
Contract Effective Date	Recommended	
Notice to Proceed Date		
Original Contract End Date		
Current Contract End Date	Recommended	
Original Contract or Task Order Amount		
Current Contract or Task Order Amount	Recommended	

Contract Modifications

This includes information on each contract modification.

Attribute	Required or Recommended?	Comments
Project ID		Link to Research Project
Contract ID		Link to Contract Detail
Modification Number		##
Cost Change		$
New Contract End Date		Date
Reason for Change		
Status		See code lists
Date Requested		Date
Effective Date		Date

Task Detail

This includes detailed information about each task of a project.

Attribute	Required or Recommended?	Comments
Project ID		Link to Research Project
Task Number		
Task Title		
Task Description		
Task Deliverables		

Attribute	Required or Recommended?	Comments
Task Start Date		Date
Task Completion Date		Date
Task Budget		$

Invoice Detail

This includes detail on the amount and status of each invoice for a contract

Attribute	Required or Recommended?	Comments
Project ID		Link to Research Project
Contract ID		Link to Contract
Invoice Number		##
Invoice Date		Date
Invoice Amount		$
Invoice Status		See code lists
Paid Amount		$
Paid Date		Date
Status Comments		

Contract Deliverable Detail

This includes detailed information supporting tracking of contract deliverables.

Attribute	Required or Recommended?	Comments
Project ID		Link to Research Projects
Contract ID		Link to Contracts
Deliverable ID		
Research Document Type		See code lists
Deliverable Name		
Deliverable Status		See code lists
Date Due		Date
Date Received		Date
Date Approved		Date
Status Comments		

4.8 Activities & Events

Communication and Event Log
This provides a place to track both project and program-level activities or events. These could include meetings of committees or project teams, peer exchanges, open houses, conference presentations, webinars or other research dissemination activities.

Attribute	Required or Recommended?	Comments
Event ID		Internal unique ID
Project ID		Link to Research Project – leave blank for program-level activities
Event Date		Date
Activity & Event Type		See code lists
Description		
Lead/Responsible Person		Link to Contacts
Number of Participants		####
Resources Required/Used		
Activity Status		See code lists
Action Items		
Link		URL

Comment Log
This tracks comments on any research document including Problem Statements, draft SOWs, research project draft deliverables, SP&R work programs, etc.

Attribute	Required or Recommended?	Comments
Document ID		Link to Documents
Comment ID		Internal unique ID
Commenter		Link to Contacts
Comment		
Date		Date
Resolution		
Comment Status		See code lists

4.9 Research Products and Results

Research Products
This tracks the final products of the research project.

Attribute	Required or Recommended?	Comments
Project ID		Link to research project
Product ID		Internal unique ID
Research Product Type		See code lists

Research Publications
This tracks publications associated with each research project.

Attribute	Required or Recommended?	Comments
Project ID		Link to Research Projects
Product ID		Link to Research Products
Agency Report Number	Recommended	
Report Link/URL	Required	URL
Report Name	Required	
Publication/Release Date	Recommended	Date
TRB Accession Number		
Corporate Authors	Recommended	
Individual Authors	Recommended	

Report Production and Distribution Tracking
This is used to plan for and track report production and distribution processes.

Attribute	Required or Recommended?	Comments
Product ID		Link to Research Products
Recipient Name		
Recipient email		
Recipient web page URL		URL
Recipient mailing address		
Digital copy?		Y/N
Number of print copies		###
Date sent		Date

Implemented Products
This lists products created by or as a result of the research that have been implemented into practice.

Attribute	Required or Recommended?	Comments
Project ID		Link to research project
Implemented Product ID		Internal unique ID
Implemented Product Type		See code lists
Description		

Research Outcomes
This records summary information describing the project's accomplishments, key findings, results and benefits, suitable for incorporation into an annual report.

Attribute	Required or Recommended?	Comments
Project ID		Link to research project
Accomplishments		Description of what was done
Findings		Description of what was learned
Results		Description of changes made based on the research
Benefits		Description of benefits achieved

Research Performance Measures
This would be used to track performance of research projects for an agency-selected set of measures.

Attribute	Required or Recommended?	Comments
Project ID	Recommended	Link to research project
Performance Measure Type	Recommended	See code lists
Performance Measure Value	Recommended	

4.10 Project and Program Documents

A variety of documents are associated with research projects or with the In addition, there are some documents that are produced as part of the research planning, coordination and scoping process and are not associated with specific projects. Documents can be stored in an agency repository and registered in the RPMD (rather than stored in the RPMD database).

Documents
This is a log of documents related to research projects or the research program as a whole.

Attribute	Required or Recommended?	Comments
Document ID		Internal unique ID
Document Type		See code lists
Document Name		
Link		URI
Digital Object Identifier		DOI

Project Documents

This tracks documents related to specific research projects.

Attribute	Required or Recommended?	Comments
Project ID		Link to research project
Document ID		Link to documents

4.11 Code Lists

The following lists of values for categorized data attributes were assembled from a review of existing state DOT RPMDs. Code used in RiP are also included here. Agencies implementing an RPMD would use these as a starting point and tailor these value lists to their own needs.

Subject Categories

TRB Subject Area	
Administration and Management	Materials
Aviation	Motor Carriers
Bridges and Other Structures	Operations and Traffic Management
Construction	Passenger Transportation
Data and Information Technology	Pavements
Economics	Pedestrians and Bicyclists
Education and Training	Pipelines
Energy	Planning and Forecasting
Environment	Policy
Finance	Public Transportation
Freight	Railroads
Geotechnical	Research
Highways	Safety and Human Factors
History	Security and Emergencies
Hydraulics and Hydrology	Society

Law	Terminals and Facilities
Maintenance and Preservation	Transportation (General)
Marine Transportation	Vehicles and Equipment

Subject Category	
Administration	Management & Performance
Construction & Specification	Materials & Pavement
Energy & Environment	Structures
Geotechnical	Surveying
Highway Geometrics	Traffic Engineering
Highway Safety	Training and Implementation Technologies
Hydrology & Hydraulics	Transit & Commuter Rail
Maintenance & Operations	Transportation Planning

Agency Goal Linkage	
Safety	Economic Vitality
Mobility	Sustainability
Preservation	

Status

Project Status – TRB RiP	
Proposed	Terminated
Programmed	Inactive
Active	Completed

Project Status – Additional Agency Categories	
Approved	On Hold (Temporarily Suspended)
Pending	Contract Complete
Closed	Implementation

Problem Statement Status	
Submitted	Deferred
Under Review	Needs Revision
Accepted	Rejected

Contract Status/Contract Modification Status	
Developed	Closed
Submitted for Signature	
Executed	

Deliverable Status	
Not Yet Due	Distributed for Comment
Overdue	Returned for Edits
Received for Review	Accepted

Invoice Status	
Received	On Hold
Approved	Cancelled
Rejected	Paid

Activity Status	
Recommended	In Progress
Rejected	Completed
Planned	Cancelled

Research Implementation Status	
NA (research in progress or terminated)	Implementation underway
Implementation not recommended or not applicable	Implementation completed
Implementation recommended but not yet started	

Comment Status
Open
Closed

Budget and Funding

Funding Source	
SP&R Part 1	Partner Agency
SP&R Part 2	University
State	In Kind Contribution
State Non-Participating	FHWA Accelerated Innovation Deployment
Pooled Funds	Other

Research Budget Category	
TRB Core Services	SP&R Research Projects
NCHRP	Overhead
Pooled Funds	

Project Type	
Pooled-Fund - Lead	Experimental Features
Pooled-Fund - Participant	Innovative Bridge
SP&R Part 2	CRP Problem Submittals
Non-SP&R Agency Research	FHWA Accelerated Innovation Deployment
University Transportation Center	Other

Procurement Type	
None - Internal Staff	Consultant Contract
University Contract	Other

Research Outputs and Outcomes

Research Product Type	
Final Research Report	Data/Database
Technical Report	Video or other multimedia
Research Brief or Factsheet	Article
Research Note	White Paper
Research Summary	

Research Document Type	
Research Manual	Task Order
Research Road Map	Correspondence
Peer Exchange Report	Meeting Notes
Preliminary Investigation	Draft Intermediate Deliverable
Literature Review	Final Intermediate Deliverable
Request for Proposals	Progress Report
Scope of Work	Final Research Report
Proposal	Technical Report
Proposal Evaluation/Comments	Research Brief or Factsheet
Contract/Agreement	Research Note
Contract Modification	Research Summary

Implemented Product Type	
Standard, Plan, Specification	Tool/Hardware/Equipment
Manual, Guidebook, Training Material	Data/Database
Legislation, Policy, Rule, Regulation	Product Evaluation
Business Practice, Procedure, Process, Method	Website/Software/App
Workshop or Training Delivery	Knowledge Transfer

Activity/Event Types	
Project team meeting	Open House
Technical panel meeting	Webinar
Field visit	Training
RFP review meeting	Conference Presentation
Project Kickoff meeting	Poster Session
Meeting - General	Newsletter/Bulletin
Peer Exchange	Web Page Posting
Conference	Social Media Posting

Performance Measures	
Agency Cost Savings	Project Within Budget
Lives Saved	PI Performance Rating
Crashes Avoided	Benefit/Cost Ratio
Customer Satisfaction Rating	Research Report(s) Published (Y/N)
Project On-Time	Project Results Implemented (Y/N)

Stakeholders

Research Group Type	
Research Project Team	RFP Review Panel
Research Project Panel	Research Advisory Committee
Project Technical Advisory Group	

Project Organization Role	
Lead Organization	Partner Organization
Research Organization	

Project Team Role	
Principal Investigator	Project Champion
Agency Project Manager	Agency Project Technical Lead/Advisor/Liaison
Agency Project Sponsor - Office	Agency Project Coordinator
Agency Project Sponsor - Individual	Report Editor

Stakeholder Discipline	
Air Quality	Hydraulics
Civil Rights	Operations
Construction and Project Management	Marketing and Communications

Stakeholder Discipline	
Design	Pavement and Materials
Environment	Planning
Financial Management	Program and Management Analysis
Freight	Realty
Generalist	Safety
Geotechnical	Structures

5. RPMD Development Options and Transition Requirements

5.1 Introduction

The primary objective of this project was to define business requirements for an RPMD. The products of this research will help decision-makers determine whether to invest in improvements – through collective efforts to improve available tools, or through individual agency efforts to enhance internal capabilities. This chapter explores options for collective action. It presents a set of possible options for future RPMD development, and then outlines considerations and requirements for transitioning to a new RPMD. The transition requirements are based on interviews with four state DOTs and representatives of the FHWA Research and Technology program.

5.2 RPMD Development Options

A broad set of options were formulated for collective development of an RPMD – or components of an RPMD through a collaborative effort (e.g. Pooled Fund or AASHTOWare) that states could adapt to meet their individual needs.

As illustrated in Figure 3, options were designed for incremental development and build upon each other – starting with a data model and building to a full-fledged, turnkey RPMD solution.

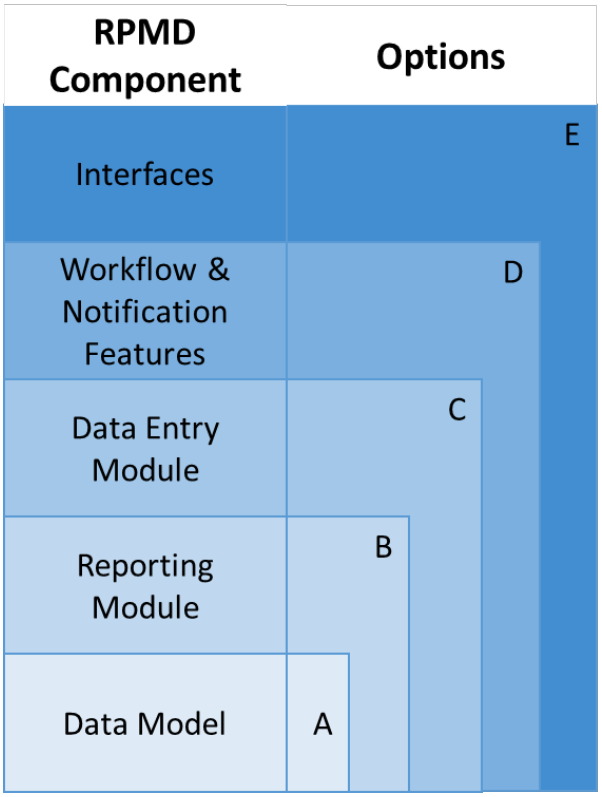

Figure 3. RMPD Development Options

The incremental approach was taken in recognition of the inherent challenges to developing a "one size fits all" system for state DOT research offices. These challenges include different information technology (IT) policies, standards and environments, differences across research offices with respect to scale (size of budget, number of projects, size of staff), the roles they play in research project management and coordination, and different business rules and terminology (e.g. how a "research project" is defined.)

Options were defined as follows:

- **Option A: Standard data model with core and optional data elements.** This would involve creation of standard data models for tracking:
  - Research problem statements - type, submitter, comments, rank, status
  - Research projects - description, status, funding sources and allocations
  - Research performance – accomplishments, output and outcome measures
  - Research activities – contracts, staff, budget and schedule
  - Research stakeholders - contact information, areas of interest/expertise, distribution lists, committee/group assignments, project assignments
  - Research staff assignments to projects and tasks
  - Meetings and events – schedules, agendas, notes
  - Research products – briefs, reports, other artifacts

  The data models could include a "core" set of elements for standardizing data exchange between states and national research databases as well as a set of additional elements that are useful for research management. Core data elements would be compatible with TRB's RiP database and TRID. The expanded set of data elements could provide a valuable resource to DOTs considering expansion of their existing RPMDs or conversion from spreadsheets to enterprise database systems.

  This option could also include a standard set of code tables with lists of values for: problem statement source, problem statement status, project type, contract type, funding source, project phase, project status, stakeholder type, research objectives, research performance measures, etc. Where applicable, lists of values would match with those of national databases in order to promote consistency.
- **Option B: Data model + Reporting module.** This option would build on the standard data models in option a and create a series of model reports, implemented using one or more commercial database reporting packages (e.g. Microsoft Access, SQL Reporting Services, Crystal Reports, etc.) Reports might include:
  - Research problem statement summary report for use in rating and ranking
  - Research portfolio report – listing all projects by status (proposed, programmed, active, closed)
  - Research project management list report – list view of projects assigned to a particular manager, with status and upcoming milestones

  - Project detail report – detail view of information for a selected set of projects – showing project description, financial information, schedule of milestones, list of products, etc.
  - Research program performance report – research outputs and outcomes by project, program area, and year.
  - SP&R2 work program report – SP&R2 annual work program report that can be edited as needed and submitted to FHWA
  - SP&R2 accomplishments report – SP&R2 annual accomplishment report that can be edited as needed and submitted to FHWA.

- **Option C: Data Model + Reporting Module + Data Entry Modules.** This option would build data maintenance modules corresponding to the different types of data listed above in option a. These modules could be developed incrementally based on priorities.
- **Option D: Data Model + Reporting Module + Data Entry Modules + Workflow and Notification Features.** This option would incorporate additional features supporting workflow and notification, including:
  - Solicitation of research needs from stakeholders
  - Solicitation of ratings and/or comments on problem statements, scopes of work, vendor proposals and research products
  - Compilation of stakeholder responses and tallying of votes
  - Obtaining project approval(s) for funding from responsible managers and FHWA
  - Email notifications to project managers and/or PIs of upcoming or past due milestones
  - Email notifications to reviewers of upcoming deadlines for completion of reviews
  - Email notifications to stakeholders about research project selections or release of final products
- **Option E: Data Model + Reporting Module + Data Entry Modules + Workflow and Notification Features + Interfaces with DOT websites, national and local research information repositories.** This option would incorporate additional features including:
  - Interfaces with national research databases (RiP, TRID, High Value Research)
  - Interfaces with project websites to populate/update information
  - Automation of research report distribution to national and local repositories

The full turnkey solution (Option E) could appeal to states wishing to move from spreadsheets to a basic system without paying for custom development. This solution would likely be most applicable to "medium" sized research programs that do not have highly complex or specialized requirements.

A more limited development approach (Development Option B) could provide basic reporting functionality and facilitation of data exchange between DOT research offices and national research data systems.

5.3 Transition Requirements

Methodology

Interviews were conducted with four state DOTs and representatives of the FHWA Research and Technology Program to (1) gauge the level of receptivity to the initial options that were developed, (2) understand the process that would be used to make the decision to move forward with a change and then implement that change within the agency, and (3) identify key barriers or constraining factors including but not limited to funding considerations.

The four DOTs were selected to represent a range in research program size/complexity. Three of the four DOTs included were members of the project's Technical Advisory Committee. Participating agencies were deliberately included because of their interest in this topic and their willingness and ability to assemble the right set of individuals within the agency to participate. While each of the four DOTs offered a different perspective, there were common themes across the agencies with respect to transition requirements.

Table 1 lists the interview participants.

Table 1. Transition Requirements Interviews

Agency (Interview Date)	Individuals
Washington State DOT (11/21/2017)	• Jon Peterson (Research Manager) • Rhonda Brooks (Research Director) • Marianne Painter (Research Business Manager) • Larry Gruginski (IT - Application Development) • Gary Brown (IT - Business Analyst) • Leni Oman (Knowledge Strategist; Project Manager)
Georgia DOT (12/7/2017)	• Binh Bui – Research Implementation Manager • Supriya Kamatkar – Research Program Manager • Brennan Roney – Research Engineer • Yusuf Ahmed – Pavement Engineer • Teague Buchanan – Assistant Administrator – Data Management • Ian Rish – State Pavement Engineer • Sarah Lamothe – Research Engineer
Michigan DOT (12/2/2017)	• Michael Townley – Research Project Administration Manager • Rebecca Petri – Departmental Analyst for Research • Joe Brewer – IT Manager – Department of Technology, Management and Budget

Agency (Interview Date)	Individuals
California DOT (Caltrans) (12/8/2017)	• Jim Appleton, Chief, Division of Research, Innovation and System Information (DRISI) • Joe Horton, Chief, DRISI Office of Safety Innovation and Cooperative Research • Joel Retanan, Chief, TMS Development Support Branch, DRISI Office of Traffic Operations Research • Tori Kanzler – Chief, Research Program Development Branch, DRISI Office of Planning, Policy and Program Development • An Sarrels – Chief, Contracts and Resources Branch, DRISI Office of Operations and Resource Management (financial management of research projects) • Sean Campbell – Senior Transportation Electrical Engineer, DRISI (Research Project Manager) • Frank Law – Senior Transportation Planner, DRISI (Research Project Manager)
FHWA Research and Technology (12/8/2017)	• Jack Jernigan - Research and Technology Program Development and Partnership Team Director • David Pamplin – Pooled Fund Program Manager • Tim Schmidt – Senior Advisor • Beth Yumlu - Office of Research, Development and Technology – Special Assistant • Carl Andersen – Office of Corporate Research, Technology, and Innovation Management Acting Director

Interview participants were provided with an interview guide in advance, describing the different options. The interviews consisted of a guided discussion around the following topics:

- How useful might this product be for your agency?
- How might you fund an effort to use this product?
- What steps you would need to take in order to transition from your current method/systems for managing research project information to using the new system?
- What barriers or constraints you would face in implementing the product?

The FHWA interviews covered the broad concept of developing a modular research project and program management system via a pooled fund or AASHTOWare project that states could adopt/adapt. They also touched on some additional options that might be pursued at the national level:

- Development of a national SP&R2 database and standard interface for DOTs to submit work programs and accomplishment reports

- Development of a national research stakeholder directory (for building mailing lists for research needs solicitations, finding reviewers, finding potential PIs, and

A synthesis of findings is provided below.

Key Findings – State DOT Interviews

Findings of the state DOT interviews are summarized below, organized into three categories:

- Receptivity to Adoption of New/Modified RPMD
- Funding/Resourcing RPMD Improvements
- Transitioning to a New RPMD: Implementation Steps and Constraints

Receptivity to Adoption of New/Modified RPMD

Receptivity to modifying their existing RPMD or implementing a new RPMD varied across the four DOT's interviewed, depending on the existing solution in place.

Three of the four DOTs have an existing RPMD solution – Caltrans and WSDOT have a FileMaker Pro system; Michigan DOT has a Microsoft Access Database that was developed in the past two years. Georgia DOT does not have an RPMD and was (not surprisingly) the most receptive of the four DOTs to developing or adopting a new system. Georgia DOT currently relies on standard agency project and contract management systems (not tailored to research) and supplements these with spreadsheets.

Each DOT weighed in on the five RPMD development alternatives:

- **Georgia DOT** preferred Alternative A – a model database. They suggested that this model database be based on an agreed-upon standard endorsed by FHWA. Their preference was to do internal development of data entry screens, reports, workflow capabilities and interfaces rather than to adopt an off the shelf product that might not meet their specific requirements or be compatible with their existing technology solutions. However, they stated that any design information related to reports could be useful for their internal development efforts.
- **Washington State DOT** preferred Alternative B – a database and set of standard reports. Their current RPMD already has reports included, but a model set of reports could be used to guide future additions. The WSDOT interview revealed that an estimated 30-40% of the information in the current RPMD is generated by the research office; the remaining 60-70% comes from other systems. This led to discussion of a data mart concept to facilitate reporting – as a variation to the original alternative B. This would involve developing a structure for a data mart (rather than a data model for a production system) – with mockups of reports that could be produced from the data in the mart. The data mart could be populated from source systems including the RPMD, financial systems, contract management systems, and others as appropriate.
- For **Michigan DOT**, Alternative C was the most attractive option since it would provide a full turnkey system that could replace and possibly extend MDOT's current functionality. MDOT was not interested in Alternative D (which added workflow) because they already have workflow management capabilities in place (via their ProjectWise solution). They were not interested in Alternative E (which added interfaces) because (1) they do not view existing interface requirements with TRB systems as a pain point, and (2) the primary internal interface

of interest is with the financial system – which would need to be custom created within the agency.

- **Caltrans** also felt that Alternative C made the most sense - providing the basic RPMD functionality for agencies that currently had no established solution. They noted that there would be challenges with designing workflow capabilities (Alternative D) since processes may not be stable. They recognized the value of interfaces with financial systems (Alternative E), but viewed this kind of capability as too much of a reach for a turnkey system. Like Michigan DOT, they did not view interfaces with the TRB systems as a pain point that needed to be addressed. They stressed the importance of providing a basic, simple RPMD system that would meet the minimum needs of a state – rather than trying to provide a "Cadillac solution."

Funding/Resourcing RPMD Improvements

All four DOTs reported similar challenges in funding RPMD improvements. They all identified SP&R2 as the most likely source of funds – though the project size would be limited to $100,00-$300,000 and the project would need to compete with other SP&R2 project candidates.

Collaboration with other agencies is an option that has been used to pool resources for application development. Models include AASHTOWare, the Transportation Pooled Fund program, or informal agreements. For example, Georgia DOT reported that they had signed an agreement with Texas DOT to obtain a rail road crossing management system developed by that agency.

Each agency does fund internal software development projects, but these are highly competitive and focused on projects that have widespread benefits across the agency.

Resourcing system maintenance and upgrades was reported as a challenge at each of the DOTs. Practices vary across states with respect to use of SP&R2 funds for annual, recurring maintenance for systems. At the three DOTs with functioning RPMDs, ongoing maintenance was handled by the research staff rather than by the agency IT staff. Georgia DOT's IT did report that they have a mechanism to support internally developed applications.

Transitioning to a New RPMD: Implementation Process

Transition to a new RPMD is not fundamentally different from other information system development and deployment efforts. It involves the basic steps of establishing a business case, determining feasibility, defining requirements, developing a deployment plan, designing and developing the system, and testing and deploying the system. Section 5.4 below describes a typical implementation process, based on a hybrid of the activities reported by the four states that were interviewed.

Key Findings - FHWA

As noted above, the FHWA interview covered three topics: (1) development of a national SP&R2 database; (2) development of a national research stakeholder directory, and (3) development of a modular RPPM database that DOTs could adopt/adapt.

National SP&R2 Database

The FHWA representatives did not support development of an FHWA-hosted database of SP&R2 work program or accomplishment information. There were several reasons:

- Lack of clear use for this information by FHWA staff at headquarters – given that FHWA divisions are charged with responsibility for approving DOT work programs;
- Time and cost that would be required to develop and support a new database and website – which would be subject to approval by an Investment Review Board and would need to meet multiple requirements (e.g. section 508 compliance, security standards); and
- Limited funding to build and support new IT assets; desire to reduce existing overhead costs.

An alternative, standards-based approach was offered which could potentially achieve some of the objectives for a national SP&R2 database – i.e. to provide a mechanism to aggregate and share information across states that would help to "tell the SP&R2 story" and facilitate increased collaboration. This approach would involve:

- Defining a standard set of data elements for research projects and products – including mandatory elements (e.g. those required for TRID and RiP) and potentially others agreed-to by state DOTs;
- Endorsement of the standard by FHWA and AASHTO;
- Publication of the standard, with definitions for each element;
- Designation of a body (e.g. AASHTO RAC) to own and update the standard;
- Designation of authoritative data sources for different elements;
- Development of Application Program Interfaces (API) at each state DOT (as well as FHWA, Universities and other data owners) to provide access to the selected data elements from the research databases or a separate data extract or mart; and
- Creation of one or more aggregator applications that would interact with the state DOT APIs to retrieve, process and report the data.

At the time of the interview, FHWA was in the process of developing a data specification for its own internal research project database, aligned with RiP and TRID. Once finalized, this specification could inform an effort to develop a more generic research project data standard.

National Research Stakeholder Directory

Participants suggested that two existing resources be leveraged to meet the need for a national research stakeholder directory: the ORCID database and the TRB member database.

- ORCID is a non-profit organization, established in 2012. Its mission is to "enable transparent and trustworthy connections between researchers, their contributions, and affiliations by providing an identifier for individuals to use with their name as they engage in research, scholarship, and innovation activities." Its sponsors include universities, libraries, scholarly societies, funding agencies, research organizations, and publishers. Any researcher can register for an ORCID – which is persistent throughout their career. Once registered, researchers can input their contact information, education, employment, funding sources and links to published works. ORCID offers APIs and best practices for integrating its information with other systems.
- TRB's online directory provides access to points of contact and information on TRB's standing committees, project-based committees and panels, and governing committees, as well as to lists of TRB sponsors, affiliates, representatives, volunteers, and staff. Access to full directory

information is limited to TRB Executive Committee members; members of TRB standing committees (but not subcommittees); and the representatives of TRB Core Program Sponsors.

Rather than creating a new directory, the potential for building on these existing resources could be explored. Part of the solution would require an initiative to encourage registration within ORCID.

DOT RPMD Development Effort

Participants acknowledged the value of maintaining good tracking information for research projects, pointing to the life cycle NCHRP project tracking activities as a model. This enables one to look up an NCHRP project, identify who did it, identify its status (and, if applicable, when it was completed), and access the final publications.

Several challenges and success factors were identified:

- Lack of alignment across DOT research functions/programs (potential barrier to developing a standard application);
- Limited funding to support such an effort – particularly for ongoing maintenance and updates;
- Need to demonstrate a positive benefit-cost for undertaking such an effort; and
- Need for active change management to adopt new, standardized processes and/or data definitions.

5.4 Transition Process Description

While specific implementation processes varied by agency, each agency had some version of the following general process in place for transitioning to a new system. Two cases are considered:

- A case in which an agency is transitioning from an existing RPMD to a new RPMD through either custom development or implementation of a new off-the-shelf solution.
- A case in which an agency is making relatively minor modifications to an existing product.

New RPMD Implementation

Step 1. Business Case

- Identify a **champion** and **sponsor** for the new/modified system;
- Identify the **stakeholders** for the new/modified system (direct users, people who would need to support or interface with the system, indirect beneficiaries, etc.)
- In consultation with stakeholders, develop a **business case** for making changes that identifies:
    - who would use the new/modified system and how;
    - what benefits would result from transition to the new system (e.g. time savings, improved basis for decision making, reduced risk of project overruns, reduced risk of project failure, improved project outcomes, etc.); and
    - what the initial and ongoing costs of the system would be – considering database and software design and development, software licensing, hardware, backups, maintenance, and training and support.
- If the business case is compelling, proceed with feasibility analysis.

Step 2. Feasibility Analysis

- Map the **business process** – including the "as is" process as well as any desired changes to the process – the "to be"
- Model the **current data entities** and their relationships (e.g. project, task, roles)
- Assess **feasibility of transitioning** to the new system:
    - Develop a crosswalk from current data elements to proposed new data elements
    - Develop a crosswalk from the current business process to the proposed new business process
    - Assess the level of effort and degree of difficulty of making changes to existing processes.
- Assess **feasibility of building interfaces** supporting the new system:
    - Investigate the feasibility of building interfaces with existing systems (financial, project and contract management) with system owners
    - Investigate the feasibility of leveraging existing agency data warehouse and reporting capabilities for the system
    - Investigate the feasibility of leveraging existing agency workflow solutions for the system
    - Investigate the feasibility of leveraging existing agency document or content management solutions for the system
    - Investigate the feasibility of interfacing with project web pages on the agency's internet and/or intranet sites
- Identify **funding sources** – including exploration of partnerships with other agencies
- Seek **approval/funding** to initiate system requirements and design (or determine that it is not worth moving forward)

Step 3. Requirements Analysis

- Establish a **formal or informal steering group** to guide the transition activities
- Designate data and system ownership and stewardship **roles and responsibilities**
- Develop and document **business requirements** that specify what the system must do, in the context of the business process analysis. Consider the results of the feasibility analysis in decisions about adding new data elements or other system features that will require ongoing maintenance and support.
- Develop and document **technical requirements** for the system – for example – reliability (up-time), capacity, scalability, security.

Step 4. Deployment Planning

- Develop a **data migration plan** specifying the source and transformations for all data to be loaded into the new/modified system.
- Develop a **deployment plan** that considers the following options:
    - Incremental deployment of new functionality (e.g. an Agile development approach

  - Single release deployment – with parallel operation of new and old system prior to full cutover
  - Single release deployment – with no parallel operation ("big bang" deployment)
- Identify **roles and responsibilities** for system maintenance and operation

Step 5. Design and Development

- Design, build and configure the new/modified system:
  - For an off-the-shelf solution:
    - Review the **system architecture** (database, front-end, other technology components) to ensure compatibility with agency standards and to maximize opportunities to leverage already existing tools (e.g. data warehouse, content management system, reporting services, workflow engines.)
    - Develop a **configuration plan** that specifies how any of the customizable elements or configuration options will be implemented.
    - Implement and configure the system
  - For a custom solution:
    - Architect, design and develop the system – utilizing a traditional "waterfall" or agile development approach.
    - Conduct unit and system testing.
- Perform data conversion/loading

Step 6. Testing and Deployment

- Move the system into a **user test environment**.
- Conduct **user acceptance testing.**
- Produce or provide **system documentation** to include
  - System metadata
  - Data models (logical and physical)
  - Data dictionary
  - User manual
  - Administrator manual/troubleshooting guide
- Conduct **training.**
- **Roll out** the system into **production** – consider:
  - A 30-day shakeout period in which resources are committed for support and bug fixes
  - Incremental roll-out depending on number of users

Modifying an Existing RPMD

For a relatively small, incremental change to an existing system, steps would be as follows:

Step 1. Business Case

- Consult with current users and other stakeholders to discuss:

  - the scope of the proposed change
  - the reasons for making it
  - the impacts of the change – on reports, on data entry requirements, on current integrations
- Get agreement that the change is worthwhile

Step 2. Requirements and Design

- Determine changes to the database, screens, reports, and functions
- Update design documents

Step 3. Development and Piloting

- Create a test copy of the system and make the changes
- Deploy in a test environment
- Pilot the modified system with a limited set of users
- Make updates based on feedback

Step 4. Deployment

- Conduct training, emphasizing the new/modified features
- Deploy the system into production

5.5 Conclusions and Implications

The purpose of looking at "transition requirements" was to understand what it would take for a DOT to move from their current methods and processes for managing research information to a new process involving a new or enhanced RMPD. Through exploration of the transition process and discussion of the initial set of options that were developed, we gained a good understanding of the challenges faced by DOTs for implementing new or improved RPMD capabilities.

DOT Challenges: Making the Case for RPMD Development or Enhancement

Ability to fund a new RPMD is clearly a major challenge, given that SP&R2 provides the primary available source of funds, SP&R2 projects are typically small (under $300,000), and the project selection process is competitive. Building a strong business case for a new RPMD is critical to obtaining funding – and involves looking at benefits and costs.

The **benefits** of transitioning to a new RPMD may include:

- Time savings for research staff charged with preparing reports to funding agencies;
- Improved project manager ability to track project status and deliverables – presumably leading to fewer instances of overruns and delays; and
- Improved information availability about research project status, products and outcomes.

The level of effort and **cost** of transitioning to a new RPMD will vary depending on several factors:

- The platform for the system – desktop software or enterprise system;

- The scope of the system – which can range from simple maintenance of information needed for project status reporting to tracking of detailed milestones, research implementation activities and stakeholder groups;
- The number and complexity of interfaces (e.g. with agency contract and financial systems); and
- The number of users - where data maintenance is performed primarily by staff within the research office, there are few hands-on users and the implementation process is relatively straightforward. However, where data updates are made by research project managers across the agency, greater effort is required for involving users in the development process and conducting training to ensure that the system is properly used, and that consistent, current data are provided.

A strong RPMD business case will depend on striking a balance between system scale and complexity and benefits. A scaled-down, simple RPMD will keep costs low, but may not have the benefits of a more fully featured (and more expensive) RPMD that has multiple features and interfaces. Based on the interviews conducted, it was clear that there is little appetite for a "Cadillac system" – it is much easier to make the case for implementing a simple system that provides the essentials.

The agencies that already have RPMDs in place understand that any change to an existing system may not only require funding and/or access to highly constrained IT resources, but effort on the part of an already overburdened research staff. This creates a great deal of inertia. Overcoming this inertia requires a change that would be both highly impactful as well as relatively low cost to implement.

6. Recommendations and Next Steps

6.1 Overview

Four initiatives are recommended to build on the results of TPF-5(181) and enhance research management capabilities within and across DOTs:

- Actively disseminate project results;
- Create and adopt a research project data exchange standard;
- Design and test research project data mart; and
- Develop a basic, web-based RPMD

These four initiatives are described further in sections 6.2-6.5. The first item (disseminate results) is recommended for immediate implementation. The other three are recommended for serious consideration in order to build on project results and improve research data management capabilities within and across DOTs. The fourth initiative – development of a turnkey RPMD is not without its challenges given the diversity of information environments and research program structures and sizes across DOTs. However, it does merit consideration to meet the basic needs of agencies that do not currently have a research database. If there is sufficient interest on the part of a handful of agencies, a collaborative software development effort could be an efficient way to address these needs.

In addition to the four initiatives listed above, several supporting initiatives have been identified to improve national research data management resources provided and/or maintained by TRB and

AASHTO. While this project focused on improvements to internal DOT research management capabilities rather than national research databases and tools, several suggestions emerged from information gathering efforts conducted as part of the project and are documented in section 6.6.

6.2 Disseminate Project Results

Objectives:

- Ensure that DOT research offices are aware of the resources that have been developed to support internal development efforts.
- Initiate discussions on potential next steps

Description

This would involve several activities to disseminate the results of the project to the target audience (DOT research offices.)

Actions:

- Conduct a webinar to review the business, functional and data requirements that have been developed. Record the webinar and make it available for future reference.
- Deliver a presentation on the results of this project at the July 2018 RAC/TRB Reps Meeting
- Add resources gathered on current DOT RPMDs to the RPPM website

Resourcing:

- These actions can be covered through voluntary activities.

6.3 Create a Research Data Exchange Standard

Objectives:

- Create a research project data exchange standard
- Enable future automated interfaces between state DOT systems and TRB RiP
- Facilitate sharing and aggregation of DOT research project data

Description

This would involve an effort to develop a research data exchange standard including mandatory and optional elements– building on the data structures of RiP and TRID – and leveraging the current FHWA effort to develop a standard data model. This effort would also define a model architecture for aggregating research data from individual RPMDs. While this would not provide states with any new RPMD capabilities, it is a positive first step towards gaining agreement on the essential data elements required for managing a research program and sharing information on its products. It would provide an important foundation for sharing and aggregating data across states for "telling the national SP&R story" and facilitating collaboration.

Actions:

- Form a work group to determine approach – involve members of RAC, FHWA, USDOT chief data officer

- Evaluate potential use or adaptation of the FHWA research data specification (currently under development)
- Consider voluntary effort and/or use of contractor for support

Resourcing:

- Initial effort: voluntary initiative
- Full implementation: $0-$100,000 (depending on level of contractor support)

6.4 Develop a Research Data Mart Specification

Objectives:

- Create a model data mart that supports research project and program status and financial reporting
- A data mart could extend the reporting capabilities of existing RPMDs and provide an improved solution for integrating data from financial and contract management systems
- Support implementation of this data mart within a state DOT to demonstrate application

Description:

Many of the data elements needed to track research project financial and status information are maintained in DOT financial, project and contract management systems. Interfaces between these systems and RPMDs can be problematic to establish and maintain over time. Several DOTs have established data warehouses that involve structured processes to create and refresh data marts to support needed reporting. Standard tools are generally made available for development of reports against the data mart. For some agencies, creating a research data mart supporting reporting would provide a way to enhance research program and project reporting capabilities without modifying existing RPMDs.

This initiative would involve developing a research data mart specification as well as specifications for sample reports that could be produced based on the data structure. To be effective, a host agency for development should be identified so that a functional solution could be demonstrated.

Actions:

- Draft a Scope of Work (SOW) for designing and testing a research project data mart, building on the results of TPF-5(181)
- Circulate the SOW to determine interest among state DOTs in participating

Resourcing:

- Data mart design and implementation support estimated to cost $50,000-$100,000 (depending on level of support)
- Assumes willingness of DOT staff to create the data mart (based on the design) and write scripts to populate the data mart from available databases

6.5 Create a Basic, Web-Based RPMD

Objectives:

- Provide a basic, turnkey RPMD solution option for DOTs that are currently using spreadsheets and desktop (e.g. MS Access) databases
- Concept would be to develop and provide sample database and software "as is" for implementation by state DOTs

Description:

This would involve an effort to develop a basic, web-based RPMD that provides a set of minimum capabilities for small to mid-sized DOTs that do not have a current RPMD solution. This could be undertaken through a new pooled fund project or through an informal collaborative effort on the part of several DOTs. This effort could use the "recommended" data model described in Appendix B as a foundation, and build out the user interface and reporting capabilities.

Actions:

- Identify a lead state
- Draft a Scope of Work – building on the results of TPF-5(181)
- Circulate to determine interest

Resourcing:

- Design and development of basic, web-based RPMD estimated to cost in the $400,000-$600,000 range.

6.6 Supporting Initiatives

The following set of initiatives were identified during the course of the research, and involve enhancements to existing national-level data sets and tools supporting research program and project management.

Feasibility Analysis for a National Transportation Research Stakeholder Database

Currently many DOT research offices maintain email lists or tables of stakeholders for annual research solicitations, RFP/RFQ distribution and for identifying individuals to include in technical review panels. DOT research offices may refer to TRB and AASHTO committee listings, but this information is often out of date. In theory, a national directory of stakeholder information offers the potential for improved data quality with less collective effort. A consolidated directory could apply a consistent method for "tagging" each individual with areas of expertise and provide the ability to generate mailing lists for different purposes. Security could be put in place to hide contact information from unauthorized users, and to provide individual users of the directory the option of maintaining a set of "private" entries for their purposes only. There may be opportunities to leverage not only the TRB and AASHTO directories, but the ORCID database as well. ORCID offers researchers to obtain a unique ID and create a record with contact information, education, keywords indicating areas of interest, current organizational affiliations, and publications. As a first step, a working group could be established to explore opportunities and potential strategies.

Research Data Quality Initiative

Maintaining current and accurate information within RiP, TRID, and research stakeholder databases maintained by TRB and AASHTO Committees is essential to getting full value from these resources. Stakeholders observed uneven data quality within these systems. For example, the status of some projects in RiP is not up to date and doesn't match other data sources (e.g. NCHRP Project 08-70 shown in RiP as status: Active, with an actual completion date of 10/1/2010; the NCHRP web page for this project indicates a completion date of 6/30/2011.) A data quality improvement initiative could be undertaken involving TRB and AASHTO staff and committee members to assess the currency and accuracy of the data, current processes and develop specific recommendations for data cleanup and new or updated processes that would maintain data currency on an ongoing basis. These might include developing reports that perform cross-checks across different data fields and databases to identify inconsistencies (e.g. completion date in the past but active status.)

Research Database Search and Query Improvement Initiative

This initiative would be aimed at increasing the efficacy of existing tools (RiP, TRID, TRB Research Needs Statement database) for sharing information about proposed, in-progress and completed research through improved search capabilities. It might include: (1) a structured process of search testing by a user panel to identify strengths and weaknesses, (2) review of search logs, and (3) undertaking improvements to taxonomy and search algorithms.

One aspect of improved search to investigate is strengthening linkage between projects and research products. The TRID database contains information on published research products. Project records from RiP are searchable in TRID while projects are in progress, but once projects are completed and closed out in RiP, the project information is archived. It would be useful to maintain a project history

view from TRID to support the research management function. This would be particularly helpful given that the AASHTO RAC's High Value Research website features completed research projects and includes the capability to interface with TRID and RiP.

Curation Effort for Research Program and Project Management (RPPM) Website

The AASHTO RPPM website was developed to support information sharing across the transportation research community. It is envisioned as the "go to" site for best practices related to funding, conducting, managing, implementing, sharing and evaluating research programs, projects, results and products. Currently RPPM depends largely on individual research community members taking the initiative to contribute content.

In order to foster collaboration across DOTs on topics of common interest and enhance awareness of completed research, an initiative could be undertaken to actively curate research roadmaps (national, state, University), literature reviews or guides on different topic areas, problem statements (tagged with common topic categories), and links to topical research needs repositories such as AASHTO's CEE TERI Database. One way to accomplish this would be to organize a "content drive" with publicity, deadlines and tracking of contributions.

Research Report Distribution Process Improvement

When SP&R2 research projects are completed, research products are distributed to the National Transportation Library (via a TRID submittal form), the FHWA Library, the FHWA Office of Corporate Research, Technology, and Innovation Management, Northwestern University Library and NTIS. Individual state DOTs have other distribution lists for reports. In the stakeholder interviews, it became evident that report distribution processes are not always followed due to changing requirements, staff turnover, and other factors. A 2014 report examined this issue and found that while best practices were generally being followed, there was some variation across DOTs in report distribution. It recommended that FHWA issue revised guidance. This revised FHWA guidance was issued in 2015, and AASHTO developed a report distribution checklist based on this guidance. There are opportunities for further education on this topic (at a minimum), and potentially additional streamlining as technologies and acceptance of publish and subscribe models for distribution increase in the future. In addition, there are opportunities to further align report distribution processes and methods across state DOTs, USDOT, and Universities. As a first step, a TRB session or workshop for 2019 could be planned on strategies for improving and aligning research report distribution processes.

Research Performance Measure Worksheet

Implementation of performance measures for research programs has been an active and important area of interest for transportation research program managers. NCHRP Project 20-63B: Performance Measurement Tool Box and Reporting System for Research Programs and Projects recommended a suite of research performance measures. Based on the results of this project, a research performance measurement website was created, with the intent that research program managers could use it to submit information for their projects. Relatively few states submitted information. Nevertheless, the stakeholder interviews found that research program managers have a keen interest in performance measurement and are seeking to implement simple and sustainable tracking and reporting approaches. A small research project could be initiated to develop a research performance measurement template with standard output and outcome measures. This could build on prior work

(such as NCHRP 20-63B). The goal would be to facilitate adoption of a set of common performance measures. This would pave the way for a future ability to aggregate information across states in order to better "tell the story" about what SP&R2 funds are yielding.

Balloting Tools

One of the common research program and project management functions is to circulate candidate research projects to a designated set of stakeholders for rating or ranking, and then compilation of these "votes" to determine which projects will be selected for funding. This process is used for annual NCHRP project selections; it is also used in many states to inform selection of new research projects for SP&R2 funding. A variety of methods are used to support the balloting process – many of which involve mailing spreadsheets and manual compilation of votes. Some states have developed tools to automate this process – for example, Caltrans has created a web-based tool for rating NCHRP problem statements and compiling results in a database.

At a minimum, there may be opportunities to identify opportunities to identify existing commercial tools that could be used, or agency balloting tools that could be shared. With relatively modest funding, a web-based system could be developed that would allow stakeholders to view information about candidate projects, submit their ratings, and then summarize the ratings (along with any comments). If intentionally designed, this system could be used by TRB/NCHRP for project selection as well as by individual states. Features for individual states could be used for soliciting opinions on national (NCHRP, AASHTO) project candidates internally in order to provide responses to requests for ratings. Given that many agencies have established IT standards and restrictions on the tools they can use, so a menu of options should be identified.

6.7 Summary

State DOT Research Programs manage a substantial amount of information for diverse purposes. The current practices are highly varied, some addressing a limited set of business requirements and others with more comprehensive coverage. Some of the research business requirements align with other agency functions and this report may help identify opportunities to take advantage of those existing data systems. Other needs are unique to research management. The business and functional requirements captured in this report provide a foundation for state DOTs to discuss research information management needs within their organizations and in support of national collaboration, reporting, and data integration.

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Appendix A: State DOT RPMD Systems

Table A-1 provides information on state DOT RPMD systems in place as of March 2018. This information was created from an AASHTO RAC survey of state DOT research offices initially conducted in 2013. Information was updated based on telephone and email contacts made by staff at the Washington State Department of Transportation (WSDOT) in the summer of 2014. Selective additional updates were made by Spy Pond Partners, LLC based on contacts made for gathering business and stakeholder requirements in early 2017. Prior to the release of this report in March, 2018, WSDOT re-sent the 2013 survey to RAC members (with the 2014 and 2017 updates) and requested that they verify this information. Additional updates were made based on the 2018 survey.

Table A-1. Current State DOT RPMD Systems

State	System Name/Platform	Features
Alabama	No information available	
Alaska	Simple (single form) MS Access database – no longer in active use Last contact indicated intent to use agency's general project management reporting system (MRS).	Older research database included tracking of project objectives, problem statement, manager, PI, advisory panel, schedule, status, implementation items, comments and associated website
Arizona	Research Track (MS Access)	Research contact management (internal , vendor, FHWA) – organizations and people Project tracking – TAC members, consultants, milestones, tasks and deliverables Project financial tracking – funding by source, budget and remaining contract amount, invoices Report editing workflow Research product distribution tracking Summary view for library Implementation tracking (free form)

State	System Name/Platform	Features
Arkansas	Spreadsheet	Project info: objectives, agency performing, deliverables, implementation actions, committee comments and actions, simple milestone status (standard items with Y/N for completion) Links to RFP, proposal, contract, tracking form, final report PI contact information
California	Research Program Management (RPM) Database (FileMaker Pro)	Problem statement and proposal tracking Project/task tracking – scope, expenditure authorization/funding sources, budget, schedule, milestones Budget request workflow (by task) Project financial tracking (no interface with accounting system; double-entry required) Pooled fund tracking (lead state info, other/in-kind contributions) Contract tracking – task orders, amendments, vendor information Project close out Program budget, expenditure, balance tracking (including non-project items) Standard reports: project plan, annual work program, annual financial summary, project status
Colorado	ResearchDB (Microsoft Access)	Project tracking – links to progress reports, scopes, contract documents Project financial tracking (no automated link to SAP, but structured to facilitate manual updates from SAP) Contract tracking Pooled fund contribution tracking
Connecticut	No information available	
District of Columbia	Spreadsheets	Current and historical project lists Research idea lists Pooled fund participation lists

State	System Name/Platform	Features
Delaware	No information available	
Florida	Research Contract Administration (RCA) System (SQL)	New in 2015 – limited information available
Georgia	Spreadsheet	
Hawaii	Spreadsheet	
Idaho	Spreadsheet	
Illinois	Transportation Project Database (Microsoft Access)	Basic project tracking – budget, schedule, comments Project technical review panel membership PI Evaluations Technical advisory group members and meeting tracking Project close-out form Basic queries and reports – project list, panel members Implementation tracking
Indiana	Joint Transportation Research Program (JTRP) Database (Microsoft Access with custom UI) Use Smartsheet.com as sharing application with Purdue University to synchronize with the Access database.	Project tracking – including budget and time extensions, milestones/events Research personnel/contacts tracking
Iowa	Converting existing SPR Access Database to off-the-shelf system - Cognito + Concord	Project tracking Project financial tracking (not linked with accounting system) Implementation tracking
Kansas	Spreadsheet	Very limited information on University and other contract Research.

State	System Name/Platform	Features
Kentucky	SQL Server - "Research Project Tracking System" developed in-house	Store basic project information for active and completed projects Produce QPRs for the SPR program Create a website/homepage for each project, complete with project status Link to key project documents stored on Dropbox Store basic financial information for each project Track back end performance measures and implementation action items (though not currently utilized)
Louisiana	Louisiana Transportation Research Center (LTRC) Project Management and Tracking System (web-based, custom developed in .NET)	Research problem submittal and evaluation workflow Searchable project database Summary work program information download Project document repository Project status and deliverable tracking Project financial tracking (direct interface with financial system) Automated progress reporting Email notifications Publication workflow tracking Implementation activities and status tracking Program and project performance measure tracking
Maine	No separate Research database. Use Department Oracle databases.	Use ProjEx project management system and TRACS contract database
Maryland	SharePoint	Track basic task information (cost, notice-to-proceed date, project number, Principal Investigator) and invoice receipt and payment information.
Massachusetts	No information available	

State	System Name/Platform	Features
Michigan	MS Access	Basic project tracking information Working (2015) on spreadsheet with consolidated accounting information
Minnesota	Automated Research Tracking System (ARTS) (Microsoft Access, custom developed)	Research needs statements entry Contract development process tracking Searchable project database Customizable reports Project document repository Project status and deliverable tracking Project financial tracking (with reconciliation across accounting systems) Automated progress reporting Email notifications Project evaluation forms Client database
Mississippi	Database (Microsoft Access)	Proposal review tracking Project tracking Project financial tracking Research organizations and people tracking
Missouri	As of 2017, using off-the-shelf "Cloud Coach" (Salesforce-based project management system in the cloud.) Formerly used SharePoint integrated with MS Project, switched platform due to change in enterprise agreements	
Montana	Spreadsheet - Currently waiting for a Department-wide program and project management system (PPMS) RFP to be issued. Research was involved in the requirements gathering.	

State	System Name/Platform	Features
Nebraska	Spreadsheet	
Nevada	Spreadsheet	Agreement tracking
New Hampshire	Research Projects Database (Microsoft Access)	Project Tracking Personnel/Roles Tracking Quarterly Progress Reporting Document tracking/links Since the beginning of FFY 2016, NHDOT has used MS Access to print out their quarterly and annual reports for FHWA Division Office
New Jersey	eProMPTS (Oracle – web based platform) Currently finalizing a scope of work to develop a system compliant with 2 CFR 200 grants administration requirements which will be heavily customized to include the risk assessment monitoring component.	Research need/problem statement tracking RFP and Proposal submittal/evaluation tracking Project tracking Deliverable tracking Document transmittal tracking and workflow (task orders, invoices, contract mods, final reports, etc.) Quarterly Progress Reporting Project financial tracking Customer and implementation survey tracking Organizations and personnel tracking
New Mexico	Project Management Database (Microsoft Access) + Spreadsheets	Project tracking Project financial tracking Project personnel tracking
New York	Combination of spreadsheets, MS Access, and Oracle databases	

State	System Name/Platform	Features
North Carolina	Combination of spreadsheets, MS Access, SharePoint, SAP. Migrating from MS Access to SQLServer; and to NCDOT grants management system. Separate systems for Project Management, Program Development and Research Contacts	Research idea collection and management of review process Basic project tracking – funding by source, schedule Research committee member tracking Research contact management – mailing labels, email lists
North Dakota	Spreadsheets	
Ohio	Research Administrative Research Management System (ARMS) (.NET system)	Project tracking Deliverable tracking Project financial tracking Project personnel tracking Contract tracking – including addenda workflow
Oklahoma	Spreadsheets	Project and program tracking is documented through various spreadsheets and email archives. Each employee is charged with the maintenance and security of their respective master files. All files are shared within the Office on a dedicated restricted server.
Oregon	Spreadsheets	SPR budget development and management
Pennsylvania	Research Program Management System (RPMS) Database (Oracle)	Selection committee membership Quotes tracking (proposals) Project tracking Project financial tracking Contract tracking Staffing and roles tracking Research agencies/vendor tracking
Rhode Island	Spreadsheet	Basic project list Addendums Invoices Progress Reports

State	System Name/Platform	Features
South Carolina	Research database (Microsoft Access)	Proposed Project tracking Research input tracking Project tracking Invoices tracking Progress reporting Final Report tracking
South Dakota	Spreadsheets	Suggestions tracking Proposal tracking Project tracking Progress reporting Contract tracking Project evaluation tracking Implementation tracking
Tennessee	Spreadsheets + Webpage	
Texas	Currently using SharePoint, transitioning to Microsoft Access	Project tracking Project deliverables tracking Project personnel tracking Project financial tracking
Utah	Research database (Microsoft Access)	Project tracking Project financial tracking Project personnel tracking Contract tracking Exploring addition of implementation tracking (2018)
Vermont	Spreadsheet	
Virginia	Research database (Microsoft Access) + Spreadsheets	Project tracking Project financial tracking (no interface with financial system) Implementation tracking: publication reference and implementation activities, and benefits

State	System Name/Platform	Features
Washington	Research Program Management Database (RPMD) (FileMaker Pro) – modified version of California's system	Problem statement and proposal tracking Research Advisory Committee (RAC) members Technical Advisory Panel (TAC) members Project/task tracking – scope, expenditure authorization/funding sources, budget, schedule, milestones Budget request workflow Project financial tracking (work order expenditures can be imported), invoices and payments Master Agreement, Reimbursable Agreement, Task Order tracking – amendments, vendor information Project close out – documentation of publications Implementation action and results tracking ORLS biennial budget Standard reports: project plan, annual work program, annual financial summary, project status
West Virginia	Research database (Microsoft Access)	Project tracking – including PIs and contract monitor names Project financial tracking (no interface with financial system)
Wisconsin	SPR Track (Microsoft Access)	Project tracking Project milestone tracking Project financial tracking (no interface with financial system) Contract tracking Research organizations tracking Research contact tracking
Wyoming	Spreadsheets	

Appendix B: RPMD Data Models

As part of TPF-5(181), WSDOT information technology staff developed three physical data models based on the data requirements presented in Chapter 4. The three data models represent three different levels of RPMD development:

- Required - a minimal system with data elements needed to meet SPR, RiP and TRID reporting requirements;
- Recommended – a system with additional data elements needed to meet internal agency management needs, and
- Optional – a more fully built out system.

The following files are available for each of the three data models:

- An ERWIN file containing the source data model information
- A SQL script that can be used to create the database tables and populate code lists
- A data dictionary spreadsheet report with table and column names and descriptions
- A PDF file showing the entity-relationship diagram for the data model

These files can be accessed from the AASHTO RAC Research Program and Project Management Website (http://rppm.transportation.org/Pages/default.aspx)

To use these models, the following steps are recommended:

1. Review each model to determine which best meets the agency's RPMD needs. In general, the "Required" model includes all of the data elements marked as "Required" in the tables in Chapter 4; the "Recommended" model includes all of the data elements marked as either "Required" or "Recommended". The "Optional" model includes all of the data elements.
2. Make changes to the data model to add or remove tables and columns to meet the agency's requirements. This can be done using ERWIN or an alternative data modeling package.
3. Review the code lists (see section 4.11) and make modifications to meet the agency's needs.
4. Create the database using the modified model.

Agencies using these data models will need to create a user interface, reports and (potentially) interfaces with other agency databases to have a functional RPMD system. However, these data models should provide a significant shortcut for the development process.

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