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Abstract

Over the past several decades a variety of federal and state programs have invested in transportation research. The United States Department of Transportation (USDOT) annually invests approximately $180 million in State Planning and Research (SPR) and University Transportation Centers (UTC). This investment generates an extensive portfolio of “grey literature” that is not yet uniformly cataloged or accessible, despite the best efforts of the National Technical Information Service, the Transportation Research Board, and the National Transportation Library. This paper reports on a review of publishing and archiving practices for transportation research technical reports, summarizes best practices, and recommends that UTC and SPR research programs seek and strengthen partnerships with libraries to facilitate improved production, stewardship and dissemination of research reports.

This paper describes an open access program in Indiana that has digitally archived approximately 1,500 SPR reports dating to 1956, implemented consistent name authority, and created digital object identifiers (DOIs) for reports and data sets to systematically integrate technical reports into scholarly literature. Through new partnerships between the researchers and the home institution, researchers have developed processes to leverage technical report production with the university press to ensure agile adaptation to emerging digital publishing and open access trends. It is suggested the adoption of the techniques and partnership herein described will result in more efficient investment of state and national transportation research funds by further reducing research duplication and by demonstrating improved stewardship of research dollars.
Problem Statement

The United States Department of Transportation (USDOT) invests approximately $180 million annually in State Planning and Research (SPR) and University Transportation Centers (UTC)[1]. This investment generates an extensive portfolio of technical report grey literature that is not uniformly cataloged or comprehensively accessible. The production of technical report literature today is not yet done in a way that (a) incorporates best practices in digital publishing, (b) integrates the technical and scholarly research literature, and (c) leverages localized initiatives, open access trends, and new scholarly communication services. Consequently, current technical report literature production introduces uncertainty into the process of eliminating duplicative research. These problems in technical report dissemination match well with efforts to improve production and dissemination of scholarly literature presently underway through emerging campus-publishing partnerships. For researchers, publishers, and information professionals alike, there is fertile ground for collaborating to improve processes and research impacts.

Background

The historical challenges around comprehensive access to and streamlined dissemination of technical transportation literature have been well-documented this past decade [2][3]. A May 2001 Government Accounting Office (GAO) report entitled “Information Management: Dissemination of Technical Reports” speaks directly to these challenges [4]. It notes that in 2001 the National Technical Information Service (NTIS) retained a print repository of approximately 2.5 million reports. Between 1995 and 2001, NTIS sold (distributed) only about 1% of 1.8 million reports over 12 years old, which account for 75% of its holdings. The GAO report further details NTIS’ challenges in acquiring a comprehensive technical report collection, despite mandated deposit policies. These findings were subsequently cited in a January 2003 GAO report entitled “Major Management Challenges and Program Risks: A Government wide Perspective” [5]. The section entitled “Improving the Collection, Use, and Dissemination of Government Information” mentions briefly, “Our recent work at the Government Printing Office and the National Technical Information Service—which also make government information available to the public—has raised questions about the adequacy of the current policies and structures in place to ensure public access to information.” The transportation research information community continues to address many of these perceived shortfalls through the establishment of “transportation knowledge networks,” both regional and national [6].
The professional librarianship literature has made similar mention of the historical issues around access to technical reports. A 2006 article from *The Reference Librarian* entitled “Elusive No Longer? Increasing Accessibility to the Federally Funded Technical Report Literature” [2] includes a brief overview of the problems in technical report dissemination and spotty distribution issues.

> “On the whole, federally sponsored technical report literature has been less well distributed and identified than other federal government publications. The literature discussing federally funded technical reports suggests several stumbling blocks for the creation, dissemination, cataloging, discovery, and preservation of these publications including weak federal information policies, the need for a federal information policy specifically for science and technical information (STI), differences in missions and mandates in scientific government agencies, and a basic lack of awareness of the technical report literature.”

Although the transition over the last decade to born-digital publication and transmission of research results has delivered value and economy in quality of publication and reduction in cost of delivery, it has also introduced an area of creative destruction in which the processes for production and distribution of technical literature remain in flux.

The June 2011 Congressional testimony of John Halikowski on behalf of AASHTO suggests the general case holds true for the results of federally funded transportation research [7]. In making the case for sustained funding of transportation research programs in an era of scarce resources, Halikowski highlights the return-on-investment that state-level agencies realize from their investment in transportation research, suggesting, “The return on the states’ investment in research is substantial. In just one example, a formal cost analysis in 2003 prepared for the Indiana Department of Transportation’s research program, jointly administered with Purdue University, showed benefit-cost ratios ranging from as high as 220 to as low as 3 to 1.” The impact of state-funded research can be further leveraged by a fast and efficient distribution of research results so that other states can implement the research findings without duplicating the investment in research. During a National USDOT Webinar for the “Every Day Counts Program” on October 27, 2011, FHWA Administrator Victor Mendez explicitly cited the need for states to find ways to reduce the duplication of research activities and leverage peer state research results.

The creative disruption around access to technical information has affected libraries and research organizations, both major entities in the present system of scholarly exchange. Through formalized programs such as digitization labs and digital scholarly repositories, the role of libraries in providing varying degrees of publishing services for historical documents and technical information continues to grow. Further, building on converging institutional service roles, libraries and university presses find themselves imagining new types of local scholarly communication services. Thus, campus-based publishing represents new opportunities for addressing emerging issues in facilitating the dissemination of local research on technical issues to a broader national audience.
Examination of Current Practice for Dissemination of Transportation Research

The process of maintaining comprehensive circulating collections of transportation research reports has relied on a policy of research agencies sending documents to a central depository (National Technical Information Service [NTIS]) with distributed regional depositories (Volpe Library, Northwestern University, University of California at Berkeley, and the FHWA Research Library). In recent years, however, digital-first document production and the ease of electronic document distribution have broken down the adherence to and utility of these print deposit processes. Over 70 transportation research agencies across 47 states publish some type of technical reports on their web sites. Full-text search terms indexed and returned by Google and scholarly literature indexes like Google Scholar deliver instant access with a convenience and reach that even the NTIS Technical Report Library subscription database [8] cannot duplicate.

SPR Research

State-level institutions that conduct transportation research with SPR funds are subject to certain requirements to facilitate the dissemination of those findings by filing final reports with specific agencies. The FHWA requirement, for example, has traditionally been to mail printed copies to several national libraries, although this requirement has been amended to indicate that electronic submission of archived reports are preferable to the deposit of printed volumes.

Those groups conducting transportation research, however, frequently make good-faith efforts to represent the corpuses of their locally produced technical literature on their Web sites. A comprehensive accounting of all organizations conducting SPR research is difficult to apprehend owing to the varying models that are used to conduct and disseminate state level research. Sampling the sites of many of these research centers (both state DOTs and University Transportation Centers) suggests that such approaches are not yet uniform, however, as many feature incomplete bibliographies and spotty access to full-text payloads for final reports of SPR projects. Several of these sites, however, are excellently arranged exemplars. Transportation research groups such as the Texas Transportation Institute (TTI), the University of Michigan Transportation Research Institute (UMTRI) and the Joint Transportation Research Program at Purdue University (JTRP) have substantial electronic catalogs of technical reports.

Grey Literature and Technical Report Dissemination Services

As noted in the background statement, comprehensive access to information-rich but informally published grey literature such as the technical reports of federally funded transportation research is a legacy issue observed by librarians and other information professionals. There are many national and non-profit initiatives and agencies that aim to address concerns related to accessing grey literature. The following non-exhaustive list identifies some of the most prominent:

- **NTIS National Technical Reports Library**: A federal government-operated subscription service launched in 2009 with an index of over 2 million technical reports and full-text access to more than 600,000 documents.[8]
- **Technical Report Archive and Image Library (TRAIL)**: A collaborative initiative of the Greater Western Library Alliance and the Center for Research Library. TRAIL focuses exclusively on print-original technical reports published prior to 1975.[9]
• **Transport Research International Documentation (TRID):** An integrated portal for the former TRIS and ITRD transportation research indexes, TRID is a service of the Transportation Research Board and provides the largest gateway to transportation research, including technical reports that have been filed with TRB, NTIS, the National Transportation Library, and others.[10]

• **OpenGrey:** A European, English-language index of grey literature. OpenGrey is a service provided through several grey literature-focused organizations operating across Europe and hosts full-text for only a small portion of its records.[11]

• **TLCat:** The Transportation Library Catalog, or TLCat, is a specific search application provided through the National Transportation Library for the structured, cross-institutional search of transportation research holdings nationally.[12]

• **National Transportation Digital Library:** The National Transportation Digital Library is a full-text digital repository managed by the Research and Innovative Technology Administration (RITA) at the USDOT—access to documents available through the TRID search platform as well as through NTL’s own integrated search interface. [13]

In general, these are indexing and database efforts that are important but do not address the fundamentals of how transportation research organizations should manage the production and stewardship of the technical reports that result from research investments.

**Case Study at Purdue University**

**Introduction of Stakeholders and Relationships**

For the present discussion, it is important to note the various stakeholders and the evolution of the relationships between them. Transportation research conducted with State Planning and Research (SP&R) funding is administered through the Indiana Department of Transportation in collaboration with researchers at Purdue University in West Lafayette, Indiana. With a legacy extending back to 1937, this partnership, known as the Joint Transportation Research Program (JTRP), completes several dozen research projects annually. The printed JTRP technical report series has been collected locally through the Purdue University Libraries on the West Lafayette campus.

**Legacy of the Purdue e-Pubs Repository Program**

In 2005, the Purdue University Libraries and Purdue University Press (an organizational unit of the libraries) embarked on the beginnings of a joint digital publishing program. Using a common digital publishing platform, Digital Commons, the Press initialized several early online scholarly journals. The Libraries used the platform to launch a digital ‘institutional repository’, branded Purdue e-Pubs (docs.lib.purdue.edu). The mission of Purdue e-Pubs is to collect and provide free online access to the scholarly work created at and affiliated with Purdue University. Both the online journal program of the Press and the digital repository program of the libraries are largely premised on the prospect of capitalizing on efficiencies in online distribution to realize Open Access, a sometimes politically overburdened business model in which the production expense for any given publication is not passed to the user of that resource. The Purdue e-Pubs publishing and repository program has thus been an exercise in research-in-development. The Press’s digital portfolio today includes 10 Open Access journals. In conjunction with the repository holdings on
Purdue e-Pubs, the program represents over 24,500 records for articles, reports, presentations, and theses authored or affiliated with campus researchers and students.

Although the Library and Press’s organizational affiliation predates the shared Purdue e-Pubs digital program, the Open Access journals program remained almost entirely separated from the libraries repository activities through 2008. In 2009, appointment of new Press leadership coincided with the physical relocation of the Press offices to the main Library administration building. As a result, both Library and Press were better able to realize collaborative digital publishing opportunities that naturally arise from shared technical infrastructure, similarity of mission in serving the campus need for scholarly exchange, and convergence of project opportunities.

**History of Intersection with the JTRP Program**

JTRP emerged among the earliest adopters of the Purdue e-Pubs program by facilitating the batch transfer of their born-digital and digitized technical reports. JTRP had maintained its own online catalog of technical reports for many years, which made participating in the Libraries’ pilot program opportune. Technical staff could export parts of the database powering the JTRP Web site and prepare the descriptive metadata for a batch deposit into Purdue e-Pubs. In October 2006, 229 documents were loaded on the Purdue e-Pubs systems and by 2009, a total of 360 technical reports dating from 1990 to 2008 had been uploaded. Figure 1a shows the download count as of December 2009 of the initial 360 JTRP reports by publication year. There are no downloads shown for reports published in 2008 or 2009 because the batch upload of these technical reports did not occur until 2011. Since there is some variation in the number of reports published in a year as well as some variation in the interest level of a particular report, there is some stochastic variation in the number of downloads.

**Early Outcomes and Rationale for Continued Partnership**

The initial 360 JTRP technical reports in the Purdue repository represented a good fraction of the entire corpus, although nowhere near comprehensive. Further, new reports continued to be published to the JTRP Web site, awaiting periodic batch transfer to Purdue e-Pubs. The high demand for the back catalogue of grey literature, coupled with the increased nature of collaboration among Libraries, Press, and external campus units suggested opportunities for additional exploration and strategic integration between libraries and JTRP to deliver additional digital service in publishing technical reports.

By 2010, it became clear that

- There exists substantial national and international demand for access to these technical reports
- Reports needed to be uploaded to Purdue e-Pubs in a more timely manner
- Partnering with the Purdue library for hosting these technical reports provided an opportunity to leverage core competencies of the library instead of duplicating electronic distribution efforts within the JTRP program

In late 2010, an effort was initiated to digitize the complete set of technical reports dating to 1956. Most technical reports from 1956 to 1989 were loaded into the Purdue e-Pubs system on April 29, 2011, although a few required re-scanning and were posted as late as July 2011. In addition, remaining electronic reports from 2008 to 2011 were uploaded. As of November 2011,
the 1,118 reports loaded in 2011 (Figure 1b callout “i” and callout “ii”) had over 21,000 downloads. Figure 2 shows the JTRP home page on e-Pubs, with reports organized in descending order by year of publication.

Table 1 shows download statistics for selected technical reports (rank ordered by cumulative download count). The technical report with over 11,500 downloads was written in 2003 [14] and first posted online in 2006. As one can see by the technical report titles, the topic area is quite diverse. Furthermore, some of the most highly downloaded reports have been only been recently added. For example,

- a technical report assessing the Indiana Furniture Supply Chain [15] and posted in December 2008, is ranked 22nd in download count with 1581 downloads.
- a technical report predicting pavement performance that was written in 1972 [16] and posted in July 2011, is ranked 153rd in download count with 463 downloads.
- a technical report assessing herbicides that was written in 1967 [17] and posted in April 2011, is ranked 335th in download count with 97 downloads.

Purdue e-Pubs download reports retrieved November 8, 2011, show that the JTRP technical reports, some over 20 years old, are among the most highly accessed content site wide and account for 224,394 total downloads on the site. JTRP technical reports account for 13% of Purdue e-Pubs downloads while only making up 6% of the total collection on the site as of November 8, 2011.

Web analytics information suggests that many of these documents, which report on projects pertaining to local Indiana conditions and initiatives, are being accessed widely at global [Figure 4a], state [Figure 4b], and local levels [Figure 4c, 4d]. Comparing Figure 4c and Figure 4d is particularly interesting as it shows a notable increase in the geographic diversity (and number) of visitors accessing the research material from within Indiana.

The apparent discrepancies between the download counts in Table 1 and the numbers reported in the Web analytics tool warrant discussion because each represents a view of some categorically discrete data. The downloads are measured according to the COUNTER methodology (http://www.projectcounter.org/), whereas the analytics tool reports on site visits to a given area of Purdue e-Pubs. Visitors who arrive directly to the report PDF via a Web search thus register a download but are never counted among the site visitors using the web analytics report in Figure 4.

**Approach for Adding Retrospective Materials to Purdue e-Pubs**

Examining Table 1 and Figure 4, it is clear that when these technical reports are readily accessible in an open access format, there is a substantial demand for these documents. Given the usage of back files already loaded into Purdue e-Pubs, a next step in the collaboration was the comprehensive digitization of all retrospective, stand-alone JTRP reports, dating from 1956. This portion of the project not only presented an opportunity to provide broader access to the JTRP back catalogue, but also an opportunity to address metadata issues for the entire project.

Applying professional metadata practices was identified as an important component of the project from a number of perspectives: improving access to reports within Purdue e-Pubs, enabling the digitization process, and enabling enhanced publishing services such as the assignment of Digital Object Identifiers (DOIs).
As a prerequisite for scanning, the development of metadata standards was an early emphasis of the collaboration. An examination of the 360 JTRP technical reports already in Purdue e-Pubs revealed a number of issues with metadata assignment and bibliographic management items that needed correction moving forward. Standards for metadata assignment developed for digitization could also be incorporated into subsequent publishing workflows. Of these issues, particularly notable was inconsistency in the assignment of author names. It was common for authors who had contributed multiple reports to be represented by multiple forms of their name (e.g., “D. Bullock,” “Darcy Bullock,” “Darcy M. Bullock”). This made it more difficult to co-locate reports by a single author, a major problem in making the repository as useful as possible. This was addressed through the application of name authority, a standard library practice in which a canonical name form is assigned to an author, regardless of how their name may appear on a report’s title page. Name authority assures users of a library collection that author searches do not accidentally retrieve records for works by similar or identically named persons. Similarly, other metadata issues were addressed through the application of library cataloging standards. The metadata for many Purdue e-Pubs collections (and JTRP in particular) are customized within the system and do not conform to a specified standard. Additionally, the system does not include many features that support standards-compliant metadata management. Therefore, standards-based practices needed to be adapted for the infrastructure. For example, name authority would typically be managed by loading Library of Congress-maintained name authority records into a library management system and then applying these names to bibliographic records. Since Library of Congress authority files could not be directly used by Digital Commons, however, metadata records for JTRP reports were created in an external database. This included a table for name authority records, using Library of Congress records where available and locally-created records where needed.

The metadata are expressed, however, in machine-readable format to any OAI harvester, and through OAI, the custom metadata is shared through Dublin Core, which is a common metadata exchange format. This OAI and Dublin Core support is a common feature across all of the major digital repository platforms, and the methods for metadata description and sharing are replicable using any of them.

Following the creation of metadata records for each report, digitization was conducted by an Internet Archive scanning center through a Sloan Foundation-subsidized program administered by Lyrasis. Digitization resulted in the creation of multiple digital versions of the reports, including high resolution JPEG2000 images suitable for archival purposes and formats more suitable for delivery over the Web such as PDF. PDF versions of the reports were loaded into the Purdue e-Pubs repository along with their associated metadata.

In a final step, unique among technical report digitization projects, reports were enhanced through the assignment of DOIs, which are unique character strings. DOIs persistently identify electronic publications, enhancing the usability of digital content by facilitating consistent citation and linkages amongst publications. Metadata generated during the initial cataloging of reports was used to register CrossRef DOIs for each report, which in turn are loaded into each report’s metadata within Purdue e-Pubs.
Publishing Reports into the Future

The Digital Commons repository software on which Purdue e-Pubs runs includes tools for open access e-journal publishing and manuscript management. The Purdue e-Pubs repository already hosts 10 online journals supported by the Purdue University Press, the editors of which use the built-in repository tools to manage various stages of journal production. Although the existing base collection of JTRP reports was established without the use or need for these tools, the Press and JTRP identified the opportunity in mid-2010 to begin re-envisioning how the technical report production could be managed in a more holistic manner through the Purdue e-Pubs publishing system. In many ways, the technical report review process mirrors the production of journal articles: draft manuscripts (draft final reports) are submitted, these drafts are evaluated by a select committee of reviewers who invite corrections and revisions from the authors, and the author submits a final manuscript which is ultimately approved and prepared for publication directly to the repository site (Figure 5).

Existing publishing workflows available within the repository software required some modification to accommodate this new use case. For example, JTRP has used a standard review document that allows various project stakeholders such as the sponsor, the field technical coordinator, and members of the advisory committee to provide feedback not only on the report but on the conduct, progress, and success of the research itself. Because Purdue e-Pubs is built on a journal publishing platform, it is provisioned to facilitate the project elements related to document publication and less so to those focused on progress-of-research reporting. Additionally, the Digital Commons platform is a hosted repository solution, unlike many similar repository packages in use throughout the library community, such as DSpace. Lack of extensibility in non-open source software, therefore, became an important factor in identifying which key elements of the report production process could be supported by Purdue e-Pubs and the Press.

It is notable that project scope has been guided by the needs of the major constituencies throughout. Representatives from both JTRP and the Indiana DOT Research Division have held consultative visits with Press and Libraries to ensure that the new paradigm for report publication is minimally disruptive to the process of research. For the purposes of this project, therefore, a new position of “Production Editor” was created, a 1-year position jointly funded by both the Purdue University Press and JTRP which reports to the Press director and is facilitating the transition. The Production Editor serves as a liaison during the report production process, interacting directly with PI’s, center staff, and agency stakeholders. Skills valued when placing this position included publishing expertise with technical content, workflow and process management, and organizational efficiency. The JTRP Production Editor position, filled Spring 2011, is the operations lead, managing the review and construction of the reports themselves while representing JTRP on-site with the Press and representing the publishing expertise of the Press to both JTRP and INDOT.

Adding New Value to Reports through Publishing Processes

Much as with the impetus and promise of the digitization project, formal collaboration with the Press has been done with an eye to leveraging Press expertise and unique service value in both the short- and long-term. As a member of CrossRef, the Press and Libraries may assign Digital
Object Identifiers (DOIs) to newly published articles in a manner consistent with the retrospective corpus (Figure 3, callout 2) [18]. As a member of DataCite, the Press and Libraries may also assign DOIs to supplementary datasets in a manner consistent with emerging standards for sharing research data (Figure 6) [18, 23]. CrossRef DOIs increase discoverability and use significantly by linking content into a network of other publishers. It is expected that over time the same will be true following broader adoption Datacite DOIs. Operational oversight by a publishing professional (the JTRP Production Editor) ensures professional quality manuscript layout and design, which more clearly communicates the JTRP brand. Associating JTRP with these indicators of quality further contextualizes JTRP research as scholarly and demonstrates appropriate stewardship of public research dollars. Bibliographic references are verified by the Production Editor and digital identifiers known to the CrossRef database are introduced directly into the report text, facilitating necessary cross-linking. Beyond these immediate gains, the Press/JTRP relationship looks to pave the way for the publication of scholarly quality monographic volumes based on the most well-regarded (or perhaps most frequently accessed) of the JTRP reports. Further, Press relationships with print-on-demand vendors ensure that book quality physical publications remain an option for born-digital documents, and that these printed volumes can be made available through online booksellers, enhancing access and increasing modes of dissemination yet further. The most recently published reports are scheduled for print-on-demand availability by December 2011, and the subsequent discoverability for end users via Amazon.com is something that further brings the results of JTRP research out of the academy into an environment that is widely accessible to practitioners and public readers. Once in full production, the Press roadmap also includes a critical ‘marketing’ component, and the Production Editor will ensure that JTRP content is properly indexed and adequately promoted throughout the transportation research community.

**Conclusions and Considerations:**

**Impacts, Processes, and the Future of Collaboration**

**Impact:** It is clear that for JTRP, the adoption of professional publishing practices as well as library expertise in information access has had tangible, immediate benefits for the technical reports it has produced. The usage (Figures 1a-b, Table 1) of this information is more readily analyzable, and ongoing report production will benefit from improved consistency as well as attention to best practices in scholarly publishing. Library systems and press processes and expertise add value to the JTRP technical report corpus: improved report visibility through Google Scholar via the library’s digital repository, persistent identifiers for both publications and data, and system-generated recommended citations placed strategically to propagate the next generation of references to JTRP research (Figure 3).

**Opportunities to Modernize Processes:** The move to re-imagine JTRP report publication is a direct response to the need to deliver value to these underserved documents while heeding the national challenge to avoid non-scalable solutions. Bringing campus-publishing partners to bear on these problems enables such solutions at scale. Although the national transportation research repositories and catalogs (e.g., NTIS, Volpe, Northwestern, Berkeley) remain serviceable, individual research programs make commitments of varying size to representing their own bodies of research on self-administered Web sites. And unlike with Purdue e-Pubs, comprehensive technical report collection falls outside the explicit collection scope of many of the national transportation research databases and certainly beyond the remit of the university-
managed catalogs. Therefore, rather than obviate existing programs for transportation research aggregation and dissemination, the JTRP technical report publishing project aims to facilitate necessary data transfer: for example by using native digital repository technologies such as Search and Retrieval via URL (SRU) and the Open Archives Initiative Protocol for Metadata Harvesting [20]. WorldCat’s OAIs ter service uses this protocol to regularly harvest descriptive Purdue e-Pubs content, increasing discoverability of JTRP reports through this nationally impactful catalog.

As suggested in the introduction, JTRP is not the first to make important investments in document presentation and collaborative relationships: For example, the Texas Transportation Institute (TTI) is well-regarded for its treatment of the research report as a first-class publishing deliverable [21], and the University of Michigan Transportation Research Institute (UMTRI) is leveraging the UM Libraries’ Deep Blue digital repository to improve access and persistence of resources [22]. Notably, the platform that underlies Deep Blue, DSpace, facilitates the assignment of Handle URIs to all content. The DOI is an application of the Handle system, and the DOIs assigned to JTRP reports, released by registration agency CrossRef, provide the same persistence assurances while networking the content into the broader context of scholarly articles with DOIs.

The processes and workflows described herein have been assimilated into the process of the conduct of research, however, which the authors believe distinguishes the Purdue Library/Press/JTRP collaboration fundamentally from other initiatives (Figure 7). Having concluded the retrospective digitization project, future reports are now produced directly through the library’s digital publishing platform. The process of research, extending from proposal to implementation, now passes through the co-administration of the libraries and press and a jointly-funded position. The assignment of the DOIs then ensures the proper, consistent citation of the reports while aiding in the process of reference linking, increasing access and compounding citability into the future.

Opportunities to Leverage Resources: Not all transportation research groups will have access to the publishing expertise of the university press or to digital repository programs facilitated by research libraries, although the number of library programs offering publishing services has increased substantially over the last decade. The reproducibility of the methods in this report, therefore, is most applicable to transportation researchers with access to research library and press partnerships that are increasingly making the necessary investments in scholarly communication service environments. A recent study funded by the Institute of Museum and Library Services (IMLS) [24], has been exploring the depth of this need and the evidence of the growing nature of library-publishing programs at academic institutions, and finds that 78% of the largest academic libraries (members of the Association of Research Libraries) are now either developing or offering publishing services. Such programs continue to seek new campus partners and projects to position themselves as providers of locally integrated scholarly communication solutions. Libraries and presses looking for collaborators as they re-imagine roles in the new paradigm of scholarship online will find a receptive community among SPR researchers and producers of technical reports.

Such relationships are mutually beneficial: for libraries and press who want to bring first-class information service to their traditional partners in scholarship, and for researchers who need to demonstrate impact and increase exposure to research findings. As noted, the roadmap for the
JTRP/Library/Press collaboration extends well-beyond the traditional publishing demands, with goals to leverage expertise in scholarly monograph development, data curation and management needs, dataset citation, geospatial data exposure, and beyond.

**Opportunity for National Economic Benefit:** Lastly, from a public policy perspective, the authors believe the techniques and partnership herein described can serve as a model that leads to more efficient investment of state and national transportation research funds by improving dissemination and discoverability of transportation research, thus complementing current initiatives to reduce research duplication and increase return on investment.
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### TABLE 1: Selected Download Statistics of JTRP Reports in Purdue e-Pubs

<table>
<thead>
<tr>
<th>Rank</th>
<th>Report Title</th>
<th>Date Added to Purdue e-Pubs</th>
<th>Downloads by Year</th>
<th>2011 to Nov 8, 2011</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dynamic Cone Penetration Test (DCPT) for Subgrade Assessment</td>
<td>10/2006</td>
<td>34 596 1286 1879</td>
<td>3404 4358</td>
<td>11557</td>
</tr>
<tr>
<td>2</td>
<td>Cone Penetration Test to Assess the Mechanical Properties of Subgrade Soils</td>
<td>10/2006</td>
<td>46 445 506 515</td>
<td>1212 1372</td>
<td>4096</td>
</tr>
<tr>
<td>3</td>
<td>Pile Design Based on Cone Penetration Test Results</td>
<td>10/2006</td>
<td>57 586 719 477</td>
<td>671 448</td>
<td>2958</td>
</tr>
<tr>
<td>4</td>
<td>Development and Application of Linear Scheduling Techniques to Highway Construction Projects</td>
<td>10/2006</td>
<td>32 219 400 689</td>
<td>922 687</td>
<td>2949</td>
</tr>
<tr>
<td>5</td>
<td>Effects of Heavier Truck Loadings and Super-Single Tires on Subgrades</td>
<td>10/2006</td>
<td>32 551 675 420</td>
<td>371 204</td>
<td>2253</td>
</tr>
<tr>
<td>6</td>
<td>Using Precast Concrete Panels for Pavement Construction in Indiana</td>
<td>10/2006</td>
<td>48 419 434 332</td>
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<td>Tordon - 2,4-D Dimethylsulfoxide Combination Herbicides for Use in Roadside Development (written in 1967)</td>
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Figure 1a: JTRP download for technical reports in e-Pubs as of December 2009

Figure 1b: Total JTRP download for all technical reports as of November 8, 2011
i. Digitized reports uploaded April 2011
ii. Electronic reports uploaded June – November, 2011
Figure 2: Joint Transportation Research Program Technical Reports in Purdue e-Pubs
Figure 3: Landing Page for Individual JTRP Technical Report in Purdue e-Pubs with (1) Recommended Citation, (2) DOI.
a) Global Impact: 17,362 visits (July 11, 2011) grew to 28,357 (Nov 10, 2011) from 146 countries.

b) National Impact: 9,894 visits (July 11, 2011) grew to 19,120 (Nov 10, 2011)

c) Indiana Impact: 2,302 visits (July 11, 2011)

d) Indiana Impact: 9,657 visits (Nov 10, 2011)

Figure 4: JTRP Google Analytics Report for visits to the JTRP technical report collection in Purdue e-Pubs since Jan 1, 2009 (docs.lib.purdue.edu/jtrp)
Figure 5: Technical Report Production Workflow Vision
Figure 6: Integration of supplementary content with (1) DataCite DOIs, (2) geospatial information, and (3) streaming media.
Figure 7: New collaborative JTRP research production cycle, with roles for researchers, university press, and libraries indicated.