Subject Area: IA Planning and Administration   Responsible Senior Program Officer: Amir N. Hanna

On the Implementation of Research Findings in Surface Transportation

An NCHRP digest of the interim findings of NCHRP Project 20-33, "Facilitating the Implementation of Research Findings," being conducted by Rand. Dr. Tora K. Bikson serves as Principal Investigator.

INTRODUCTION

In recent years, there has been unprecedented commitment to the conduct of research as evidenced by the funding of the recently completed Strategic Highway Research Program (SHRP) and the large increases in research spending called for in the International Surface Transportation Efficiency Act (ISTEA) of 1991. Underlying this increased commitment to research is the belief that "research pays off" by yielding innovative products and processes that will benefit future transportation users and providers. However, as pointed out in *TRB Special Report 202*, "America's Highways: Accelerating the Search for Innovation," "Research often fails to change practice because of limited understanding, organizational inertia, inflexible standards, preoccupation with first costs, mistrust of change, or a desire to perpetuate jobs." Add to this list the very decentralized multijurisdictional nature of transportation decision making, and the challenge of turning transportation research results into improved products or practices becomes clear. Especially in the private sector, daunting institutional and organizational barriers to change—such as the lack of economic incentives or other rewards and a risk-averse public management culture—impede the implementation of research findings.

To improve technology transfer and facilitate the rapid use of research findings in surface transportation, there is a need to recognize and address the significant factors that influence implementation, to identify the characteristics of organizations that have succeeded in being innovative, and to develop and apply strategies for the creation of an environment conducive to innovation and timely application of research findings. NCHRP Project 20-33 was initiated, with partial funding provided by the Federal Highway Administration (FHWA), to address this need.

The first phase of research, completed in late 1994, focused on identifying the factors affecting implementation of research findings, strategies that are expected to promote this implementation, and themes for future research to test the more viable strategies for moving transportation research results into practice. To better understand implementation issues and formulate recommendations for addressing them, the second phase of research—to be completed in late 1995—will involve a nationwide survey of transportation industry organizations to identify successful implementation practices.

This digest provides a summary of Phase I. These are interim findings, which may be revised at the completion of the research. The material in this digest is extracted from an interim report on the project.

FINDINGS

As part of this project, factors that affect implementation of research results, strategies that can improve this implementation, and further research needs to evaluate these strategies were identified. This was accomplished by reviewing general and transportation-specific literature on the implementation of research results in user settings, interviewing and discussing implementation issues with professionals from the various sectors of the transportation industry, and conducting a workshop with representatives from a range of industry constituencies.

Factors Affecting Implementation

A conceptual framework that draws heavily on major studies on the implementation of innovations was adopted for this project. This framework suggests that the factors affecting whether and how quickly research results are implemented can be divided into three classes:

- Characteristics of the research results, e.g., their adaptability to varied user settings or their ease of commercialization.

- Characteristics of the implementing organization, e.g., its size, degree of centralization, and culture; and its institutional context, e.g., political and regulatory constraints.

- Characteristics of the implementation process, that is, the activities that put into practice the research output, e.g., how the research is communicated, whether researchers and users interact, and whether users receive output-specific training.

A set of factors within each of the three classes that appeared to have some significant effect on implementation success was identified. The relative importance of these factors was evaluated by workshop participants from various sectors of the transportation industry. These factors were divided into "barriers," i.e., factors that impede implementation, and "boosters," i.e., factors that promote implementation. A rating—on a 1 to 5 scale, with 5 being the most important—was assigned to each factor.

Characteristics of Research Results

Some attributes of the research output itself can impede implementation. Most obviously, if the research does not match the needs of potential users, these users will have little incentive to introduce the results into their own settings. Also, if users do not see evidence that a new product or process has been adequately tested and proven, they may not want to be the guinea pigs. Conversely, research results are more likely to be put rapidly and effectively into practice if research agencies had accounted for users' real-world needs. Thus, high ratings were given to the conduct of pilot projects in real user settings and inclusion of an implementation package as part of the research output. Figure 1 illustrates the relative importance of the factors pertaining to characteristics of research results.

Characteristics of the User Context

The most important context-related barriers to implementation include organizational inertia, risk-averse behavior, management discomfort with change, and inadequacy of resources. Implementing organizations are often government agencies, e.g., state departments of transportation and municipal public-works departments, which have been experiencing cutbacks in personnel and other resources; thus they are often unable to put in the extra effort required to implement a new product or practice. Also, new products and processes entail a degree of risk—some will not prove worth their cost and may even malfunction. Government officials tend to be risk averse: they have much less to gain from research-based improvements that merit complimentary notices in public-works journals than they have to lose from a single costly failure that wind ups as a front-page news story.

Conversely, if users are provided incentives to change, such as rewards and official recognition, the adoption of new research outputs could be facilitated. Also, the value of authoritative exemplars within user organizations needs to be recognized. These include commitment on the part of senior management to implementing new products and processes and the presence of offices or individuals of long tenure that have served as champions of innovation. Figure 2 illustrates the relative importance of the factors pertaining to the internal organizational context.
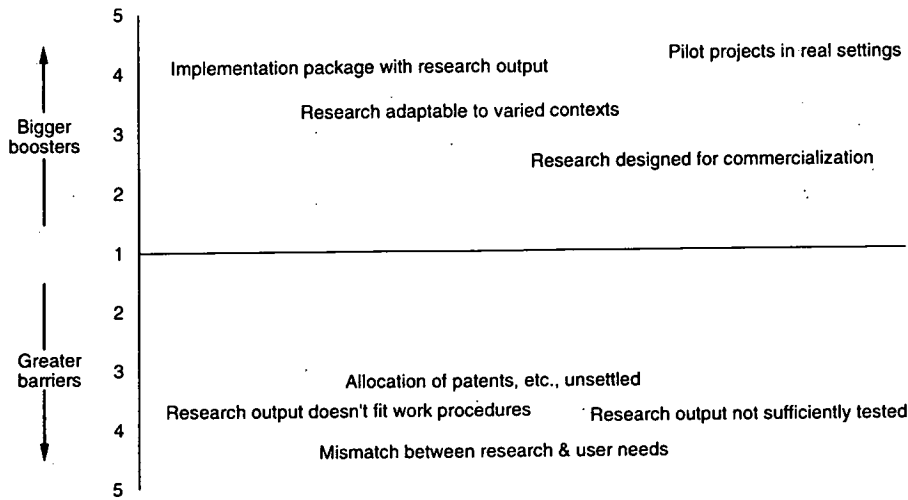
Bigger
boosters

Greater
barriers

5

4   Implementation package with research output   Pilot projects in real settings

3   Research adaptable to varied contexts

2   Research designed for commercialization

1

2

3   Allocation of patents, etc., unsettled

4   Research output doesn't fit work procedures   · Research output not sufficiently tested

5   Mismatch between research & user needs

Figure 1. Factors pertaining to characteristics of research results.

Bigger
boosters

Greater
barriers

5   · Management commitment

4   Long-term innovation champions   Capability to sustain innovation   Incentives for change   In-house expertise   On-the-job recognition

3   Performance-oriented contract specs

2   Job rotation assigned

1

2

3   No local precedents   Inadequate travel budget

4   Political involvement of managers   Skill obsolescence

5   Discomfort with change   Inadequate resources   Inflexible contract specs   Legal liability   Risk aversion
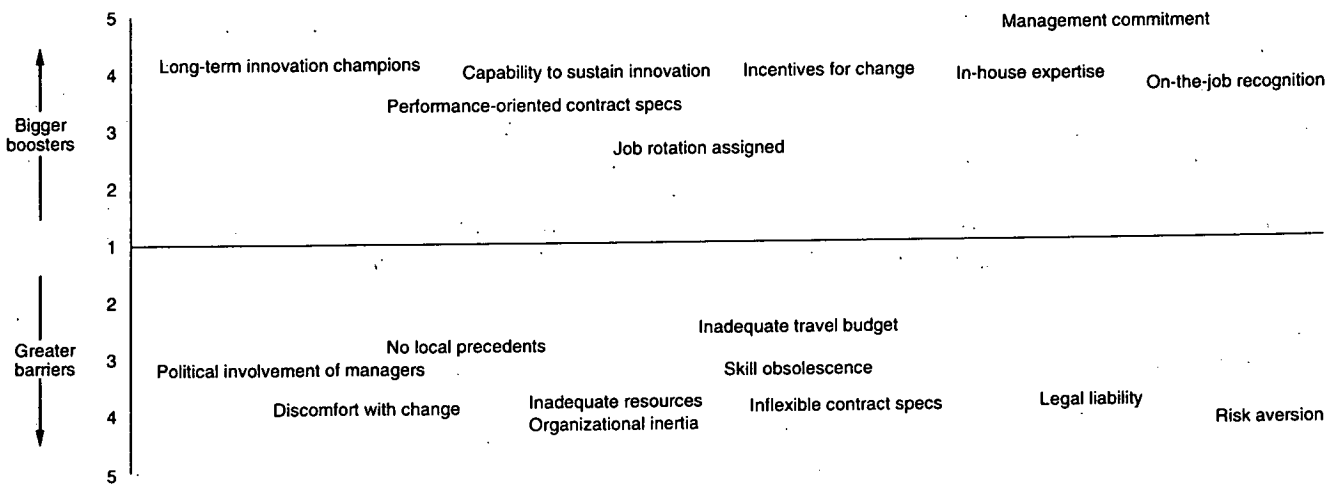   Organizational inertia

Figure 2. Factors pertaining to internal organization context.

Attributes of the external institutional environment are viewed as less critical, though still important in some cases. Implementation of research results can be hindered, for example, by differences between researcher and user cultures. Research conducted in other countries, for instance, may not be implemented because it is published in a foreign language. On the other hand, adoption of new products can be fostered in cases where user organizations form consortia to jointly conduct or evaluate research and implement its results. Figure 3 illustrates the relative importance of factors pertaining to the external organizational context.

Characteristics of the Implementation Process

Cost is frequently a major impediment to establishing better links between research and use. Costs can also be problematic because of the allocation of responsibility. For example, a state may build a road using an innovative paving material or design, but the responsibility and cost of maintaining it may rest with the counties. Notwithstanding the importance of cost, communication and interaction characterize most of the implementation-related barriers and boosters. Users would be more likely to take a chance on new products if successful applications by other users were better publicized. Improving researcher-user interactions was given a high priority. A high rating was assigned also to providing for joint researcher-user collaboration in pilot and development projects and ensuring user participation in designing, evaluating, and disseminating research. Much of this, of course, relates to the issue of cost because initiatives to increase researcher-user interactions may either increase both researcher and user costs or decrease the attention paid to other aspects of the research and other user activities. Figure 4 illustrates the relative importance of factors pertaining to the characteristics of the implementation process.

STRATEGIES FOR PROMOTING IMPLEMENTATION

Strategies to improve the implementation of research results were inferred from the ratings of barriers and boosters and from the literature search

and interviews. The following high-leverage implementation approaches are expected to have a more profound impact on the speed and effectiveness of using research results.

1. Researcher-user interactions should be encouraged and facilitated through the R&D process. This would allow researchers to find out users' interests and give researchers greater credibility in users' eyes.

2. Research organizations should take a marketing orientation or proactive dissemination approach. This entails making in-person contact with potential research users to explain the pay off of each new process or product.

3. User organizations should reward the timely adoption and effective use of research. For example, job descriptions and performance evaluations could be redesigned to reflect the importance of individual contributions to innovation. Also, given the effort that must be expended to employ a new product or process within an established organization, it is entirely appropriate to regard users—not just researchers—as innovators.

4. User organizations should build their institutional capabilities for sustained innovation. They could, for example, make it a practice to survey their contacts in research organizations for pertinent developments or to upgrade the skills of employees engaged in certain critical technology areas.

5. National organizations might develop more alternatives for mitigating the effects of risk in general and of liability exposure in particular on user organizations. Lessons might be drawn from experiences with other new types of risk insurance.

6. Research organizations should work to eliminate the perception among researchers that there is a clear distinction between dissemination and implementation. Researchers should not assume that their work is done when a technical report has been issued or a paper has been accepted by a journal.

7. Research organizations should seek to involve users in R&D from the start, and user organizations should encourage such activity on the part of their
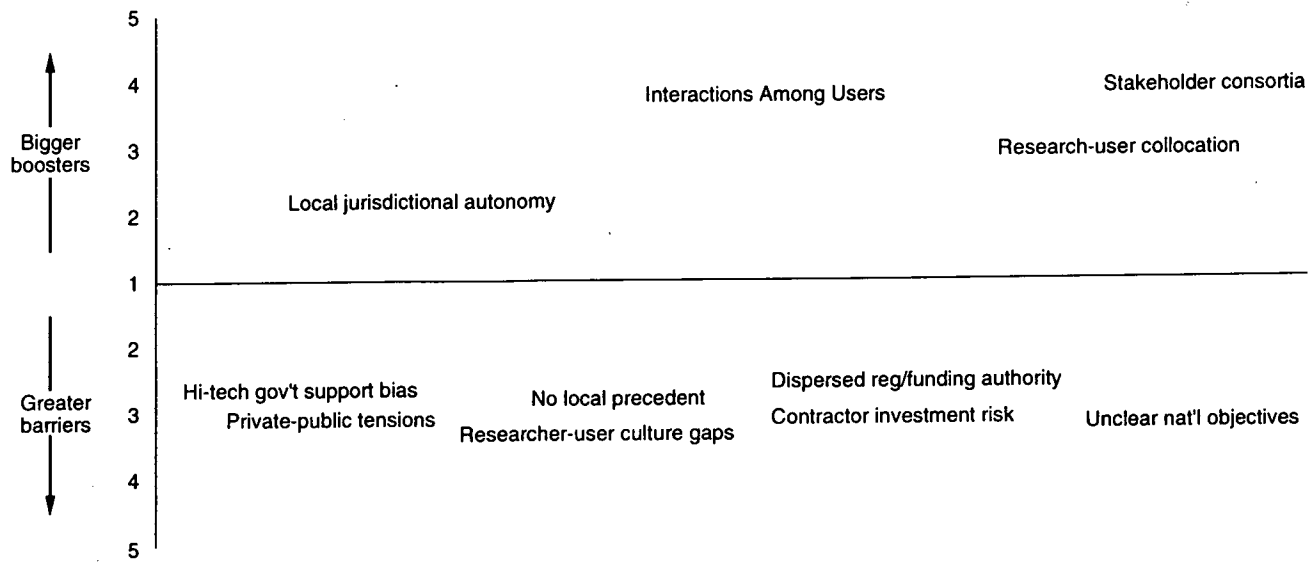
Bigger
boosters

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|

5

4   Interactions Among Users   Stakeholder consortia

3   Research-user collocation

2   Local jurisdictional autonomy

1

Greater
barriers

↓
|
|

2

3   Hi-tech gov't support bias   No local precedent   Dispersed reg/funding authority
          Private-public tensions   Researcher-user culture gaps   Contractor investment risk   Unclear nat'l objectives

4

5

Figure 3. Factors pertaining to external organization context.

Bigger
boosters

↑
|
|

5   Users help design research   Researcher-user pilot collaboration

4

3   Easy access to researchers   Effective training   Targeted funding
                                Mandatory innovation use

2

1

Greater
barriers

↓
|
|

2   Researchers not market-oriented

3   Unknown information source
   Costliness   One-way dissemination   Poor quality/relevance filters   User successes unpublicized
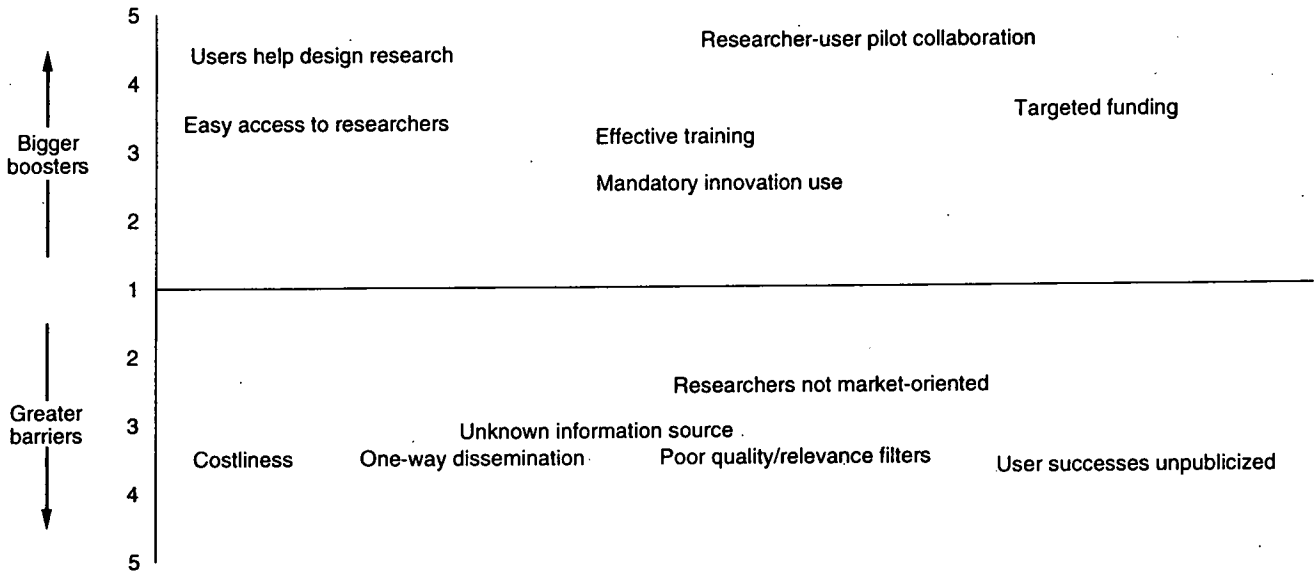
4

5

Figure 4. Factors pertaining to characteristics of implementation process.

staffs. This does not simply refer to the production of problem statements by users or the inclusion of one user on a research oversight committee. Users should be involved frequently and directly throughout the course of research, on a collegial and participatory basis. Such an approach gets users to "buy in" to research, making them more likely to use its outputs. It also brings user concerns most forcefully to the attention of researchers.

THEMES FOR FUTURE RESEARCH

As a number of approaches were identified to improve technology transfer and facilitate implementation of research findings in surface transportation, a comprehensive list of research themes aimed at evaluating several of the identified approaches was developed. Workshop participants rated the research themes—on a scale of 1 to 5, with 5 being high priority and 1 being low priority—to quantify individual judgments, establish the relative standings of the themes, and generate discussion. A list of these themes including a brief description and mean rating of each is provided in Appendix A.

CONCLUSIONS

The need to improve technology transfer and facilitate the implementation of research findings in surface transportation has been recognized by the FHWA, state highway agencies, and other organizations. The initial phase of research identified the factors affecting implementation of research findings, approaches for promoting the implementation of research results, and themes for future research studies.

To achieve a better understanding of implementation issues and formulate recommendations for addressing them, a second phase of research will be performed. To accomplish this objective, the research will involve a nationwide survey of transportation industry organizations to identify successful implementation practices.

INTERIM REPORT

The agency interim report, titled "Facilitating the Implementation of Research Findings" (December 1994), gives a detailed account of the project and its interim findings. For a limited time, the report is available for loan on request to National Cooperative Highway Research Program, Transportation Research Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

APPENDIX A

FUTURE RESEARCH THEMES

The following themes were rated based on a scale of 1 to 5, with 5 being high priority and 1 being low priority.

1. **Interactive Access to Information** (mean rating = 1.4)—Design and test a prototype system interface that relies on more advanced and easier to use technologies (e.g., Mosaic, hypertext links, expert systems) to support users' needs for distributed online information.

2. **Interactive Person-to-Person Contact** (mean rating = 1.5)—Design an interface to networked communication systems (or enhance an existing one) to promote interaction among and between varied stakeholders and stakeholder groups. Determine the effects of computer-based communication on subsequent research implementation.

3. **Improving Information Currency** (mean rating = 1.2)—Design and test systems and procedures for organizing and updating distributed databases on innovations during research and implementation stages. Design and test methods for creating and updating information on those responsible for or potentially interested in these innovations. Provide for linkage between the two databases when relevant.

4. **Computer-Based Training and Technical Assistance** (mean rating = 1.2)—Design and test the use of interactive CD-ROM disks or networked-based systems for learning at a distance about new research processes or products.

5. **Quality/Relevance Filters for Disseminated Research Information** (mean rating = 3.0)—Drawing on a cross-sectional sample of user organizations, determine what procedures are employed to sort information about research findings for relevance to a site-specific task for potential implementation. Explore ways to systematize and test the most promising procedures.

6. **Effects of Proximity on Implementation Outcomes** (mean rating = 3.6)—Compare implementation outcomes in settings where the research provider organization is remote from the user organization with those where the two organizations are in close proximity. Gather data about researcher-user interactions in the two types of settings and determine their relations to implementation outcomes.

7. **Risk Simulation and Decision Support & Strategies** (mean rating = 1.7)—Design and test a computer-based simulation that would allow potential users of research to evaluate the likely risks and benefits associated with adopting an innovation.

8. **Implementation Outcome Assessment** (mean rating = 3.5)—Using detailed data from case samples, develop procedures for grading the extent and success of implementation of research results. Provide measures and assessment instructions for future use, including potential use to project future outcomes of planned implementation efforts.

9. **Implementation Cost Assessment** (mean rating = 1.7)—Develop protocols and specialized training in the cost analysis of proposed implementations of innovative processes or products, incorporating factors often overlooked. Test the procedures and evaluate their potential usefulness for estimating future cost.

10. **Consistently Successful User Settings** (mean rating = 4.2)—Conduct replicated case studies of implementation processes in states that have long-term track records as effective innovators. Determine the factors that systematically account for their successes.

11. **Building the Capability for Innovation in User Organizations** (mean rating = 3.3)—Design and conduct a model project aimed at building up a user organization's capability to find, adopt, and absorb research innovations. Compare outcomes with those obtained by comparable sites where no systematic capability-building efforts have been initiated.

12. **Reward for Innovation in User Organizations** (mean rating =3.5)—Evaluate the performance effects of adopting a work system that provides positive incentives for change to individuals and groups in user organizations. Explore the extent to which incentives and rewards found to be effective in private-sector settings could be extended to public-sector settings.

13. **Effects of Major Change on Organizational Acceptance of Innovation** (mean rating = 3.9)—Define a sample of organizations where dramatic changes—for example, restructuring—are underway or recently completed; determine whether and how these kinds of changes that "unfreeze" routine behavior influence subsequent implementation of innovations.

14. **Contractors and Contracting Methods as Change Agents** (mean rating = 4.1)—Examine the extent of implementation of selected new products or processes in sites that have adopted contracting methods identified as innovative; compare the results with implementation outcomes for the same products or processes in otherwise similar sites that do not use innovative contracting approaches.

15. **Effects of Privatization** (mean rating = 2.5)—Design and conduct a cross-sectional study of sites to test the hypothesis that a lack of positive economic incentives is a deterrent to timely implementation of transportation innovations. Compare settings where government agencies perform the work with settings where the same functions are contracted to private-sector firms.

16. **Risk Management Methods** (mean rating = 2.0)—Evaluate the effects of methods intended to encourage innovation by mitigating risk. Use a comparison group design, involving otherwise similar organizations that do and do not have such systems in place; determine how the studied risk-management methods influence timeliness and effectiveness of implementation processes.

17. **Consultants as Change Agents** (mean rating = 2.9)—Examine the extent of implementation of new products or processes in sites that rely on consultants for expertise in certain areas; compare the results with implementation outcomes in similar sites that rely on internal expertise in those areas.

18. **Systematic Prospective Implementation Research** (mean rating = 4.0)—Follow the implementation progress of various research outputs in a number of user settings that vary in ways hypothesized to have an important influence on success. Identify the factors that are strongly predictive of success and failure.

19. **Comparative Assessment of Implementation Strategies** (mean rating = 2.9)—Design trial implementation strategies for a small number of innovations that include characteristics of successful approaches. Introduce and follow these model strategies in a number of sites. Compare the implementation outcomes with one another and with those in similar settings where standard dissemination strategies are employed.

20. **Changing Organizational Cultures and Processes** (mean rating = 3.9)—Determine the extent to which organizational process improvement efforts do or can lead to improved implementation (a) in research organizations, by making transfer of findings to users an element of high-quality R&D performance, and (b) in user organizations, by making innovation a part of performance improvement.

21. **Effectiveness of Targeted Funding** (mean rating = 2.6)—Design and conduct a study to evaluate the relative effectiveness of targeted funding to speed the implementation of selected innovations in user organizations. Collect similar information about comparable classes of innovations that were (a) mandated and (b) not subject to special policy intervention.

22. **Lessons from Local Technical Assistance Program (LTAP)** (mean rating = 3.5)—Study a cross-section of LTAP-assisted sites to determine the kinds of context factors and inter-institutional relationships that promote local implementation of innovations. Recommend ways of extending the lessons learned to other levels of government and institutions engaged in transfer of transportation-related research results.

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