



Active Implementation at the National Cooperative Highway Research Program

Frameworks for Moving Research into Practice

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The National Cooperative Highway Research Program (NCHRP) manages practical, applied research that addresses problems identified by practitioners and managers in state departments of transportation (DOTs). NCHRP publishes the research results and delivers implementable products.

The benefits from the project findings, however, begin with implementation by state DOTs and other transportation agencies. To ensure that the research products are viable, NCHRP considers implementation throughout the course of a project—from the development of the problem statement (see sidebar, page 30) to the awarding of the research contract and beyond to the completion of the research.

The transportation community has employed a variety of strategies, methods, and techniques to implement research products, but these approaches have been ad hoc. A lack of dedicated funding and a dependence on champions who must rely on available resources have constrained successful implementation. In short, the ad hoc approaches have not produced the desired effects (1, 2). As noted in 1984 in *NCHRP Synthesis 113: Administration of Research,*

Development, and Implementation Activities in Highway Agencies, “most ... departments currently approach the incorporation of new research findings in practice on an informal basis” (3).

To address this situation, NCHRP has adopted

Definitions

Implementation—A specified set of activities designed to put into practice an activity or product of known dimensions (4). Implementation includes diffusion but is not defined by it. Similarly, implementation includes dissemination but is not defined by it. Diffusion and dissemination focus on the innovation. Implementation focuses on how to use innovations as intended and achieve the promised results in typical practice settings (2).

Implementation science—The systematic study of specified activities designed to put into practice activities or products of known dimensions (4).

A case study in NCHRP Report 750 involved context-sensitive solutions including redesigned roads that integrated bike lanes, planters, and vehicle traffic.



Photo: Paul Krusek, Flickr

TABLE 1 Comparison of Ad Hoc and Systematic Active Implementation

Ad Hoc	Systematic Active
Cumbersome or variable activities	Implementation infrastructure within the state DOT (for policy, guidance, training, etc.)
Lack of funding and expertise	Dedicated funding and expertise (e.g., NCHRP Project 20-44: Administration of Highway and Transportation Agencies, SHRP 2, and FHWA's Every Day Counts)
Champions needed	Implementation by teams
Incremental change or no impact	Accelerated implementation

a systematic approach called “active implementation” (see Table 1, above), which builds on a solid implementation infrastructure, dedicated funding, expertise, and implementation teams. The process aligns with the findings of implementation science, which has identified the factors influencing the full and effective use of innovations in practice.

National Network

In 2005, the National Implementation Research Network (NIRN) released a monograph synthesizing the implementation of research findings across a range of fields (5). The monograph summarized findings from a review of the literature.

The review identified efforts to collect data on implementation practices or programs in any domain, including agriculture, business, child welfare, engineering, health, juvenile justice, manufacturing, medicine, mental health, nursing, and social services. The researchers located nearly 2,000 citations; 1,054 met the criteria for the review, and 743 remained after a full text review. Out of those

citations, 377 were deemed most relevant; 22 studies included an experimental analysis of factors influencing implementation.

From these findings, NIRN developed five overarching frameworks, called the active implementation frameworks. NCHRP has adapted its active implementation procedures largely from these frameworks.

Active Implementation Components

A formula for successful product implementation multiplies three components: effective products, effective implementation, and enabling contexts (see Figure 1, below). If any component is weak, the intended outcomes will not be achieved, sustained, or deployed on a socially significant scale.

The three components of the equation signify what is implemented, how it is implemented, and where it is implemented. To achieve a significant impact, the product must be well specified, well matched to the needs of the users, implemented in a deliberate and adaptive manner, and supported by a hospitable environment and learning processes (4).



FIGURE 1 Implementation formula for success [adapted from National Implementation Research Network (4)].

Active Implementation Frameworks

NIRN translated the formula and the components into the five active implementation frameworks. NCHRP modified the frameworks to accommodate processes that implement research outcomes as products instead of as interventions (see Figure 2, page 31).

NCHRP recognizes that there is no one-size-fits-all solution for successful implementation. Each research product is unique and requires particular treatment. Some projects may not yield implementable results. A systematic approach based on active implementation frameworks is key in selecting the most appropriate strategies and activities for technology transfer for each NCHRP product.

Framework 1: Effective Products

The implementation plan aims at well-defined, effective products that are usable and implementable. Detailed knowledge is required for a product to be implementable. The details enable the training of staff to implement the product with confidence and to measure the use of the product.

A product must be teachable, learnable, doable,

NCHRP Requirements for Problem Statements

NCHRP requires all problem statements to include plans for implementation, to maximize the timely deployment of the research results. Problem statements should identify the following:

- ◆ The appropriate target audience for the research findings and products;
- ◆ Key decision makers who can approve, influence, or champion the implementation of the research products;
- ◆ AASHTO committees, individuals, and other organizations with likely responsibility for the adoption of the results; and
- ◆ Early adopters—state DOTs that would be willing to evaluate the research products in their agency.

The problem statement also should identify any institutional or political barriers to the implementation of the anticipated research products.



Washington State Department of Transportation (DOT) workers paint bike lanes green. The agency has used the process presented in *NCHRP Report 803: Pedestrian and Bicycle Transportation Along Existing Roads, throughout the state.*

and readily accessible in practice. Table 2 (page 32) presents the NCHRP criteria for evaluating research products for implementation.

Framework 2: Implementation Stages

Implementation is a process, not an event. According to NIRN, implementation entails “a specified set of activities designed to put into practice an activity or product of known dimensions” (4). These activities occur in stages that overlap and are revisited as necessary. Implementation proceeds through four functional stages:

1. Exploration,
2. Product development,
3. Initial implementation, and
4. Full implementation.

One stage does not cleanly end as another begins. The stages often overlap, with activities for one stage continuing while activities for the next stage begin. Moreover, changes in circumstances may require revisiting the work of earlier stages (4).

Exploration

The exploration stage assesses the needs of users. NCHRP focuses on user needs during the development of problem statements, with input from committees of the Transportation Research Board (TRB) and the American Association of State Highway and Transportation Officials (AASHTO), as well as from representatives of state DOTs and the Federal Highway Administration (FHWA). One task is to identify programs and practices that can meet the needs iden-

tified; this helps to determine gaps in knowledge.

The exploration stage also assesses the fit and feasibility of implementing and sustaining the product to be developed. The findings assist the AASHTO Standing Committee on Research in selecting problem statements and the NCHRP project panel in drafting a request for proposal.

Product Development

Product development involves communication with the project oversight panel, AASHTO committees, and the identified stakeholders, as well as ensuring that the necessary resources are in place for funding the project and selecting the research team. At this stage, contracts are awarded and the research is conducted to develop effective products. In addition, evaluations of the usability of the developed product continue from Framework 1, and analyses of the factors that will drive implementation begin—a focus in Framework 3.

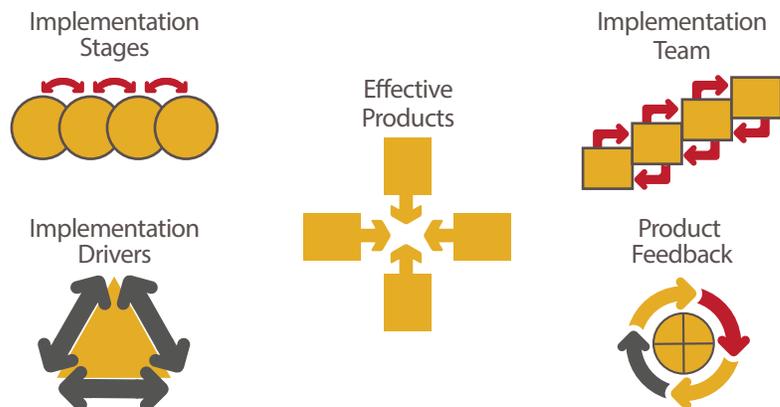


FIGURE 2 NCHRP active implementation frameworks [adapted from Fixsen et al. (5)].

TABLE 2 Product Evaluation Scorecard

Criterion	Considerations	Score ^a
Need	Did this product meet the panel's expectations?	
Readiness	Is the product fully developed and ready to implement?	
Resource availability and fit	Do you expect that implementation of the product will be relatively straightforward (e.g., in relation to training, policy, and state priorities)?	
Evidence	Was there evidence of positive results during the project through field testing or simulation?	
Return on investment	Do you anticipate the product will yield significant benefits compared with the costs of implementing it?	
Total score (≤25)		

^a 5-point rating scale: 5 = high and 1 = low.



FIGURE 3 Implementation drivers and infrastructure [adapted from Fixsen et al. (5)].

TABLE 3 Implementation Drivers

Leadership Driver	Organization Driver	Competency Driver	Effective Product	Possible Implementation Outcome
Generally enabling	Strong	Strong	Strong	High
		Weak	Weak	Low
	Weak	Strong	Strong	Medium
		Weak	Weak	Low
Generally hindering	Strong	Strong	Strong	Medium
		Weak	Weak	Low
	Weak	Strong	Strong	Low
		Weak	Weak	na

NOTE: na= not applicable. Implementation drivers influence the implementation outcome of a product. Understanding the influence of implementation drivers is crucial during the product development stage in selecting appropriate technology transfer strategies and addressing any adverse influences or shortcomings during the initial and full implementation stages.

Initial Implementation

Initial implementation plans out the strategies for technology transfer that are appropriate for the developed product. The barriers to implementation are identified, addressed, and rapidly resolved. The monitoring of the implementation drivers continues, and any unexpected problems are addressed. Work concentrates on moving the product into adoption—primarily through AASHTO—and on providing support before and after the product’s adoption.

Full Implementation

Skilled practitioners—for example, DOT staff and consultants—are now using the developed product. NCHRP verifies that the implementation is correct, provides support to practitioners, and documents feedback on the outcomes for product assessment and improvement.

Framework 3: Implementation Drivers

Implementation drivers are key components of capacity and infrastructure that influence a product’s success (see Figure 3, left)—the infrastructure that is needed to make use of effective and well-defined innovations. Implementation drivers can be sorted into three types: competency, organization, and leadership (5); when integrated and used collectively, the three types of drivers ensure effective and sustainable implementation (see Table 3, left).

◆ **Competency drivers** influence the developing, improving, and sustaining of users’ competence to apply the product effectively. Competency drivers include staffing, training, coaching, and related feedback.

◆ **Organization drivers** develop the support and infrastructure to create a hospitable environment for new product implementation, including the alignment of programs, policies, procedures, and opportunities, as well as the buy-in from all involved (4). Organization drivers include the following:

- Decision support data systems to assess the outcome of product implementation and of related implementation strategies, to help staff members make good decisions;
- Facilitative administration, which provides leadership and makes use of a range of data to inform decision making, support implementation, and keep staff organized and focused on the implementation outcomes—the goal is to give careful attention to the alignment of an organization’s policies, procedures, structures, culture, and climate with the needs of stakeholders; and
- Identification of the barriers and the facilitators for using new products.

◆ Leadership drivers guide leaders to the right strategies for dealing with the technical and adoption challenges that often emerge in managing changes that affect decision making, guidance, and an organization's functioning (4).

Framework 4: Implementation Teams

Members of the implementation team need special expertise in program processes, implementation science and practice, cycles of improvement, and methods of change for organizations and systems. The work of the implementation team does not have to wait for the completion of the research; the team can help create readiness throughout the implementation stages and by applying the implementation drivers. Implementation teams also do not have to wait for a champion; they can help organizations and systems provide environments more hospitable to effective innovations and more supportive of implementation.

Although NCHRP cannot directly implement the products of its research in state DOTs, each project's implementation team and research team can assemble an implementation plan that offers the following:

- ◆ A clear description of the developed research product, including the essential functions that define the product;
- ◆ A realistic assessment of the drivers that will move the product's implementation forward; and
- ◆ A plan for technology transfer that identifies strategies to expedite or facilitate implementation in state DOTs or other agencies (see Figure 4, page 35).

Team Selection

The NCHRP project panel selects an implementation team soon after selecting the research team. The implementation team may include the NCHRP project manager and implementation coordinator plus stakeholders—for example, panel members, the research team members, representatives from the AASHTO and TRB technical committees, and representatives from state DOTs and other agencies. The composition of the implementation team depends on the project and the products.

Team Responsibilities

The implementation team leverages principles of implementation science and best practices in change management to support the widespread use of the developed products. Team members are accountable for making implementation happen and for ensuring the use of product implementation methods that effectively yield the intended outcomes. Team members work purposefully, actively, and effectively toward implementation and perform additional activities:

Evaluating the Effectiveness of Products

NCHRP Report 750: *Strategic Issues Facing Transportation, Volume 3: Expediting Future Technologies for Enhancing Transportation System Performance* presents the Systematic Technology Reconnaissance, Evaluation, and Adoption Methodology (STREAM) (6).

STREAM is a tool for identifying, assessing, shaping, and adopting new and emerging technologies to help achieve objectives for long-term system performance. The process reflects relevant trends in technologies and their applications and is designed to help transportation agencies anticipate, adapt to, and shape future changes.

Three case studies in the report illustrate STREAM applications. The report targets state DOT research units and other units and organizations responsible for evaluating new technologies.



NCHRP Report 750 Volume 3, Expediting Future Technologies for Enhancing Transportation System Performance, is available online at <http://www.trb.org/Main/Blurbs/170083.aspx>.



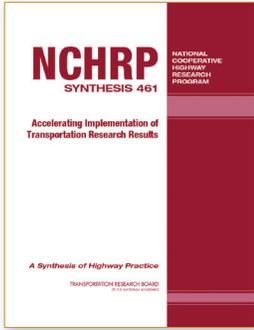
An NCHRP project panel meets to develop guidelines for solid-state roadway lighting.

NCHRP Implementation Support Program

Part of NCHRP's Moving Research into Practice initiative, the Implementation Support Program has funding of approximately \$2 million a year to facilitate implementation of research results. The range of eligible products and activities is broad; the *Guide to NCHRP Implementation Plans* lists several examples. Eligible expenses include essential travel, production of materials, professional services, meeting costs, and necessary equipment.

Recipients awarded funds for activities must deliver a report to NCHRP within three months of completion. The report must describe the activities that were carried out, assess how the activities have facilitated implementation, and indicate plans to continue monitoring the impacts.

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NCHRP Synthesis 461: Accelerating Implementation of Transportation Research Results examines implementation practices of nontransportation agencies in the public sector, nonprofits, and academia that have accelerated the practical application of research results. The synthesis focuses on practices useful for transportation agencies in creating responsive research programs and presents a series of implementation case examples and practices. (www.trb.org/Publications/Blurbs/171446.aspx)



PHOTO: MICHAEL ERISOV, FLICKR

Fort Point, which sits at the foot of the Golden Gate Bridge in San Francisco, California, served as a case study for NCHRP Project 25-25, which explored construction vibration and its effects on historic buildings adjacent to transportation projects.

- ◆ Increasing users' buy-in and readiness;
- ◆ Installing and sustaining the implementation infrastructure;
- ◆ Assessing and reporting on outcomes of product implementation; and
- ◆ Solving problems and promoting sustainability.

Framework 5: Product Feedback

The NCHRP implementation team uses feedback from users of the product to maintain the product's quality and practical value and to incorporate

improvements. In this way, product feedback supports the purposeful process of change.

Implementation teams also measure a product's impact on practice and determine the return on investment to the first users—the innovators and early adopters, according to the terminology developed by Rogers in his work on the diffusion of innovations (7)—with the goal of persuading those who would resist the change as long as possible—whom Rogers terms the late majority and laggards. As Rogers makes clear, the way adopters behave in response to an innovation is one of many influences on the rate of change within an organization.

How It Works

NCHRP active implementation frameworks are applied in research product development and in research product implementation.

Product Development

The implementation team collects data about the drivers or influences that affect the implementation outcome of the developed product. The analysis of the implementation drivers helps the implementation team select appropriate strategies for technology transfer.

Technology transfer is a process of communication that brings the results of scientific research into use. Technology transfer often includes implementation strategies and activities. Technology transfer strategies for the adoption of products may include knowledge transfer, training and education, demonstrations and showcases, communications and marketing, technical assistance, managing the complex

CASE STUDY: NCHRP PROJECT 5-20

Implementing Guidelines for Nighttime Visibility of Overhead Guide Signs

- ◆ *Dissemination*—Panel members have been sharing project results in several ways, including a presentation at the 2017 TRB Annual Meeting.
- ◆ *Policies*—States can use the guidelines to reassess lighting policies for urban and suburban highways that have high visual complexity.
- ◆ *Assistance*—The principal investigator and project panel members, as well as members of the TRB Standing Committee on Signing and Marking Materials, are available to help and advise state DOTs in implementing the guidelines.
- ◆ *Guidance*—AASHTO is incorporating the guidelines developed in this research into Chapter 10 of the Roadway Lighting Design Guide.

For more information, <http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2954>.



FIGURE 4 Technology transfer strategies.

processes of change, and dealing with cultural and technical issues (see Figure 4, above).

The project implementation team selects the appropriate technology transfer strategies and activities, considering such factors as the potential users, the potential uses at different stages, and the resources needed to conduct the implementation activities.

Product Implementation

NCHRP facilitates collaboration among stakeholders by managing communication, reinforcing technology transfer activities, measuring outcomes, and keeping all stakeholders moving toward the same goal during the active implementation process. The selection of implementation strategies depends on the research product, but organizations’ responses to change can range from embracing change with excitement—characteristic of Rogers’ innovators and early adopters (7)—to resisting change as long as possible, like Rogers’ late majority and laggards.

Implementation Activities

Implementation activities may include workshops or peer exchanges; webinars; presentations, posters, or exhibits at committee meetings or at state, regional, and national meetings and conferences; training; software beta-testing; focus groups; the development of promotional materials such as flyers, brochures, or videos for target audiences; the development of briefing materials for senior management; follow-on NCHRP contracts for proof of concept, validation, development of prototypes, or further development; and demonstrations or pilot projects in a host agency. (See the case studies of two NCHRP projects, outlined on page 34 and page 36.)

Effective implementation strategies accomplish the following:

- ◆ Ensure a continuing, high level of involvement by the product developers;
- ◆ Use multilevel approaches to implementation with clear goals;
- ◆ Implement only those attributes of a product or practice that are replicable and that add value; and
- ◆ Know what has to be in place to achieve the desired results for consumers and stakeholders.

These activities affect the speed and effectiveness of implementation.

In contrast, implementation that relies on access to information appears to have little effect on practitioners’ performance. Experimental studies have shown that the dissemination of information alone does not result in positive implementation, in changes in practitioner behavior, or in benefits to



NCHRP Report 768: Guide to Accelerating New Technology Adoption Through Directed Technology Transfer presents a framework for using technology transfer to guide and accelerate innovation within a state DOT or other agency (8). The guidance assists agency personnel at any level of experience in adopting new technology. The report includes illustrative examples of innovations in organization and policy as well as in design, materials, and operations. (www.trb.org/Publications/Blurbs/171082.aspx.)

Photo: Bossi, Flickr



NCHRP Project 03-41, completed in 1993, offered procedures for setting work zone speed limits to increase safety.

Wildlife crossing over Highway 9 in Colorado. NCHRP Project 25-27 created guidelines for the use and effectiveness of wildlife crossings.



PHOTO: JEFFREY BEALL, FLICKR

consumers. Similarly, a reliance on training alone, even well done, has proved ineffective as a strategy for implementation.

Driving Implementation

Through active implementation, NCHRP is managing research projects and moving the results into practice by building on a procedural infrastructure, applying dedicated funding, and relying on proven expertise and on implementation teams. NCHRP's national partners drive the implementation of the research products, in conjunction with the following:

- ◆ **Innovative outreach**—NCHRP staff develop innovative dissemination tools to circulate research findings and solicit feedback to confirm or to improve the effectiveness of each outreach effort.

- ◆ **On-target findings**—The appointment of AASHTO committee members to NCHRP project panels helps ensure that the research produces findings implementable by state agencies and practitioners.

- ◆ **National networks**—Partnerships among AASHTO, FHWA, and NCHRP underscore the importance of relationship building at the national level to implement research findings that advance transportation practice and infrastructure.

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CASE STUDY: NCHRP PROJECT 3-110

Estimating the Life-Cycle Cost of Intersection Designs

- ◆ **Awareness**—A webinar posted on the TRB website provides an overview of the Life-Cycle Cost Estimation Tool (LCCET).

- ◆ **Policy**—Use of the LCCET may require revision of an agency's procedures. The FHWA Office of Safety includes the LCCET as a resource during presentations on intersection control evaluation policies.

- ◆ **Promotion**—The LCCET needs an agency champion who also can encourage use of the tool by local agencies and consultants.

- ◆ **Training**—Key staff must be trained in the use of the LCCET. FHWA is introducing the LCCET via Every Day Counts workshops, customized intersection safety and design courses, and several National Highway Institute programs.

For more information, <http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3392>.