
Louisiana Transportation Research Center

Final Report 625

Synthesis on Documentation and Tracking Research Implementation

by

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TECHNICAL REPORT STANDARD PAGE

1. Title and Subtitle
Synthesis on Documentation and Tracking Research Implementation
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Louisiana Department of Transportation and Development
P.O. Box 94245
Baton Rouge, LA 70804-9245
5. Report No.
FHWA/LA.17/625
6. Report Date
December 2020
7. Performing Organization Code
LTRC Project Number: 19-1PF
SIO Number: DOTLT1000286
8. Type of Report and Period Covered
Final Report
12/2018 – 12/2019
9. No. of Pages
132

10. Supplementary Notes
Conducted in Cooperation with the U.S. Department of Transportation, Federal Highway Administration

11. Distribution Statement
Unrestricted. This document is available through the National Technical Information Service, Springfield, VA 21161.

12. Key Words
Documentation, Tracking, Research Implementation

13. Abstract
In general, research funding departs from short-term objectives if the research results are not implementable. Planned and documented technology transfer efforts work to incorporate research findings and evidence-based interventions into real life. However, many research studies in different areas and fields were completed successfully without a real impact on society or undocumented and untracked implementation efforts. Documentation and tracking the technology transfer efforts of research studies are essential throughout the life-cycle of any project. Considering this issue, there is a need for formal guidelines for documenting and tracking the technology transfer efforts to be used by the Southeast Transportation Consortium (STC) and other State Highway Agencies (SHAs). The review of the literature of this project (Task 1) primarily documented the different practices by several agencies for tracking and documenting the technology transfer efforts. An online survey was developed to identify successful examples of guidelines for documentation and tracking of research implementation efforts currently developed/used in different state departments of transportation

(DOTs), agencies, organizations, and institutions. The reviewed literature and the online survey results provided the research team of this project with valuable information and a list of the best practices by SHAs and other agencies for documenting and tracking research implementation efforts/activities. The overall technology transfer process of research findings encompasses different interacting domains. The review of the literature indicated that these domains are categorized differently based on the nature of the research itself. As an outcome of this project, the research team has developed formal guidelines to guide any funding agency tracking and monitoring their projects and the Technology Transfer (T2) efforts.

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Each research project will have an advisory committee appointed by the LTRC Director. The Project Review Committee is responsible for assisting the LTRC Administrator or Manager in the development of acceptable research problem statements, requests for proposals, review of research proposals, oversight of approved research projects, and implementation of findings.

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LTRC Project No. 19-1PF

SIO No. DOTLT1000286

conducted for

Louisiana Department of Transportation and Development

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The contents of this report reflect the views of the author/principal investigator who is responsible for the facts and the accuracy of the data presented herein.

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December 2020

Abstract

In general, research funding departs from short-term objectives if the research results are not implementable. Planned and documented technology transfer efforts work to incorporate research findings and evidence-based interventions into real life. However, many research studies in different areas and fields were completed successfully without a real impact on society or undocumented and untracked implementation efforts.

Documentation and tracking the technology transfer efforts of research studies are essential throughout the life-cycle of any project. Considering this issue, there is a need for formal guidelines for documenting and tracking the technology transfer efforts to be used by the Southeast Transportation Consortium (STC) and other State Highway Agencies (SHAs).

The review of the literature of this project (Task 1) primarily documented the different practices by several agencies for tracking and documenting the technology transfer efforts. An online survey was developed to identify successful examples of guidelines for documentation and tracking of research implementation efforts currently developed/used in different state departments of transportation (DOTs), agencies, organizations, and institutions. The reviewed literature and the online survey results provided the research team of this project with valuable information and a list of the best practices by SHAs and other agencies for documenting and tracking research implementation efforts/activities. The overall technology transfer process of research findings encompasses different interacting domains. The review of the literature indicated that these domains are categorized differently based on the nature of the research itself. As an outcome of this project, the research team has developed formal guidelines to guide any funding agency tracking and monitoring their projects and the Technology Transfer (T2) efforts.

Implementation Statement

The outcome of this project will provide recommended formal guidelines for documenting, monitoring, and tracking implementation efforts of research projects. The guidelines will be implemented and used by the STC and other SHAs research sections to formalize their documentation and tracking efforts on implementation. More controlled research projects and high impact of implementations are expected from the STC and other SHAs research projects by the use of the formal guidelines developed in this study.

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Introduction

Scientific research is generally the process of studying and evaluating a specific concern, problem, or issue utilizing a scientific method to devise new applications [1]. Scientific research could be regarded as the adult form of the science fair projects in elementary school, where an experiment is performed to try to learn something. This is best achieved through formalizing the issue into a question, with the objective of the research to solve this question [1]. Scientific research has been defined in a number of different ways, but the underlying concepts are similar. Table 1 summarizes the common definitions of scientific research according to different authors/organizations. Scientific research is primarily categorized into [2]:

1. **Basic Research:** Covers the fundamental aspects of research and is conducted to improve knowledge, such as a research experiment.
2. **Applied Research:** Analyzes and solves real-life problems using scientific procedures, such as finding a specific cure for a disease.
3. **Problem-Oriented Research:** Conducted to recognize the exact nature of a specific problem and provide relevant solutions. For example, a research that is conducted to understand why the revenue of a car company decreased in the last year.
4. **Problem Solving Research:** Uses applied research (category number 2) to find solutions to existing problems.
5. **Qualitative Research:** Provides a detailed understanding of the problems in their natural settings. It is a non-statistical research procedure.
6. **Quantitative Research:** Utilizes computational, statistical procedures to collect and analyze data.

The economic and social benefits of scientific research are well-recognized [3]. It is believed that scientific research pays off by providing innovative processes and products that benefit future challenges. In this consequence, there has been a huge commitment to conducting research, as evidenced by the large increases in research spending called for in the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991 [4].

Yet, as indicated in the Transportation Research Board (TRB) Special Report 202 “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” [5]. In addition, failure of implementation of research findings results from the decentralized multijurisdictional nature of decision making, particularly in transportation agencies. This problem becomes more significant in public sectors since organizational and institutional barriers to changes impede the implementation of research findings. Such barriers include the lack of economic incentives or other rewards and a risk-averse public management culture [6].

Table 1. Common Scientific Research Definitions

Study/Author	Field/Area	Definition
Earl Robert Babbie [7]	Social Science	“systematic inquiry to describe, explain, predict and control the observed phenomenon. Research involves inductive and deductive methods.”
Organization for Economic Co-operation and Development (OECD) [8]	Economics	“Any creative systematic activity undertaken in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this knowledge to devise new applications.”
John W. Creswell [9]	Education	“process of steps used to collect and analyze information to increase our understanding of a topic or issue.”
Clifford Woody [10]	Education	“careful enquiry or examination in seeking facts or principles, a diligent investigation to ascertain something.”
D. Slesinger and M. Stephenson [10]	Social Science	“the manipulation of things, concepts or symbols for the purpose of generalizing to extend correct or verify knowledge whether that knowledge aids in construction of theory or in the practice of an art.”

Considering these problems, there is an urgent need for research studies that can help in (1) improving technology transfer and research implementation and (2) accelerating the use of research findings in practice. Therefore, the main objective of this synthesis project is to thoroughly review the literature and previous works/projects on tracking and documenting the implementation efforts of research projects. Based on this comprehensive review, the best practices by state highway agencies (SHAs) and other agencies for documenting and tracking research implementation efforts/activities are provided and summarized in different chapters throughout this report. In addition, a formal guideline for tracking and documenting the implementation efforts has been developed in this study and is presented at the end of this report. The results and

outcomes of this synthesis study will be used by the Southeast Transportation Consortium (STC) and other SHAs sections to formalize their documentation and tracking research implementation activities. The outcomes of this study will keep all STC and other SHAs research projects under control and will assure a high impact on the society and economy by having well-documented and monitored implementations.

Literature Review

Overview on Implementation Research

Definition of Implementation Research

In general, implementation research is a relatively new concept, and a consensus on the name has yet to emerge. Over the past decade, considerable progress has taken place to conceptualize implementation research; however, significant confusion still exists regarding its terminology [11], [12], [13]. Several terms have been developed in different geographic regions to describe some elements of efforts to shift from knowledge to practice, yet the underlying concepts are the same [14].

A study of 33 applied research funding agencies in nine different countries was conducted by Graham et al., who reported that 29 terms are used to name the process of shifting from knowledge to action [15]. While the term “knowledge translation” is popular in Canada [15], the term “technology transfer” or “implementation of research” is common in the United States [16]. Similarly, the term “implementation research” is the most commonly used term in Europe and in the United Kingdom [17]. Alternatively, other studies used the term “optimizing practice through research” to address challenges at the intersection of public health research and practice [18]. Table 2 summarizes the definitions of implementation research (or knowledge transfer) commonly used in different fields as described by different authors/studies.

Table 2. Common Definitions of Implementation Research or Knowledge Translation

Study/Author	Field/Area	Definition
Canadian Institute for Health Research [19]	Health	“the exchange, synthesis and ethically-sound application of knowledge-within a complex system of interactions among researchers and users - to accelerate the capture of the benefits of research for [people] through improved health, more effective services and products, and a strengthened health care system.”

Study/Author	Field/Area	Definition
World Health Organization [20]	Health	“Systematic approach to understanding and addressing barriers to effective and quality implementation of health interventions, strategies and policies.”
Peters, David H., et al. [21]	Health	“the scientific inquiry into questions concerning implementation—the act of carrying an intention into effect, which can be policies, programs, or individual practices (collectively called interventions).”
Sanders and Haines [22]	Health	“Implementation research is that subset of health services research
Werner [23]	Social Science	“Implementation research is used as a general term for research that focuses on the question ‘What is happening?’ in the design, implementation, administration, operation, services, and outcomes of social programs. Implementation studies can have multiple purposes, such as supporting the impact study by describing the precise nature of the program being tested and explaining the pattern of impact findings over time or across program sites.”
Eccles and Mittman [24]	Health	“Implementation research is the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice, and, hence, to improve the quality and effectiveness of health services. It includes the study of influences on healthcare professional and organizational behavior.”
Padian et al. [25]	Medicine	“Implementation science is the study of methods to improve the uptake, implementation, and translation of research findings into routine and common practices (the 'know-do' or 'evidence to program' gap).”
Leroy et al. [26]	Health	“to transfer what we already know into action; deliver the interventions we have in hand to those who need them.”
Hood et al. [27]	Transportation	“Technology transfer refers to a way that ideas, knowledge, practices, products, processes, or techniques are shared between and within organizations.”

Function of Implementation Research

In general, research funding departs from short-term objectives if the research results are not implementable. Implementation research aims to meet this challenge and move towards long-term objectives and sustainability. Implementation research works to incorporate research findings and evidence-based interventions into real life. Therefore, implementation research transfers research findings from effectiveness studies to real-life settings obtaining information to guide scale-up and sustainability. The function of implementation research includes the following [28]:

- To determine the optimum procedure to introduce practical solutions into the relevant system and facilitate their full-scale implementation, modification, and evaluation.
- To develop and test practical solutions to problems that are particular to specific systems and environments or that address a problem common to a specific region.
- To identify how evidence-based interventions, services, and tools could be adjusted to obtain sustained impacts in practice.
- To identify implementation problems that delay access to interventions, delivery of services, and usability of evidence-based interventions, and their key determinants.

Characteristics of Implementation Research

Although implementation research has been defined differently by different authors and institutions, most of the interpretations emphasize the systematic approach to understand and address the barriers to quality and effective implementation of policies and strategies. Table 3 highlights the common key characteristics of implementation research in the health system.

Table 3. Main characteristics of implementation research in the health system [28]

Characteristic	Description
Systematic	<ul style="list-style-type: none">• The systematic study of how a particular set of activities integrate an evidence-based public health intervention within particular settings and how health outcomes differ between communities.• Balances relevance to practical situations with strictly adhering to norms of scientific inquiry.

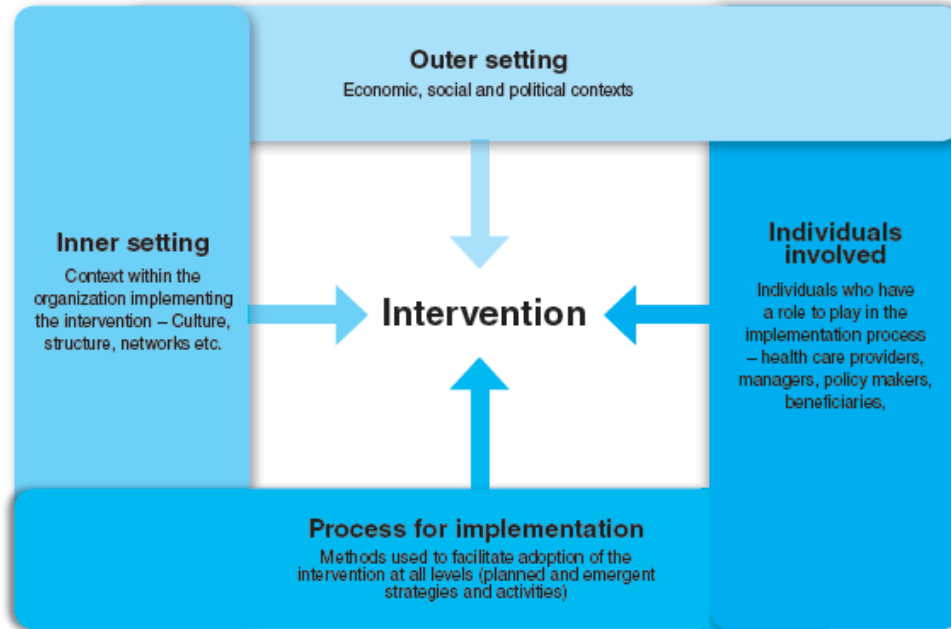
Characteristic	Description
Multidisciplinary	<ul style="list-style-type: none"> • Analysis of social, biological, political, economic, system, and environmental factors that affect the implementation of research findings. • Interdisciplinary collaborations between behavioral and social scientists, clinicians, epidemiologists, statisticians, engineers, business analysts, policy makers, and main stakeholders.
Contextual	<ul style="list-style-type: none"> • Demand driven: research questions identified by implementers are based on the demand in the health system. • Generates generalizable knowledge that can be applied across contexts. • Culture, community. • Aware of cultural and community-based influences.
Complex	<ul style="list-style-type: none"> • Adaptive and dynamic. • Multi-scale: occurs at multiple levels of health care systems and community practices. • Analyzes multi-component programs and policies. • Non-linear, iterative, evolving.

Although these key characteristics in Table 3 were outlined in the context of health systems, they could be generalized to other fields/areas. These elements should be given due consideration to ensure the successful implementation of the research findings.

Interacting Domains

The overall implementation process of research findings encompasses different interacting domains. The review of the literature indicated that these domains are categorized differently based on the nature of the research itself. The World Health Organization (WHO) classified the interacting domains into five main categories, namely, intervention, outer setting, inner setting, individuals involved, and process for implementation. These domains are shown and described in Figure 1.

Figure 1. Interacting domains as categorized by WHO [20]

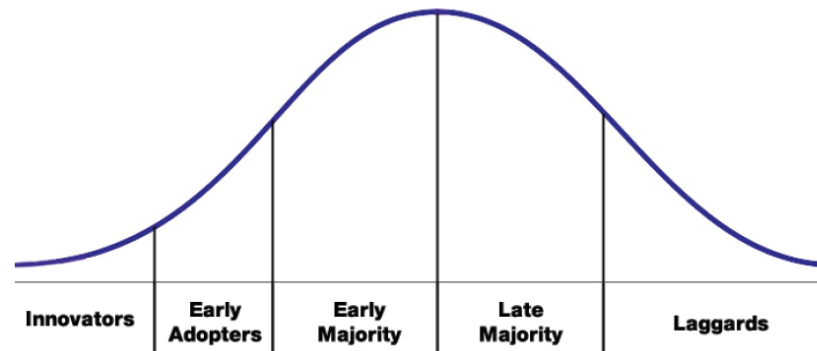


On the other hand, a research study was conducted by Rogers [29], and described the adopter categories based on innovativeness as follows; see Figure 2:

1. **Innovators:** Such organizations or individuals immediately recognize the benefits of new ideas and have an organizational culture that embraces innovation. They have a strong willingness to take the risk which comes with being “the first.”
2. **Early adopters:** Such organizations or individuals are not far behind the innovators. They are interested in particular innovations, yet, who want to look at it in more detail prior to committing to deployment. Generally, early adopters have the willingness to bring new improvements and ideas to their organizations.
3. **Early majority:** As more people in an organization begin deploying an innovation, the momentum builds for others to join in. This early majority helps to advance their colleagues from wondering whether they will deploy the change to asking themselves and others why they haven’t deployed the change. This group ultimately brings the majority into the practice.
4. **Late majority:** Such organizations or individuals are more risk-adverse and tend to wait until the innovation has been accepted by the majority of their peers. The optimum strategy to reach these organizations or individuals usually needs a heavy “push” to remove any barriers standing against the deployment.

5. **Laggards (Late adopters):** Such individuals or organizations are the last to adopt new ideas and innovations. In some organizations, there may be a strong aversion to risk, reinforced by a strong interest to continue doing things the same way that they have always been done. Sometimes, this resistance is only overcome when the change is mandatory through regulatory policy or new specifications.

Figure 2. Adopter categories on the basis of innovativeness [29]



Factors Affecting Implementation

Different research studies have been conducted to evaluate the factors that affect the ease and timing of implementation of research findings. Some of these factors exist independently, but many depend on a variety of other factors in the implementation process and in the deployment environment. The National Cooperative Highway Research Program (NCHRP) Report 382 classified factors affecting implementation into three classes [6]:

1. **Characteristics of the research results:** for example, their adaptability to various user settings or their ease or readiness for commercialization;
2. **Characteristics of the implementing organization:** for example, its size, resources, culture, and its institutional context (e.g., political and regulatory constraints); and
3. **Characteristics of the implementation process:** for example, how the research is communicated, whether researchers and users interact, and whether users receive output-specific training.

The factors within each of these three classes were categorized into boosters (i.e., factors that promote implementation) and barriers (i.e., factors that impede implementation).

Figure 3 to Figure 6 present the relative importance of the boosters and barriers within each class on a scale from 1 to 5, with 5 being the most important.

Figure 3. Factors related to characteristics of research results [6]

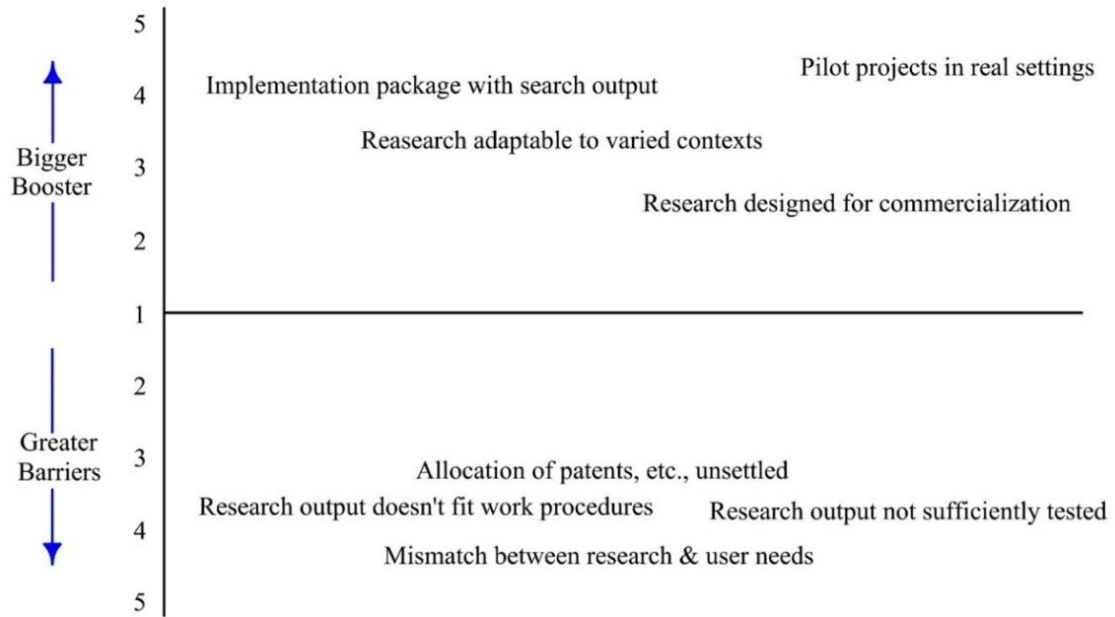


Figure 4. Factors related to internal organization context [6]

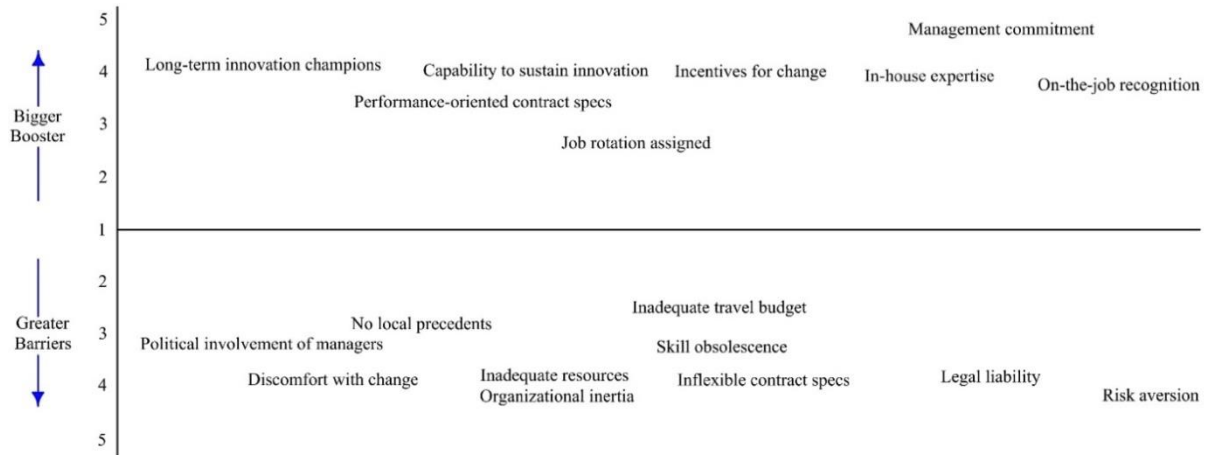


Figure 5. Factors related to external organization context [6]

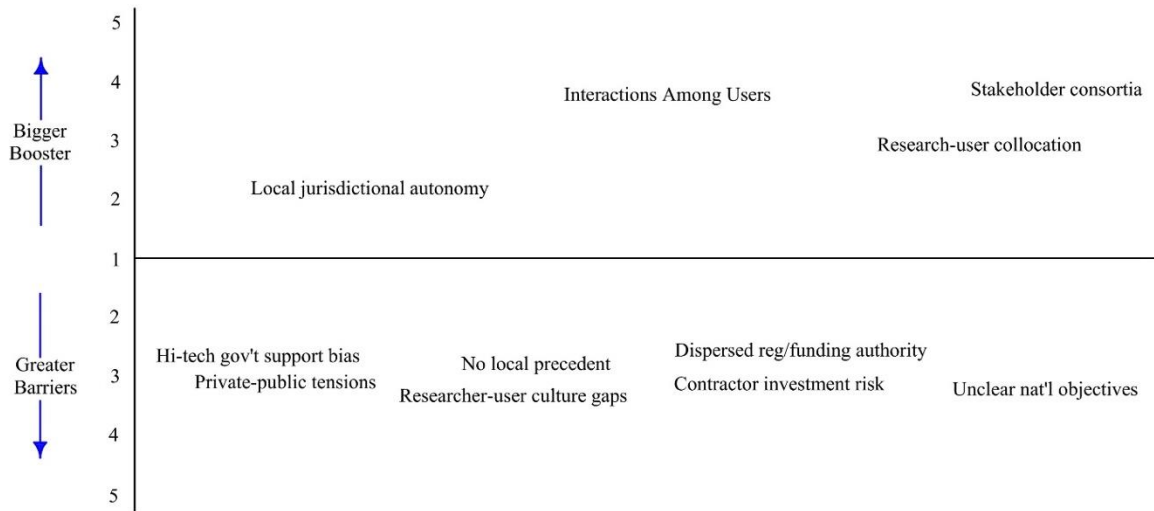
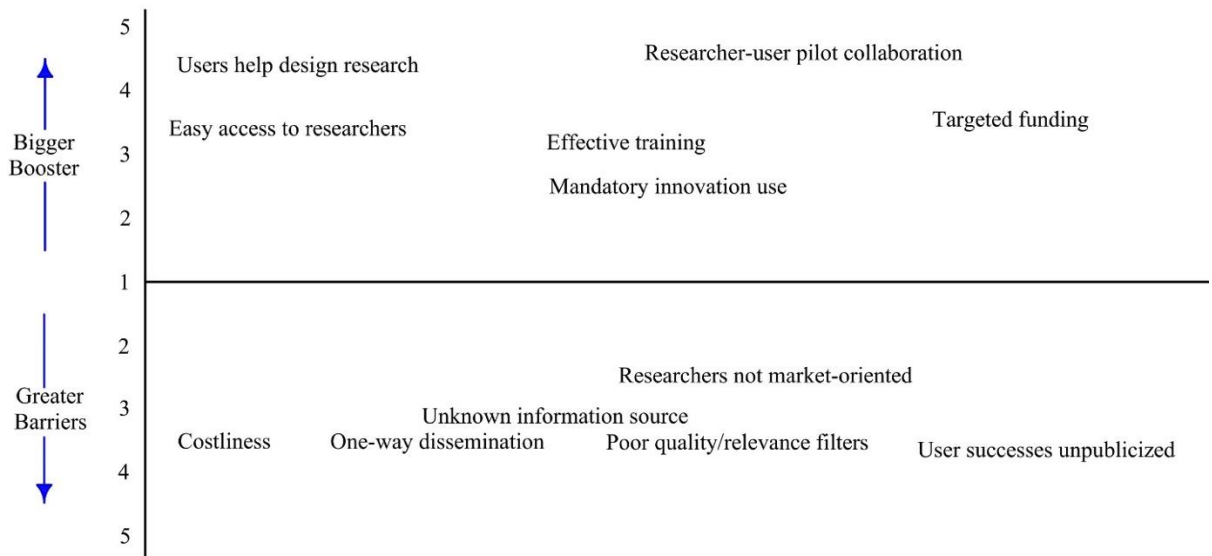
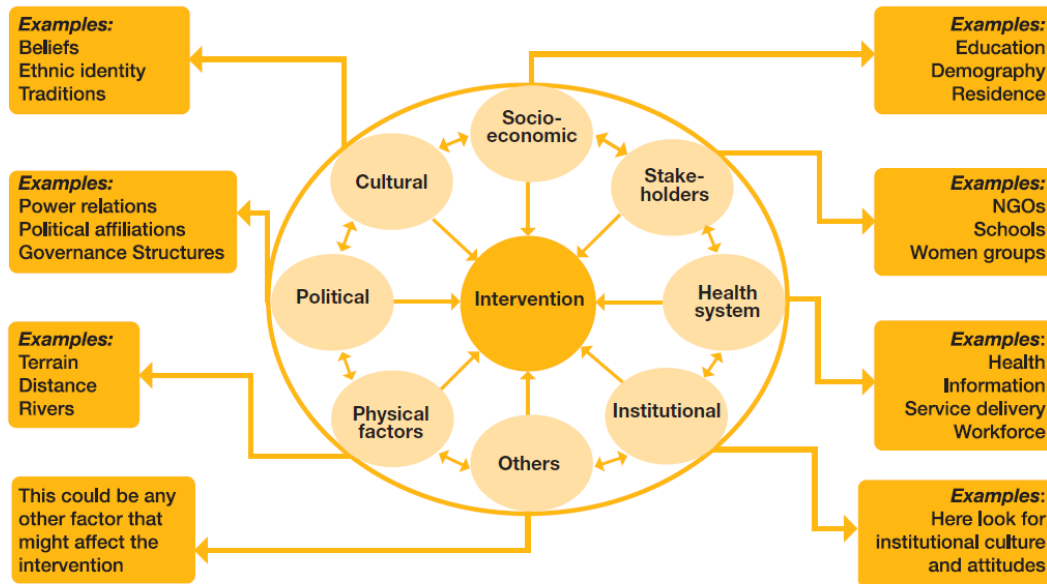


Figure 6. Factors related to the characteristics of the implementation process [6]



In the context of health systems, the WHO identified several factors that affect the implementation process of research findings. These factors were categorized into eight key classes, including physical, political, socioeconomic and cultural factors, health systems, stakeholders, institutional culture, and other factors [20]. Figure 7 depicts these factors with some examples.

Figure 7. Factors affecting the implementation process in health systems [20]



In the context of transportation systems and highway industry, several factors have been identified as barriers to technology transfer and innovation. First, while technology transfer involves risk, public-sector decision-makers work in an environment that does not reward risk-taking; therefore, discouraging the implementation process. Second, the procurement environment in the public sector is driven by a low-bid process which is based on particular specifications. Unfortunately, these specifications often determine the types of used materials, the designs to be followed, how facilities are to be built, and the construction processes to be applied. Consequently, new materials or technologies with the potential for enhanced performance may not meet existing specifications.

Additionally, in a procurement environment dominated by selection based on the lowest initial cost, the private sector is not motivated to take risks. Such factors significantly stifle the process of technology transfer and implementation of research findings [30].

Third, fragmentation, which is disagreement among public works constituencies, within the highway industry is a key barrier to technology transfer and innovation.

“Fragmentation results because no single government agency or organization is responsible for the state of a particular category of public works [such as highways]” [31]. Fourth, the speed of technology transfer is significantly affected by the way public agencies are organized. In most of cases, public agencies have limited knowledge of new technologies, limited funds to initiate new programs, including technology transfer, and

limited staff technical experience [32]. Table 4 summarizes many other impediments to technology transfer and innovation in the highway industry.

Table 4. Major barriers to technology transfer in the highway industry [30]

Barrier Category	Type	Description
Technical	Testing and demonstration	New technologies need to be tested and demonstrated thoroughly before public agencies will accept them in competition with other, well-established technologies.
	Standards	Standards-setting groups that offer a safeguard against unexpected failure are often slow and deliberate and can delay the implementation of innovative solutions.
	Testing to failure	Long-term testing is difficult, expensive, and can preclude innovative solutions that are large and/or expensive.
Procurement	Disclosure rules	Public-sector disclosure rules can prevent the use of a proprietary design or process.
	Low-bid contracts	Such contract awards do not account for future operating and maintenance costs and can result in higher total costs.
	Life-cycle costs	Making awards based on life-cycle costs is difficult; adequate information on such costs may not be available.
	Specifications	Public agencies rely on design or method specifications. This can discourage innovative techniques and products that could be considered if performance specifications were used.
Legal	Design-build limitations	Requiring that separate firms provide design and construction dampens the potential for innovation.
	Product liability and insurance costs	The potential for product liability tort claims, high insurance costs, and prospects for litigation discourage both the development and application of new techniques and products.
	Community participation	Technical choices are open to such intense public scrutiny that officials avoid controversy by relying on engineering design standards that simply repeat the previous practice.
	Permit processes	Federal, state, and local permit processes are needed to protect public health and safety but can preempt consideration of innovative solutions.
	Resistance to change	The natural tendency to resist change and the conservative nature of public-sector organizations institutionalize this resistance.

Barrier Category	Type	Description
Public-sector and institutional	Lack of institutional incentives	Highway agency engineers have little incentive to examine new or innovative technologies to solve familiar problems.
	Limited agency capabilities	Highway agencies with limited technical capabilities may be unable to maintain complex new technology.
	Interest group resistance	Many organizations and interest groups committed to preserving the status quo act as a check on innovation.
	Effect of political patronage	Political patronage can dilute agency technical competence, further reducing the incentive for innovation.

Steps of the Implementation Research

Technology transfer or implementation research is not a single activity, but a cyclical, stepwise process. Figure 8 highlights the six key steps of the implementation research cycle in the context of the health system. Yet, these steps could be generalized for other industries/fields. The first step is a clear identification of the implementation challenges and working with key stakeholders to generate relevant research questions. In this consequence, an interdisciplinary team can bring together the relevant skills to (1) develop a detailed research proposal and plan, (2) mobilize resources, and (3) execute the study. Ultimately, it can present the findings in an appropriate format for uptake and use by planners and decision-makers.

Figure 8. Steps of implementation research cycle [20]



While conducting the implementation research, there must be regular monitoring of activities and continuous feedback for necessary changes and updates. During the implementation process, dissemination of findings should take place continuously throughout the cycle as well as after the completion of the research project. These findings should be presented properly for each stakeholder so that the most relevant results are available in a timely manner to influence practice and encourage adoption.

NCHRP identified technology transfer as an integral key component of the “Innovation Adoption Process,” which is defined as a process that advances innovation and brings new ideas to transportation organizations. In NCHRP Report 768, it was reported that technology transfer is composed of 10 key components as follows [27]:

1. Address societal and legal issues
2. Have an effective champion
3. Engage decision-makers
4. Develop a technology transfer plan
5. Identify, inform, and engage stakeholders
6. Identify and secure resources
7. Conduct demonstrations/showcases
8. Educate, inform, and provide technical assistance
9. Evaluate progress
10. Reach deployment decision

Although the previous components of research implementation differ from one field to another, the concept and details of the components in different fields are similar. The following sections will document the best practices by SHAs and other agencies for tracking and documenting research implementation efforts.

Overview on Documentation of Research Implementation

In the late 19th century, there was an increased concern with the rapid increase in the number of publications in various fields. Due to this, the term “documentation” was adopted early in the 20th century to denote the techniques required to collect, preserve, organize, describe, retrieve, copy, and disseminate this vast number of documents [33].

From about 1920, the term “documentation” was generally used to include the bibliography, scholarly information services, records management, and archival work [34]. After 1950, other terms were used interchangeably with “documentation” such as “information science,” “information storage and retrieval,” and “information management [33].”

It is well-recognized that documentation plays a significant role in the success of any project if conducted properly and timely to ensure that the project requirements are fulfilled and to establish traceability with regard to what has been done, who has done it, and when it has been done [35]. Documentation is essential throughout the life-cycle of any project. This includes during the technical phase of the research project, during the implementation phase of research findings, during and after technology transfer workshops, and the list goes on all the way through deployment and market launch [36]. The review of the literature in this study primarily documented the different practices by several agencies for tracking and documenting the research implementation efforts. The collected and reviewed literature provided the research team of this project with valuable information as related to the following topics:

- Documentation prior to research implementation;
- Practices for tracking and monitoring research implementation efforts;
- Guidelines for implementation plans; and
- Practices for documenting research implementation efforts.

Appendix A outlines all the 39 agencies that were considered in this project for data collection throughout this literature review. It also outlines the field/area as well as the collected data/documents from each agency.

Documentation Prior to Research Implementation

From a public health perspective, research ethics are essential to ensure that the relative implementation risks and benefits to society, as well as the individual research participants, are given due consideration. Hence, before initiating an implementation research study, a number of documents are required to be submitted for approval to the Institutional Review Board and/or the research ethics committee. These documents generally include [20]:

- A cover letter briefly describing the research proposal and ethical issues involved, if any.
- A full research protocol including rationale, research problem, review of the literature, methodology, data collection tools, procedures, and expected outcomes.
- Analysis of potential risks and benefits, including protection of privacy and confidentiality.
- A detailed subject recruitment process and target population.
- An informed consent that is available in the local language.
- A process of communicating the research findings to participants and communities.
- A plan for addressing post-study obligations such as improvements in health care and facilities, provision of new-proven interventions to participants, long-term surveillance, and strengthening of local research expertise.
- A curriculum vitae of the principal investigator and the research team members.
- A proposed dissemination of the study results.

It is worthy to note that these documents may vary between committees; therefore, it is essential to check the specific documentation and protocol requirements with the relevant ethics committee. Among the required documents, the Informed Consent is the most important ethical document required for conducting and implementing research involving human subjects. This document ensures that individuals can make decisions freely to participate in the implementation process based on their interests, values, and priorities [37]. The key elements that should be considered in the informed consent are provided by the Federal regulations 45 CFR 46.116 as follows [38]:

- A statement that the study involves research.
- An explanation of the purposes of the research.
- The expected duration of the subject's participation.
- A description of the procedures to be followed.
- An identification of any procedures which are experimental.
- A description of any reasonably foreseeable risks or discomforts to the subject.

- A description of any benefits to the subject or to others which may reasonably be expected from the research.
- A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject.
- A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained.
- For research involving more than minimal risk, an explanation as to whether any compensation and an explanation as to whether any medical treatments are available, if an injury occurs, and if so, what they consist of, or where further information may be obtained.
- Research, Rights, or Injury: An explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject.
- A statement that participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and the subject may discontinue participation at any time without penalty or loss of benefits, to which the subject is otherwise entitled.
- A statement that the particular treatment or procedure may involve risks to the subject (or to the embryo or fetus, if the subject is or may become pregnant), which are currently unforeseeable.
- Anticipated circumstances under which the subject's participation may be terminated by the investigator without regard to the subject's consent.
- Any additional costs to the subject that may result from participation in the research.
- The consequences of a subject's decision to withdraw from the research and procedures for orderly termination of participation by the subject.
- A statement that significant new findings developed during the course of the research, which may relate to the subject's willingness to continue participation, will be provided to the subject.
- The approximate number of subjects involved in the study.

Informed consent should be clearly written at a readability level appropriate for the intended subjects. It is often recommended that informed consent is written at the eighth-

grade reading level. Additionally, it is essential to write informed consent in the local language and avoid using technical or scientific terms unless described in lay terms [39].

A research study was conducted to analyze the experience of the research ethics committee for the Carlos III Health Institute in the ethical assessment of research proposals involving human subjects [40]. It was reported that two-thirds of the evaluated projects needed modifications. About 57.6% of the comments aimed to enhance informed consent and procedures to ensure confidentiality, 18.9% of the comments were related to the principles of nonmaleficence and beneficence, while the remaining comments involved incomplete or incorrect documentation or requests for additional information [40]. Such statistics emphasize that due consideration should be given during the documentation process of informed consent. To overcome these documentation problems, various agencies developed their own Informed Consent templates that include the key elements. Appendix B provides examples of these templates.

Practices for Tracking and Monitoring Research Implementation Efforts

Most agencies view the implementation as a process that starts at the beginning of a research project and concludes well after the project wraps up. Therefore, tracking and monitoring of implementation potential and progress should be given due consideration to achieve a successful implementation program [41]. As per a study by the Illinois Department of Transportation (IDOT), tracking and monitoring of the implementation of research findings can result in one of the two following outcomes [42]:

1. Assist in selling the importance of funding research projects if implementation tracking can provide evidence that the research result benefited the department in any way.
2. By showing that very little of what has been researched is implemented could increase motivation to ensure research results are implemented among research division staff, and if communicated properly, throughout the department as well.

Considering these possible outcomes, the TRB Special Report 296 indicated that transportation departments using funds from the Second Strategic Highway Research Program should track and evaluate the implementation of research findings regularly using quantitative and qualitative methods [43]. The review of the literature reported

several practices that are critical to the success of implementation tracking/monitoring and help determine the value of research. These practices are summarized as follows:

- inclusion of preliminary implementation plans in research problem statements or proposals;
- using forms and documents to track and monitor progress during the research project and after it concludes;
- using effective tools to track projects and monitor implementation;
- effective communication between stakeholders; and
- development of evaluation plans.

These practices are described in the subsequent sections.

Inclusion of Preliminary Implementation Plans in Research Problem Statements or Proposals

The Arizona Department of Transportation (ADOT) requires researchers on the *Research Problem Statement* form to document how their research results will be implemented and disseminated [44]. Similarly, the Louisiana Transportation and Research Center (LTRC) recommends researchers to include the following in research proposals with regard to implementation: “An assessment by the researcher of the areas of potential application of anticipated research findings. The form in which the findings might be reported (mathematical model or formula, test procedure, specification, design procedure, etc.) should be described. The specific area of practice that would be changed by the findings and those organizations or groups that might benefit from the new technology should be identified. The responsibility for and means of technology transfer relative to the study should be proposed when possible [45].”

The Texas Department of Transportation (TxDOT) requires researchers to document initial planning for implementation of research results in the *Research Problem Statement* which determines the office primarily responsible for implementing the expected results and products of the research project and defines the products desired as outcomes of the research project, including the format for delivery of the products [46].

Although actual implementation of the research findings is the responsibility of the Michigan Department of Transportation (MDOT), research proposals should encompass an initial implementation plan that describes the activities anticipated to promote the

application of the research findings. The following should be considered in the initial implementation plan [47]:

- A list of the products expected from the research and suggested methods of implementation; e.g., a proposed specification, a design manual or guide, field or laboratory procedures, a training manual, hardware for demonstration, equipment, etc.
- A description of the audience or market for this product and a statement of how the research results may be used to solve the problem.
- A realistic assessment of impediments and barriers to successful implementation.
- The activities necessary for successful implementation such as training, demonstration of projects, revision of standards.
- The criteria for judging the progress and consequences of implementation.
- A detailed estimate of the costs of implementation.

IDOT requires *Problem Statements/Proposals* to include documented initial implementation plan, which identifies the most pressing needs of the DOT that can be addressed through research, emphasize the goals of the research, and indicate the desired application of the project's outputs. IDOT's proposed *Research Idea form*, used to solicit proposals from all interested parties, requests an expected implementation outcome and asks submitters to: "Describe the expected quantitative outcomes in terms of policy advances, cost savings, increased life cycle, safety, environmental impacts and sustainability, user benefits, and/or other appropriate metrics. At a minimum, explicitly list the benefits to IDOT regarding life-cycle cost and sustainability. Please note that IDOT is interested in the immediate implementation of research outcomes." A copy of this form is presented in Appendix C [48].

Ohio Department of Transportation (ODOT) emphasizes the importance of considering the implementation of research findings in each researcher's proposal. Each proposal should encompass a section that outlines the potential implementation of the research findings. If the results of the study anticipated being inappropriate for immediate implementation, the proposal must clearly describe all the additional steps that may be required before implementation can take place. These additional steps could include additional research, field testing, changes in policy, etc. Failure to address such items may result in the denial of the proposal [49].

Tracking and Monitoring Progress during the Research Process and after a Research Project Concludes

A critical factor to the success of any implementation program is the continuous monitoring of implementation potential and progress throughout the research project life cycle. Therefore, most transportation agencies require researchers to submit regular documents to summarize the implementation status of the project. For instance, LTRC evaluates each research project at several stages to assess whether the research findings have potential that merits implementation. The *Research Assessment and Implementation Report* is completed by the Technology Transfer Engineer Administrator/Manager in conjunction with the LTRC Engineer Manager following the receipt of final reports or when a considerable breakthrough results from the study. The *Research Assessment and Implementation Report* generally outlines implementation recommendations, potential impact, target audience, strategies and tactics, timeline, implementation responsibilities, and how the implementation effort will be assessed. A template for this report is presented in Appendix D [45].

Similarly, TxDOT requires a focused, documented implementation plan as the project approaches completion. This implementation plan should clearly describe the required steps to implement the research findings into TxDOT operations and could be delivered in various formats, including stand-alone devices, handbooks, analytical tools, guidelines, specifications, training, workshops, manuals, or simple recommendations [46].

The MDOT gives due consideration to implementation plans throughout the research project cycle, particularly as the project approaches completion. An *Implementation Action Plan Proposal* shall be turned in and approved with the final project. This proposal is a technical report of 10 pages or less that outlines how MDOT could best utilize the findings of the research study. The report should describe the recommended implementation steps, the estimated cost of implementation, and the benefits of adopting the implementation plan. If the findings of a study are not suitable for immediate application in practice, the proposal should specify additional steps that are needed before the application can occur [47].

The IDOT's tracking and monitoring of implementation continue throughout the project. Implementable deliverables should be included in work plans developed for approved research projects. IDOT encourages researchers to develop and update implementation strategies during the research project using *Implementation Planning Worksheet*. Furthermore, IDOT requires researchers to document in their final report

recommendations for implementation, potential barriers to implementation and how to overcome them, as well as implementable deliverables such as draft policy statements, specifications, standard drawings, test procedures, etc., as appropriate. A copy of the *Implementation Planning Worksheet* is provided in Appendix E [48].

Once the research project is awarded, ODOT encourages project researchers to solicit input from the Technical Panel on implementation for clarification purposes. In order to effectively track and monitor the implementation process, a discussion on implementation will be included in every project start-up meeting. An initial implementation assessment summary will be prepared by the Research Section to summarize the project's implementation potential based on information provided in the Request for Proposal (RFP) and the proposal. The initial implementation assessment would be discussed at the meeting and would include the following [49]:

- goals and objectives of the research;
- impact meeting the goals and objectives may have on ODOT and its business practices;
- identify steps that may need to be taken in order to utilize the results of the research;
- identify potential key players in the implementation of results;
- criteria that will be used to evaluate the success of the research in terms of the specific research contract and the potential utilization of results long term; and
- project-specific deliverables and other items as appropriate.

The implementation assessment will be formally reviewed and updated by the Research Section at each project review session. Implementation potential will be a key point of the research findings presentations held at the end of each research project. While research results presentations only address the theoretical and technical components of implementation from the researcher's point of view, the managerial aspects of actual implementation activities will be discussed at the project close-out meeting involving only ODOT staff [49].

Research projects that produce implementable findings that need additional action beyond the research project will have a formal *Implementation Plan* developed. This *Implementation Plan* is developed by ODOT staff, not the researcher, and is separate from the project's final reports and should not be included in that document [49].

Using Effective Tools to Track Projects and Monitor Implementation

Selecting an effective tracking tool is critical to the success of implementation tracking and monitoring. Between 2009 and 2011, a nationwide survey was carried out by IDOT to summarize and analyze the process of tracking implementation results in DOTs [42]. In total, 26 states responded to the survey questions. The result of the survey indicated that slightly less than half of the DOTs research divisions use a formal implementation tracking system. Yet, the majority of these research divisions reported that their current implementation tracking system was outdated, ineffective, or not consistently used. On the other hand, more than half of the DOTs research divisions reported that they do not currently track the implementation of research findings.

Almost all the survey respondents indicated that time limitations and reduced staff sizes are the primary reasons for not effectively using the implementation tracking system. In addition, some survey respondents reported that they were incapable to effectively use the implementation tracking system either because of the lack of necessary expertise, newness to their position, or an extreme lack of resources in their division [42].

Interestingly, state transportation department research divisions that stated that they have an effective implementation tracking system reported easier upper management buy-in for their research division, increased support from project champions, and easier reporting to Federal Highway Administration (FHWA). Some survey respondents emphasized that it must be a requirement for any research division to have an effective and updated implementation tracking system claiming that tracking implementation is the only way to be accountable to tax-payers and the only way to make future improvements to the research division [42]. Below are some examples of a variety of tools, including databases, forms, and periodic reports, used by different agencies to track projects and monitor implementation.

Illinois Department of Transportation (IDOT)

In November 2010, IDOT developed a new *Implementation Tracking Database* in the form of an Excel spreadsheet, as shown in Appendix F. This spreadsheet-based database works in conjunction with the Implementation Planning Worksheet (shown in Appendix E). The database provides IDOT research staff and upper management with macro- and micro-level perspectives into the entire research program as follows [42]:

- **Macro-level perspective “Main Progress View (Sheet One)”**: This sheet provides all the needed information from the *Implementation Planning Worksheet* related to

stakeholders and communication. In addition, it tracks the use and versions of the *Implementation Planning Worksheet* over the course of the project's life cycle.

- **Micro-level perspective “In-Depth Activities View (Sheet Two)”**: This sheet lists all the items provided from its accompanying planning worksheet section (Part III: Implementation Activities). The key difference is the addition of the column entitled “Status,” which tracks whether a task has been completed by the provided estimated due date. Furthermore, this column reports a “percentage completed” value for the implementation tasks provided by the submitter of the Implementation Planning Worksheet. It is coded to divide the number of completed tasks by the number of listed tasks. This calculated percentage is also reported in the first sheet of the database spreadsheet in the last column. This feature allows IDOT's research division to easily track implementation activities on a project basis.

Missouri Department of Transportation (MoDOT)

MoDOT tracks the implementation of research findings using a periodic publication, namely, *Tracker*. This tool documents MoDOT's performance measurement system that evaluates the effectiveness at which MoDOT delivers services and products to the costumers. *Tracker* is organized around several tangible results, with senior- and mid-level managers involved in monitoring approximately 100 individual measures. This tool is published quarterly to ensure accountability and allow customers to see the progress done towards implementation [50].

Louisiana Transportation Research Center (LTRC)

LTRC utilizes its “Research Project Management System” to track and monitor all the aspects of research and implementation. In page 2 of the LTRC's 2009-2010 Annual Report [51], Harold “Skip” Paul indicated, “This web-based management system automates every process used in the administration of the research program, including modules for our research project solicitation process, work program development, biannual reporting, and implementation reporting along with access to project files and other management reports. The financial side will be included when DOTD initiates the state's Enterprise Resource Program. Additional modules will be added as necessary. Hundreds of man-hours are saved through this management system.” LTRC utilizes five key categories to record project status for tracking a project over a five-year period:

1. Project in progress.
2. Implementation recommended.

3. Implementation complete.
4. Project not implemented (unsuccessful project).
5. No implementation results expected (basic research).

The University of Minnesota’s Center for Transportation Studies

The University of Minnesota’s Center for Transportation Studies utilizes various performance measures to track the implementation of research findings (new technologies, policies, procedures, design practices). Data sources for the tracking process encompass annual surveys completed by university researchers, quarterly status reports, Minnesota Department of Transportation (MnDOT) project close-out memos, anecdotal information, and follow-up inquiries [41].

Effective Communication between Stakeholders

The stakeholder is the entity who is (or might be) interested in your research project and its outcomes. A wide range of stakeholder types can be involved in a research project. Stakeholders can be:

- Public/Governmental Agencies/Entities (i.e., city, county, state, or federal);
- Non-Profit Organizations;
- Industry Partners; and
- Others (federal governmental agencies, trade associations, research institutions, and tribal organizations).

Effective communication between stakeholders is critical to the success of implementation tracking and monitoring. For instance, in IDOT, the responsibility for tracking implementation activities for individual research projects ultimately lies with (1) the Research Development Unit, (2) the sponsoring Technical Advisory Group (TAG), and (3) the Technical Review Panel (TRP) Chair. In page 61 of the 2018 Research, Development and Technology Transfer Manual of Procedures [48], it is mentioned “Close communication between TRP Chairs and PIs, IDOT technical contacts for national research studies, and the Research Implementation Engineer is critical to the success of implementation tracking and help determine the value of research.” Yet, no formal communication plan or any other document is used to assist in effective communication.

The Washington Office of Financial Management (OFM) contracted Public Consulting Group (PCG) to evaluate the structure and financing of the adult mental health system, as required by Engrossed Substitute Senate Bill 6656. In the final deliverable for this assessment, namely, “Implementation and Communication Plan,” it was reported that effective communication of ideas, progress, and changes to different stakeholders is crucial to the success of the implementation tracking process [52]. A stakeholder communication matrix was developed to provide a framework for documenting stakeholder needs. It was recommended to expand and update this matrix as the project evolves. Table 5 presents the developed stakeholder communication matrix. In this table, “OFM” would refer to Washington Office of Financial Management, “DSHS” would refer to Washington State Department of Social and Health Services, “MCO” would refer to Managed Care Organizations, “BHO” would refer to Behavioral Health Organizations, and “HCA” would refer to the Health Care Authority.

Table 5. Stakeholder communication matrix [52]

Stakeholder Group	Communication Needs	Owner	Frequency	Communication Format
Governor’s Office	Receive updates on progress, timelines, milestones, and any risks identified. Provide feedback on program direction, budget needs, and alignment with evolving state strategies.	OFM	Bi-monthly, and as needed	Scheduled Meetings
Behavioral Health Clients	Receive information on developments and changes in system redesign that impact care delivery. Provide input on service needs to inform definitions and program design.	DSHS, MCOs/BHO, Providers	As needed	Public Website, Documents that may be distributed, and links.
Select Committee on Quality Improvement in State Hospitals	Receive updates on implementation efforts as they relate to State Hospital operations.	OFM	Monthly, and as needed in the interim	Scheduled Meetings

Stakeholder Group	Communication Needs	Owner	Frequency	Communication Format
	<p>Provide feedback on strategic direction and program design.</p>			
Behavioral Health Organizations	<p>Receive information on pending changes in delivery system and responsibilities in providing services and care management impacting short-term operations.</p> <p>Provide feedback on program design and feasibility of program requirements.</p>	DSHS, HCA	Bi-weekly, and as needed	Workgroup Meetings, Emails
Managed Care Organizations	<p>Receive information on pending changes in delivery system and responsibilities in providing services and care management impacting both short term and long-term operations.</p> <p>Provide feedback on program design and feasibility of program requirements.</p>	HCA	Bi-weekly, and interim meetings as needed	Workgroup Meetings, Emails
Behavioral Health Providers	<p>Receive information on changes in the delivery system and responsibilities in providing services at varying levels.</p> <p>Provide input to shape program design for new and expanded services, as well as feedback on proposed delivery changes and feasibility of new requirements.</p>	DSHS, MCOs/BHOs	Monthly, and as needed in the interim	Workgroup Meetings, Emails

Stakeholder Group	Communication Needs	Owner	Frequency	Communication Format
County Behavioral Health Departments	<p>Receive information on changes in the delivery system expected at the state and county level.</p> <p>Provide input regarding the feasibility of county-level changes and experience in service delivery that may inform program design.</p>	DSHS, MCOs/BHOs	Monthly, and as needed in the interim	Meetings, Email

Development of Implementation Evaluation Plans

In general, an evaluation plan is defined as a written document that outlines (a) the required procedures to monitor and evaluate the implementation program, as well as (b) how the evaluation results would be used for program improvement and decision making. An evaluation plan is similar to a roadmap as it indicates the required steps to evaluate the processes and outcomes of a program. Effective evaluation plans must be dynamic (a living document) that should be updated continuously to consider program changes and priorities over time [53].

The Federal Railroad Administration (FRA) gives due consideration to evaluation plans in the implementation process of research findings. The director of Research and Development (R&D) appoints and assigns an evaluation coordinator to help develop evaluation plans and coordinate their execution. The office of R&D provided an outline to help R&D’s evaluators in developing sound designs to evaluate R&D programs, including implementation programs. This outline is required to be used as a general template when developing program evaluation plans. This outline is provided in Appendix G for reference [54].

WHO defines the monitoring and evaluation (M&E) plan as a document that describes how an implementation research project is tracked, monitored, and evaluated, and that links strategic information obtained from several data collection systems to decisions about how to enhance the project regularly. The M&E plan aims to achieve the following key objectives [20]:

- Outlining how achievements of the project will be measured;

- Documenting consensus, therefore encouraging transparency, accountability and responsibility;
- Guiding implementation of M&E; and
- Preserving institutional memory.

WHO provided six key steps that should be followed when developing the M&E plan as follows [20]:

1. **Stakeholder consultation and participation:** Stakeholder consultations and participation must regularly take place throughout the entire process of developing the M&E plan. Such consultations are necessary to ensure a clear understanding of the project goals and objectives and how these will be evaluated. Stakeholder involvement increases the chance that the results guided by the M&E plan will be consistent with their expectations.
2. **Developing the M&E plan:** Answering the following four corresponding questions is crucial to M&E planning: (1) What does the project want to change, and how? (2) What are the specific objectives that are designed to achieve this change? (3) What are the indicators, and how will they will be measured?, and (4) How the M&E data will be collected and analyzed? The answers to these questions will guide decisions about which elements need to be monitored and assessed in order to evaluate progress.
3. **Determining the M&E methodology:** Once the M&E plan is developed, it is necessary to determine the proper procedures by which data can be collected and analyzed. For instance, it is necessary to determine whether existing data collection systems will be used or if new systems require to be developed. In addition, it is important to determine how the information will be recorded, analyzed, and reported.
4. **Assign responsibilities for implementation:** The responsibilities of various stakeholders must be clearly outlined. This step will describe how the M&E plan will be specifically implemented and what reporting system will be adopted.
5. **Setting targets:** It is crucial to set targets in consultation with all stakeholders to ensure that everyone understands the project’s objectives. This process should consider the following question: “What can realistically be achieved given the resources and the environment in which the project is operating?”. To answer this question, several factors need to be considered, such as baseline levels, previous

trends, expert opinions, research findings, what has been achieved elsewhere, client expectations, and the capacity and logistics to achieve targets.

6. **Defining the reporting system, dissemination, and utilization of results:** When developing the M&E plan, the end-users' information needs should be addressed to ensure utilization of the results of research projects. It is required to include in the M&E plan a clear plan for utilizing and disseminating the M&E results.

A research study was conducted by London School of Hygiene and Tropical Medicine (LSHTM) in England and Ifakara Health Research and Development Centre (IHRDC) in Tanzania to develop M&E plan for the use of vouchers for scaling up insecticide-treated nets in the United Republic of Tanzania [55]. The research team used the aforementioned six steps proposed by the WHO to develop their M&E as follows [55]:

1. **Stakeholder consultation and participation:** The M&E strategies were developed during scheduled meetings of Tanzania National Voucher Scheme (TNVS) partners. Stakeholders included (a) researchers from IHRDC, (b) researchers from LSHTM, (c) groups involved in implementing insecticide-treated net (ITN) distribution activities in Tanzania, and (d) officers from the National Malaria Control Program. Subsequent to broad-based consultation, a comprehensive and multidisciplinary framework for monitoring and evaluation was developed to cater for novelty and complexity of the intervention.
2. **Developing the M&E plan:** The stakeholders developed an M&E plan to examine the program effects over five key domains: (1) ITN coverage among target groups; (2) provision and use of reproductive and child health (RCH) services; (3) leakage of vouchers, in terms of non-target groups receiving vouchers, and vouchers being used to purchase items other than ITNs; (4) the commercial ITN market; and (5) cost and overall cost-effectiveness of the scheme. Furthermore, the stakeholders developed the necessary indicators to evaluate the progress. These indicators were agreed upon by the Global Fund to fight AIDS, TB, and Malaria (GFATM), which funded the project. Appendix G provides the developed M&E plan, including the evaluation domains, the core indicators, and the data sources for each domain.
3. **Determining the M&E methodology:** The principle of triangulation was adopted, where the required data was collected from different sources including household surveys, facility surveys, health facility user surveys, focus group discussions (FGD) and in-depth interviews, a retail audit for data on ITN availability, voucher tracking, and cost study.

4. **Assign responsibilities for implementation:** The responsibility of conducting the M&E activities was assigned to independent researchers from IHRDC and LSHTM.
5. **Setting targets:** The set targets for the impacts of the voucher program encompassed the following: (a) evaluating the impact of the voucher scheme on ITN use among children under five years of age and pregnant women; (b) use of RCH services, including the voucher scheme; (c) impact of the scheme on RCH service provision; (d) Pregnant mothers' use of RCH services, their voucher knowledge and use, ITN use and knowledge of malaria in pregnancy; (e) community and provider perspectives on the scheme; (f) ITN availability and retail prices at selected shops; (g) degree of leakage of vouchers and (h) economic and financial costs of the voucher scheme.
6. **Defining the reporting system, dissemination, and utilization of results:** In the first two years, the results from different segments of research were presented to TNVS partners at scheduled meetings. Regular feedback regarding the results of the research assisted implementers in identifying the problems early in the project, which allowed updating the M&E strategies where necessary.

The Centers for Disease Control and Prevention (CDC) outlined a framework for program evaluation in public health to help to develop effective evaluation plans. Although the framework is outlined in terms of steps, the process is not always linear and is often completed in a back-and-forth effort that is cyclical in nature. Figure 9 presents the developed framework, which includes the following six main steps [53]:

1. Engage stakeholders;
2. Describe the program;
3. Focus the evaluation design;
4. Planning for gathering credible evidence;
5. Planning for conclusions; and
6. Planning for dissemination and sharing of lessons learned.

In addition to this framework, the CDC considered crucial evaluation standards to improve the quality of evaluations by guarding against potential errors or mistakes in practice. These standards are grouped around four key attributes: **utility** (serve information needs of intended users); **feasibility** (be realistic, prudent, diplomatic, and frugal); **propriety** (behave legally, ethically, and with due regard for the welfare of those

involved and those affected) and **accuracy** (evaluation is comprehensive and grounded in the data). These attributes are indicated by the inner circle in Figure 9.

Figure 9. CDC's framework for program evaluation in public health [53]



Considering the aforementioned framework and attributes, the CDC requires the developed evaluation plan to encompass the following elements [53]:

1. Title page
2. Question overview
3. Intended use and users
4. Program description
5. Evaluation focus
6. Methods
7. Analysis and interpretation plan
8. Use, dissemination, and sharing plan

It is worthy to note that the developed evaluation plan must be adapted to the specific evaluation needs and context of the project. Furthermore, the evaluation plan should be designed dynamic to adapt to the complexities of the environment within which the program is implemented. If changes are made, they should be documented and done with

a fully informed evaluation stakeholder workgroup. The evaluation plan sketchpad proposed by CDC is provided in Appendix G.

Guidelines for Implementation Plans

In the previous section, the review of the literature indicated that the development of implementation plans is one of the key practices to successfully tracking and monitoring implementation efforts. Therefore, this section will provide a detailed description of the development process of implementation plans by different agencies.

Recently, a research study was conducted by Gagliardi et al. to develop a guideline implementation planning checklist [56]. Documents that assessed or explained the processes of planning or undertaking implementation were identified in various publications through reviewing medical literature databases such as MEDLINE and EMBASE. Data that discussed (a) implementation planning; (b) how to develop guideline versions or tools that would support user implementation; and (c) options and mechanisms for disseminating or implementing guidelines were independently extracted from 35 eligible documents by the research team. Eventually, data were integrated to create a unique list of guideline implementation planning processes and considerations. The developed guideline implementation planning checklist is provided in Appendix H. Developers or users can apply this checklist to prepare for and/or undertake guideline implementation. It is worthy to note that the references in the second column of this checklist in Appendix H belong to that study and could be found elsewhere [56].

Process documentation research was conducted by the Gujarat Institute of Development Research in India to document the implementation of a social forestry project by a leading non-governmental organization (NGO), the Aga Khan Rural Support Programme (AKRSP). This social forestry project was an integral part of the overall farming system, improving cultivation, land husbandry, tree and soil conservation simultaneously, and in a mutually reinforcing manner. The implementation plan consisted of seven major steps, as follows [57]:

1. Understanding the project objectives and the participatory approach adopted by the NGO.
2. Identifying a framework of the key factors and their influence on the participatory process.
3. Recruiting and training the field observers who reflect the field realities.

4. Establishing close rapport and building confidence among the village community.
5. Village mapping and identification of the key factors influencing people's participation.
6. Preparing the chronology of the major events.
7. Identification of major issues, discussion with the NGO and report writing.

The modus operandi, central themes, and lessons learned from each of the seven steps are described in more detail in Appendix I.

In 2017, the Edith Cowan University and the Chronic Disease Prevention Directorate developed a practical *Research and Evaluation Framework and Implementation Guide*. This implementation guide provides a step-by-step process for conducting research and evaluation in the context of health promotion programs to ensure that the Western Australian community benefits from the health promotion programs being implemented through the Department of Health and its partners. The developed framework is presented in Figure 10. The framework consists of four phases, including eight steps [58]:

1. **Program Planning Phase:** This phase is designed to help summarize the context in which the program will be implemented (Step 1), to identify program needs, relevant evidence, and capacity for it to be implemented (Step 2), and to define the goals, objectives, and activities of the program (Step 3).
2. **Research and Evaluation Planning Phase:** This phase aims to develop a method for assessing whether the program was effective (and why) by first developing an Evaluation Proposal (Step 4), which can be reviewed and developed into a final Evaluation Plan (Step 5).
3. **Implementation Phase:** This phase involves implementing both the program and the research and evaluation plans. Data is collected (Step 6), then analyzed and interpreted (Step 7) using methods outlined in the Evaluation Plan.
4. **Review Phase:** This phase involves reviewing the program, providing recommendations, and disseminating findings to relevant stakeholders (Step 8).

Figure 10. Phases and steps included in the developed Research and Evaluation Framework and Implementation Guide [58]



It is worthy to note that the requirements for this framework will change for different programs based on their size and complexity. Therefore, while each of these steps of the framework is relevant to all programs, the nature and focus of the evaluation will differ widely from program to program. In this consequence, it is essential to have strong partnerships and communication between all stakeholders. Appendix J provides three examples of the application of this framework to three different programs.

Software implementation is the process of upgrading from spreadsheets to business intelligence software or replacing the old email-based system with a help desk program. Developing and following a thorough software implementation plan is extremely important to avoid unrealistic expectations, overlooked impacts, and frustrated employees [59]. Businesses that fail to define and achieve a software implementation plan wreck the long-term value of the new system and waste the resources spent on the system. In this consequence, different agencies proposed several steps to develop a successful software implementation plan. For instance, Software Advice, a Gartner Company, developed a 5-step software implementation plan which is applicable to most of the industries and most of the new software as follows [60]:

1. Keep Vendors Accountable with a Detailed Needs Document

First, it is important to “Make a list of every person, team, and department that will use the new tool. This includes day-to-day users, as well as leaders who consume data the tool will produce. Be sure to not only address who your stakeholders are but how they will be impacted and the timing of the impact.” Then, a needs document should be created to share with vendors by answering critical questions from the vested parties. This document should be taken into the vendor demos to check that the new system covers all the company’s needs.

2. Control Your Scope—Or It Will Control You

Scope creep will take place in the software implementation plan when it is decided to set up and customize all the features of every capability at once. To avoid this problem, it is essential to employ some project management tools and best practices to the software implementation plan based on the business size as follows:

- a. Larger businesses (50+ employees) might look to adopt formal project management systems.
- b. Midsize businesses (11-50 employees) could likely get by with free project management tools (such as Wunderlist) to help manage and assign implementation tasks.
- c. Smaller businesses (10 or fewer employees) could always just stay organized using Google Sheets, Calendars, and other manual digital methods.

3. Assign Realistic Teams to Drive Software Implementation Plans

The next key step in the software implementation plan is to assemble the team necessary for implementation success. The makeup of an implementation team will change for every business, based on the unique needs of this business as well as the scale of implementation. According to a research study by Brian Westfall [61], senior content analyst at Software Advice, it is recommended to start with a team of two as follows:

- a. **Acting administrator for the new system:** Probably an Information Technology (IT) administrator who has already been working closely with the vendor. Likely that this employee has to handle prior integrations/relationships with vendors.
- b. **Training lead for the new system:** Point person for the new software. Likely leads the team that will use the system on a daily basis and has led the charge for adoption from the beginning.

Depending on the business size, this might be the extent of the implementation team. Smaller businesses might even require an implementation team of one. In comparison, larger organizations might need an extended team that can champion the new system for their unique business unit. This extended team should encompass an IT lead to handling needs and concerns surrounding configuration and integration with other systems, along with a small sample of end-users (e.g., employees, customers, channel partners) for testing and feedback [61].

4. Generate User Adoption with a Proactive, Engaging Strategy

No matter how intuitive and useful the selected new system and tools are, the implementation does not mean adoption. It is necessary to put strategies in place to gather user acceptance and adoption of the new system. Lack of positive engagement around the product would probably ruin the software implementation plan. According to Taylor Short, a senior content analyst at Software Advice, there are key steps to obtaining great organizational changes, such as implementing new software and achieving adoption rates [62]:

- a. Adopt a proven methodology to set guidelines for change using a popular change management model called “ADKAR,” which breaks down organizational change into five key outcomes, as shown in Figure 11.
- b. Define clear goals that the newly implemented software will help achieve.
- c. Personalize messaging and communication about the implementation for each team.

Figure 11. ADKAR change model outcomes [62]



5. Focus on Continuous Improvement

To strengthen the long-term implementation of the new software, it is important to start by prioritizing those essential capabilities that require to be mastered first. This will help influence training and provide benchmarks for regular check-ins. Training is a key component in continuous improvement if conducted correctly. It is recommended to employ different types of training throughout the software implementation plan as shown in Figure 12.

Figure 12. Training initiatives designed to drive user engagement and adoption [60]



As previously mentioned, ODOT tracks the implementation of research findings through developing an implementation plan. This plan is developed by ODOT staff, not the researcher, and is separate from the projects' final report and should not be included in that report. The research section and Technical Panel develop the implementation plan to ensure that all the necessary information is considered to appropriately track and monitor implementation. At a minimum, ODOT requires the implementation plan to include the following [49]:

1. Background – A brief description of the reason the research was conducted. The purpose of the project should be clearly stated.
2. Research Objectives – A brief description of the main objective(s) or goal(s) of the study. The intended outcome(s) of the project should be noted.
3. Research Deliverables – A listing of all deliverables that were received from this project (e.g., reports, specifications, devices, prototypes, software, etc.). Brief

- descriptions of specific deliverables should be provided, as needed, for clarification purposes.
4. Researcher's Recommendations – A summary of the researcher's recommendations for implementation. The information listed here represents the opinions of the researcher. Information in this section does not signify concurrence and/or approval from ODOT.
 5. Liaison's Recommendations – A summary of the Technical Panel's recommendations for implementation. These may or may not coincide with the researcher's recommendation.
 6. Implementation Actions and Schedule – A description of the actions that must be taken in order to implement the results. This will include dates for when each item should be completed and the individual(s) responsible for conducting each task. If it is not possible to assign exact dates to each task, an estimated duration for how long it will take to complete each action will be provided. Any actions that may occur simultaneously or are dependent on the successful completion of other steps should be indicated.
 7. In the event that assistance is needed from the researcher to perform implementation activities, the Research Section will work with the Technical Panel and researcher to determine the contributions needed and the role the researcher will have in the overall implementation effort. Typically, considerations for implementation work to be conducted by the researcher are already included in the project contract. When this is not the case, additional funds may be provided if necessary and appropriate. The researcher should not begin conducting any work beyond what is included in the project contract until specifically authorized by the Research Section.
 8. Expected Benefits – A description of the anticipated benefits ODOT may receive from the successful implementation of these results.
 9. Expected Risks, Obstacles, and Strategies to Overcome Them – A discussion of the anticipated risks and obstacles that may be faced while implementing these results. Strategies for overcoming each item should also be included.
 10. Groups Impacted by the Implementation – The groups that may be affected by the implementation should be indicated. This may be limited to ODOT, such as the Office of Maintenance Administration and all Districts, or it may also include external groups, such as the Ohio Environmental Protection Agency (EPA), Ohio Department of Natural Resources (ODNR), industry, the traveling public, etc.

11. Progress Reporting and Time Frame – A timeline for the sponsoring office to follow for reporting to the Research Section on the progress of implementation. Updates can be provided weekly, monthly, quarterly, or so forth based on the implementation schedule. The Research Section will follow-up with the sponsoring office based on the schedule noted in this section.
12. Technology Transfer Methods to be Used – A description of the methods that should be used to inform others about the activities and results stemming from this implementation effort. Examples of technology transfer methods include, but are not limited to: presentations at meetings, seminars, and conferences (i.e., OTEC, and TRB); conducting webinars and other training sessions; publishing articles in newsletters such as the Transcript, TRB News, and Moving Forward.
13. Implementation Costs and Sources of Funding – The costs (if any) associated with executing the implementation plan. A brief explanation of how the funds will be used (e.g., training costs, equipment purchases, etc.) should be provided as well as the source(s) of the funding (e.g., sponsoring office budget, research funds, planning funds, district funds, etc.). Specifying costs and funding sources on this plan does not constitute approval to access funds. It is the responsibility of the sponsors of the plan, e.g., Technical Panel or Office Administrator (not the Research Section), to formally request and secure any and all funding as appropriate.
14. Implementation Evaluation/Return on Investment – A mechanism for determining the ongoing performance of the implemented research result. Included in this evaluation should be a method for calculating ODOT’s return on its investment in the initial research and subsequent implementation efforts as appropriate. The processes utilized for this item are expected to vary based on the specifics of the research results that are being implemented.

In 2017, the US Department of Transportation published the “Grant Deliverables and Reporting Requirements for 2016 University Transportation Centers,” which mandated a Center-wide Technology Transfer (T2) Plan for the university transportation centers around the US [63]. Based on the content requirements of the plan and other instructions, the Region 6 University Transportation Center “Transportation Consortium of South-Central States (Tran-SET)” developed in 2018 its own implementation (or Technology Transfer “T2”) plan. Recognizing that Tran-SET administers research in diverse transportation topical areas with varying technology maturity, the T2 Plan requires each funded project to have an individual, project-specific T2 plan. The project-specific T2 plans specify their own unique set of key stakeholders and unique methods to engage

these stakeholders. Appendix K provides the template of the Project-Specific T2 Plan [64].

Practices for Documenting Research Implementation Efforts

The documentation process of research implementation activities is essential to ensure the successful implementation of research findings. Many research studies in different areas and fields were completed successfully, achieved their research objectives, and had development and implementation stages in their research plan but ended up with low impact or undocumented implementation efforts. All efforts spent on implementation or technology transfer are uncontrolled if not documented properly. The documentation of research implementation works will move results from effectiveness studies and efficacy trials to real-world settings, obtaining information to guide scale-up and sustainability. The most common forms for documenting research implementation efforts are (1) implementation reports, (2) evaluation reports, and (3) dissemination documents. The subsequent sections will provide an in-depth discussion in regard to these three forms.

Implementation Reports

Implementation Report is defined in *Glossary of Terms and Definitions Supporting Policies, Standards and Guidelines for Information Technology and Information Security* by Georgia Technology Authority as a report that “Documents the successes and failures of a project and suggest follow up actions. It provides a historical record of the planned and actual budget and schedule. Other selected metrics on the project can also be collected, based upon state organization procedures. The report also contains recommendations for other projects of similar size and scope [65].”

After the Implementation Plan is developed by ODOT, the Research Section will coordinate the submission of the Initial Research Implementation Progress Report with the Technical Panel during the first scheduled follow-up [49]. The Initial Research Implementation Progress Report summarizes the actions that have been taken toward implementing the findings of the research project. The Technical Panel will provide the Research Section a copy of the completed report, and the Research Section will initiate reviews and updates to the report according to the schedule in the implementation plan. Appendix L provides the template of the “Initial Research Implementation Progress Report.”

The information provided in the Implementation Plan and the Initial Research Implementation Progress Report will be used by the Research Section to prepare several reports related to the impacts and progress resulting from research projects. For instance, the research section will prepare an Annual Summary at the end of each fiscal year to summarize the implementation progress. The following key elements are included in this summary [49]:

- Discuss implementation decisions/activities which occurred during the given fiscal year on completed and/or active projects.
- Highlight implementation on the horizon in regard to active projects that are showing good potential for implementation and proposed projects that are probable candidates for implementation.
- Address research being conducted in other states that could potentially be beneficial to Ohio.

The prepared Annual Summary is provided to the Director, Assistant Directors, and FHWA. Furthermore, this summary is posted on the ODOT Research website. An email notification with a link to the Annual Summary is also sent to all Deputy Directors, Office Administrators, and research managers at other state DOTs.

In addition to the aforementioned documents, the Research Section in ODOT develops a Historical Report to maintain a historical record of research project implementation efforts. The Historical Report includes a summary for each research project, in addition to the overall synopsis of the benefits achieved from conducting research. Furthermore, the Historical Report could include the Implementation Plan and the final Implementation Progress Report for each project. This report is thoroughly reviewed and updated once every three years for the purposes of (a) long-term tracking of implementation progress and (b) evaluation of the overall achieved benefits. Following each update, a synopsis of significant findings is provided. It is worthy to note that research projects are included in the Historical Report once an Implementation plan is developed [49].

Unlike ODOT, Tran-SET (Region 6 UTC) requires the Principal Investigator of the research project to prepare the Implementation Report and submit it 10 days after the implementation phase of the project is completed [64]. The Implementation Report is a companion document to the aforementioned project-specific T2 plan, shown in Appendix K. While the project-specific T2 plan is a guide to plan and execute activities during the implementation phase, the Implementation Report is a report out of such activities. The

Implementation Report provides a comprehensive description of the technology transfer and workforce development activities that were conducted during the implementation phase. Appendix L provides the template used to prepare the Implementation Report.

In recent years, Canada developed a program, namely, Connecting Canadians Program (CCP), to ensure households in rural and remote areas get access to high-speed Internet and participate in the digital economy [66]. This program supports private investments to extend and improve broadband service in areas where low population density would otherwise make this uneconomical. Similar to Tran-SET, this program mandates funding recipients to submit Progress and Final Implementation Report to describe the progress executed during the implementation of their respective projects. Appendix L provides the Progress and Final Implementation Report Template. This template was specifically developed to assist funding recipients in fulfilling the reporting frequency and requirements that were outlined by the risk assessment CCP executed before the signing of the contribution agreement.

In 1975, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) entered in force as an international agreement between governments to ensure that international trade in specimens of wild animals and plants does not threaten their survival [67]. CITES works by subjecting international trade in specimens of selected species to certain controls. All import, export, re-export, and introduction from the sea of species covered by the Convention has to be authorized through a licensing system. Each Party to the Convention must designate one or more Management Authorities to administrate this licensing system.

CITES provides a framework to be respected by each Party, which has to adopt its own domestic legislation to ensure that CITES is implemented at the national level. In this consequence, CITES mandates all the participating parties to submit an Implementation Report before each meeting of the Conference of the Parties to ensure and document the implementation of the Convention. The Implementation Report shall include legislative, regulatory, and administrative measures taken to enforce the Convention. Appendix L presents the template that should be used by the Convention Parties to submit the Implementation Report. Examples of past Implementation Reports for different Parties or countries can be found elsewhere [67].

The Centers for Medicare & Medicaid Services (CMS) is a federal agency in the United States Department of Health and Human Services (HHS) that is responsible for managing and administrating the Medicare program. In addition, CMS works in partnership with

state governments to administer Medicaid, the Children's Health Insurance Program (CHIP), and health insurance portability standards. Based on HHS' framework, CMS developed the eXpedited Life Cycle (XLC) to meet their specific needs [68]. XLC is CMS' version of the Information Technology (IT) system lifecycle. XLC was designed in the form of a methodology agnostic framework to enable the accommodation of multiple approaches to software development and project management.

CMS is committed to changing and strengthening XLC processes regularly, with a special focus on responding to business demands with value-add and flexible approaches to managing IT projects. These changes, such as the adoption of Agile values, principles, and practices, are believed to have a positive impact on the IT systems, CMS community, and customers if implemented properly. In this consequence, CMS documents its implementation efforts using the Post Implementation Report. This report results from monitoring the performance of the system/application during normal operations against original user requirements and any newly implemented requirements or changes. In general, the Post Implementation Report is divided into various sections, as follows [68]:

- Introduction
- Overview
- User/customer assessment
- Performance assessment
- Recommendations
- Appendices

A template of the Post Implementation Report is provided in Appendix L [68].

Evaluation Reports

In general, the success of the implementation process is evaluated in terms of (a) timeliness (relative to the complexity of the effort), (b) effectiveness (in achieving the agency's intended goals), and (c) scope (the portion of potential users who become actual users of the new product or process) [6]. To document the evaluation of implementation efforts, evaluation reports are utilized. The evaluation report could be defined as a document that objectively outlines all of the steps executed to establish the evaluation, including the program background, evaluation purpose, methods and procedures used,

evaluation results, programmatic achievements, and lessons learned. The evaluation report is a critical document which provides a transparent basis for [69]:

- Understanding the program’s accountability to its theory of change
- Decision-making on policies and programs
- Drawing lessons for program improvement

The Corporation for National and Community Service (CNCS) requires grantees to submit a full evaluation report to evaluate the implementation of their respective projects. The evaluation process is often conducted by independent evaluators. The final evaluation report should encompass the following key elements [69]:

1. Executive summary
2. Background and purpose
3. Evaluation methods (design, data collection, analysis)
4. Results
5. Conclusions and recommendations
6. References and appendices

In addition to the final evaluation report, grantees are required to submit the Evaluation Report Brief to summarize the findings of the evaluation process. This report briefly answers the following questions [70]:

1. What is the community challenge?
2. What is the promising solution?
3. What was the purpose of the evaluation?
4. What did the evaluation find?
5. How are evaluation findings improving policy and practice?

Appendix M provides an example for an Evaluation Report Brief that was submitted by the Corporation for Supportive Housing (CSH) to CNCS [70].

Implementation evaluations are conducted by the Federal Railroad Administration (FRA) to monitor, document, evaluate, and report on the implementation of program plans [54]. These evaluations are critical since they provide feedback throughout a program’s implementation and eventually report on the extent to which the program was

implemented as planned. The program staff utilizes periodic evaluation reports to assess their progress, determine issues related to implementation, and update their plans and performance to ensure effective implementation, in terms of program quality and timely delivery of services. After completion of the implementation process, the program staff can utilize the implementation evaluation’s documentation to determine whether the implementation process was executed properly. In addition, the implementation evaluation’s documentation could be used to evaluate whether a program’s deficient outcomes were due to insufficient implementation of the strategy or due to a weak intervention strategy.

In general, the FRA classifies the implementation evaluation reports into two groups: formative and summative. Table 6 presents the evaluation role, objectives, and questions to be addressed by each evaluation report group. Depending on need, the FRA conducts implementation evaluations either internally or externally. Internal evaluations are conducted by evaluators internal to the organization. Yet, internal evaluators are often independent of the project they are evaluating to minimize bias. On the other hand, external evaluations are executed by independent evaluators external to the organization, namely, evaluation contractors. These contractors are ideally free of any control or influence by those responsible for the project implementation. Although external evaluations are often time-consuming and more costly than internal evaluations, external evaluations showed to be more credible and objective [54].

The office of the FRA R&D provided an outline for R&D staff members to consider when writing final implementation evaluation reports. This outline is provided in Appendix N. Furthermore, the FRA requires the evaluators of R&D’s implementation programs to complete the Evaluation Standards Attestation Form and append it to the final implementation evaluation report. This form acts as an attestation of the extent to which the evaluation report adhered to applicable, specific standards of Utility, Feasibility, Propriety, Accuracy, and Evaluation Accountability. The Evaluation Standards Attestation Form is provided in Appendix O [54].

Table 6. Implementation evaluation report groups as classified by the FRA [54]

Evaluation Report Group	Evaluation Role	Objective	Questions to be Addressed
Formative	Proactive application of descriptive and judgmental	Guidance for executing the operational plan by monitoring,	<ul style="list-style-type: none"> To what extent is the R&D program proceeding on time,

Evaluation Report Group	Evaluation Role	Objective	Questions to be Addressed
	information to assist decision making, program implementation, quality assurance, and accountability.	documenting, judging, and repeatedly reporting on program activities and expenditures	<p>within budget, and effectively?</p> <ul style="list-style-type: none"> • If necessary, how can the design be improved? • How can one strengthen the implementation?
Summative	Retroactive use of descriptive and judgmental information to sum up the program's value, e.g., its quality, efficiency, cost, practicality, safety, impact, and significance.	Judging program execution by fully describing and assessing the actual process and costs, comparing the planned and actual processes and costs, and assessing compliance with relevant codes, regulations, and laws	<ul style="list-style-type: none"> • To what extent was the program carried out as planned or modified with an improved plan? • How well was the program executed?

The Reading First (RF) program is a federal education initiative designed under *the No Child Left Behind Act of 2001* (PL 107-110) and administered by the Federal Department of Education [71]. The Reading First program requires that schools funded by Reading First utilize a scientifically based reading instruction to help ensure that all children can read at or above grade level by the end of third grade. Reading First grants have been awarded to all 50 states to assist in the implementation process of the Reading First program. As in 2006, states have awarded subgrants to about 1,550 local school districts, which provided funds to approximately 5,200 schools nationwide. These funded schools were at different stages of implementing their Reading First program primarily because (a) grants to states were awarded over an extended period of time, and (b) states differed in the amount of time they allotted to their competitive subgrant processes.

For documentation purposes, the enabling legislation for Reading First mandates the United States Department of Education to contract with an outside agency to evaluate the implementation process of the Reading First Program. Therefore, to achieve this requirement, in October 2003, the US Department of Education contracted with Abt

Associates to evaluate the implementation process of the Reading First program. The implementation evaluation addresses the following key questions [71]:

1. How is the Reading First program implemented in districts and schools?
2. How does reading instruction differ between Reading First schools and non-RF Title I schools?
3. How does reading instruction differ between Reading First schools and non-RF Title I schools as RF schools' implementation efforts mature over time?
4. Does student achievement improve in schools with Reading First funds?
5. Is there any relationship between how schools implement Reading First and changes in reading achievement?

The evaluation results addressing Questions 1 and 2 were documented in an interim evaluation report published in 2006, while the evaluation results addressing Questions 3, 4, and 5 were documented in the final evaluation report. These reports were organized to include the following components [71]:

- **Introduction:** This chapter started with a background about the Reading First program, followed by the study design. The study design outlined the data collection (a) methods, such as surveys, interviews, and databases, (b) samples, (c) schedule, and (d) limitations. Eventually, the organization of the report was presented and briefly described.
- **Composition of the study sample:** This chapter investigated the characteristics of the sampled schools presenting background information on staffing, student populations, school enrollment, and external resources targeted at reading schools' reading programs.
- **Results of the evaluation measures:** This section is divided into five chapters; each chapter presents the results of a specific evaluation measure. The measures used in this study to evaluate the implementation of the Reading First program were reading instruction, interventions for struggling readers, assessment oversight, classroom support activities, and professional development.
- **Summary and conclusions:** This chapter summarized the (a) key findings of the implementation evaluation, (b) limitations to the findings, and (c) future activities.

The Administration for Children and Families (ACF) within the US Department of Health and Human Services developed the Health Profession Opportunity Grants (HPOG)

program [72]. The purpose of this program was to provide education and training to Temporary Assistance for Needy Families (TANF) recipients and other low-income individuals for occupations in the healthcare field that pay well and are expected to either experience labor shortages or be in high demand. In 2010, the ACF awarded the first round of 5-year HPOG grants (HPOG 1.0) to 32 organizations in 23 states to help them implement the HPOG program through providing eligible participants with education, occupational training, and support and employment services. In order to document and evaluate these implementation efforts, ACF's Office of Planning, Research, and Evaluation (OPRE) used a multi-pronged evaluation strategy. The National Implementation Evaluation (NIE) is part of this strategy and encompasses the non-tribal HPOG 1.0 grantees (27 out of the 32 organizations).

The NIE consisted of three main studies: (1) Descriptive Implementation Study, (2) Systems Change Analysis, and (3) Outcome Study. These studies evaluated the implementation of the HPOG 1.0 grants and described the associated system changes and the outputs that took place through addressing the following three questions [72]:

1. How are health professions training programs implemented across the grantee sites?
2. What changes to the service delivery system are associated with program implementation?
3. What individual-level outputs and outcomes occur?

In 2016, Abt Associates and its partner, The Urban Institute, published two reports to summarize the results of the three related studies through September 2014 (the first 4 years of the 5-year grant period): (i) the Descriptive Implementation and Outcome Study Report and (ii) Systems Change under the HPOG Program Report. Later in 2018, Abt Associates and its partner, The Urban Institute, published the final implementation evaluation report of the HPOG NIE to evaluate the HPOG 1.0 implementation process through the end of HPOG 1.0 in September 2015. This report summarized the HPOG training and services offered to and received by the participants. In addition, it outlines the education, employment, and earnings outcomes for samples of participants at different time periods following enrollment. Furthermore, it summarizes the findings from the NIE Descriptive Implementation and Outcome Studies and Systems Change Analysis [72].

Dissemination Documents

Information dissemination is one of the critical components of technology transfer [41]. In the context of health care, dissemination is “the targeted distribution of information and intervention materials to a specific public health or clinical practice audience. The intent is to spread knowledge and the associated evidence-based interventions [73].” In the context of informal Science, Technology, Engineering, and Mathematics (STEM) education, “Sharing the value of the project goes beyond distributing the primary products, program, exhibit or activities, or reporting the deliverables and outcomes to the funder. Dissemination communicates information to the informal STEM education and stakeholder communities about the project planning or implementation process, findings from research, lessons learned, and changes made through evaluation, methods or approaches taken, audiences reached, and challenges encountered along the way [74].” Although these definitions were specific to health and education, they could be generalized to all other fields.

Dissemination activities could be in the form of traditional print and electronic data, such as brief summaries, or non-traditional outreach activities, such as webinars and workshops. Regardless of its form, dissemination activities should be documented appropriately and timely to foster and support the implementation of the research findings and to establish traceability with regard to what has been done, who has done it, and when it has been done. The following sections discuss how different agencies document their dissemination activities.

At LTRC, the Technology Transfer Engineer Administrator/Manager for each research project develops a two-page Project Capsule as soon as the project is approved. Project Capsules summarize the problem to be addressed by the research, research objectives, methodologies used to accomplish these objectives and the implementation potential of the project, and are published online [75].

After completion of the research project, several agencies develop and publish brief summaries of the completed research to disseminate their findings and promote its implementation. Table 7 presents the different brief summaries published by different agencies. In addition to the brief summaries, some agencies disseminate their implementation efforts using periodic newsletters informing stakeholders of implementation activities. Table 8 presents the different periodic newsletters published by different agencies.

Furthermore, several agencies utilize webinars, workshops, field trips, and staff meetings to disseminate their implementation efforts. For instance, the California Department of Transportation (Caltrans) organize video conference series, namely, the Research Connection, to bring researchers and practitioners together for exchanging information and transferring knowledge [76]. LTRC organizes quarterly seminar series that focus on a specific implemented research result or technology. This seminar, which moves to several locations around Louisiana, is open to the public, and practitioners usually attend [77]. The Center for Transportation Studies in Minnesota organizes an annual research conference to promote research results and real-world projects taking place throughout the state. This conference acts as a forum for researchers and industry representatives from Minnesota and the Upper Midwest to share their research results in different transportation-related areas [78].

Table 7. Brief summaries published by different agencies

Agency	Brief Summary	Reference Link
LTRC	Technical summaries	http://www.ltrc.lsu.edu/pubs_techsummaries.html
Caltrans	Research project summaries	http://www.dot.ca.gov/newtech/researchreports/two-page_summaries.htm
	Research notes	http://www.dot.ca.gov/research/researchreports/current_research/index.htm
MnDOT	Technical summaries	http://dotapp7.dot.state.mn.us/projectPages/pages/homepage.jsf
MDOT	Research spotlights	https://www.michigan.gov/mdot/0,4616,7-151-9623_26663_59797_59805_59806--,00.html
NHDOT	Posters	https://www.nh.gov/dot/org/projectdevelopment/materials/research/projects/index.htm
CTDOT	Research bulletins and research highlights	https://www.ct.gov/dot/cwp/view.asp?a=1387&q=259640
WisDOT	Research brief	https://wisconsindot.gov/Pages/about-wisdot/research/geotech.aspx
PennDOT	Innovation information bulletins	http://www.vancerenz.com/researchimplementation/IIB.asp

Agency	Brief Summary	Reference Link
Tran-SET UTC	Final report	http://transet.lsu.edu/completed-research/

Table 8. Periodic newsletters published by different agencies

Agency	Periodic newsletter	Reference Link
LTRC	Technology today	http://www.ltrc.lsu.edu/pubs_technology_today.html
MoDOT	Fast forward	https://library.modot.mo.gov/RDT/reports/NewsLtrs/FastFwd/FastFwdv03i04.pdf
Alaska DOT&PF	Technology for Alaskan transportation	http://www.dot.state.ak.us/stwddes/research/assets/pdf/10v35n2.pdf
MDOT	Research newsletters	https://www.michigan.gov/mdot/0,4616,7-151-9622_11044_25626---,00.html
PennDOT	PennDOT innovations	http://www.vancerezn.com/researchimplementation/default.asp?Show=Newsletters
NHDOT	Focus on research	https://www.nh.gov/dot/org/projectdevelopment/materials/research/newsletter.htm
UDOT	Research newsletter	https://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:1399

Some agencies document their dissemination activities towards the implementation of research findings in a Dissemination Report. The Open Science Link project was funded by the European Union to introduce a comprehensive framework to the publication, sharing, linking, review, and evaluation of research findings based on the open access to scientific information [79]. The Community Research and Development Information Service (CORDIS) published a Dissemination Report which documented the dissemination activities of the first year of the Open Science Link project, in addition to the key objectives of the commercial exploitation of the platform. The documented dissemination activities during the first year focused in (a) the launching of the project's web site, (b) the release of the Open Science Link platform, (c) the launch of the Biomedical Data Journal, (d) the linking with libraries and organizations across Europe, (e) the issuing of press releases, and (f) the creation of an external users/stakeholders group. Additionally, various presentations and meetings were executed to present the Open Science Link project and ideas to potentially interested parties.

Similarly, Rhine-Waal University developed and published a Communication and Dissemination Report to document the dissemination efforts for implementing the NUCLEUS project in its first year, from September 2015 to August 2016 [80]. The objectives of this project were to develop new cultural and organizational approaches to allow universities to better react to societal needs and challenges. The Communication and Dissemination Report summarized the progress and deliverables related to the (a) project identity, (b) online communication, (c) internal communication, and (d) dissemination. Eventually, the report outlined reflection on the progress made in the first year of the project and discussed upcoming priorities and tasks in the second year. Key dissemination activities executed during the first year included the development of the NUCLEUS corporate design, project website, and social media accounts.

Likewise, Aalto University developed and published a Dissemination and Exploitation Report to document the dissemination efforts for implementing the PRECIOUS project which aimed to implement a preventive care system to promote healthy lifestyles with a specific focus on the environmental, socio-psychological and physiological factors linked to two common non-communicable diseases: Type 2 Diabetes and cardiovascular diseases [81]. The dissemination efforts documented in this report included (a) website and social media, (b) press releases, (c) project leaflet, (d) bi-annual newsletter, (e) conference posters and presentations, (f) journal articles, (g) attendance at non-academic events, (h) PRECIOUS workshops and seminars, (i) a PRECIOUS demonstration event, and (j) interaction with other projects and forums.

Summary

Implementation of research findings is a major problem facing funding agencies primarily because of the decentralized multijurisdictional nature of decision making, particularly in transportation agencies. This emphasizes the urgent need for research studies that can help improve technology transfer and research implementation and accelerate the use of research findings in practice. Therefore, the main objective of this chapter is to thoroughly review the literature and previous works/projects on documenting and tracking the implementation efforts of research studies. To achieve this objective, the research team analyzed the strategies of 39 funding agencies in several fields/areas that are used to document and track the implementation efforts of research findings. In specific, the collected and reviewed literature provided the authors with valuable information as related to the following topics:

- Documentation prior to research implementation;
- Practices for tracking and monitoring research implementation efforts;
- Guidelines for implementation plans; and
- Practices for documenting research implementation efforts.

The main findings of each of these sections are summarized below.

Documentation prior to Research Implementation

The results in this section indicated that before initiating an implementation research study, particularly in health organizations, several documents are required to be submitted for approval. Among the required documents, the Informed Consent is the most important ethical document required for conducting and implementing research involving human subjects. Examples of Informed Consent templates developed by different agencies are provided in Appendix B.

Practices for Tracking and Monitoring Research Implementation Efforts

This section reported various strategies and practices that are critical to the success of implementation tracking/monitoring and help determine the value of research. These practices could be summarized as follows:

- Inclusion of preliminary implementation plans in research problem statements or proposals;
- Using forms and documents to track and monitor progress during the research process and after a research project concludes;
- Using effective tools to track projects and monitor implementation;
- Effective communication between stakeholders; and
- Development of evaluation plans.

Guidelines for Implementation Plans

This section provided a detailed description of the development process of implementation plans by different agencies. Appendices H through K provide the implementation plan templates proposed by different agencies.

Practices for Documenting Research Implementation Efforts

The results of this section indicated that the most common forms for documenting research implementation efforts are (1) implementation reports, (2) evaluation reports, and (3) dissemination documents.

Online Survey

Introduction

Surveys are effective tools that are widely used by researchers in different fields to collect data and information from a sample of a specific population. The samples for surveys comprise the population and can be individuals, agencies, or other establishments that can be meaningfully thought of as defining a population to be studied. Recently, researchers started to utilize online surveys for many advantages such as low cost, convenient data gathering, good statistical significance, and precise results.

In this part of the study, an online survey as a discovery research tool was developed by the research team to identify successful examples of guidelines for documenting and tracking of research implementation efforts and activities. To achieve this objective, the online survey has been sent to different funding agencies, state DOTs, and institutions in the US and some European countries where the findings and collected answers have been analyzed. Survey questions were developed in three main categories and were approved by the Project Review Committee (PRC) of this project before distribution.

According to the literature review (Task 1) conducted for this project, a total of 39 funding agencies based on their relationships to research and funding projects were selected to assess their approaches in tracking and documenting research implementation efforts. In order to collect more information and to enrich the study results, another group of agencies that are responsible for research and funding was selected for the online survey (Task 2). In total, the developed online survey has been sent to 79 different agencies. Appendix P outlines the names and contact information of all individuals in the 79 agencies that were considered in this study for data collection throughout the developed online survey.

In the following sections of this report, the survey objectives, the development of the online survey questionnaire, and the target audience, as well as the survey results and analysis, are presented. Finally, the main findings and conclusions are stated.

Survey Objectives

Surveys are designed and used to collect information that will answer certain questions for specific objectives. The first consideration in designing a survey is to define its main objective(s) in the context of these questions.

Documenting and tracking research implementation efforts/activities by funding agencies are essential to ensure the successful implementation of research findings. Many funded research projects in different areas and fields were completed successfully, achieved their research objectives, and planned the activities of their development and implementation stages. However, these research projects ended up with low impact and uncontrolled and/or undocumented implementation efforts. All efforts spent on implementation or technology transfer are uncontrolled if not monitored or documented properly by the funding agency and the research team. The documentation of research implementation activities helps to transfer research outcomes to practice, moves outputs from effective results and useful trials to real-world settings, obtains information to guide scale-up and sustainability.

The main objective of this survey is to identify successful examples of guidelines for documentation and tracking of research implementation efforts currently developed/used in different state DOTs, agencies, organizations, and institutions. The survey was developed to suit all research fields and to be completed by personnel managing or coordinating funded research projects. The outcomes of this survey will be the main source to develop the formal guidelines of this project that will be used by the STC and other SHAs to formalize their documentation and tracking implementation activities.

The questions of the online survey of this project have been designed in three key sections:

- Section 1 – General Overview
- Section 2 – Planning, Tracking, and Monitoring of Research Implementation Efforts
- Section 3 – Documenting of Research Implementation Efforts

The questions of each survey section and the development of the online survey are presented in the following sections.

Development of Survey

A survey instrument is a tool for consistently implementing a scientific protocol for obtaining data from respondents. For most social and behavioral surveys, the instrument involves a questionnaire that provides a script for presenting a standard set of questions and response options. The survey instrument includes questions that address specific study objectives and information. Generally, developing a survey comprises three main steps:




















- The first step starts with designing the survey questions. Words with clear meaning need to be used, covering all options without overlapping, and with questions that are simple and to the point. The survey questions often begin by describing the purpose of the survey and respondent rights.
- The second step is to define the target audience, contact them to communicate the survey objective(s), and request participation in the survey. The contact process generally involves repeated attempts on different days and at different times of the day.
- The third step is selecting a tool that allows developing the online survey with the intended audience and questions.

Qualtrics is an online software that is used to create, distribute, and analyze robust online surveys. Qualtrics survey software can be used for simple questionnaires to detailed and complicated surveys for research projects. It provides a chance to design the survey with an intuitive drag-and-drop survey tool, powerful logic, many different types of questions, and pre-built survey templates. After preparing the survey questions, the email survey distribution tool allows researchers to directly approach the audience by building email lists and send them all by one click. Figure 13 shows different question types that can be developed using Qualtrics survey software. The most important advantages of the Qualtrics survey software could be summarized as follows:

- Reach respondents wherever they are with surveys on mobile devices, apps, websites, and many more;
- Create and test surveys in real-time and collaborate effortlessly;
- Uncover new insights with predictive intelligence and powerful statistical analysis built-in;

- Launch the survey with confidence and improve survey quality with Expert Review-Powered by iQ;
- Create, test, and modify surveys instantly with no coding required;
- Intuitive and powerful survey flow logic options to tailor your survey; and
- Set-up automatic actions and alerts.

Figure 13. Different types of questions in Qualtrics survey software

Static Content	 Descriptive Text	 Graphic
Standard Questions	 Multiple Choice	 Matrix Table
	 Text Entry	 Slider
	 Rank Order	 Side by Side
Specialty Questions	 Constant Sum	 Pick, Group, and Rank
	 Hot Spot	 Heat Map
	 Graphic Slider	 Drill Down
	 Net Promoter Score®	 Highlight
	 Signature	
Advanced	 Timing	 Meta Info Question

Survey Questions

The survey questionnaire of this project contains three main sections and 28 questions that were approved by the Project Review Committee (PRC) of this synthesis project before distribution. These survey sections are organized as follows:

- **Section 1 – General Overview**

This section provides general information about the participant. It includes questions about the agency or organization the participant works for, the number of employees working on research projects, and the role of the participant in the sponsored research projects.

- **Section 2 – Planning, Tracking, and Monitoring of Research Implementation Efforts**

In this section of the survey, participants are supposed to answer several questions that show the importance of the technology transfer in their agency/organization, and if there are any specific formal guidelines/template/tool to track the implementation efforts of the sponsored research projects/program in their agency. Moreover, in this section, the participants are asked to express their opinion on the importance of the planning, tracking, and monitoring of research implementation efforts throughout the research project life cycle.

- **Section 3 – Documenting of Research Implementation Efforts**

Along with the information that comes from the previous sections, participants in this section are asked to answer some questions that demonstrate the significance of documenting the research implementation efforts and also their opinion on the importance of documenting the research implementation efforts.

The sequence of questions for these three sections are as follows:

Section 1 – General Overview

1. Which agency/organization do you work for?

2. Do you deal with sponsored research projects?

- a. Yes
- b. No

If Q2 is “Yes,” go to Q3. If “No,” go to Q10.

3. What is your role in the sponsored research projects?

- a. Champion (person responsible for ensuring that implementation tasks are completed)
 - b. Program Engineer/Coordinator
 - c. Research Engineer/Coordinator
 - d. Technology Transfer Engineer/Coordinator
 - e. Director/Manager
 - f. Operations Engineer
 - g. Funding Coordinator
 - h. Administration
 - i. Upper Management
 - j. Other (please state): _____
4. How many members/employees in your agency/organization working on sponsored research projects?
- a. 1-3
 - b. 4-6
 - c. 7-10
 - d. 11-15
 - e. 15+
5. How long have you worked in your current position at your agency/organization?
- a. Less than 1 year
 - b. 1-5 years
 - c. 6-10 years
 - d. 11-15 years
 - e. 16-20 years
 - f. 20+ years
6. What is your highest level of education?
- a. High school
 - b. Some college
 - c. College undergraduate degree
 - d. Some graduate work
 - e. Graduate degree (Masters, Ph.D.)
 - f. Prefer not to answer

7. If an implementation champion (a person responsible for ensuring that implementation tasks are completed) is identified, what level of the agency/organization is the champion typically from?
- a. Working level—person responsible for the implementation task(s)
 - b. Management level—mid-level person over the area responsible for implementation tasks
 - c. Upper management level—person over all organizational units involved or impacted by the implementation activities
 - d. Research staff member
 - e. Other _____
8. Would you be available for a follow-up interview (if needed)?
- a. Yes
 - b. No
9. If yes, please provide your name and email/phone that you can be contacted at:
- Name: _____
- Email/Phone: _____

Section 2 – Planning, Tracking, and Monitoring of Research Implementation Efforts

10. Does your agency/organization allocate a dedicated amount in the research project/program fund for Technology Transfer (or Research Implementation)?
- a. Yes
 - b. No
 - c. In progress
11. Does your agency/organization specify a dedicated amount of time in the research project/program duration for Technology Transfer (or Research Implementation)?
- a. Yes
 - b. No
 - c. In progress
12. Do you have staff members in your agency/organization whose role is to monitor/track implementation effort of research findings?

- a. Yes
- b. No
- c. In progress

13. Does your agency/organization require a formal Technology Transfer (or Research Implementation) Plan for the sponsored research projects/program?

- a. Yes (If available online, could you provide a link?) _____
- b. No
- c. In progress

If Q13 is “Yes,” go to Q14. If “No” or “In progress,” go to Q16.

14. Does your agency/organization use specific guidelines/template/tool for the formal Technology Transfer Plan of the sponsored research projects/program?

- a. Yes (If available online, could you provide a link?) _____
- b. No
- c. In progress

If Q14 is “Yes,” go to Q15. If “No” or “In progress,” go to Q16.

15. When is the formal Technology Transfer (or Research Implementation) Plan required?

- a. With the research proposal
- b. During the research phase of the project
- c. Just before the end of the research phase of the project
- d. With the final report of the project
- e. Other (please state): _____

16. Does your agency/organization track/monitor the implementation efforts of the sponsored research projects/program?

- a. Yes
- b. No
- c. In progress

If Q16 is “Yes,” go to Q17. If “No” or “In progress,” go to Q22.

17. Does your agency/organization use specific formal guidelines/template/tool to track the implementation efforts of the sponsored research projects/program?

- a. Yes (If available online, could you provide a link?) _____

- b. No
- c. In progress

If Q17 is “Yes,” go to Q18. If “No” or “In progress,” go to Q22.

18. What satisfactory percentage would you give for your agency’s/organization’s formal tracking guidelines/template/tool on the following criteria:

- a. Practicality
- b. Simplicity
- c. Comprehensiveness
- d. Usefulness

19. What is the major challenge in tracking implementation activities/efforts related to the research project/program?

- a. Time available for the agency/organization to track implementation activities/efforts
- b. Personnel qualifications responsible for tracking implementation activities/efforts
- c. Fund allocated for tracking implementation activities/efforts
- d. Tools used to track implementation activities/efforts
- e. Other (please state): _____

20. I feel that the formal tracking guidelines/template/tool used by my agency/organization make(s) a meaningful contribution to the research project/program and its outcomes.

- a. Strongly agree
- b. Agree
- c. Neither
- d. Disagree
- e. Strongly disagree

21. The formal tracking guidelines/template/tool used by my agency/organization is highly valued by the researcher(s) of our sponsored research projects/program.

- a. Strongly agree
- b. Agree
- c. Neither
- d. Disagree
- e. Strongly disagree

22. Do you think your agency/organization should use specific formal guidelines/template/tool to track the implementation efforts of the sponsored research projects/program?
- a. Yes
 - b. No

Section 3 – Documenting of Research Implementation Efforts

23. Does your agency/organization document the implementation efforts of the sponsored research projects/program?
- a. Yes
 - b. No
 - c. In progress

If Q23 is “Yes,” go to Q24. If “No” or “In progress,” go to Q28.

24. Does your agency/organization use specific formal guidelines/template/tool to document the implementation efforts of the sponsored research projects/program?
- a. Yes (If available online, could you provide a link?) _____
 - b. No
 - c. In progress

If Q24 is “Yes,” go to Q25. If “No” or “In progress,” go to Q28.

25. What satisfactory percentage you give for your agency’s/organization’s formal documentation guidelines/template/tool on the following criteria:
- a. Practicality
 - b. Simplicity
 - c. Comprehensiveness
 - d. Usefulness
26. I feel that the formal documentation guidelines/template/tool used by my agency/organization make(s) a meaningful contribution to the research project/program and its outcomes.
- a. Strongly agree
 - b. Agree
 - c. Neither

- d. Disagree
 - e. Strongly disagree
27. The formal documentation guidelines/template/tool used by my agency/organization is highly valued by the researcher(s) of our sponsored projects/program.
- a. Strongly agree
 - b. Agree
 - c. Neither
 - d. Disagree
 - e. Strongly disagree
28. Do you think your agency/organization should use specific formal guidelines/template/tool to document the implementation efforts of the sponsored research projects/program?
- a. Yes
 - b. No

Figure 14 shows the order in which questions are asked in the survey of this study.

Figure 14. The order in which questions are asked in the survey of this study

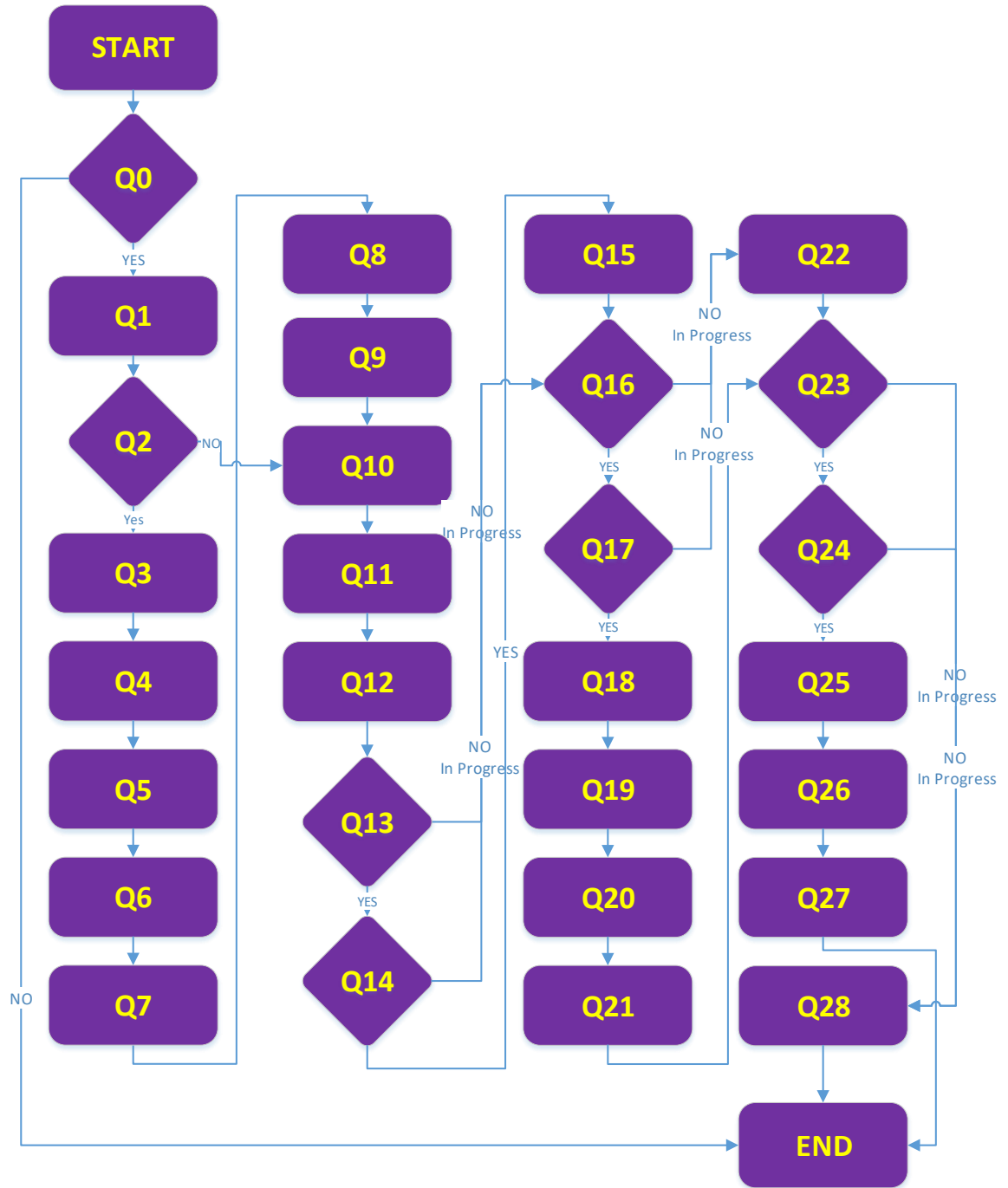


Figure 16. Dispersion of the target audience across Europe



Survey Results and Analysis

This part of the report summarizes the aggregated results of the online survey of this project, question by question. For each question, graphic representation and the main findings are provided. The survey starts with a brief explanation of the survey and its purpose. Following, the participants were asked if they want to continue and complete the survey questionnaire or not after understanding the objective of the study. The results show that 98% of the participants agreed to continue and complete the survey. The results, analysis, and findings of each question in the three sections are presented as follows.

Section 1 – General Overview

1. Which agency/organization do you work for?

The aim of this question was to check which agency/organization is responding to the online survey of this project. Table 9 shows the list of the agencies or organizations that the participants are working for, and 97% of the participants who responded to the survey

are from transportation agencies. The research team believes that it is maybe because they found the project title more related to the transportation area.

Table 9. Participating agencies/organizations

No	Agency/Organization Name	No	Agency/Organization Name
1	Louisiana Department of Transportation and Development	22	Ohio Department of Transportation
2	Kentucky Transportation Cabinet	23	District Department of Transportation
3	Illinois Department of Transportation	24	Arkansas Department of Transportation
4	South Carolina Department of Transportation	25	Vermont Agency of Transportation
5	Michigan Department of Transportation	26	Maryland Department of Transportation
6	Alabama Department of Transportation	27	Arizona Dept. of Transportation
7	Indiana Department of Transportation	28	Maryland Department of Transportation
8	Transportation Consortium of South-Central States	29	New Hampshire Department of Transportation
9	Maine Department of Transportation	30	Iowa Department of Transportation
10	University of Nevada, Las Vegas	31	Applied Research Associates, Inc.
11	Alaska Department of Transportation & Public Facilities	32	Federal Highway Administration
12	Nevada Department of Transportation	33	Arizona Department of Transportation
13	Georgia Department of Transportation	34	California Department of Transportation
14	New Jersey Department of Transportation	35	Texas Department of Transportation
15	Montana Department of Transportation	36	Volpe National Transportation Systems Center
16	Delaware Department of Transportation	37	North Carolina Department of Transportation
17	Washington State Department of Transportation	38	Mid-America Transportation Center
18	Wisconsin Department of Transportation	39	Missouri Department of Transportation
19	Utah Department of Transportation	40	University of Michigan
20	The University of Minnesota, Center for Transportation Studies	41	Connecticut Department of Transportation
21	Connecticut Department of Transportation		

2. Do you deal with sponsored research projects?

The objective of this question was to know if the participant is working on funded research projects. The result of this question [Figure 17] illustrates that 95% of the

participants were dealing with sponsored research projects, which makes the collected information more solid. Moreover, the very high percentage (i.e., 95%) confirms that the targeted audience has been selected perfectly, making the results more valid.

Figure 17. Percentage of participants who are dealing with sponsored research projects



3. What is your role in the sponsored research projects?

The main objective of this question was to identify the role of the participants in the sponsored research projects, which will signify the answers to the following questions. The results show that the majority of the participants were research engineers/coordinators, or they are directors/managers in the sponsored research projects. Additionally, the results indicate that, in more than 40% of the target agencies, there are people who are directly dealing with research projects, and they have dominance in details and different phases of that. Table 10 presents the percentage of participants in different roles. In addition, it was noticed that no participant has the role of Champion (Option "a"), which is an important role in any funding agencies to ensure completing the implementation tasks, track and document them.

Table 10. Role of the participants in different research projects

	What is your role in the sponsored research projects?	Percentage
a	Champion (person responsible for ensuring that implementation tasks are completed)	0%
b	Program Engineer/Coordinator	10%

	What is your role in the sponsored research projects?	Percentage
c	Research Engineer/Coordinator	27%
d	Technology Transfer Engineer/Coordinator	7%
e	Director/Manager	32%
f	Operations Engineer	0%
g	Funding Coordinator	2%
h	Administration	2%
i	Upper Management	2%
j	Other (please state)	18%
	Total	100%

4. How many members/employees in your agency/organization working on sponsored research projects?

This question asks about the number of members in the agencies who are working on managing funded research projects. In fact, the number of employees who are working on research projects is one of the factors that show the significance of research projects in different agencies, and a higher number of employees working on research projects may imply that there is more control on the projects and their implementation activities.

Whereas, the target audience are notable agencies in several fields/areas that are used to document the implementation efforts. The results of Question 4 in Figure 18 show that 34% of the agencies have more than 15 members working on sponsored research projects, which show that these agencies have a good number of team members managing their funded projects and track their activities. On the other hand, 33% of the agencies have only 1 to 3 members working on research projects, and 24% of the participated agencies have 4 to 6 members managing research projects. The low number of members may affect the performance of the agency in tracking and documenting the activities of implementation. However, the results may differ with respect to their work experience and what percentage of the total do they make up.

5. How long have you worked in your current position at your agency/organization?

This question is to assess the experience of each participant on sponsored research projects. It shows if the research projects funded by these agencies are managed by experienced personnel. As shown in Figure 19, 45% of the survey participants have 1 to 5 years of experience, while more than 15% of the participants have 6 to 10 years of experience, and only 10% of them have more than 20 years of experience in their current positions. These percentages are expected since agencies usually form a team of a senior

staff member supported by a number of junior members to manage the sponsored research projects. Despite the majority of the participants working in their current roles for less than 10 years, their level of education shown in the next question makes them qualified for their role in sponsored research projects.

Figure 18. Percentage of the employees in different agencies who are working on sponsored research projects

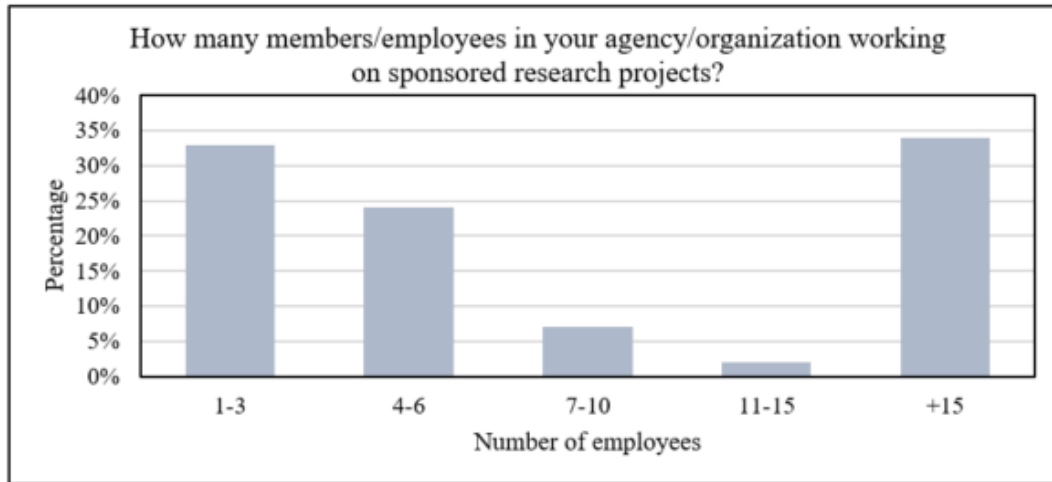


Figure 19. Percentage of participants versus their years of experience

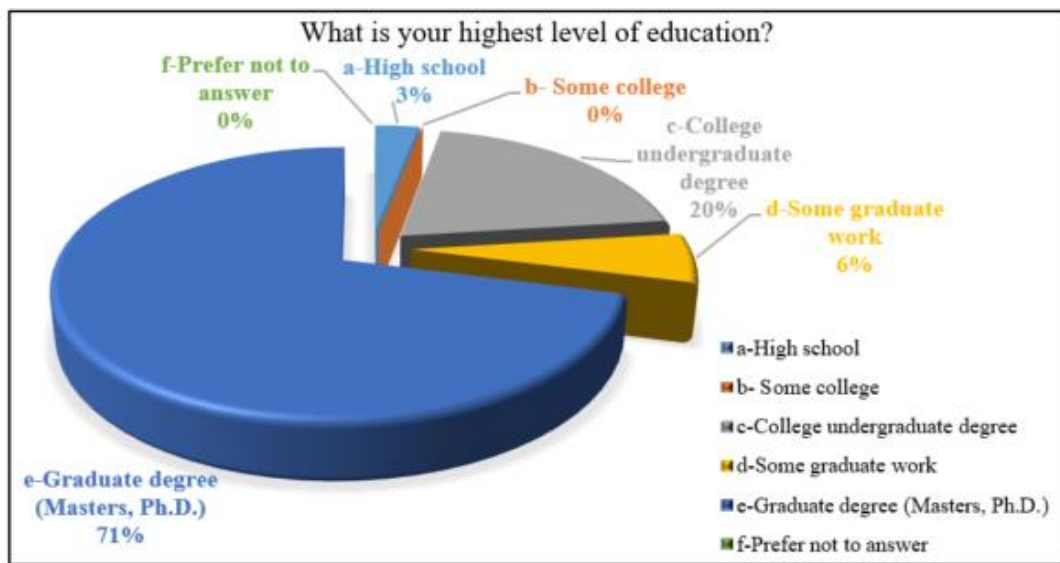


6. What is your highest level of education?

The level of education for the employee of a funding agency monitoring a research project and its implementation activities is very important and can help the researchers

significantly. If the research projects are managed by highly-educated personnel, more guidance and better facilitation will be provided to the researchers throughout the project duration. The main objective of this question is to know the level of education for the agency personnel who is managing/monitoring the sponsored research project. The level of education ranges from high school education to a graduate degree, i.e., Masters and/or Ph.D. As shown in Figure 20, the majority (71%) of the participants have a graduate degree, which implies that the research projects have a high level of management in the targeted agencies.

Figure 20. Percentage of participants versus their level of education



7. If an implementation champion (a person responsible for ensuring that implementation tasks are completed) is identified, what level of the agency/organization is the champion typically from?

In each agency or organization, there should be a person (champion) who is responsible for ensuring that implementation tasks are completed as planned. In this question, the survey participant is asked about the level of which the champion is typically from. These levels range from working level, management level, upper management level, to research staff member. The results in Figure 21 show that in 31% of the agencies, an implementation champion is selected from the working level. However, in 23% of the agencies, the champion is not a specific role to identify, or conversely, the champions could be from any of the mentioned levels.

Figure 21. Percentage of the level of the agency which the champion is typically from



Questions 8 and 9 of the survey are for the name and contact information of the participants for a follow-up interview if agreed. Appendix P outlines the names and contact information of all 79 agencies that were considered in this study for data collection throughout this online survey. However, none of the participants agreed to a follow-up interview.

Section 2 – Planning, Tracking, and Monitoring of Research Implementation Efforts

10. Does your agency/organization allocate a dedicated amount in the research project/program fund for Technology Transfer (or Research Implementation)?

In order to ensure activities on technology transfer and implementation during the research project duration, a dedicated amount of funds should always be allocated for these activities. The researchers should keep in mind that there is a specific amount of funds only to be used for implementation activities. Also, the funding agencies will monitor and document the activities and expenses related to the implementation phase of the project. According to the results in Figure 22(a), 63% of the target agencies allocate a dedicated amount of funds to aid Technology Transfer and implementation efforts in the research project/program. It implies that the target audiences of the survey are from notable agencies who pay proper attention to the Technology Transfer. Although 6% of the target agencies are planning to allocate a specific amount of funds for research implementation, 31% of the agencies do not have a dedicated amount of funds to support Technology Transfer, which is a high percentage and certainly affecting their ability to track and document implementation activities.

11. Does your agency/organization specify a dedicated amount of time in the research project/program duration for Technology Transfer (or Research Implementation)?

Similar to the dedicated funds, a specific amount of time for technology transfer activities needs to be dedicated in the project duration. In the technology transfer phase, the researchers should work only on introducing the outcome of their projects to the potential adopters and decision-makers through a variety of activities. At the same time, the funding agencies will be tracking and documenting these activities. The main goal of Question 11 is to obtain information about the number of agencies that allocate a specific amount of time in the research project duration for Technology Transfer. According to the results shown in Figure 22(b), it is obvious that more than half (%53%) of the agencies do not specify a dedicated amount of time for research implementation. It does not mean that all of 53% agencies disagree with allocating a specific time for technology transfer, they might believe that research implementation should be during the research/technical phase of the project.

12. Do you have staff members in your agency/organization whose role is to monitor/track implementation effort of research findings?

As a matter of fact, monitoring is defined as observing the progress of (something) over a period of time. It is clear that all efforts spent on implementation or technology transfer are uncontrolled if not monitored or documented properly by the funding agency and the research team. This question asks about the presence of staff members in the funding agency who are responsible for monitoring the implementation efforts of the research findings. The results in Figure 22(c) show that 42% of the agencies have staff members dedicated to tracking implementation activities. Likewise, 25% of them are planning to have staff members with this specific responsibility. However, 33% of the participated agencies do not have staff members for monitoring technology transfer activities, which will negatively affect the level of control on these projects and activities.

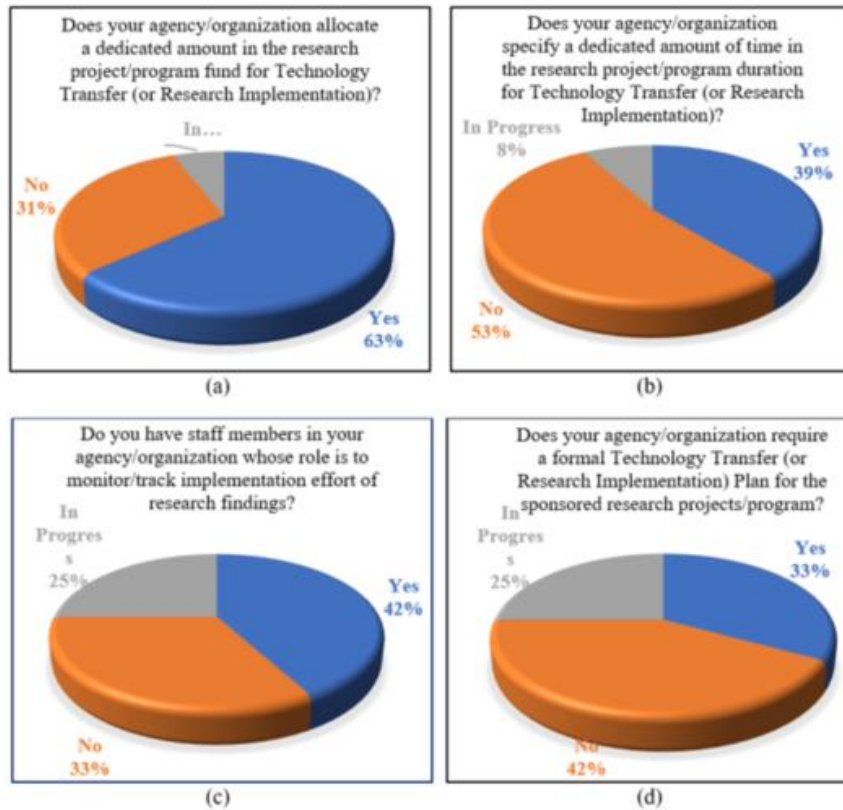
13. Does your agency/organization require a formal Technology Transfer (or Research Implementation) Plan for the sponsored research projects/program?

Formal planning for technology transfer activities forces the research team to think of the future, to set priorities, to encourage creativity, to articulate clear objectives, and to forecast the future in terms of anticipated problems. In this question, organizations have been asked about the use of formal planning in sponsored research projects. As shown in Figure 22(d), 42% of them are not using a specific formal plan, which might be due to the

fact that they do not have any implementation phase in their agencies, or they are not aware of the benefits of the formal plans. While 33% of the agencies are using a formal technology transfer plan in their sponsored projects, and 25% of them are in the process of having one.

Figure 22. Responses to survey questions 10 through 13

- (a) Percentage of the target agencies that allocate a dedicated amount of fund to aid Technology Transfer and implementation efforts in the research project
- (b) Percentage of the agencies who allocate a specific amount of time in the research project duration for Technology Transfer
- (c) Percentage of the staff members dedicated to tracking implementation activities
- (d) Percentage of the agencies who require a formal Technology Transfer Plan for the sponsored research projects



14. Does your agency/organization use specific guidelines/template/tool for the formal Technology Transfer Plan of the sponsored research projects/program?

Formal guidelines for tracking and documenting the research implementation are used by funding agencies to formalize their documentation and to track research implementation

activities. The results of this question [Figure 23] show that the number of agencies that use specific guidelines for the formal Technology Transfer Plan of their sponsored research projects is the same as agencies that do not use specific guidelines. However, 16% of the agencies responded are planning to make a guideline for the Technology Transfer Plan of their sponsored research projects.

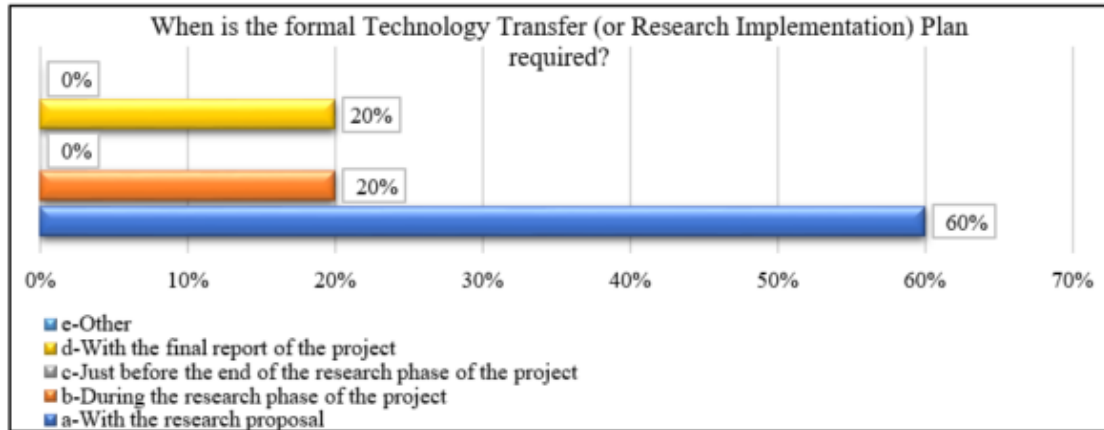
Figure 23. Percentage of the agencies that use specific guidelines for the formal Technology Transfer Plan



15. When is the formal Technology Transfer (or Research Implementation) Plan required?

This question was asked to identify when the formal technology transfer plan is required to be submitted by the research team to the funding agency. The formal Technology Transfer Plan could be submitted with the research proposal, during the research phase, just before the end of the research phase or finally, with the final report of the project. As shown in Figure 24, the majority of the participants (60%) responded that the formal Technology Transfer Plan is submitted with the research proposal before the start of the project, which is a good practice since it will allow early planning for the activities.

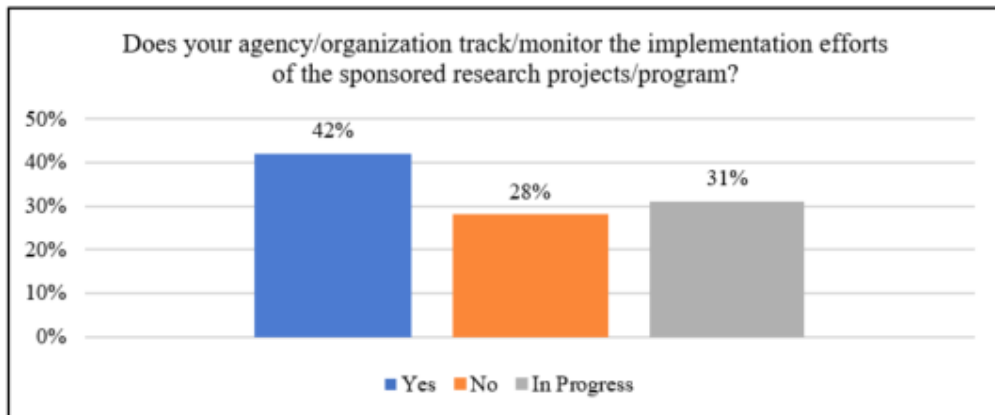
Figure 24. Percentage of the participants versus the time that formal Technology Transfer Plan required



16. Does your agency/organization track/monitor the implementation efforts of the sponsored research projects/program?

The main objective of this question was to check if the agencies participated in this survey track or monitor the implementation efforts of the sponsored research projects. As shown in Figure 25, the majority of the agencies are monitoring these efforts, or they are working on this. However, still, 28% of the agencies do not track the implementation efforts. In this step, the agencies that are monitoring the implementation efforts of the sponsored research projects will automatically go to the next question to answer more specific questions.

Figure 25. Percentage of the agencies that track the implementation efforts of the sponsored research projects



17. Does your agency/organization use specific formal guidelines/template/tool to track the implementation efforts of the sponsored research projects/program?

In order to well-track the implementation efforts of a research team, a formal guideline, template, or tool should be used by the funding agency. The results in Figure 26 show that a high percentage of the agencies (67%) monitoring the implementation efforts of the sponsored research projects use specific formal guidelines to track the implementation efforts of their projects. The aim of the formal guideline is to assist in making decisions and criteria regarding management and execution in specific areas. Furthermore, according to the results, 13% of the agencies are in the process of using a specific formal guideline.

Figure 26. Percentage of the agencies that use specific formal guidelines to track the implementation efforts of the sponsored research projects



18. What satisfactory percentage would you give for your agency's/organization's formal tracking guidelines/template/tool on the following criteria:

This question was designed to evaluate the percentage of satisfaction for the formal tracking guidelines/templates/tools that different agencies use. The results in Table 11 shows that based on the average, the majority of the agencies believe that their formal tracking guidelines are practical, simple, comprehensive, and useful. It is clear that these guidelines/templates/tools will help supervisors and employees think more carefully and creatively about how a flexible work arrangement can support institutional goals and improve implementation tracking efforts. In addition, the results indirectly show that the guidelines/template/tool used by these agencies need to be simpler and more practical in order to be much more efficient and easier to implement.

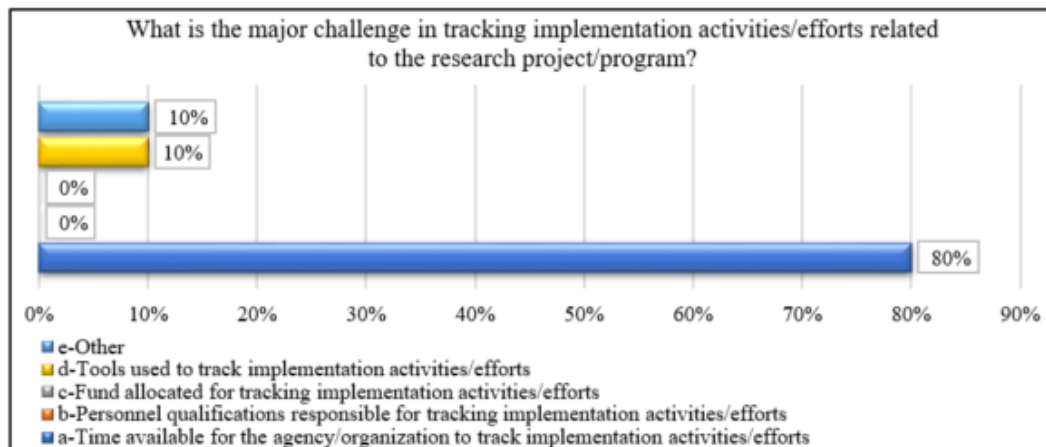
Table 11. The satisfactory percentage given by the participants for their agency's/organization's formal tracking guidelines/template/tool

What satisfactory percentage would you give for your agency's/organization's formal tracking guidelines/template/tool on the following criteria				
No	Field	Minimum	Maximum	Mean
1	Practicality	48	100	79
2	Simplicity	22	100	75
3	Comprehensiveness	43	100	83
4	Usefulness	36	100	80

19. What is the major challenge in tracking implementation activities/efforts related to the research project/program?

As discussed earlier, there is enough allocated funds in 63% of the participated agencies to support the tracking implementation activities, and it is not the major challenge in this phase. However, the answers for Question 19 in Figure 27 show that the availability of time for the agencies to track and monitor implementation activities is the most important challenge which agencies are facing.

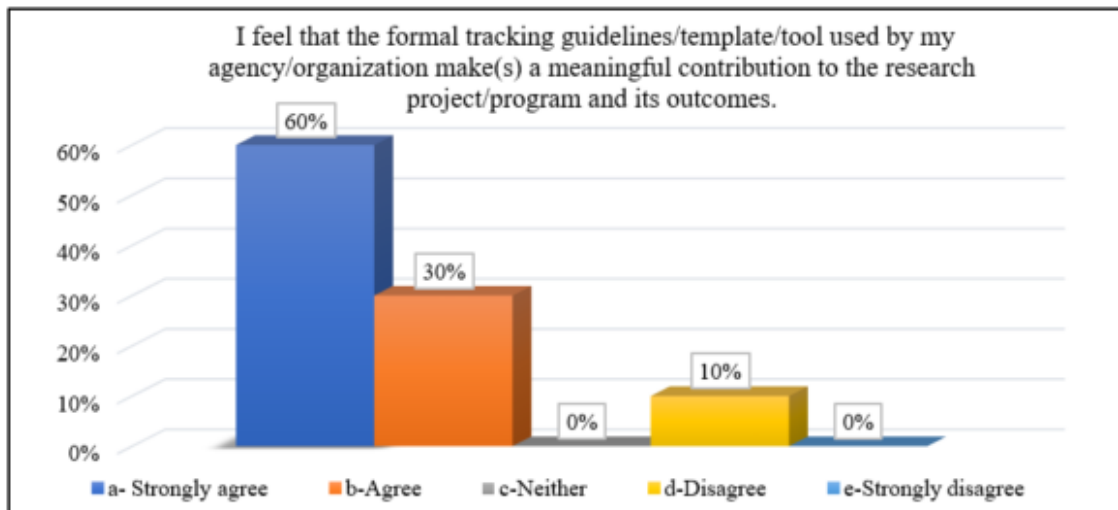
Figure 27. Percentage of the different challenges the participated agencies are facing in tracking implementation efforts



20. I feel that the formal tracking guidelines/template/tool used by my agency/organization make(s) a meaningful contribution to the research project/program and its outcomes.

The main objective of the formal tracking guidelines was to make a meaningful contribution to the development of research projects and signify its outcomes. In the following, participants who are using formal tracking guidelines in their research projects are supposed to answer this question. The main goal of this question is to determine the degree of contribution of the formal tracking guidelines being used by the agencies to their research projects. The choices range from strongly agree to strongly disagree. According to the results shown in Figure 28 below, the majority of the participants believe that the formal tracking guidelines that are used by their agencies can make a meaningful contribution to the research project.

Figure 28. Percentage of the participants versus the degree of meaningful contribution of the formal tracking guidelines being used by their agencies to their research projects

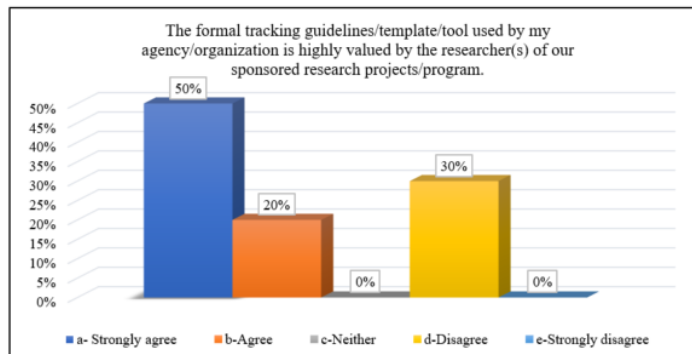


21. The formal tracking guidelines/template/tool used by my agency/organization is highly valued by the researcher(s) of our sponsored research projects/program.

This question is to evaluate the acceptance of the agencies’ formal tracking guidelines by researchers of the sponsored research projects. As mentioned before, the target audiences are large agencies that typically deal with different sponsored research projects.

According to the results shown in Figure 29, 50% of the respondents strongly agree, and 20% of the respondents agree that the formal tracking guidelines that they use in their sponsored research projects are highly valued by the researchers. On the contrary, 30% of the participants disagree and believe that the researcher would appreciate a more effective tracking tool.

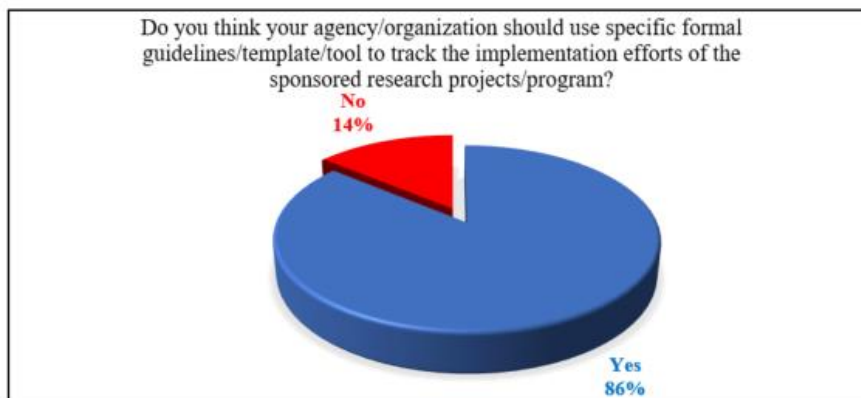
Figure 29. The acceptance of the agencies formal tracking guidelines by researchers of the sponsored research projects



22. Do you think your agency/organization should use specific formal guidelines/template/tool to track the implementation efforts of the sponsored research projects/program?

Question 16, discussed earlier, was designed based on skip logic. Skip logic sends the respondents to a later point in the survey based on how they answer a question. In this survey, only the respondents who indicate that their agencies do not monitor the implementation efforts of the sponsored research projects are to skip to this question, i.e., Question 22. This question is knowing the participants' general opinion regarding the use of the specific formal guidelines to track the implementation efforts of the sponsored research projects. The results in Figure 30 indicate that 86% of the skipped participants believe that their funding agencies should use specific formal guidelines to track the implementation efforts of the sponsored research projects.

Figure 30. Participants' general opinion regarding the use of the specific formal guidelines to track the implementation efforts of the sponsored research projects



Section 3 – Documenting of Research Implementation Efforts

23. Does your agency/organization document the implementation efforts of the sponsored research projects/program?

In addition to tracking implementation efforts, documenting them is also very important to keep the project and all efforts under control and easy to evaluate. The main objective of this question is to collect information about the agencies which document the implementation efforts of the sponsored research projects. As shown in Figure 31(a), 41% of the agencies are documenting these efforts, and 28% of them are making progress in this direction. However, 31% of the agencies do not use specific formal guidelines to document the implementation efforts of the sponsored research projects. In this step, the agencies that are documenting the implementation efforts of the sponsored research projects will automatically go to the next question to answer more specific questions. Others will skip the following questions and go directly to Question 28.

24. Does your agency/organization use specific formal guidelines/template/tool to document the implementation efforts of the sponsored research projects/program?

In order to document the implementation efforts of a research team properly, a formal guideline, template, or tool should be used by the funding agency. The results of this question in Figure 31(b) show that 80% of the organizations use the specific formal guideline to document the implementation efforts of the sponsored research projects. The formal guidelines to document the implementation efforts can potentially help in evaluating these efforts and identifying the main gaps for real-world implementation. Furthermore, according to the results, 20% of the agencies do not use specific formal guidelines/tools to document the implementation efforts, which for sure affecting their ability to control the sponsored projects and the technology transfer activities.

Figure 31. Responses to survey questions 23 and 24

- (a) Percentage of the target agencies that document the implementation efforts of the sponsored research projects/program
- (b) Percentage of the agencies that use specific formal guidelines to document the implementation efforts of the sponsored research projects



25. What satisfactory percentage you give for your agency’s/organization’s formal documentation guidelines/template/tool on the following criteria:

This question is designed to evaluate the percentage of satisfaction for the formal documentation guidelines that are being used by different agencies. Results in Table 12 show that based on the average, the majority of the agencies believe that their formal documentation guidelines/templates/tools are practical, simple, comprehensive, and useful.

Table 12. The satisfactory percentage given by the participants for their agency's/organization's formal documentation guidelines/templates/tools

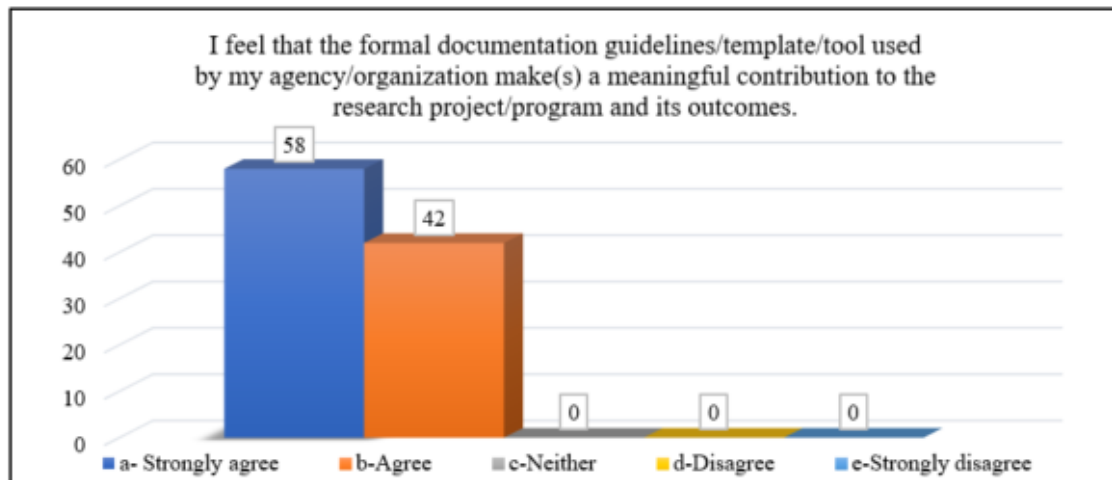
What satisfactory percentage you give for your agency's/organization's formal documentation guidelines/templates/tools on the following criteria				
No	Field	Minimum	Maximum	Mean
1	Practicality	40	100	78
2	Simplicity	38	100	81

What satisfactory percentage you give for your agency's/organization's formal documentation guidelines/templates/tools on the following criteria				
No	Field	Minimum	Maximum	Mean
3	Comprehensiveness	40	100	78
4	Usefulness	40	100	79

26. I feel that the formal documentation guidelines/template/tool used by my agency/organization make(s) a meaningful contribution to the research project/program and its outcomes.

The main goal of this question is to determine the degree of contribution of the formal documentation guidelines/templates/tools to the research projects and to their outcomes. The choices range from strongly agree to strongly disagree. According to Figure 32 below, the majority of the participants strongly believe that the formal tracking guidelines that are used by their agencies make a meaningful contribution to the research project.

Figure 32. Percentage of the meaningful contribution of the formal documentation guidelines to the research projects and to their outcomes

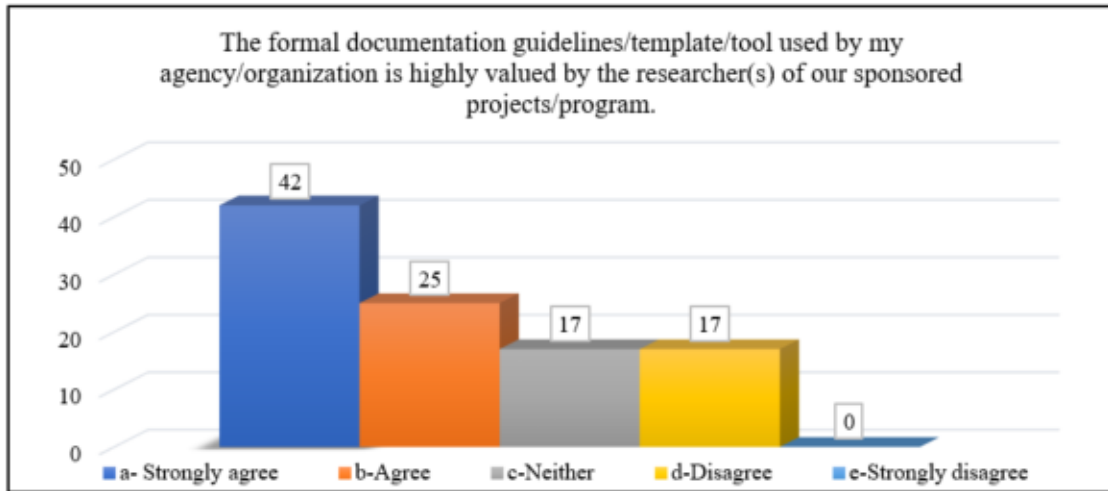


27. The formal documentation guidelines/template/tool used by my agency/organization is highly valued by the researcher(s) of our sponsored projects/program.

The results of Question 27 of this survey shown in Figure 33 indicate that in most cases, these formal documentation guidelines are highly valued by the researchers of the sponsored projects. However, 17% of the participants disagree and believe that the agency's formal documentation guidelines are unvalued by the researchers. It might be

because of different reasons. For instance, the researchers believe that the formal guidelines/templates/tools are not practical enough or reasonable.

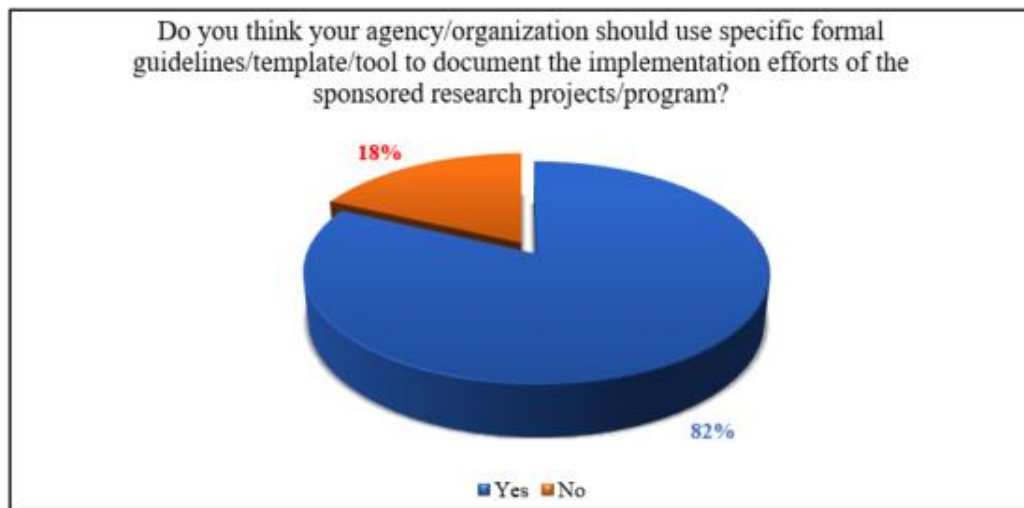
Figure 33. The acceptance of the agencies formal tracking guidelines by researchers of the sponsored research projects



28. Do you think your agency/organization should use specific formal guidelines/template/tool to document the implementation efforts of the sponsored research projects/program?

Question 23 discussed earlier has been designed based on the skip logic. As explained previously, skip logic send the respondents to a later point in the survey based on how they answer a question. In this survey, respondents who indicate that their agencies do not use specific formal guidelines/templates/tools to document the implementation efforts of the sponsored research projects are to be skipped to this question (i.e., Question 28). This question is about the participants' general impression regarding the use of the specific formal guidelines to document the implementation efforts of the sponsored research projects. The results shown in Figure 34 indicate that 82% of the respondents agree with the fact that agencies should use specific formal guidelines to document the implementation efforts of the sponsored research projects, which gives importance to this study and its outcomes.

Figure 34. Participants' general opinion regarding the use of the specific formal guidelines to document the implementation efforts of the sponsored research projects



Summary

As shown in the analysis of the survey answers, 98% of the people who received the survey invitation found it to be relevant to their profession and completed it. In fact, 95% of the participants are people who have been working in the transportation field, and the majority of them are dealing with sponsored research projects. The survey results indicate that in the majority of these agencies, there are departments that are specifically working on research projects, and in most cases, the leadership has a graduate degree. The following section addresses a summary of the main participants' responses to the questions under Section 1 of the survey:

- In most cases, the survey was completed by employees who have an important role in sponsored projects, such as research coordinators and managers.
- 45% of them are working in their current positions in a service duration of 1 to 5 years.
- 70% of the participants have a graduate degree (Master/Ph.D.), and nearly 20% of the participants have college or undergraduate degrees.
- In 31% of the targeted agencies, a person who is responsible for ensuring the implementation tasks is typically from the working level, 11% and 26% are from the

upper management and management levels, respectively. Only 9% are researchers, and the rest (i.e., 23%) believe that this role doesn't apply for them.

The main objective of this survey was to identify the successful examples of guidelines for documentation and tracking of research implementation efforts. Therefore, the specific questions in Sections 2 and 3 of the survey that are directly related to the tracking and documenting of research implementation efforts were analyzed. Whereas Technology Transfer Plan is a guide to successfully plan and execute activities during the implementation phase of the project, the majority of the participants believe that the formal Technology Transfer Plan is supposed to be submitted with the research proposal. The results of these two sections of the online survey are summarized as follows:

- On the whole, 63% of the organizations allocate a dedicated amount of funds for research implementation, and 6% of them are planning to allocate a specific amount of funds on research implementation.
- Even though 53% of the organizations do not specify a dedicated amount of time in the project duration for research implementation activities, 39% of them have this specific amount of time, and 8% of them are planning to add it to the duration of their future sponsored project.
- 42% of the organizations believe that they do not require a formal Technology Transfer Plan for their sponsored research projects.
- 33% of organizations believe that they require a formal Technology Transfer Plan, and 25% of them are planning to make a formal Technology Transfer Plan for their sponsored research projects.
- 58% of the organizations that have a formal Technology Transfer Plan are using specific guidelines, or they are planning to create their formal Technology Transfer Plan.

The majority of the organizations with formal Technology Transfer Plan are tracking and documenting the implementation efforts of the sponsored research projects, or they are in the progress of start monitoring and documenting the implementation efforts. Similarly, about 67% of them are using a specific formal guideline to track and document the Technology Transfer efforts of their sponsored research projects and also agree with the fact that that their guidelines are practical, simple, comprehensive, and useful.

On the other hand, there might be some challenges in tracking the implementation activities. The survey results show that the availability of time for the agencies in tracking the implementation activities is the most important challenge they are facing. None believe that personnel qualifications or the allocated fund could be the major challenge for tracking the implementation activities.

The information, data, and results of the online survey will be combined with the outcomes of the literature review of Task 1 in order to develop a list of the best practices for tracking and documenting research implementation efforts. The developed list is provided in the following sections of the report and includes the selected best implementation tracking and documentation tools, methods, formal programs, and guidelines used nationwide and by different funding agencies to show the full picture of the techniques used. Then, the developed formal guidelines for tracking and documenting implementation efforts of research findings will be presented at the end of this report. The formal documentation guidelines will ensure full access to the performed activities related to research findings implementation and will encourage transparency, accountability, and responsibility. The developed tracking guidelines will assure full control on the implementation activities related to research results. The tracking tool will encourage on-time and focused implementation efforts for the research projects.

Best Practices for Documenting Research Implementation Efforts

Based on the outcomes of the literature review and the online survey conducted in this project, the research team has found and discussed several formal tools/methods that are used by the funding agencies to document the implementation activities of a research project. In this part of the study, the selected best practices found for documenting research implementation efforts are listed as follows:

- The use of implementation reports; and
- The use of dissemination documents

For each of these selected best practices, the practice is defined, and the feedback and recommendations provided by the research team of this project are summarized in the following subsections.

The Use of Implementation Reports

As previously mentioned, the majority of the funding agencies are asking the researcher to submit an implementation report to document the efforts and all activities conducted during the implementation phase of the funded project. As already thoroughly discussed in the literature review of this project, the implementation report is defined by the Georgia Technology Authority as a report that “Documents the successes and failures of a project and suggest follow up actions. It provides a historical record of the planned and actual budget and schedule [65].” Below are some comments by the project team on this selected practice to be considered during the development of the formal guidelines for documenting the research implementation efforts of this project:

- The research team believes that these implementation reports are documenting the activities that have been conducted to transfer the developed technology or the outcome of a funded research project to the potential adopters or end-users. Therefore, the term “Technology Transfer” or “T2” is deemed more appropriate than “Implementation.”
- Some of the funding agencies are using a Progress Implementation Report for projects with long T2 phase durations (i.e., more than 6 months). These agencies

mandate funding recipients to submit progress and final reports to describe/document the progress executed during and at the end of the T2 phase of their respective projects. As an example, Appendix L provides the Connecting Canadians Program (CCP) Progress and Final Implementation Reports templates. The research team believes that if the technology transfer period of the project is more than 6 months, it is recommended to use a Progress Technology Transfer (T2) Report in the mid-way of the technology transfer phase.

- In the implementation (or T2) reports, researchers are supposed to document what activities have been performed during the T2 phase, and it is the responsibility of the funding agencies to review and identify which activities worked best. It is recommended to select the best activities that have been conducted during the technology transfer phase for all projects, and then recommending them for future projects to reach more adopters and make the outcomes highly implementable.

The Use of Dissemination Documents

Some of the funding agencies use different forms of dissemination activities to document and report out the project outcome(s) as well as the conducted implementation (or T2) activities. Dissemination could be in the form of traditional printed and electronic data, such as brief summaries and project highlights, or non-traditional outreach activities, such as webinars, seminars, and workshops. The literature review of this project presented several dissemination activities used by different agencies to document the project findings as well as the technology transfer efforts. Best forms of these activities are presented as follows:

- After the completion of the funded research project, several agencies develop and publish brief summaries or highlights of the completed research to disseminate the findings and to promote its outcome's implementation. WisDOT, for example, documents and disseminates the projects' outcomes and the T2 activities in Research Briefs.
- Some agencies use periodic newsletters informing stakeholders and potential adopters of the performed (or planned) T2 activities. For instance, MDOT disseminates activities of the funded project towards the implementation of research findings in Research Newsletters.

- Caltrans organizes video conference series, namely, the Research Connection, to bring researchers and practitioners together for exchanging information and transferring knowledge.

The research team believes that all of these dissemination forms are good documentation practices that can be used/embedded in the formal guideline developed in this project.

Best Practices for Tracking Research Implementation Efforts

In this section of the final report, the best practices for tracking and monitoring research implementation efforts are listed and discussed. It is obvious that a critical factor to the success of any implementation program is the continuous monitoring of implementation potential and progress throughout the research project life cycle.

The review of the literature and the online survey results reported several practices that are critical to the success of implementation tracking/monitoring and to help to determine the value of any research project. The best of these tracking practices that are selected by the research team could be summarized as follows:

1. **Initial Implementation Plan:** Research proposals should encompass an initial implementation plan that describes the activities/efforts anticipated to promote the application of the research findings. Each proposal should contain a section that outlines the potential implementation of the research findings. However, the research team believes that the implementation plan presents a complete explanation of the activities that are to be conducted during the implementation (or T2) phase. Tran-SET UTC is doing this for its research proposals, and Appendix K shows the “Project-Specific T2 Plan” template that is used as an initial T2 plan being submitted with proposals. The T2 plan is a very effective tool to monitor the technology transfer activities toward implementation, and the agencies can always use it to track their funded projects. The initial T2 plan is recommended for the formal guidelines that are developed in this project.
2. **Final Implementation Plan:** Most of the templates or guidelines that are used by different funding agencies are only valid for specific adoption and programs, and they are not practical for use as a general template for all kinds of projects. However, based on the literature review and the survey results, there are two practices that are effective for planning technology transfer activities:
 - a. The “Research Assessment and Implementation Report” used by LTRC generally outlines implementation recommendations, potential impacts, target audience, strategies and tactics, timeline, implementation responsibilities, and how the implementation efforts will be assessed. A template for this report is presented in Appendix D.

- b. IDOT encourages researchers to develop and update implementation strategies during the research project using the “Implementation Planning Worksheet.” A copy of the “Implementation Planning Worksheet” is provided in Appendix E.

As mentioned earlier, these practices are very useful for planning, but it should also be used in monitoring the planned activities by the funding agencies.

- 3. **Trackers:** Although the survey respondents emphasized that the majority of the funding agencies are monitoring the implementation efforts, or they are working on this. Table 13 lists the best form of the trackers that have been collected by the research team from the literature review and the online survey of this project.

Table 13. Effective Tools to Track Projects and Monitor Implementation

Agencies	Effective Tracking Tools
IDOT	“Implementation Tracking Database” in the form of an Excel spreadsheet
MoDOT	Using a periodic publication, namely, Tracker
LTRC	“Research Project Management System” to track and monitor all the aspects of research and implementation efforts

Based on the literature review and the online survey results, there are some limitations in these tracking tools that can be summarized as follows:

- a. Time limitations and reduced staff sizes are the primary reasons for not effectively using the available implementation tracking systems.
- b. Agencies’ staff dealing with funded projects are generally incapable to effectively use the tracking systems, either because of the lack of necessary expertise, newness to their position, or an extreme lack of resources in their division.

The project team believes that it is mandatory for any funding agency to have an effective and flexible tracking system for the technology transfer efforts.

- 4. **Development of Implementation Evaluation Plans:** In general, an evaluation plan is defined as a written document that outlines (a) the required procedures to monitor and evaluate the implementation program, and (b) how the results of the evaluation would be used for program improvement and decision making. One of the best practices was found in the World Health Organization (WHO). As mentioned

previously, the WHO provided six key steps that should be followed when developing the M&E plan as follows [20]:

- a. Stakeholder consultation and participation: Stakeholder consultations are necessary to ensure a clear understanding of the project goals and objectives and how these will be evaluated. Stakeholders' involvement increases the chance that the results guided by the M&E plan will be consistent with their expectations and highly implementable.
- b. Developing the M&E plan: In this step, it is important to answer what does the project want to change/solve and how, what are the specific objectives that are designed to achieve this change, what are the indicators and how they will be measured, and finally how the M&E data will be collected and analyzed.
- c. Determining the M&E methodology: In this step, the proper procedure by which data can be collected and analyzed is determined.
- d. Assign responsibilities for implementation: This step will describe how the M&E plan will be specifically implemented and what reporting system will be adopted.
- e. Setting targets: It is crucial to set targets in consultation with all stakeholders to ensure that everyone understands the project's objectives and the expected outcomes.
- f. Defining the reporting system, dissemination, and utilization of results: When developing the M&E plan, the end-users' information needs should be addressed to ensure the utilization of the research results.

The WHO defines the M&E plan as a document that describes how an implementation research project is tracked, monitored, and evaluated. The M&E plan aims to achieve the following key objectives [20]:

- i. outlining how achievements of the project will be measured;
- ii. documenting consensus, therefore encouraging transparency, accountability, and responsibility;
- iii. guiding the implementation of M&E; and
- iv. preserving institutional memory.

It could be concluded that the evaluation plan that is used by the World Health Organization is a dynamic/living evaluation plan which could be updated continuously

and consider program changes and properties over time. The research team believes that it is one of the best practices that can be used in the guidelines developed in this project.

As previously discussed, the main purpose of the last two chapters of this report is to recognize the best practices for documenting and tracking research implementation efforts. Overall, the selected best practices are tabulated and presented in Figure 35. These practices include three main phases: Proposal Phase, Research Phase, and Implementation (or T2) Phase. Below are the details of each phase:

1. Proposal Phase:

- The Principal Investigators (PIs) submit an Initial Implementation (or T2) Plan along with the proposal.
- The Initial Implementation Plan documents the area of practice that would be changed by the findings, groups benefit from the new technology, and how the research results will be promoted for implementation.
- The Initial Implementation Plan is the main outcome of this phase.

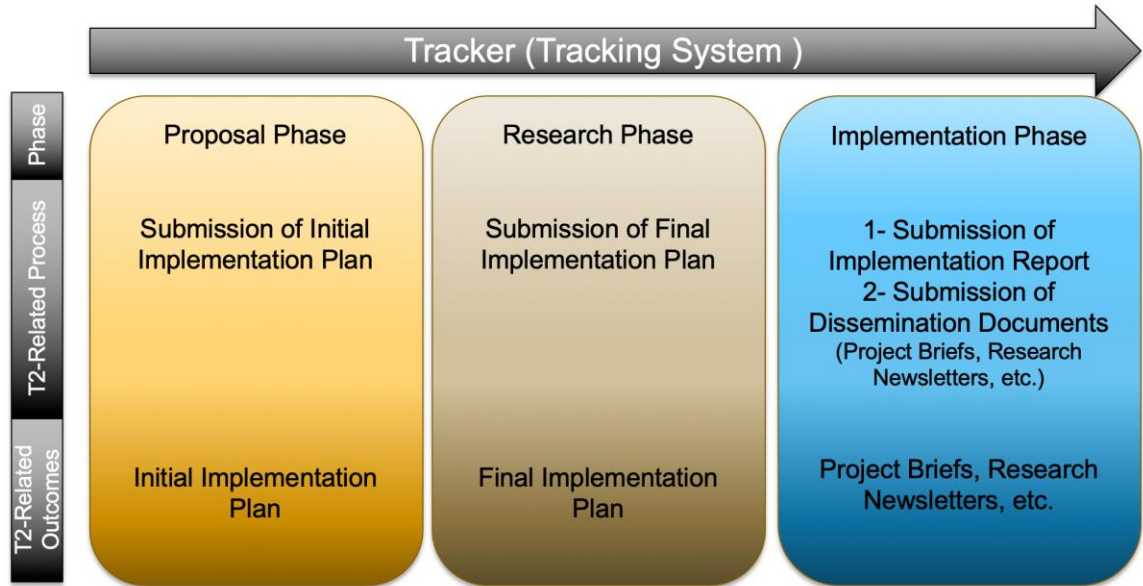
2. Research Phase:

- At the end of the research phase, PIs are supposed to submit the Final Implementation (or T2) Plan with the Final Report of the project.
- The Final Implementation Plan is an updated version of the Initial Implementation Plan, which the PI will follow during the Implementation (or T2) Phase to transfer the project outcome to potential adopters.

3. Implementation Phase:

- PIs submit the Implementation Report as the implementation phase approaches to the completion.
- In the Implementation Report, researchers are documenting the activities that have been conducted to transfer the developed technology or outcomes to the potential end-users.
- Researchers document what has been conducted/performed during the implementation phase, and disseminate the projects' outcomes and T2 activities in project briefs, research newsletters, etc.

Figure 35. Overview of best practices for documenting and tracking research implementation



The above-mentioned phases, T2-related processes, and outcomes are the foundation of the formal guidelines developed in this project. In the next chapter of this report, the developed formal guidelines for documenting and tracking research implementation efforts are presented and discussed.

Formal Guidelines for Documenting and Tracking Implementation Efforts

The value and impact of any research project are in transferring the technology and implementing its results and findings into the current state of practice. However, many research studies in different areas and fields were completed successfully and achieved their research objectives without a real impact on society, or undocumented and untracked implementation efforts. Research funding agencies are always looking for formal guidelines for documenting and tracking the implementation component of the research projects. The STC and other SHAs are increasingly being required to monitor and document the progress of their funded research projects, and also the implementation of the findings into the field. In this chapter, the research team has developed formal guidelines to guide any funding agency tracking and monitoring their projects and the technology transfer efforts. The formal guidelines developed in this study is expected to be mainly used by the STC and SHAs to formalize their documentation and tracking implementation efforts. The developed guidelines provide a step-by-step process for conducting research, evaluating the results, and documenting and tracking the implementation efforts. It should be noted that any funding agency can make its own specific templates that can serve the research project's main objectives, needs, and purposes.

Figure 36 presents an overview of the different stages of the proposed guidelines. As shown in Figure 36, the developed guidelines outline four main stages for tracking and documenting technology transfer and research implementation activities of each funded research project. It should be noted that there is a performance measurement system, referred to as "Tracker" that evaluates the effectiveness of the funding agencies delivering services and products to the customers. This tool allows the funding agencies and the interested users of the expected outcome to monitor the progress done towards each stage. Depending on the main objectives of the funded research project, its needs, and purposes, the technology transfer tracking system could be in various forms. It could be in the form of an Excel spreadsheet, periodic publication, or a web-based management system. The tracking system should publish quarterly to ensure the accountability and liability of technology transfer activities. This tool provides all the needed information related to the different stages of the project, and the technology transfer, and also tracks whether a task has been completed by the provided estimated due date or not. Furthermore, it should report a "percentage completed" value for the tasks. This feature

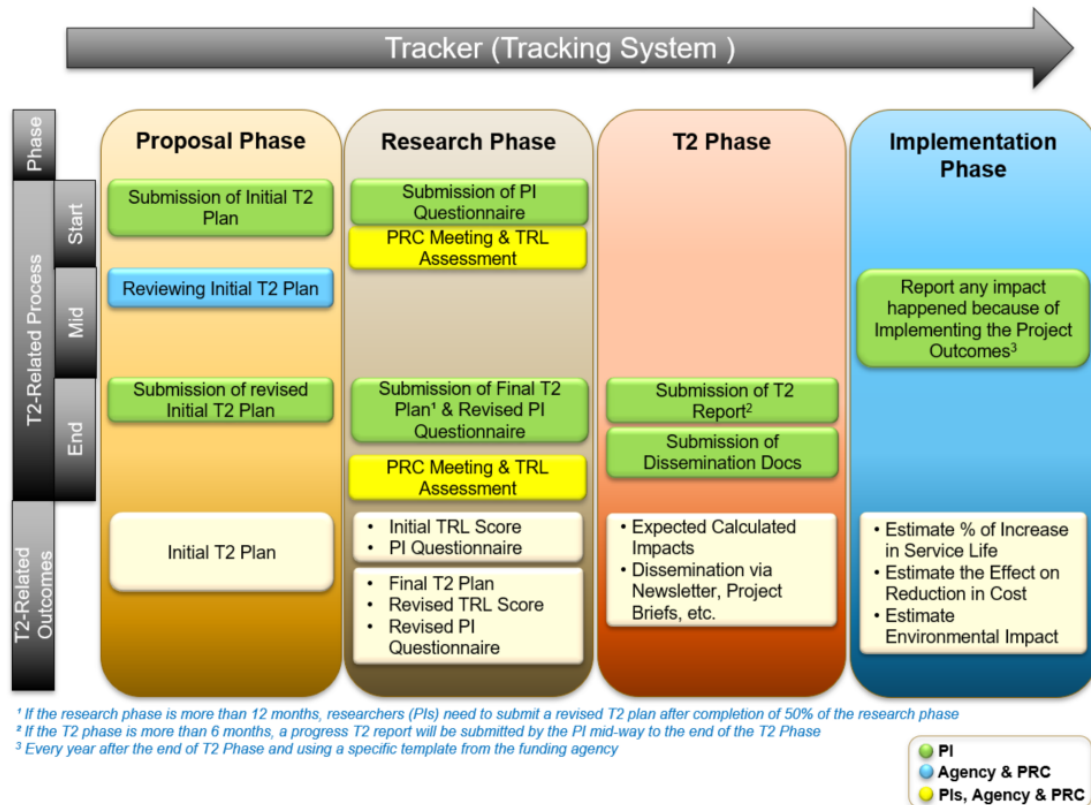
allows funding agencies to easily track the project phases and the technology transfer activities on a project basis.

The following sections explain the four stages of the developed guidelines shown in Figure 36 in more details:

Stage 1: Proposal Phase

Each funded project needs to have an individual project-specific Technology Transfer (T2) Plan. Therefore, the submitted proposal must include an initial T2 Plan, as shown in Figure 36. The initial T2 Plan will specify the unique set of key stakeholders that are targeted, and the unique activities/efforts to engage them. Initial T2 Plans are a guide to successfully plan and execute activities during the T2 phase of the project. The following information describes the requirements and some guidance to help in the submission of the initial T2 Plan.

Figure 36. Overview of the proposed guideline for documenting and tracking research implementation



1. PIs should submit an initial, project-specific T2 Plan with the proposal. An initial T2 Plan should include at least the following context:
 - Project information;
 - A description of the audience or market for the expected outcome of the project, and a statement of how the research results may be used to solve a defined problem;
 - Stakeholder groups by their name and role relative to the adoption of the expected outcome, and assess the level of authority they have;
 - Communication tracking for stakeholder groups, develop engagement plans and identify resources to engage all stakeholders;
 - The activities that are necessary for the successful implementation such as training, demonstration of projects, revision of standards; and
 - A realistic assessment of impediments and barriers to successful implementation.
2. The initial T2 Plan will be reviewed by the Project Review Committee (PRC) and the agencies' staff that are dealing with funded research projects during the proposal review process. The PRC will constitute members from state DOTs or highway agencies, academia, and/or private sector.
3. The PI will receive a copy of PRC feedbacks and the written review comments on the initial T2 Plan. Based on the comments received, the PIs will revise the initial T2 Plan and submit it for awards.

The initial T2 Plan is the main outcome of this stage. A good example of the project-specific Technology Transfer (T2) Plan template is the one used for Tran-SET projects and is accessible on Tran-SET's website (<http://transet.lsu.edu/pi-toolbox/>).

Stage 2: Research Phase

A critical factor to the success of any implementation program is the continuous monitoring of implementation potential and progress throughout the life cycle of the research project. The Research phase involves the technical aspects of the project to achieve the project's objective(s). The subsequent steps provide general guidelines and requirements related to the technology transfer during this stage:

1. At the beginning of the Research Phase, the researcher(s) will complete and submit a PI Questionnaire that describes the project expected outcome(s), potential end-users,

expected impacts (e.g., economic, environmental, and service life), with a self-assessment for the readiness level of the expected outcome(s) for implementation (i.e., initial TRL score will be specified). Then, the funding agency will arrange for a kick-off meeting (a webinar or in-person) with the researcher(s) and the PRC members of the funded project. In this meeting, the researcher(s) will present the project objective(s), methodology, and also discuss the information provided in the PI Questionnaire. The feedback and recommendations from the PRC members are very beneficial for the researcher(s) during the Research Phase. It should be noted that the Federal Highway Administration (FHWA) of the U.S. Department of Transportation published a Technology Readiness Level (TRL) Guidebook [82] in 2017 that has been used as a reference in this report in terms of PI Questionnaire, TRL assessment, and TRL score.

2. As the research phase approaches completion, Principal Investigators (PIs) should submit the Final T2 Plan and a revised PI Questionnaire (with a TRL score for the developed outcome). The PI will update the targeted stakeholders, planned T2 activities, and/or barriers to adoption. It should be noted that if the research phase is more than 12 months, the PIs need to submit a revised T2 plan after the completion of 50% of the research phase in order to keep tracking the development of the project technology transfer plan.
3. At the end of the research phase, another in-person or webinar meeting will be conducted for the PRC panel to (a) assess the technology readiness level (TRL) of the developed outcome of the project, (b) identify the elements of the developed outcome currently lack regarding the implementation, and (c) provide recommendations to take the outcome of the project to a higher TRL level. All the meeting outcomes should be documented by the funding agency.
4. The T2 Plan will act as the PIs' main roadmap during the T2 phase, documenting and guiding its outreach activities.

Stage 3: Technology Transfer (T2) Phase

The knowledge generated from the research study is to be disseminated and transferred to the stakeholders who are (or might be) interested in the study results/outcomes. Stakeholders can be state DOTs, local government entities, non-profit organizations, and research communities, as well as transportation and construction industries. Examples of T2 activities include, but are not limited to, presentations, journal articles, technical

reports, design specifications, professional events (e.g., seminars and workshops), or any other medium that the researchers find suitable. The T2 report is a report out of executing activities during the T2 phase of the project. The subsequent steps provide instructions for submitting the T2 report:

1. At the end of the T2 phase, PIs will submit the T2 Report that includes a complete description of the developed outcome from the education, T2, and workforce development activities that were executed during the T2 phase. The T2 report should, at least, include the following sections:
 - Project Information;
 - List of the key stakeholders who were involved in the T2 activities;
 - List of each activity that occurred during the T2 phase with a brief description and the main purpose;
 - Success stories and/or achievements happened during the T2 phase;
 - Expected calculated impacts (e.g., economic, environmental, and service life); and
 - List of expected barriers to adoption and how to address them.
2. If the T2 phase lasts longer than 6 months, a progress T2 report should be submitted by the PI in the middle of the T2 phase. The progress T2 report summarizes the actions that have been taken towards transferring the findings of the research project.
3. In addition, the PIs will submit several dissemination documents to the funding agency (e.g., Project Highlights, Project Brief, Materials for Social Media or Newsletter, etc.). These documents will be used by the agency to disseminate the findings of the project and promote implementation.

Stage 4: Implementation Phase

The implementation phase starts after the completion of the T2 phase and is one of the most critical aspects of the entire research program since implementing projects' outcomes is the main goal of any funded research project. Before the start of the implementation phase, it is important to establish the effectiveness goals of the project and a perform continuing review and evaluation of the outcomes during the implementation phase. Moreover, the PIs should report any impact that occurred because

of implementing the project outcomes every year after the end of the T2 Phase, using a template provided by the agency. The main outcomes of this implementation report are:

- The quantified impact of the project implementation on the reduction in cost;
- The environmental impacts; and
- The percentage of increase in service life.

Conclusions and Recommendations

Many research studies in different areas and fields are completed successfully and obtained their research objectives without a real impact on society or economy. Planned and documented technology transfer efforts will move results from effectiveness studies and efficacy tests to real-world aspects. All efforts spent on implementation or technology transfer are uncontrolled if not documented and monitored accurately from day one. Considering this issue, there is a need for formal guidelines for documenting and tracking the implementation efforts to be used by the STC and other SHAs. Therefore, the main objective of this synthesis project is to thoroughly review the literature and previous works/projects on tracking and documenting the implementation efforts of research studies. The first chapter of this report (Task 1) presented a comprehensive review of the available guidelines and best practices used by different agencies and organizations to document and track the technology transfer efforts of research studies. Then, an online survey was developed and used by the research team after PRC approval as a discovery search tool. The online survey has been sent to several agencies, state DOTs, and institutions in the U.S. and Europe to identify successful examples of guidelines for documentation and tracking of research implementation or T2 efforts. Based on the comprehensive review and online survey, the best practices by SHAs and other agencies for documenting and tracking research implementation (or T2) efforts/activities have been listed and discussed in this report.

The last part of this report was dedicated to developing a formal guideline for documenting, monitoring, and tracking the T2 plan and activities for research projects to be used by the STC and other SHAs research sections. The developed guidelines outline four main stages for tracking and documenting technology transfer and research implementation activities. The main stages of the developed guidelines are briefly outlined below:

1. Proposal Phase:

- Submission of an initial T2 Plan with the proposal by the research team.
- Reviewing the initial T2 Plan by the funding agency and the PRC members.
- Submission of the revised initial T2 Plan by the research team for awarding.

2. Research Phase:

- Submission of the PI Questionnaire by the research team for a PRC Meeting and TRL Assessment at the beginning of the Research Phase.
- If the research phase lasts longer than 12 months, the research team needs to submit a revised T2 plan after the completion of 50% of the research phase.
- Submission of the Final T2 Plan and the revised PI Questionnaire for a second PRC Meeting and TRL Assessment at the end of the Research Phase.

3. Technology Transfer (T2) Phase:

- Submission of the T2 Report by the research team at the end of the T2 phase.
- If the T2 phase is more than 6 months, a Progress T2 Report should be submitted by the research team in the middle of the T2 phase.
- Submission of dissemination documents (e.g., Project Highlights, Project Brief, Materials for Social Media or Newsletter, etc.) by the research team.

4. Implementation Phase:

- The impact of the project implementation on the reduction in cost;
- The environmental impacts; and
- The percentage of increase in service life.

Based on the findings obtained from the different tasks performed in this study, below are some recommendations:

- It is necessary for any research funding agency and especially for STC and other SHAs research sections to ensure that the Technology Transfer Phase and the Implementation Phase of funded projects are under control and well-documented.
- Presence of formal guidelines for monitoring, documenting, and tracking the research technology transfer efforts is essential for any funding agency.
- Each agency needs to develop its own specific templates for every deliverable in each phase of the project. These templates should include the key elements that are specific for each funded research project.

Acronyms, Abbreviations, and Symbols

Term	Description
ACF	Administration for Children and Families
ADOT	Arizona Department of Transportation
AKRSP	Aga Khan Rural Support Programme
Alaska DOT&PF	Alaska Department of Transportation and Public Facilities
BHO	Behavioral Health Organizations
Caltrans	California Department of Transportation
CCP	Connecting Canadians Program
CDC	Centers for Disease Control and Prevention
CHIP	Children's Health Insurance Program
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Centers for Medicare & Medicaid Services
CNCS	Corporation for National and Community Service
CORDIS	Community Research and Development Information Service
CSH	Corporation for Supportive Housing
CTDOT	Cincinnati Department of Transportation
DOT	Department of Transportation
DSHS	Department of Social and Health Services
EPA	Environmental Protection Agency
FGD	Focus Group Discussions
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
GFATM	Global Fund to fight AIDS, TB and Malaria
HCA	Health Care Authority
HHS	Health and Human Services
HPOG	Health Profession Opportunity Grants
IDOT	Illinois Department of Transportation
IHRDC	Ifakara Health Research and Development Centre

Term	Description
ISTEA	Intermodal Surface Transportation Efficiency Act
IT	Information Technology
ITN	Insecticide-Treated Net
LADOTD	Louisiana Department of Transportation and Development
LSHTM	London School of Hygiene and Tropical Medicine
LTRC	Louisiana Transportation Research Center
OECD	Organization for Economic Co-operation and Development
M&E	Monitoring and Evaluation
MCO	Managed Care Organizations
MDOT	Michigan Department of Transportation
MoDOT	Missouri Department of Transportation
MnDOT	Minnesota Department of Transportation
NCHRP	National Cooperative Highway Research Program
NGO	Non-Governmental Organization
NHDOT	New Hampshire Department of Transportation
NIE	National Implementation Evaluation
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
OFM	Office of Financial Management
OPRE	Office of Planning, Research, and Evaluation
OTEC	Ohio Transportation Engineering Conference
PCG	Public Consulting Group
PennDOT	Pennsylvania Department of Transportation
PI	Principle Investigator
PRC	Project Review Committee
R&D	Research and Development
RCH	Reproductive and Child Health
RF	Reading First
RFP	Request for Proposal
SHA	State Highway Agency

Term	Description
STEM	Science, Technology, Engineering and Mathematics
STC	Southeast Transportation Consortium
T2	Technology Transfer
TAG	Technical Advisory Group
TANF	Temporary Assistance for Needy Families
Tran-SET	Transportation Consortium of South-Central States
TNVS	Tanzania National Voucher Scheme
TRB	Transportation Research Board
TRL	Technology Readiness Level
TRP	Technical Review Panel
TxDOT	Texas Department of Transportation
UDOT	Utah Department of Transportation
U.S.	United States
UTC	University Transportation Center
WHO	World Health Organization
WisDOT	Wisconsin Department of Transportation
XLC	eXpedited Life-Cycle

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List of Appendices

To access the following appendices in full, please contact Husam Sadek, Ph.D., at hsadek1@lsu.edu or 225-578-0131.

Appendix A: List of Agencies Considered in The Literature Review

Appendix B: Informed Consent Templates

Appendix C: Research Idea Statements

Appendix D: Research Assessment and Implementation Report

Appendix E: Implementation Planning Worksheet

Appendix F: Implementation Tracking Database

Appendix G: Evaluation Plans

Appendix H: Guideline Implementation Planning Checklist

Appendix I: Seven-Step Implementation Plan

Appendix J: Research and Evaluation Framework and Implementation Guide

Appendix K: Tran-SET Project-Specific T2 Plan

Appendix L: Implementation Reports

Appendix M: Evaluation Report Brief

Appendix N: FRA Evaluation Report Outline

Appendix O: FRA Evaluation Standards Attestation Form

Appendix P: List of All Agencies Considered in The Online Survey

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