Establishing an Evaluation Framework for Technology Transfer

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This document will help technology transfer (T2) teams understand the usefulness of evaluation and facilitate evaluation activities related to their T2 programs. Evaluation can help to generate and preserve lessons learned that can improve T2 processes and results.

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List of Abbreviations

Abbreviation	Term
app	smartphone application
Evidence Act	Foundations for Evidence-Based Policymaking Act of 2018
FHWA	Federal Highway Administration
GAO	United States Government Accountability Office
T2	technology transfer
USDOT	United States Department of Transportation

1. Introduction

Evaluation helps a program to tell its story: of processes that lead to technology adoptions; of goals achieved; of gaps in progress that need to be addressed; and of whom can benefit from technology transfer (T2).[1] T2 teams play an integral role in documenting and sharing the activities that have led to successful (and unsuccessful) technology adoptions. [2]

This document will help technology transfer teams understand the usefulness of program evaluation and facilitate evaluation activities in their T2 programs. The United States Department of Transportation (USDOT) seeks to demonstrate the value of its research and technology programs. Program evaluations rigorously measure how successfully research and technology have met their intended goals, which can help technology developers improve understanding of transportation research results and make the case for future support.

The *Foundations for Evidence-Based Policymaking Act of 2018* ("Evidence Act") requires agencies to make their data accessible and to use evidence-based methods to support policymaking. Program evaluation aligns with these goals of the Evidence Act. Under the Evidence Act, agencies, including USDOT, must designate an Evaluation Officer who will coordinate evidence-building activities as well as a Statistical Official to advise on methodological matters. Agencies must then develop systematic evaluation plans that will address a variety of areas, including:

- Questions for developing evidence to support policymaking,
- Data the agency intends to collect, use, or acquire to facilitate use of evidence in policymaking,
- Methods and analytical approaches that may be used to develop evidence to support policymaking,
- Challenges to developing evidence to support policymaking, including statutory and other restrictions to accessing relevant data.[3]

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[1] USDOT defines T2 as the process of transferring and disseminating transportation-related scientific information to stakeholders who may apply it for public or private use. For further discussion, please see: US Department of Transportation. 2020. "Research, Development, and Technology Strategic Plan: FY2018-2022." URL: https://www.transportation.gov/sites/dot.gov/files/2020-11/DOT%20RDT%20Strat%20Plan%20-%20112320%20-%20Final.pdf Last accessed: December 4, 2020.

[2] T2 teams often consist of a dedicated T2 coordinator, T2 supporting staff (if applicable), as well as the director and/or project manager of the research product that is to be transferred. The T2 team typically develops the T2 plan for the research product that identifies the steps needed to ensure that the technology is useful, usable, and adopted widely. For further information on T2 teams, please see: Cuddy, Matthew et al. 2016. "Building a Foundation for Effective Technology Transfer through Integration with the Research Process." URL: https://rosap.ntl.bts.gov/view/dot/12262 and Epstein, Alexander and Santiago Navarro. 2018. "Developing and Executing Your Technology Transfer Plan: A 10-Point Checklist." URL: https://rosap.ntl.bts.gov/view/dot/36733 Last accessed: September 22, 2020.

[3] For further information see: *Foundations for Evidence-Based Policymaking Act of 2018,* Public Law 115-435, *U.S. Statutes at Large* 132 (2018): 5529-5557. URL: https://www.congress.gov/115/plaws/publ435/PLAW-115publ435.pdf and Office of Management and Budget. 2019. "Memorandum M-19-23." URL: https://www.whitehouse.gov/wp-content/uploads/2019/07/M-19-23.pdf Last accessed: September 24, 2020.

This document incorporates evaluation techniques into T2 and will assist USDOT in meeting the requirements of the Evidence Act. There are already many Federal and academic resources related to T2 and evaluation; where appropriate, this document will direct readers to those resources.

2. Understanding Evaluation

Often, the inputs and processes that shape the early stages of a program are known only to a small group of people—and those people may not stay with a program for its entire duration. As a result, critical lessons can be lost. It is important to support evaluations, which can discover and preserve those lessons for future T2, upcoming research programs, and potential technology adopters. For the purposes of this framework, it is helpful to distinguish between evaluations focusing on research and those focusing on T2. Research evaluations would examine processes and outcomes associated with a technology's effectiveness (e.g., did new work-zone safety apps improve commercial drivers' situational knowledge of work zones?), while T2 evaluations would examine processes and outcomes associated with technology deployment and adoption (e.g., are more commercial drivers using work-zone safety apps?).[4] The following examples illustrate key T2-related lessons that would be important to preserve.

- Some T2 programs may require re-examining State and local regulations, a process that can be costly and time-consuming if a technology adopter does not anticipate these difficulties.
- It may be difficult to establish necessary T2 partnerships with academia, private sector, and other entities in a given technology area.
- Some technologies may have negative impacts, particularly on vulnerable populations. It is important to learn how previous adopters prevented or mitigated those impacts to ensure that future T2 efforts account for potential negative effects.

Two categories of evaluation are often relevant for T2: process and outcome. Process evaluations address questions of how, and to what extent, activities have been implemented as intended and whether these activities are targeted to appropriate problems and populations (GAO 2012).[5] Process evaluations often compare program performance to a criterion established in advance—such criterion may be derived from regulations, a logic model, expectations of involved parties, and so forth (GAO 2012). Specifically, a process evaluation of technology transfer could examine:

- Was the T2 team able to identify the correct entities who would be affected by a technology?
- Did the T2 team collect the appropriate information from those entities?
- To what extent did the T2 team succeed in increasing favorable opinions of a given technology?

Outcome evaluations focus on the extent to which a T2 program achieves its objectives--namely, increasing levels of technology adoption. These evaluations can answer such questions as:

- Did the T2 team succeed in increasing technology adoptions?

[4] US Department of Transportation. 2020. "Research, Development, and Technology Strategic Plan: FY2018-2022." URL: https://www.transportation.gov/sites/dot.gov/files/2020-11/DOT%20RDT%20Strat%20Plan%20-%20112320%20-%20Final.pdf Last accessed: December 4, 2020.

[5] United States Government Accountability Office. 2012. "Designing Evaluations: 2012 Revision." URL: https://www.gao.gov/assets/590/588146.pdf Last accessed: June 29, 2020.

- What proportion of skeptical potential adopters ultimately adopted the technology?
- Why did skeptical potential adopters ultimately adopt a technology?

Regardless of the category of evaluation that is chosen, it is important for researchers and T2 teams to consider the budget and time needed for an evaluation. Evaluation budgets consist not only of the time and funding needs of the evaluators, but these budgets should also consider the time and funding needed for research and T2 teams to provide data and other inputs to the evaluators. Depending on the technology and its deployment sites, travel costs should also be factored into an evaluation budget.[6]

With respect to the timing of an evaluation, evaluations could be conducted in parallel with T2, known as a prospective study, or after T2 has been completed, known as a retrospective study. In a prospective study, an evaluation would follow the technology or program in real time as it develops and is transferred, collecting data and documenting any changes in circumstances. In a retrospective study, the evaluation looks back at what has happened and gathers information from entities based on their recollections, data collection, and documentation. Both of these types of evaluation can provide valid results for measuring the effectiveness of a technology or T2 program. However, T2 teams should confirm with the technology researchers, funders, and other entities whether a prospective or retrospective evaluation will be conducted, as the timing of the evaluation can impact planning for T2, budgeting, and other areas.

2.1 Identify Project Goals

It is essential for a T2 team to identify the goals that the transfer of a given technology would accomplish. Clearly identifying these goals will facilitate a future evaluation. Some questions to consider include:

- What problem(s) does this technology solve?
- How will this technology generate improvements in safety, operations, or other areas of interest?
- What would happen (or continue to happen) in the absence of this technology?

The final question listed above represents a "baseline" or "no-build" scenario—that is, what would happen to an existing situation or trend if no new technology were adopted and current conditions persisted. It is important to understand how a baseline scenario might evolve over time, as this baseline will serve as a comparison for the outcomes of a given technology.

As part of identifying project goals, the T2 team should also clarify who are the relevant audiences for a

[6] For further information on budgeting for evaluation, please see: Corporation for National and Community Service. No date. "Evaluation Budgeting Quick Guide." URL: https://www.nationalservice.gov/sites/default/files/documents/SIF%20Evaluation%20Budgeting%20Quick%20Guide.pdf Last accessed: September 24, 2020.

new technology. Such audiences may include:[7]

- Sponsors of research and T2
- Research and development teams
- Technology adopters
- Technology users
- Technology non-users
- Others

To guide both T2 and an evaluation of T2 processes and outcomes, a T2 team should create a logic model. A logic model maps out the inputs (e.g., financial, legal, technical) that go into a particular technology; the activities conducted to develop and deploy that technology; and the outputs and outcomes that follow technology adoption. Table 1 presents an example logic model. For an additional resource on logic models, please see Kellogg Foundation (2004).[8]

Table 1. Example logic model.

Inputs	Activities	Outputs	Outcomes
• Staff expertise and research • Funding • Materials • Partnerships	• Product development • T2 stakeholder identification • Meetings • Workshops	• Technology adoptions • Awareness • New knowledge • Changed opinions	• Changed behaviors • New policies and procedures

Table 1, meant to be read from left to right, depicts an example logic model for technology transfer. Some T2 inputs could include staff expertise, funding, and partnerships to develop a new technology. These inputs would then lead to T2 activities, such as identification of key interested parties and T2 meetings. T2 meetings could help realize such outputs as technology adoptions and increased awareness. Finally, following technology adoption, long-term outcomes like changed behaviors and new policies could be attained.

In addition to the above components of the logic model, T2 teams should also consider any external factors that may affect a T2 program's processes as well as adoption of a given technology. Such factors may include economic declines, legislative changes, and advances in alternative technologies. For example, a broader economic decline could lead to lower revenues for potential technology adopters,

[7] For additional references on key groups for T2 and evaluation please see: Luna, Joseph, et al. 2019. "Considerations for Evaluating Automated Transit Bus Programs." URL: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/146801/considerations-evaluating-automated-transit-bus-programs-fta-repor-no0149.pdf and Epstein, Alexander and Santiago Navarro. 2018. "Developing and Executing Your Technology Transfer Plan: A 10-Point Checklist." URL: https://rosap.ntl.bts.gov/view/dot/36733 Last accessed: December 4, 2020.

[8] W.K. Kellogg Foundation. 2004. "Logic Model Development Guide." URL: https://www.wkkf.org/resource-directory/resources/2004/01/logic-model-development-guide Last accessed: June 29, 2020.

which could reduce the rate of adoption of a given technology.

2.2 Develop T2 and Evaluation Plans

Drawing on the identification of potential technology adopters and beneficiaries as well as development of a logic model, T2 teams should formulate their T2 plans. For additional information on T2 plans, please see the T2 10-Point Checklist.[9] Specifically, T2 teams should determine the interests of key entities to identify potential supporters and opponents of a given technology. Table 2 indicates actions T2 teams can take to engage potential interested parties, depending on how supportive (aligned) they are of a proposed technology as well as how interested they are in adopting that technology. Ideally, public and private entities will be both highly aligned and interested in a given technology.

Table 2. Recommended stakeholder engagement based on alignment and interest.[10]

Alignment	Low Interest	High Interest
High Alignment	Inform and raise interest	Engage closely and ally
Low Alignment	Monitor (minimal effort)	Negotiate, lobby, or mitigate

Upon developing this mapping, T2 teams should then develop engagement plans for how key parties will be contacted and what information will be obtained, such as user needs and technology benefits. The T2 10-Point Checklist recommends the following approach:

1. Prioritize and contact potential technology adopters.
2. Once positive stakeholder engagement is obtained, set up a meeting to cover the following areas:
    a. Public or private entity's role regarding technology adoption
    b. Entity's interest in participating in technology transfer
    c. Participation of other persons along key entity's chain of command
    d. Potential challenges to technology adoption
    e. Formal processes concerning technology adoption
    f. Establishing periodic stakeholder contact

Developing a T2 plan helps to keep T2 processes and information organized. T2 teams can use the information obtained to fill gaps in the stakeholder map, design pathways for technology adoption, and improve future practices in technology transfer.

[9] Epstein, Alexander and Santiago Navarro. 2018. "Developing and Executing Your Technology Transfer Plan: A 10-Point Checklist." DOT-VNTSC-OSTR-18-02. URL: https://www.transportation.gov/sites/dot.gov/files/docs/research-and-technology/318066/technology-transfer-10-point-checklist.pdf Last accessed: December 4, 2020.

[10] This table is adapted from: Mendizabal, Enrique. 2010. "The Alignment, Interest and Influence Matrix (AIIM) Guidance Note." URL: https://www.odi.org/publications/5288-alignment-interest-and-influence-matrix-aiim-guidance-note Last accessed: December 4, 2020.

The logic model and T2 plan (especially the documentation of key parties and engagements) can well inform the evaluation of T2 processes and outcomes by easing the data-gathering process for the independent evaluation. In terms of conducting an evaluation, it is recommended that an external party (that is, not the T2 team) evaluate T2 processes and outcomes to maintain impartiality. Regardless of who conducts an evaluation, though, it is important that the evaluators develop an evaluation plan. An evaluation plan can consist of the following sections:

1. Logic Model (should draw from T2 team's logic model, if available)
2. Evaluation Strategy, including:
    a. Evaluation Questions or Hypotheses
    b. Performance Measures
    c. Evaluation Design
3. Data Collection and Analysis Strategy
4. Communications Strategy

The logic model is described earlier in this document, and essentially maps out the inputs and activities that go into transferring a technology and then the outputs and outcomes that result from that technology transfer. In developing the logic model, it is also necessary for evaluators to think about the "counterfactual" or "no-build" scenario—that is, what would happen if there were no T2 process?[11] In the absence of a T2 process, it may not be clear whether a given technology would have been developed or deployed.[12] Understanding what would happen in the absence of a T2 process is needed to measure how much the T2 process "moved the needle" with respect to evaluation questions related to levels of technology adoption and potentially other areas.

To develop an evaluation strategy, evaluators must think about the key questions to answer concerning T2 processes and outcomes. Put another way, these questions are the hypotheses that an evaluation tests. Ideally, evaluation questions should be clear, specific, objective, and politically neutral; the terms in these questions should also be readily defined and measurable, whether qualitative or quantitative (GAO 2012). As indicated earlier, for T2 process evaluations, these questions might look like:

- Did the T2 plan help to identify the correct entities who would be affected by the technology?
- Did the T2 team collect the appropriate information from those entities?
- To what extent did the T2 team succeed in increasing favorable opinions of a given technology?

Similarly, for outcome evaluations, evaluation questions could look like the following:

- Did the T2 team succeed in increasing technology adoptions?

[11] For an example of a no-build scenario, consider a Federally funded work zone safety program that supports adoption of technologies that better inform truck drivers of highway work zone locations. One no-build or counterfactual scenario is that such a Federally funded program does not exist, which might result in limited adoption of these technologies. However, it is possible that State and local governments might step in to fund adoption of work zone safety technologies, resulting in increased technology adoptions. This scenario may be a more likely no-build scenario, though it is not clear if State and local governments could devote as much funding as the Federal government.

[12] For instance, if a particular technology is in high demand and likely to be supplied by the private sector, then it is possible that a given T2 process is less essential.

- What proportion of skeptical potential adopters ultimately adopted the technology?
- Why did skeptical potential adopters ultimately adopt a technology?

It is important for evaluators to brainstorm, identify, and validate these questions early in the evaluation. These questions are likely to be the questions of most interest to T2 teams, external funders, agency leadership, the public, and so forth. While the number of questions that an evaluation can seek to answer will depend on the evaluation's budget and timeline, the evaluation team should pay close attention to identifying the right questions to investigate.

To determine the answers to evaluation questions, evaluators identify appropriate performance measures. Taking one of the outcome evaluation questions from above, an evaluation team could establish the following performance measure:

- Question: did the T2 team succeed in increasing technology adoptions?
    - Ideal Performance Measure: rate of technology adoptions prior to T2 intervention vs. rate of technology adoptions following T2 intervention.

In this example, the rate of technology adoptions could refer to the proportion of a given sample of potential users (e.g., commercial drivers licensed in a given State) that downloads a work-zone safety app. An increase in the proportion of users that downloads an app following T2 intervention could indicate success for a T2 team.[13]

After establishing evaluation questions and performance measures, the evaluation team should think about the evaluation design and data-collection methods to employ. There are a variety of evaluation designs that an evaluation can adopt, and GAO (2012) notes that good evaluation designs should be appropriate for the evaluation questions, fit available time and resources, and rely on credible data. A few common designs include:

- Case studies: in-depth investigations of specific phenomena or entities.
- Randomized experiments: assessment of the differences in outcomes between groups that differ only (and randomly) on whether they received a particular technology.
- Quasi-experiments: assessment of the differences in outcomes between groups that are broadly similar but differ (though not necessarily randomly) on whether they received a particular technology.
- Statistical analysis: applying techniques to quantitative data to determine the relationship between a technology and observed outcomes.

Within these evaluation designs, there can be a wide array of data-collection methods, including:

- Surveys and questionnaires[14]

[13]It is helpful to reiterate here the distinction between T2- and research-focused evaluations. While this document examines T2-focused evaluations, research evaluations are no less important, given that they evaluate the effectiveness of a technology. Ideally, T2 and research teams should discuss together the synergies, successes, and lessons learned from both T2 and research evaluations.

[14] Please note that if the same information is being requested of 10 or more people or groups, Paperwork Reduction Act (PRA) clearance will be needed from the Office of Information and Regulatory Affairs (OIRA). Other

- Archival records
- Internet searches
- Sensors
- Interviews
- Focus groups
- Participant-observation

For further information on performance metrics, evaluation designs, and data collection, please see GAO (2012) and Federal Highway Administration's (FHWA's) "Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program" (2019).[15]

2.3 Execute T2 and Evaluation Plans

T2 and evaluation plans, while often distinct, can be coordinated. As a T2 team identifies interested parties and conducts interviews, they should keep records of how such parties were contacted, what questions were asked, and what information was learned. Such details inform evaluation. In developing a logic model or evaluation questions, evaluators should consult the T2 team to ensure that the evaluators understand a given technology and its T2 process.

Flexibility while executing T2 and evaluation plans is critical. Extenuating circumstances, such as budgetary or legislative changes, may force a given T2 process or evaluation to change goals, data collection, or other aspects. In these cases, the T2 and evaluation teams should be in contact to determine whether pre-planned activities should proceed or be revised.

2.4 Develop Recommendations and Publish Results

Evaluators use the results of their analysis to provide recommendations to improve future outcomes. With respect to T2 processes, evaluators may discover that opposition to a technology arose because the T2 team did not engage specific entities early enough; it would be important for future T2 teams to devote additional resources to early engagement. Additionally, the evaluation team might discover that a technology was difficult to adopt because of specific user requirements or lack of user resources. Future T2 efforts should then devote resources to understanding better users' needs.

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conditions that necessitate PRA clearance may also apply. For further information, please see: Office of Management and Budget. No date. "A Guide to the Paperwork Reduction Act." URL: https://pra.digital.gov/ Last accessed: December 11, 2020.

[15] Petrella, Margaret et al. 2019. "Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program." URL: https://ops.fhwa.dot.gov/publications/fhwahop19053/fhwahop19053.pdf Last accessed: June 29, 2020.

To preserve lessons for future use, both the T2 and evaluation teams should publish their findings. Example communications media include:

- Reports
- Case studies
- Short memos
- Presentations

To the extent possible, these materials should be made available online. T2 and evaluation teams can then distribute these results to relevant entities, technology adopters, and potential adopters. Various organizations may have e-mail distribution lists for disseminating such materials.

Evaluations, like technologies, can only be useful if they provide implementable lessons. Following the completion of an evaluation report, a T2 team should review the report and reflect on its findings and recommendations. Incorporating appropriate recommendations for future T2 processes will help to improve technology transfer and, ultimately, the state of transportation.

2.5 Additional Resources

Corporation for National and Community Service (presentations to help build evaluation skills)
https://www.nationalservice.gov/resources/evaluation/planning-evaluation

Government Accountability Office (reference on designing evaluations)
https://www.gao.gov/products/GAO-12-208G

FHWA Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program (reference on designing evaluations)
https://ops.fhwa.dot.gov/publications/fhwahop19053/fhwahop19053.pdf

FHWA Research and Technology Evaluations (example evaluation reports)
https://highways.dot.gov/research/research-development/rt-performance-evaluation/rt-evaluation

Millennium Challenge Corporation (example evaluation reports)
https://data.mcc.gov/evaluations/index.php/catalog

United States Agency for International Development (reference materials and evaluation reports)
https://www.usaid.gov/evaluation

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Cuddy, Matthew, et al. 2016. "Building a Foundation for Effective Technology Transfer through Integration with the Research Process." URL: https://rosap.ntl.bts.gov/view/dot/12262 Last accessed: September 22, 2020.

Epstein, Alexander and Santiago Navarro. 2018. "Developing and Executing Your Technology Transfer Plan: A 10-Point Checklist." DOT-VNTSC-OSTR-18-02. URL: https://www.transportation.gov/sites/dot.gov/files/docs/research-and-technology/318066/technology-transfer-10-point-checklist.pdf Last accessed: June 29, 2020.

Foundations for Evidence-Based Policymaking Act of 2018, Public Law 115-435, *U.S. Statutes at Large* 132 (2018): 5529-5557. URL: https://www.congress.gov/115/plaws/publ435/PLAW-115publ435.pdf Last accessed: June 29, 2020.

Luna, Joseph, et al. 2019. "Considerations for Evaluating Automated Transit Bus Programs." FTA Report No. 149. URL: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/146801/considerations-evaluating-automated-transit-bus-programs-fta-repor-no0149.pdf Last accessed: June 29, 2020.

Luna, Joseph, et al. 2020. "Technology Transfer Case Study: Improving Work Zone Safety Technologies in Arizona and Kentucky." URL: https://rosap.ntl.bts.gov/view/dot/49221 Last accessed: June 29, 2020.

Mendizabal, Enrique. 2010. "The Alignment, Interest and Influence Matrix (AIIM) Guidance Note." URL: https://www.odi.org/publications/5288-alignment-interest-and-influence-matrix-aiim-guidance-note Last accessed: December 4, 2020.

Office of Management and Budget. No date. "A Guide to the Paperwork Reduction Act." URL: https://pra.digital.gov/ Last accessed: December 11, 2020.

Office of Management and Budget. 2019. "Memorandum M-19-23: Phase 1 Implementation of the Foundations for Evidence-Based Policymaking Act of 2018." URL: https://www.whitehouse.gov/wp-content/uploads/2019/07/M-19-23.pdf Last accessed: September 24, 2020.

Petrella, Margaret, et al. 2019. "Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program." URL: https://ops.fhwa.dot.gov/publications/fhwahop19053/fhwahop19053.pdf Last accessed: June 29, 2020.

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