

# Chapter 4

## TRAFFIC ENGINEERING RESEARCH

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## CHAPTER 4 - TRAFFIC ENGINEERING RESEARCH

### 4-1.00 INTRODUCTION

Traffic Research is critical to fully utilizing existing transportation facilities and associated devices as well as to the development of new methods and devices. This chapter introduces the general concept of traffic engineering research.

#### 4-1.01 Purpose

The purpose of this chapter is to: (1) familiarize the reader with the responsibilities and capabilities of the Traffic Research Coordinator, (2) describe the nature and use of traffic engineering research activities, (3) improve the effectiveness of the district traffic offices and the central office traffic sections by facilitating the use of special skills, services, and knowledge that are available from the Research Services Section, and (4) improve the quality of research done directly by Districts or other Sections.

#### 4-1.02 Scope

This chapter will discuss: (1) the role of traffic engineering research, (2) research techniques, and (3) the use of research activities to benefit the traffic engineer's work. This chapter will not describe past, current, or future research projects. Information on current research is available through the Traffic Research Coordinator.

#### 4-1.03 Chapter Organization

Certain terms commonly used in traffic engineering research are defined in the following section. Further sections include:

1. A definition of the role of traffic research.
2. A description of the individual roles in traffic research
3. A description of the traffic research program.
4. A discussion of project development, including project sources, typical task sequence, and implementation of recommendations.
5. An overview of research methods, including data collection, data processing, data analysis and equipment.

### 4-2.00 ROLE OF TRAFFIC RESEARCH

Traffic engineering research may be defined as the careful, systematic and patient study of traffic engineering concepts, methods, and products undertaken to discover or describe facts, techniques, or applications related to traffic engineering.

The concepts and methods of traffic engineering are similar to those used for typical traffic engineering or operation analysis studies. The primary differences being the degree of effort, the level of detail, and the use of the results. In the case of operational studies, just enough data is gathered to permit a decision-maker to answer a question by making assumptions and supplying judgment. This information is compared to known principles and standards and applied to real-time problems. The researcher, on the other hand, must gather sufficient data to satisfy statistical tests to prove that his conclusions are correct. The researcher gathers the same information as the operations analyst, but the researcher collects data in greater detail to search for new innovative facts, concepts, principles, and/or techniques for future use and to advance the "state-of-the-art."

### **4-3.00 INDIVIDUAL ROLES IN TRAFFIC RESEARCH**

The following section describes roles and responsibilities of the individuals conducting and facilitating traffic research at any given time.

#### **4-3.01 Technical Advisory Panel (TAP)**

The research TAP may consist of a principal investigator (PI) performing the research, a technical liaison (TL) representing the agency's interest, an administrative liaison (AL) representing Mn/DOT's contractual obligations, a Traffic Research Coordinator (TRC) who monitors, evaluates and disseminates information from research projects to applicable parties and additional panel members (PM) representing agency practitioners', beneficiaries', or stakeholders' interests in transportation research.

#### **4-3.02 Principal Investigator (PI)**

It is the responsibility of the PI to:

1. Design, perform, and document the research project with Technical Advisory Panel (TAP) guidance and input
2. Provide timely notification to the Technical Liaison (TL) and Administrative Liaison (AL) of any matters which may affect contractual obligations
3. Submit project progress reports on a quarterly (calendar year) basis
4. Develop and provide contract task deliverables for approval
5. Obtain current Electronic Publishing Guidelines and Software Deliverable Guidelines for final deliverable requirements
6. Contact CTS for technical and editorial review coordination of draft final deliverables

#### **4-3.03 Technical Liaison (TL)**

It is the responsibility of the TL to:

1. Assist with development of the project work plan and its final approval
2. Coordinate Mn/DOT assistance for the Principle Investigator (PI)
3. Assist with the recruiting and selection of TAP members
4. Provide technical expertise to the project
5. Review and recommend approval of any contractual changes to Research Services Section (RSS)
6. Schedule and conduct Technical Advisory Panel (TAP) meetings following the appropriate agenda outlines (initial, intermediate, final)
7. Record and distribute TAP meeting notes using the Panel Meeting Form
8. Review and approve or disapprove (provide comments) contract deliverables based on recommendations from the TAP using the electronic Deliverable Approval Form
9. Lead efforts in implementation planning using the Implementation Guide as a reference for completion of the Implementation Plan Outline
10. Provide draft final deliverable technical comments, including additional Panel Member (PM) comments, to the Center for Transportation Studies (CTS)
11. Provide Report Dissemination Categories
12. Completion and submittal of the Consultant Performance Evaluation form and the Report on Professional/Technical Contracts form when necessary

#### **4-3.04 Administrative Liaison (AL)**

It is the responsibility of the AL to:

1. Assist Technical Liaison (TL) in recruiting TAP members
2. Outline the research process and review the responsibilities of TAP members
3. Monitor projects for contract compliance
4. Ensure TAP meetings are scheduled
5. Maintain project status updates in Automated Research Tracking System (ARTS) database in a timely manner
6. Coordinate with the TL for Task Approvals using the Deliverable Approval Form. Deliverable Approval Forms should be submitted to the TL and returned by TL within the quarter after submittal of a deliverable
7. Document implementation activities
8. Ensure research funds are spent effectively
9. Provide TL with the necessary contract evaluation and reporting forms
10. Consult with Mn/DOT Research Manager and university/consultant representative with concerns or problems.

#### **4-3.05 Traffic Research Coordinator (TRC)**

It is the responsibility of the TRC to:

1. Monitor and evaluate ongoing research
2. Disseminate information to district and central office staff
3. Coordinate the validation of new traffic engineering concepts
4. Assist in research projects being done by others in the department
5. Coordinate with Research Services Section and university personnel.

Additional panel members (PMs) may be asked to provide user perspective and technical input on research projects as well as reviews of deliverables materials

### **4-4.00 TRAFFIC RESEARCH PROGRAM**

#### **4-4.01 Purpose**

There are literally thousands of people and organizations involved in transportation and traffic research programs on the national and international levels. The Transportation Research Board (TRB), the Federal Highway Administration (FHWA), the Urban Mass Transportation Administration (UMTA), the American Association of State Highway and Transportation Officials (AASHTO) and the Institute of Transportation Engineers (ITE) sponsor hundreds of projects each year. In addition, there are many ongoing projects being done in cooperation with the Regional Transportation Management Center, the Center for Transportation Studies at the University of Minnesota, other offices within Mn/DOT, and in partnership with various consulting firms.

The Traffic/ITS research program, which is administered by the Research Services Section and operates within this framework, has three primary responsibilities:

1. To monitor research conducted by others and disseminate the information as appropriate
2. To conduct in-house research in response to Department requirements, needs or concerns and to publish and disseminate results
3. To assist in the implementation of research derived from recommendations

#### **4-4.02 Research Monitoring**

One of the major responsibilities of the Traffic Research Coordinator is to monitor and evaluate ongoing research. By maintaining knowledge of the state-of-the-art in traffic research, costly duplication of effort can be avoided and results can be practically applied much earlier.

##### *4-4.02.01 Information Sources*

Some of the primary sources of information regarding traffic research include: (1) newsletters, (2) journals, (3) reports, (4) technical conferences, (5) technical society committees such as ITE and the American Society of Civil Engineers (ASCE), (6) TRB committees, (7) AASHTO committees, and (8) other research gatherings. All research project results must be analyzed for technical validity and for limitations to their usefulness in Minnesota.

Research results are often known many months before they are formally presented in generally available publications. For this reason, the Traffic Research Coordinator attempts to monitor ongoing programs by developing personal contacts with other researchers. Thus, any significant findings can be discovered, evaluated, and practically applied to local problems more quickly.

##### *4-4.02.02 Dissemination of Information*

The Traffic Research Coordinator attempts to relate monitoring activities to current traffic problems in Minnesota. Therefore, this individual maintains frequent contact with the district and central office staffs to identify existing or anticipated problems. Further coordination is required through the Traffic Engineer's Organization (TEO) to ensure relevant research information is fully disseminated throughout the Department. Appropriate ongoing research programs can then be identified and evaluated for immediate as well as future use in Minnesota. Information is disseminated via published reports, presentations, technical memos or other means as appropriate.

#### **4-4.03 Traffic Research Projects**

The Department also conducts research studies where there is:

1. An important gap in traffic engineering knowledge,
2. An immediate need for the data, or
3. A unique Minnesota concern.

The latter may be created by legislation, weather conditions, or population characteristics which are different from those conditions found in most other states. If a project can be conducted by the researcher, an analysis of Department priorities must be made. This requires input from the client, Department management, Research Services Section and ongoing program review. This process will be partly facilitated by the TRC. If the assigned priority is low, the project will be deferred (Task 6A) until the resources are available or priorities change and the client will be notified. The project will be reviewed periodically and scheduled when possible (Task 7A).

Traffic research may involve but is not limited to:

1. Original research,
2. New techniques,
3. New traffic control devices, or
4. New traffic engineering concepts.

#### *4-4.03.01 Original Research*

Original research projects may fall into a number of categories, depending on current Department priorities. The scope of effort may range from a few hours to several years, and may involve from one person to as many as 20 to 30 people.

#### *4-4.03.02 New Techniques*

Research in this category may involve the development and analysis of new traffic engineering techniques including but not limited to:

1. New systems such as automatic data recording and processing,
2. New statistical tests and
3. New analytical methods.

This individual is responsible for testing and evaluating new techniques as well as for developing any new forms or computer programs which may be necessary.

#### *4-4.03.03 New Traffic Control Devices*

Research in this category may involve the development and analysis of new traffic control devices and methods as well as modifications of existing tools and devices. Common tools used for traffic control include but are not limited to;

1. Signal systems
2. Signing and striping techniques
3. Ramp metering
4. ITS applications not listed above

#### *4-4.03.04 New Traffic Engineering Concepts*

The basic principles of driver performance and traffic flow dynamics are still not completely understood. Therefore, this category of research involves the development and validation of new traffic engineering concepts, particularly as they relate to human behavior in traffic situations.

### **4-4.04 Support Services**

One of the functions of the Research Services Section (RSS) is to assist in research projects being done by others within the department. Many of the special study techniques used by the RSS staff can be used by other traffic engineering personnel as well. Examples are statistical analyses, computerized data processing and special data acquisition techniques. Staff from RSS will provide assistance in the use of these techniques as well as in conducting literature searches and reviews. RSS staff can arrange for contacts between internal and external researchers.

Questions on implementation of findings can also be answered by the RSS staff, either by using available documents or by contacting report authors.

## 4-5.00 TRAFFIC RESEARCH PROJECT DEVELOPMENT

### 4-5.01 Project Sources

Ideas and requests for research projects come from a variety of sources, both within the research unit and from other units and agencies. Internal projects usually develop because of staff interest or are an extension of research for others. External projects are developed to provide assistance to district or other central office personnel, or local or federal agencies.

### 4-5.02 Project Subjects

Research projects address many problems encountered by traffic engineers.

The general classes of projects are:

1. General traffic engineering, and
2. Freeway corridor traffic management.

Traffic research studies typically evaluate new or existing concepts or applications.

#### 4-5.02.01 *General Traffic Engineering*

Examples of research subjects in general traffic engineering include the following:

1. Signals
2. Signs
3. Markings
4. Policies
5. Concepts
6. Design standards
7. Warrants
8. Safety improvements
9. Legislation
10. Study methods
11. Products
12. Procedures

#### 4-5.02.02 *Freeway Corridor Traffic Management*

The following are typical subjects of traffic research in the area of freeway traffic management:

1. Ramp metering
2. Priority treatments
3. Lane use signals
4. Changeable-message signs
5. Closed-circuit television
6. Motorist-aid systems
7. Driver information systems

### 4-5.03 Task Sequence

Each research project involves a series of tasks that address various aspects of the question. The sequence of these tasks is shown in Figure 4-1 and the tasks are defined as follows

#### 4-5.03.01 *Isolate the Research Question*

Most traffic engineering problems involve several variables that are unknown to some degree. Before a study can be conducted, the researcher and the client must be in agreement about which problems are of most concern.



#### *4-5.03.02 Determine Available Data*

Once the problem is defined, the researcher, with assistance from RSS, can review current literature and ongoing programs to determine if someone else has already studied the problem and if so, are results are valid and applicable. If usable results are available, the researcher will report to the client and the project will be terminated, or assistance in implementing the results will be provided. If usable results are not available, further analysis will be needed.

#### *4-5.03.03 Research Plan Development*

After a set of potential research projects has been identified, the scope of the proposed study should be determined. Plan development also includes forming of the Technical Advisory Panel, and appointments of the Technical Liaisons, Administrative Liaisons and Principal Investigators that develop the research work plan.

#### *4-5.03.04 Determine Level of Effort*

If additional work is needed to obtain answers for the client, the researcher and RSS will analyze the methods and resources required. This analysis will include manpower, equipment, supplies, and budget.

#### *4-5.03.05 Determine Staff Capability*

Once the scope of effort is known, a decision is made regarding the researcher's ability to handle the technical or practical needs of the project. Special expertise or resource demands beyond those available may require that the problem be referred to others for consideration (Task 5A), and this fact will be reported to the client.

#### *4-5.03.06 Adjust Work Schedule*

High priority projects are started as soon as ongoing projects can be completed or delayed to release resources. Staff assignments and budget allocations are determined for the projects which will be undertaken.

#### *4-5.03.07 Obtain Approval and Funds*

Traffic engineering research projects can be funded by any of several means. RSS can provide administrative assistance and the TRC will facilitate searches for funding sources for research projects. If the funding is provided from the OTST budget, these projects must be approved by the Traffic Engineer and the TRC. If other Department funds (for example State Planning and Research-SP & R) are used, the appropriate staff (usually Research Services) must concur and approve the expenditure. If sources of funds outside the Department are used, agreements must be executed and approved by the Commissioner. Even if project expenses are to be reimbursed, the expenditures must be budgeted and encumbered before they are incurred. RSS can provide the guidance in searching for financial assistance, including new public/private partnerships authorized by the 1993 Legislature.

#### *4-5.03.08 Prepare Study Design*

When approvals have been given and funds are available, detailed plans will be prepared for the data collection and analysis. Quantities of data for statistical reliability, appropriate measures, study techniques and personnel, and material needs will be determined. Schedules will be set to minimize extraneous variables.

#### *4-5.03.09 Gather Data*

Appropriate quantities and types of data will be gathered as needed. Techniques must be carefully controlled to avoid interference with the measured objective.

#### *4-5.03.10 Analyze Data*

When data has been collected, it will be processed (by computer if possible) and calculations will be made. Statistical tests of before/after comparisons or other measures will be utilized to determine data accuracy.

#### *4-5.03.11 Determine Results*

After all the results have been analyzed and tested, they will be compared with known and suspected hypotheses, and conclusions (or answers) will be drawn.

#### *4-5.03.12 Report to Client*

The final results of the project will be reported to the client by memo, oral report, or formal written report, depending on the scope of the effort. In some cases, multiple reports for several different users will be needed. Users may also require follow up assistance in implementing research results.

### **4-6.00 RESEARCH SERVICES SECTION**

#### **4-6.01 Scope**

The Mn/DOT Research Services Section (RSS) in the Office of Investment Management Division manages and coordinates the Department's research program. Departmental research is funded through a number of sources within and outside of Mn/DOT. RSS provides the Office of Traffic, Safety and Operations, as well as other Mn/DOT offices with administrative assistance in Research Management, Financial Services, Technology Development and Library/Informational Services. Research Services staff determine the research needs of the Department, and develop and manage a research program to meet those needs. Financial Services staff provide contract administration and manage budgets for the Cooperative Program for Transportation Research (COPTRS), the Local Road Research Board (LRRB) and others.

Technology Development staff provide technology transfer, research implementation, new technology development and evaluation services.

#### **4-6.02 Intra-Office Cooperation**

OTST collaborates with the RSS through participation in identifying Departmental research needs. Brainstorming sessions are used to identify issues and barriers being experienced by transportation practitioners that might be solved by research. One of the 13 Research Categories is "Traffic/ITS". Representatives from Mn/DOT, municipalities, counties, consultants, contractors and public interest groups brainstorm ideas and prioritize them as a group. RSS works through the process of eliminating duplicates, evaluating and prioritizing these ideas with staff from OTST. Contact: Research Program Development Engineer (651) 366-3779.

**4-6.03 Research Services**

The Research Services Section develops contracts and monitors the progress of a variety of research projects. Each research project includes a Technical Advisory Panel (TAP) made up of individuals with technical expertise from Mn/DOT and Minnesota's transportation community. The TAP works closely with the project Principal Investigator (PI) to provide input and practitioner perspective to the investigation. OTST provides personnel to serve on TAP's, in addition to the Traffic Research Coordinator as needed. Funding for research is provided by local and state government at the following levels:

- Local Government Funding: Local Road Research Board (LRRB); Research Implementation Committee (RIC).
- State Government Funding: State Transportation Improvement Program (STIP) and Cooperative Program for Transportation Research and Studies (COPTRS); Implementation Funding Program (IMP); Federal Funding (SPR); National Cooperative Highway Research Program (NCHRP)

Contact: Research Program Manager (651) 366-3757.

**4-6.04 Technology Development**

The Research Implementation, Outreach and Marketing Unit provides OTST a program of Technology Transfer (T2) which provides research and technology information from within and outside of Mn/DOT. The T2 effort is accomplished partially through the development and dissemination of information. An example is the publication of technical reports and summaries or training. Usable products are applied to traffic problems through product development or demonstration efforts. Organizational issues are addressed by establishing conduits for implementation and dealing with barriers to implementation. The focus of these efforts is to provide measurably effective technology to solve traffic engineering problems. The OTST's Traffic Research Coordinator is the liaison with the RSS in this exchange of information.

Contact: Marketing Program Coordinator (651) 366-3769 or Implementation Coordinator (651) 366-3772

**4-6.05 Financial Services**

This section handles contract development and the program budget. Tasks include drafting contractual documents, coordinating the approval process, allocating funding, processing payment requests and managing program budgets.

Contact: Financial Services Manager (651) 366-3759.

**4-6.06 Library**

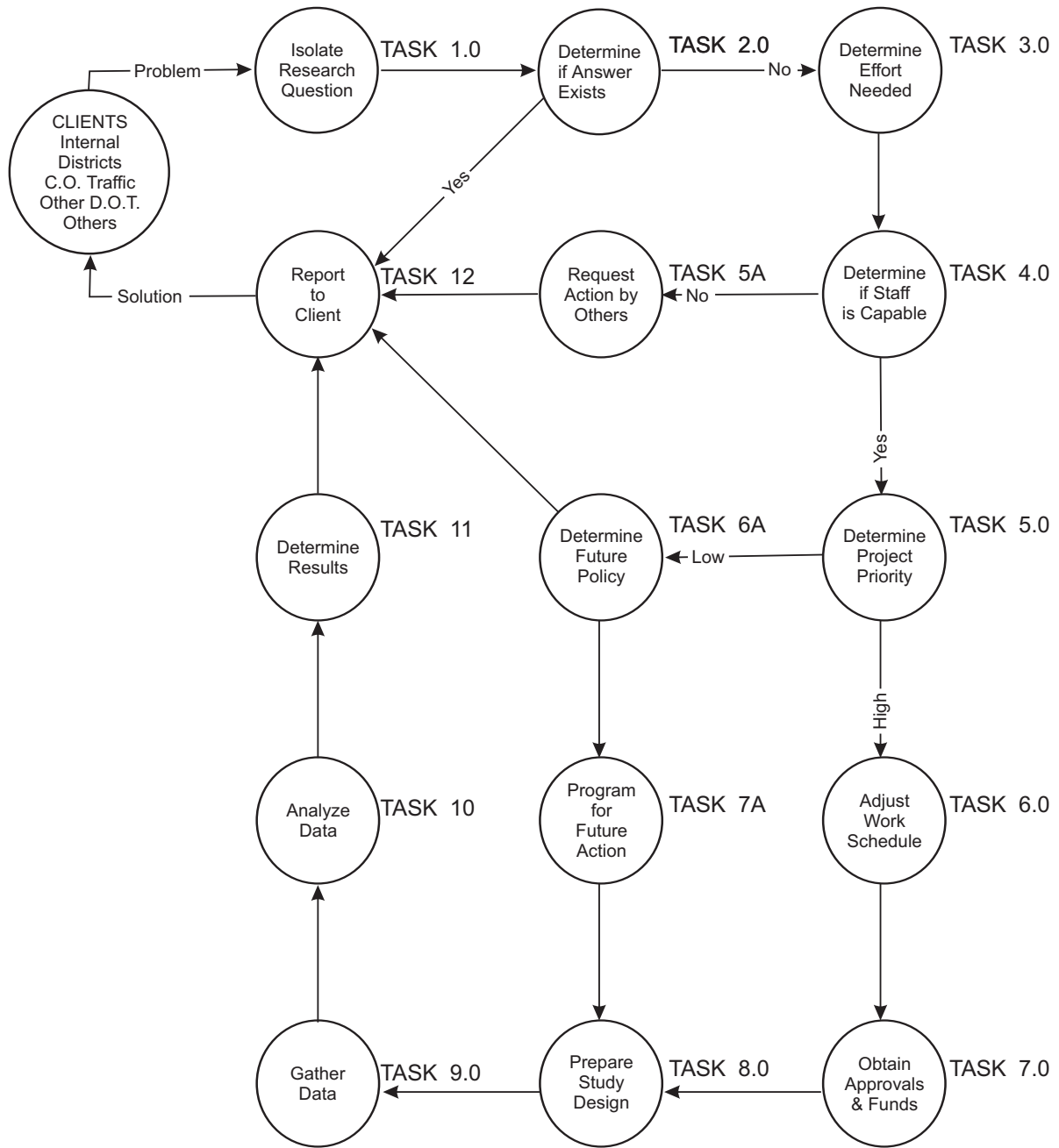
Mn/DOT's Library serves a broad spectrum of customers - the general public, city and county engineers, university faculty and students. The library exists to serve, and is structured to meet the needs, primarily of Mn/DOT employees, especially its professional, technical and managerial staff.

**4-6.07 Technical Specialists**

Mn/DOT also has technical specialists in the following research specialty areas who are available as resources:

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>- Sandy McCully (651) 366-3768</li> </ul>                | <ul style="list-style-type: none"> <li>Mn/DOT Library (651) 366-3743</li> </ul>                            |
| <ul style="list-style-type: none"> <li>Location: Research Services Section</li> </ul>           | <ul style="list-style-type: none"> <li>Location: 1st Floor, Transportation Bldg.</li> </ul>                |
| <ul style="list-style-type: none"> <li>Technology Transfer Specialist (Publications)</li> </ul> | <ul style="list-style-type: none"> <li>Conducts literature searches on specific research topics</li> </ul> |





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**PROJECT FLOW DIAGRAM**

**FIGURE  
4.1**

