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Minnesota Intelligent Transportation Systems



ITS Architecture Wants and Needs Analysis

Prepared for the Minnesota Department of Transportation by:

Lockheed Martin Federal Systems
Intelligent Transportation Systems
Mail Drop 0124
1801 State Route 17C
Owego, New York 13827-3998

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Table of Contents

1	<u>Executive Summary</u>	1
2	<u>Introduction</u>	5
	2.1 Purpose	5
	2.2 Approach	5
	2.3 Document Structure	6
3	<u>Minnesota Traveler Wants and Needs Opportunities</u>	7
	3.1 Objectives	7
	3.2 Approach	7
	3.3 Results	8
	3.3.1 Opportunity Map: Overall	10
	3.3.2 Opportunity Map: Heavy Drivers	11
	3.3.3 Opportunity Map: Single Occupancy Vehicles (SOV)	12
	3.3.4 Opportunity Map: Carpools	13
	3.3.5 Opportunity Map: Bus/Public Transit Riders	14
	3.3.6 Opportunity Map: Employed: Non-work Related Trips	15
	3.3.7 Opportunity Map: Non-Workers	16
	3.3.8 Opportunity Map: Unfamiliar Areas	17
	3.3.9 Demand Weight Analysis	18
	3.3.10 Demographic Analysis	19
4	<u>Minnesota ITS Service Relationships</u>	21
	4.1 Objectives	21
	4.2 Approach	21
	4.3 Results	26
5	<u>Appendix A: Minnesota Wants and Needs Definitions</u>	27
6	<u>Appendix B: Minnesota Services Definitions</u>	29
7	<u>Appendix C: Wants and Needs Demand Weight Tables</u>	33
8	<u>Appendix D: Demographic Analysis Tables</u>	41

List of Figures

Figure 1. Minnesota Research Process	3
Figure 2. Opportunity Map Concept	7
Figure 3. Opportunity Map: Overall	10
Figure 4. Opportunity Map: Heavy Drivers	11
Figure 5. Opportunity Map: Single Occupancy Vehicles (SOV)	12
Figure 6. Opportunity Map: Carpools	13
Figure 7. Opportunity Map: Bus Riders	14
Figure 8. Opportunity Map: Workers: Non-work Related Trips	15
Figure 9. Opportunity Map: Non-workers	16
Figure 10. Opportunity Map: Unfamiliar Areas	17
Figure 11. QFD Matrix Concept	25
Figure 12. Wants and Needs Relationship Matrix	26

Executive Summary

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The purpose of this document is to serve as a guide in the planning and development of Intelligent Transportation Systems (ITS) within the state of Minnesota. It identifies key ITS opportunity areas based on the results of statewide market research, and associates those opportunities with the most appropriate ITS services. This information will be used to evaluate the potential benefits of ITS projects developed for the Polaris Implementation Plan.

The basis for this analysis is the results of the Polaris statewide market research study, Minnesota Traveler Wants and Needs, April 24, 1996. As illustrated in , Minnesota Research Process, this separately published study identifies eighteen fundamental wants and needs of travelers who use the Minnesota transportation system. This information was obtained during qualitative, “brain storming” sessions with randomly selected participants from across the state. The resulting wants and needs and their definitions are contained in Appendix A for reference. This same market research study also contains quantitative data from a telephone survey which was conducted to measure the relative importance of each want and need and how well each want and need was currently being satisfied. A total of 901 survey participants were asked to assess importance and satisfaction based on a scale of 1 to 10, with 10 meaning the want and need was greatest in importance, or level of satisfaction was at its highest. The resulting importance and satisfaction values for each want and need are contained in Appendix C and are the data used in the opportunity analyses.

6

The opportunity analyses, contained in Section 3.0, provide several views of the data in Appendix C. The first defines opportunities graphically in terms of Highest Leverage (most important/least satisfied), Moderate Leverage (least importance/least satisfied), Incremental Improvement (most important/most satisfied), and Lowest Leverage (least important/most satisfied) for each of the following traveler group categories:

- 8
- Overall
- Heavy Drivers (drive extensively for business purposes)
- Travel To/From Work - Single Occupancy Vehicles (SOV)
- Travel To/From Work - Bus / Public transit users
- Travel To/From Work - Carpoolers
- Employed - Non-work related travel
- Not Employed - All travel
- Travel in unfamiliar areas

This analysis concluded that, overall,

- high leverage opportunity areas were those which reduce stress and provide a sense of driving security.
- moderate opportunity areas were those which address the need for travel information such as congestion delays, route plans and “yellow pages” information.
- incremental opportunity areas were those which address more intrinsic needs such as safety, value, availability, and comfort.

- no opportunities fell within the lowest leverage area.

A second view provides a more structured analysis by ranking the wants and needs according to a demand weight formula as detailed in Section 3.3.9. Based on this analysis, the overall top ten wants and needs opportunities were:

1. Fair Aggressive Law Enforcement
2. Timely, Accurate Construction, Maintenance Information
3. Free of Stressful Experiences
4. Get Help Quickly in Event of Accident, Emergency, or Breakdown
5. Timely Information on Alternatives to Avoid Delays
6. Timely, Accurate Accident, Traffic and Congestion Information
7. Timely, Accurate Weather and Road Conditions Information
8. Safe from Accident, Injury, Theft, Violence
9. Best Route Plan Based on Specified Criteria
10. Choice of Travel Modes

A final view, Section 3.3.10, summarizes the survey results according to demographics such as age, gender, location (e.g., metro), income etc. Importance and satisfaction values for various demographic pairs (e.g., males/females, metro/non-metro) were statistically tested to determine if there were any differences in their responses. The results showed that no demographic group's responses for any of the wants and needs were both more important and less satisfied than those of its paired demographic group.

Section 4.0 completes the analysis by defining strength relationships between the above wants/needs opportunities and Minnesota's corresponding ITS services. This section explains how the services were derived, and how the relationships were determined. Its purpose is to aid the Implementation Plan assessment of which ITS services best address the above opportunities.

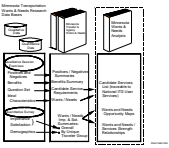


Figure 1. Minnesota Research Process

1 Introduction

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3.1 Purpose

The purpose of the wants and needs analysis as documented in this report was two-fold:

- to identify key opportunity areas based on Minnesota Traveler Wants and Needs
- to define strength relationships between these opportunities and their associated ITS services.

This information will be used to evaluate the potential benefits of ITS projects developed for the Polaris Implementation Plan.

1.1 Approach

The wants and needs opportunity analysis was based on the results presented in the Minnesota Traveler Wants and Needs, April 24, 1996 document. These results provided:

- a list of eighteen (18) Minnesota traveler wants and needs
- quantitative summary tables of importance and satisfaction values for each want and need; results were based on a scale of 1(least) to 10(most) and summarized according to the following traveler group categories:
 - Overall
 - Heavy Drivers (drive extensively for business purposes)
 - Travel To/From Work - Single Occupancy Vehicles (SOV)
 - Travel To/From Work - Bus Riders / Public transit users
 - Travel To/From Work - Carpoolers
 - Employed - Non-work related travel
 - Not Employed - All travel
 - Travel in unfamiliar areas
- a test for statistical differences in importance and satisfaction values according to demographics (e.g., metro-vs-outstate counties, age, gender, income, etc.)

Three different analyses were used against this data to identify opportunity areas. The first analysis identifies high, incremental, moderate, and low leverage areas of opportunity by graphing the importance and satisfaction values onto an x-y coordinate system. A separate graph is provided for each of the above traveler group categories. The second analysis prioritizes Minnesota's wants and needs according to a demand weight calculation. The last analysis was a statistical test to determine if any opportunities could be based on demographic criteria.

Strong, medium and weak strength relationships between Minnesota wants/needs and their associated Minnesota ITS services were generated and documented as a reference matrix. The matrix will be used as a planning and implementation guide for determining which Minnesota ITS services best address the identified opportunities.

1.1 Document Structure

Section 3.0 details the three opportunity analyses. Supporting information for Section 3.0 is contained in the Appendices. Appendix A contains the Minnesota wants and needs definitions, Appendix B contains the Minnesota services definitions, Appendix C contains the demand weight analysis data, and Appendix D contains the demographic analysis data. Section 4.0 details the strength relationship analysis.

1 Minnesota Traveler Wants and Needs 2 Opportunities

2

3

3.1 Objectives

The objective of this analysis was to:

- Establish opportunity areas which are representative of Minnesota travelers overall
- Establish opportunity areas for specific traveler groups (i.e.; Heavy drivers, SOV, Carpools, Bus, Workers: Non-work related trips, Non-workers, Trips in Unfamiliar Areas)
- Establish a prioritized list of opportunities based on a demand weight calculation
- Determine if opportunities could be derived from the market research demographic data

These opportunities were used to identify problem areas for the different traveler groups.

1.1 Approach

The first three objectives were met using opportunity maps as illustrated in , Opportunity Map Concept. These maps use a simple X-Y grid system to plot the mean importance and satisfaction values for each want and need. The importance value is represented by the vertical axis, the satisfaction value is represented by the horizontal axis.



Figure 2. Opportunity Map Concept

Given this arrangement, the four quadrants represent areas of opportunity as follows:

- Top left quadrant: High Importance + Low Satisfaction = Highest Leverage Opportunity
- Bottom left quadrant: Low Importance + Low Satisfaction = Moderate Leverage Opportunity
- Top right quadrant: High Importance + High Satisfaction = Opportunity for Incremental Improvement
- Bottom right quadrant: Low Importance + High Satisfaction = Lowest Leverage Opportunity

Opportunity maps representing the traveler groups were plotted using the survey data in Appendix C. The center point for the axis was placed near the center point of the data (it was shifted slightly to keep apparent clusters together, and to ensure that no point fell directly on an axis line). For reference, the axis center point for the following maps is approximately $X=7.8$, $Y=7.6$).

Each data point is labeled with the letter designation of the associated want and need as defined on the Overall graph and in Appendix A: Wants and Needs Definitions. Maps for the specific traveler groups use trend arrows to provide a visual comparison with respect to the overall group. The source of each arrow is the location of a want/need data point on the overall map. The destination of the arrow is the new location for the same want/need on the specific group map. These arrows can indicate trends based on the following interpretations:

- Horizontal trends indicate that the specific traveler group and overall group have similar importance values
- Vertical trends indicate that the specific traveler group and overall group have similar satisfaction values
- The length of the arrow represents the relative difference between the specific traveler group and the overall group i.e., long arrows indicate that the values are further apart
- The direction of the arrow indicates shifts in opportunity between the specific traveler group and the overall group
- An upward/left trend is a key trend as it indicates greater importance and less satisfaction.

1.1 Results

Most letters placed consistently across the groups, with general exceptions noted below and on the maps in which the exceptions appear. The conclusions reached from the quadrant placements in the overall group were:

High leverage opportunity areas were those which reduce stress and provide a sense of driving security. Stress/driving security concerns were reflected in concerns over the poor driving behavior of others, of getting help in an emergency, and of hazardous road conditions.

Moderate opportunity areas were those which address the need for travel information such as congestion and construction delays, alternative route plans and “yellow pages” information.

Incremental opportunity areas were those which address more intrinsic needs such as safety, value, availability, and comfort.

No opportunities fell within the lowest leverage area.

These conclusions were based on the following quadrant placements:

Highest Leverage:

- R. Fair Aggressive Law Enforcement - This is the only need to appear in the highest leverage area for all traveler groups.
- P. Get Help Quickly in the Event of An Accident, Emergency or Breakdown
- M. Free of Stressful Experiences - Note: R and M were also expressed as significant opportunities by the group participating in the qualitative “brainstorming” market research sessions as described in the Minnesota Traveler Wants and Needs document. When these participants were asked to describe their negative transportation related experiences, their top response, cited by 87 of 146 participants, was summarized as “Increased stress and reduced safety due to poor driver behavior and insufficient law enforcement.”
- F. Timely, Accurate Weather and Road Conditions Information
- G. Clear, Timely Directions to Follow Desired Route

Moderate Leverage: (Low Importance/Low Satisfaction)

- L. Timely, Accurate Construction, Maintenance Information
- E. Timely, Accurate Accident, Traffic and Congestion Information
- J. Timely Information on Alternatives to Avoid Delays
- A. Choice of Travel Modes - The least satisfied need overall.
- B. Best Route Plan Based on Specified Criteria
- K. Easy Access to Comprehensive Travel Services and Information
- N. Able to Make Good Use of Travel Time

Incremental Leverage: (High Importance/High Satisfaction)

- I. Safe from Accident, Injury, Theft, Violence - The most important need overall.
- O. Good Value for Cost - Higher leverage for bus riders and heavy drivers. Transportation costs impact these groups more directly.
- H. Get to Destination Directly Without Unnecessary Stops or Delays
- D. Travel Mode is Available Wherever Needed
- C. Travel Mode is Available Whenever Needed - The most satisfied need overall.
- Q. Comfortable and Easy to Use

Lowest Leverage:

None

1.1.1 Opportunity Map: Overall

1.1.2

1.1.3

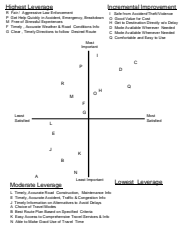
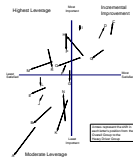


Figure 3. Opportunity Map: Overall



1.1.1 Opportunity Map: Heavy Drivers

1.1.2

1.1.3 **Trends:** This group shows larger vertical trends than horizontal indicating less change in satisfaction. Low values for A (Choice of Modes), B (Best Route Plan) and K (Traveler Services Info) indicate that survey participants had a standard mode of travel and standard route plan. This group considers N (Make Good Use of Travel Time) more important, and shows a greater need for reducing M (Stress).

1.1.4

1.1.5 **Quadrant Shifts to Highest Leverage:** There is a greater need for O (Good Value for Cost), and H (Get to Destination Directly w/o Delay).

1.1.6

1.1.7 **Opportunities:** This traveler group needs to have their extensive travel time made faster and more efficient.

Figure 4. Opportunity Map: Heavy Drivers

1.1.1 Opportunity Map: Single Occupancy Vehicles (SOV)

1.1.2

1.1.3 **Trends:** This group shows a trend towards higher satisfaction in areas of importance. SOV commuters have less use for K (Access to Travel Services Info), B (Route Plan), and G (Clear Directions). These are of little value to travelers who have already selected their mode (personal car) and have a single destination to which they routinely travel (place of work).

1.1.4

1.1.5 **No Quadrant Shifts to Highest Leverage:** P (Get Help Quickly in Emergency) loses some leverage with this group. Independence/routine may improve sense of driving security.

1.1.6

1.1.7 **Opportunities:** The satisfaction trend and length of the arrows indicate that important wants/needs are basically satisfied for this group.

1.1.8

1.1.9

1.1.10



1.1.11

1.1.1 Opportunity Map: Carpools

1.1.2

1.1.3 Trends: Opposite trend than SOV. Most show a less satisfied trend. This group is much more receptive to A (Choice of Modes), R (Enforcement) and M (Free of Stress) values indicate people may carpool to avoid driving stress. A need for J (Alternatives to Avoid Delays), F (Road/Weather Conditions), and L (Construction Information) was also indicated.

1.1.4

1.1.5 Quadrant Shifts to Highest Leverage:

Carpoolers reflect a greater time dependency than the other groups. They must minimize pick-up delays and are responsible for getting others to work on time. Thus the shift for H (Directly without Delay) is not surprising.

1.1.6

1.1.7 Opportunities:

This group has a great need for reducing travel time. Driving stress may be a significant motivator for the use of carpools. As expected, carpoolers have little need for G (Clear Directions) or K (Access to Travel Services Info).

Figure 5. Opportunity Map: Single Occupancy Vehicles (SOV)

has a great need for reducing travel time. Driving stress may be a significant motivator for the use of carpools. As expected, carpoolers have little need for G (Clear Directions) or K (Access to Travel Services Info).



Figure 7 Opportunity Map: Bus Riders

1.1.1 Opportunity Map: Bus/Public Transit Riders

1.1.2

1.1.3Trends: Trends show a need for N (Make Good Use of Travel Time) and A (Choice of Modes). Q (Comfortable/Easy to Use) gets a boost toward higher leverage.

1.1.4

1.1.5Quadrant Shifts to Highest Leverage: Considerably less satisfaction for C (Available Whenever Needed) and D (Available Wherever Needed) indicates a need for improved schedules and bus routes.

1.1.6

1.1.7Opportunities: This group desires greater flexibility on when and where they can acquire alternate modes of transportation. They also indicate a need to make idle riding time more efficient. As expected with SOV and Carpools, K (Access to Travel Services Info), F (Weather/Road Conditions), G (Clear Directions) are less important for these commuters.

1.1.1 Opportunity Map: Employed: Non-work Related Trips



Figure 8. Opportunity Map: Workers: Non-work Related Trips

1.1.2

1.1.3 **Trends:** Trend toward greater satisfaction, no significant importance trends. Indicates most trips are to familiar destinations and can be scheduled when conditions are favorable.

1.1.4

1.1.5 **Quadrant Shifts to Highest Leverage:** None.

1.1.6

1.1.7 **Opportunities:** Same as with the overall group.

1.1.1 Opportunity Map: Non-Workers

1.1.2

1.1.3**Trends:** Trend in scope and direction toward more importance and greater satisfaction in most areas.

1.1.4E (Traffic Info), J (Alternative Route Info), A (Choice of Modes), and B (Route Plans) show larger importance values.

1.1.5

1.1.6**Quadrant Shifts to Highest Leverage:** L (Construction Info) moves into this area.

1.1.7

1.1.8**Opportunities:** The above observations suggests this group is receptive to alternative modes and has a desire to obtain travel conditions/services information.

1.1.9

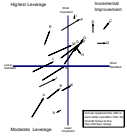


Figure 9. Opportunity Map: Non-workers



Figure 10. Opportunity Map: Unfamiliar Areas

1.1.1 Opportunity Map: Unfamiliar Areas

1.1.2

1.1.3**Trends:** This group shows a higher importance trend for most wants and needs since they are in the most vulnerable position relative to getting to their destination quickly and safely. K (Comprehensive Traveler Information, e.g., “yellow pages”) and G (Clear Directions) showed the most significant shift for this group.

1.1.4

1.1.5**Quadrant Shifts to Highest Leverage:** L (Construction Information) moved to this area.

1.1.6

1.1.7**Opportunities:** This group, understandably shows a need for travel conditions and services information.

1.1.1 Demand Weight Analysis

1.1.2

1.1.3 The Minnesota Traveler Wants and Needs, April 24, 1996 document prioritized Minnesota's wants and needs according to their importance values and according to their satisfaction values. This demand weight analysis considered both values in order to establish a priority list based on opportunity. This was accomplished using the following formulas:

1.1.4

1. Multiply the importance value, I, by ΔS ($\Delta S = S_t - S_a$, where S_t is the target or desired level of satisfaction (assumed to be 10 for all wants and needs) and S_a is the actual satisfaction value from the survey). It is easy to see that the factor $(I) * (\Delta S)$ increases with high importance values and low levels of satisfaction. This factor is called the absolute weight value (AB).
2. The demand weight calculation simply converts all of the absolute values for each want and need into a percent (%) of the total or:

$$[AB(\text{individual want and need}) / \sum AB (\text{all wants and needs})] * 100\%.$$

Tabulated demand weight results for the overall and specific traveler groups are contained in Appendix C. Given the above calculation, the values in the demand weight column for each of the tables should add to a total of 100% (allowing for slight errors due to the rounding of values to the nearest 10th decimal point). The prioritized results for the overall traveler group were:

1. R. Fair Aggressive Law Enforcement
2. L. Timely, Accurate Construction, Maintenance Information
3. M. Free of Stressful Experiences
4. P. Get Help Quickly in Event of Accident, Emergency, or Breakdown
5. J. Timely Information on Alternatives to Avoid Delays
6. E. Timely, Accurate Accident, Traffic and Congestion Information
7. F. Timely, Accurate Weather and Road Conditions Information
8. I. Safe from Accident, Injury, Theft, Violence
9. B. Best Route Plan Based on Specified Criteria
10. A. Choice of Travel Modes
11. G. Clear, Timely Directions to Follow Desired Route
12. O. Good Value for Cost
13. H. Get to Destination Directly Without Unnecessary Stops, Delays
14. K. Easy Access to Comprehensive Travel Services and Information
15. N. Able to Make Good Use of Travel Time
16. D. Travel Mode is Available Wherever Needed
17. C. Travel Mode is Available Whenever Needed
18. Q. Comfortable and Easy to Use

The demand weight value gives an indication of how each want and need "weighs" in priority against the others in the list. The relative closeness in values can also lend insight into levels of opportunity. For example, a large difference between two adjacent values near the top of the list can be interpreted as a separation point between high, moderate, and lower leverage opportunities. This occurs for the Overall

group between #6 & #7 (values 6.0 and greater) and #13 & #14 (values 5.9-5.0). These same break-point values can also be applied to the demand weights for the specific traveler groups.

1.1.1 Demographic Analysis

1.1.2

1.1.3 The Polaris Minnesota Traveler Wants and Needs telephone survey database included demographic data such as the survey participant's age, gender, income range, etc. Statistical testing was performed to determine if there were any differences in the responses of paired demographic groups for the importance and satisfaction values. The results are tabulated in Appendix D. Any responses that showed a 95% confidence level for being statistically different are marked with an "X" and are organized for planning purposes in terms of "More Important" and "Less Satisfied". The tested comparisons were as follows:

1.1.4

- Metropolitan Counties (Anoka, Carver, Chisago, Dakota, Hennepin, Ramsey, Scott, Washington) - vs- Non-Metro Counties (Blue Earth, Olmsted, Otter Tail, St. Louis, Stearns, Wright, Others)
- Those who commute 10 miles or less to work -vs- Those who commute 10 miles or more to work
- Those who travel during peak hours (6AM-9AM; 3PM-6PM) - vs- Those who travel during non-peak hours
- Males -vs- Females
- Age group: 18-34 -vs- Remaining ages
- Age group: 35-54 - vs- Remaining ages
- Age group: 55 and older -vs- Remaining ages
- Income Level: Less than \$30,000/year -vs- Remaining incomes
- Income Level: \$30,000-50,000/year -vs- Remaining incomes
- Income Level: \$50,000 or greater/year -vs- Remaining incomes
- Employed -vs- Not-Working/Part-Time

The results showed that no demographic group's responses for any of the wants and needs were both more important and less satisfied than those of its paired demographic group. Some of the most consistent differences include the following:

- Females rated nearly all the wants and needs as more important and nearly all more satisfied than did males.
- Non-workers or part-time workers rated most of the wants and needs as more important and most more satisfied than did full-time employed workers.
- Respondents younger than age 55 rated nearly all the wants and needs as less satisfied than did those 55 and older.
- Respondents earning less than \$30,000 per year rated about half the wants and needs as more important and about half more satisfied than did those earning over \$30,000 per year.

- Respondents earning more than \$50,000 per year rated about one third of the wants and needs as less important and one third less satisfied than did those earning under \$50,000 per year.
- Non-peak hour travelers rated some of the wants and needs as more important and some more satisfied than did those traveling during peak hour.

1.1.1 The remaining demographic comparisons showed few and/or inconsistent differences in ratings of the wants and needs. However, they can still provide information on a needs by needs basis. For example, and not surprisingly, the non-metro/rural traveler showed only the need for responsive emergency services as being more important i.e., Get Help Quickly in Event of Accident, Emergency, Breakdown. They were also more satisfied in that they have less stress, feel safer, and feel they are less likely to experience unnecessary delays than their Metro counterparts. In contrast, Metro travelers showed a more statistical importance trend towards those needs which minimize delays (construction info, traffic info, info on alternatives to avoid delays) and maximize flexibility (choice of modes, mode available whenever and wherever needed).

1.1.2

1.1.3

2 Minnesota ITS Service Relationships

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4.1 Objectives

This section establishes a relationship matrix that identifies which services best address Minnesota traveler wants and needs. This matrix can be used as a guide for ITS planners in determining which ITS services best address the opportunities highlighted in the previous sections.

1.1 Approach

First, a candidate services list had to be generated which represented both Minnesota traveler and national ITS requirements. This process involved identifying all relevant requirements from the following document sources:

- Polaris - Minnesota Traveler Wants and Needs, April 24, 1996
- Polaris - Minnesota Agency Wants and Needs, April 24, 1996
- ITS National Architecture User Service Requirements - Traceability Matrix, Appendix A, April 1996
- Guidestar Goals and Objectives - Minnesota Guidestar Strategic Plan, June 1994
- Secondary research under Polaris contract.

These requirements were then allocated to the 29 National ITS services. After requirements to service allocation, a functional analysis of the services was performed. The results indicated an inconsistent mapping with the national effort, and the services were tailored to better represent the unique needs of the state. Tailoring generally took the form of either adding functions to an existing service, or merging services that were found to provide common functions for Minnesota. The results of the tailoring effort are summarized in Table 1, National -vs- Minnesota ITS Services Comparison. The service definitions are contained in Appendix B for reference.

Table 1. National -vs- Minnesota ITS Services Comparison			
National Services	ITS User	Minnesota ITS User Services	Comments: ★ Enhanced Service → {description of change}
	Travel Management	Advanced Traveler Information Services	

Pre-Trip Travel Information	Travel Conditions Information(TCI)	★ Travel Conditions Information
En-route Driver Information	Trip Planning/Directions (TPD)	★ Trip Planning/Directions
Route Guidance		→ { merged into Trip Planning/ Directions }
Ride Matching and Reservation	Ride Matching and Reservations (RMR)	
Traveler Services Information	Traveler Services Information (TSI)	★ Traveler Services Information
Traffic Management	Traffic Management	
Traffic Control	Traffic Control (TC)	
Incident Management		→ { merged into Incident/ Emergency Management }
Travel Demand Management	Travel Demand Management (TDM)	
Emission Testing and Mitigation	Emission Testing and Mitigation (ETM)	
Public Transportation Management	Public Transportation Management	
Public Transportation Management	Public Transportation Fleet Management (TFM)	★ Public Transportation Fleet Management
En-route Transit Information		→ { merged into Travel Conditions Information }
Personalized Public Transit		→ { merged into Ride Matching and Reservation }
Public Travel Security	Public Travel Security	★ Public Travel Security
Electronic Payment	System Management	
Electronic Payment Services	Account Management	★ Account Management
	Maintenance	→ { additional service }
	Training	→ { additional service }
Commercial Vehicle Operations	Commercial Vehicle Operations	
Commercial Vehicle Electronic Clearance	Commercial Vehicle Inspection/Clearance (IC)	★ Commercial Vehicle Inspection/Clearance
Automated Roadside Safety Inspection		→ { merged into Inspection Clearance }

On-Board Safety Monitoring Commercial Vehicle Administrative Process Hazardous Material Incident Response Commercial Fleet Management	Commercial Fleet Management (CFM)	→ { moved to Advanced Vehicle Safety Systems } → { merged into Commercial Fleet Management } → { merged into Incident/ Emergency Management }
Emergency Management Emergency Notification and Personal Security Emergency Vehicle Management	Emergency Management Incident/Emergency Management (IEM) Public Travel Security (PTS) {includes Regulation and Enforcement}	★ Incident/Emergency Management → { merged into Incident/ Emergency Management } → { moved from Public Transportation Management }
Advance Vehicle Safety Systems Longitudinal Collision Avoidance Lateral Collision Avoidance Intersection Collision Avoidance Vision Enhancement for Crash Avoidance Safety Readiness Pre-Crash Restraint Deployment Automated Vehicle Operation	Advanced Vehicle Safety Systems Longitudinal Collision Avoidance (LAC) Lateral Collision Avoidance (LOC) Intersection Collision Avoidance (ICA) Vision Enhancement for Crash Avoidance (VEC) Safety Readiness (SR) Pre-Crash Restraint Deployment (CRD) Automated Vehicle Operation (AVO) On-Board Safety Monitoring (OSM)	→ { moved from Commercial Vehicle Operations }

Once the services were established, relationships between them and the Minnesota traveler wants and needs had to be defined. A structured analysis tool called Quality Function Deployment (QFD) Capture was used to assign strength relationships and record results. A brief description of the QFD process steps are illustrated in , QFD Matrix Concept and described below:

Step 1: Fill in the list of wants and needs

Step 2: Fill in the list of services (Reference 4.3 and Appendix B for this step)

Step 3: As a team, assign a strength relationship between each service and each want and need:

- Filled circle = The service has a strong relationship in addressing the want/need
- Open circle = The service has a medium relationship in addressing the want/need

- Triangle = The service has a weak relationship in addressing the want/need
- Blank = The service has no relationship in addressing the want/need

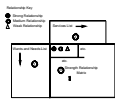


Figure 11. QFD Matrix Concept

This matrix is useful to transportation planners and engineers wanting to provide ITS systems which meet a known public need. Reading across the matrix along the line for a given want/need highlights the ITS services which will best meet that traveler need. Reading down the matrix for the various services highlights services which meet many traveler needs. Through these means, agencies can evaluate individual projects or entire ITS services in terms of their public benefit.

This tool allows for a numerical analysis to rank the services based upon the demand weights of the individual wants and needs along with the strength relationships between the individual services and the wants and needs. The relationship between a benefit for a specific subgroup of the population and benefit for the entire population complicates this analysis. For example, the Public Transportation Fleet Management service has a strong relationship toward meeting many of the identified wants and needs, but for many of the wants and needs the benefit applies only to the low percentage of the population who utilize transit services. Therefore, the ranking of that service is not straightforward. For any one service, the percentage of the population for which the benefit applies varies among the individual wants and needs. Because these population factors require subjective judgment, no numerical analysis is provided here.

1.1 Results

Figure [12](#). Wants and Needs Relationship Matrix

The assigned strength relationships are shown in , Wants and Needs Relationship Matrix. The relationships were evaluated in both directions for consistency, i.e., each assignment was evaluated against the others in its row (against other services) as well as its column (against other wants and needs). Item O: Good Value for Cost shows no relationships due to its highly subjective nature.

1 Appendix A: Minnesota Wants and Needs

Definitions

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A. **Choice of Travel Modes**

Should provides a choice of modes that meet the traveler's needs.

B. **Best Route Plan Based on Specified Criteria**

Should provide help planning optimum travel modes and route according to selected criteria including preferred mode(s), total travel time, cost, intermediate stops, scenery, etc.

C. **Travel Mode Is Available Whenever Needed**

Travel mode should be available whenever needed all day, every day including holidays without having to wait. It should not be late, break down or go on strike.

D. **Travel Mode Is Available Wherever Needed**

Travel mode that provides transportation from origin to destination should be available in all areas where needed.

E. **Timely, Accurate Accident, Traffic and Congestion Information**

Sufficient advance warning of accidents, and current and predicted traffic and congestion conditions should be available so that traveler can make informed alternative travel decisions prior to trip or en-route.

F. **Timely, Accurate Weather and Road Conditions Information**

Sufficient advance warning of current and forecast weather and road conditions should be available so that traveler can make informed alternative travel decisions prior to trip or en-route.

G. **Clear, Timely Directions to Follow Desired Route**

Should provide easy to understand directions and guidance on how best to proceed from traveler's starting point or current location to traveler's destination following traveler's planned or alternate route.

H. **Get to Destination Directly without Unnecessary Stops, Delays**

Should allow travel directly to destination without delay. Travel should be smooth flowing and free of unnecessary stopping, waiting, transfers, or traveling below the speed limit.

I. **Safe from Accident, Injury, Theft, Violence**

Traveler's should have confidence that travel will be free of accident, injury, theft, or violence.

J. **Timely Information on Alternatives to Avoid Delays**

Information on alternative routes, modes, departure times, etc. should be available in time to avoid travel conditions that cause unacceptable travel delays.

- K. Easy Access to Comprehensive Travel Services and Information**
Should provide easy access to accurate travel services information along traveler's route and at traveler's destination such as food, lodging, sights, entertainment, events, etc. Information should be available prior to trip or en-route.
- L. Timely, Accurate Road Construction, Maintenance Information**
Sufficient, advanced warning of current and planned road construction and maintenance conditions should be available so that traveler can make informed travel alternatives decisions prior to trip or en-route.
- M. Free of Stressful Experiences**
Travel should be free of experiences that cause confusion, frustration or fear such as: poorly lighted or striped highways, confusing/insufficient signage and directions information, congestion, unnecessary starting and stopping, unknown road conditions, unsafe or discourteous driver behavior, unreliable transit schedules, etc.
- N. Able to Make Good Use of Travel Time**
Should allow traveler to make good use of their travel time. Should be able to conduct business such as phone calls, banking or using a computer, etc. or enjoy leisure activities such as reading, music, TV, movies, games, eating etc. while traveling.
- O. Good Value for Cost**
Should be economical and cost-effective for the value provided.
- P. Get Help Quickly in Event of Accident, Emergency, Breakdown**
Accidents, emergencies and breakdowns should be quickly detected and reported. All necessary services should be readily available, respond quickly, and deal with the situation in a safe manner.
- Q. Comfortable and Easy to Use**
Should be clean, comfortable, quiet, well-lit and marked, protected from weather, should not smell, should provide rest rooms, smoke-free options, and good viewing of scenery. Transportation services should be easy to use.
- R. Fair, Aggressive Law Enforcement**
Should provide fair, aggressive enforcement of law and regulation violations such as speeding, tailgating, improper use of turn signals, slow travel in passing lanes, drunk driving, overweight loads, illegal use of HOV lanes, etc.

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Appendix B: Minnesota Services Definitions

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Minnesota User Service Descriptions

Advanced Traveler Information Services

Travel Conditions Information (TCI) provides current and/or forecast (future) travel conditions for a specific area or along a specific single mode or multi-modal route. Travel conditions information includes traffic speeds and congestion levels, weather, road surface conditions, accidents, construction, planned events, transit conditions, and parking lot status. The effects these conditions have on travel are also reported, including delay times, reduced speeds, dangers/hazards, road/ramp closures, detours, parking availability, and expected duration of the conditions (start time and end time). Travel conditions information is provided to travelers through a variety of devices available prior to trip or en route.

Trip Planning and Directions (TPD) provides the ability to build the optimum single mode or multi modal route travel plan based on a mix of user-specified criteria such as origin/destination, travel mode(s), departure time, arrival time, trip duration, route type, cost, etc. Trip Planning and Directions supports "what if" route planning based on different criteria combinations. This service recommends alternate routes/route segments based on criteria or travel conditions changes, gives current conditions along the alternate route, and provides new estimated travel/arrival time.

The Trip Planning and Directions Service also provides the ability to get step-by-step directions, in text and/or map form, for any route or specific user-specified destination. Optionally, this service provides automated location, and guidance through a set of directions.

Ride Matching and Reservations (RMR) provides users with information on ride share options (such as public transit bus, express bus, car pool, vanpool, taxi, paratransit or other specialized service), based on user-specified criteria (such as date/time of pick-up/drop-off, origin, destination, and specific restrictions and preferences). This service provides real-time matching of user ride needs with services available from providers. In addition, this service provides users with the capability to reserve a ride.

Traveler Services Information (TSI) provides travelers with access to "yellow pages" information, and allows them to filter the information by category (such as restaurants, lodging, travel modes, etc.) by preferences (such as price, provider, cuisine, etc.) and/or location perspective (such as nearest to my current location, at this exit, along my route, at my destination, etc.). This service also provides the traveler with the capability to make reservations or purchase tickets.

Advance Traffic Management

Traffic Control (TC) provides the capabilities to optimize traffic movement on freeways, highways, and arterials throughout jurisdictions and multi-jurisdictional areas. This service provides for coordinated traffic flow via pre-planned traffic control plans. Signal timing and message signing are adaptable based on control plans and real-time traffic conditions feedback.

Travel Demand Management (TDM) provides the capability to reduce single occupancy vehicle use and encourages use of higher occupancy modes travel (e.g., carpools, transit, rail, etc). It provides intermodal information to travelers prior to their departure, and makes high occupancy modes of travel more convenient and easier to use.

Emission Testing and Mitigation (ETM) provides the capabilities to monitor and log pollution levels within a pre-defined geographic area and report pollution levels to regulatory agencies. This service analyzes collected pollution data to create a recommended pollution control strategy for state and local environmental and regulatory agency.

Public Transportation

Public Transportation Fleet Management (TFM) monitors real-time schedule adherence of public transit vehicles, and provides assistance in getting transit vehicles back on schedule when schedule deviations occur. This service also develops transit routes and schedules, dispatches vehicles, allocates drivers to vehicles and routes, provides real-time guidance directions to drivers of demand responsive transit vehicles, monitors vehicle systems, determines maintenance schedules for fleet vehicles and facilities, assigns maintenance personnel to individual vehicle maintenance tasks, and determines when drivers and maintainers need additional training or certification.

System Management

Account Management (AM) provides the capability for users to maintain travel services account information including personal profiles, fees for services used, billing for services and payment.

Maintenance (MNT) compares vehicle mileage and other vehicle condition data with preventative maintenance schedules to develop a prioritized list of maintenance tasks. Personnel availability and skill levels are then compared to the prioritized and unscheduled (i.e. vehicle breakdown) maintenance tasks to a) assign mechanics to vehicle maintenance tasks, and b) request vehicles be assigned to a maintenance garage. Vehicle maintenance and condition history information is maintained to assist the mechanic in performing maintenance tasks.

Training (TNG) provides a capability to educate both transportation service provider personnel and public users of transportation services. For transportation service provider personnel, Training compares personnel training records with periodic training and certification requirements to develop a prioritized list of training tasks. Personnel availability is then compared to the prioritized list of training tasks and course availability information to assign personnel to courses. Personnel training and

certification history information is maintained to plan future training activity, and to assist various regulatory agencies by providing easy access to credential information.

Commercial Vehicle Operations

Commercial Vehicle Inspection/Clearance (IC) automates domestic and international border clearance functions. Vehicles are inspected for safety, credentials, size and weight. Drivers are checked for certification, tax payment status, alertness, etc. Automated data collection and automated/integrated processes eliminate unnecessary delays at border crossings for both the carrier and enforcement personnel.

Commercial Fleet Management (CFM) optimizes the commercial fleet dispatch function in order to improve reliability and efficiency of commercial vehicle operations. CFM receives customer/load move requests and determines the most appropriate dispatch response based on real-time vehicle and driver information. Vehicle information includes current location, status, ETA, and equipment configuration (such as load limits and refrigeration capability, etc). Driver information includes certification, availability, etc. This information may be expanded to include additional management functions such as vehicle maintenance schedules and driver certification status and education/training requirements. All processes associated with vehicle dispatching, to the conclusion and historical logging of the delivery, are contained within this service. This service includes electronic administration functions for certification applications, mileage, fuel, and tax payment reporting. Scope of responsibility may be regional, interstate, intrastate, or international.

Emergency Management

Incident/Emergency Management (IEM) provides the capability to rapidly and effectively respond to detected or reported incidents and travel emergencies. This service provides for coordinated multi-jurisdictional incident response via preplanned action plans and procedures. Emergency resources (vehicles, personnel and equipment) are assigned as needed based on incident response needs and available resources. This service also provides for real-time monitoring and reporting of incident status.

Public Travel Security (PTS) provides identification for ridesharing participants for verification by other ridesharing participants. An optional capability to include Transit Police Functions could also be provided. (Need to define Transit Police functions). It also provides the capability to collect and report federal, state and local regulatory information to law enforcement personnel or other authorized enforcement agencies; and receive notifications from citizens about dangerous situations (i.e.; reckless driving, robberies, etc.). Law enforcement information may consist of driver traffic citations, vehicle registration and insurance, reporting of dangerous situations, and/or commercial vehicle clearances.

1 Appendix C: Wants and Needs Demand

2 Weight Tables

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Minnesota Traveler Wants and Needs: Overall Group	Importance (1-10)	Satisfaction (1-10)	Demand Weight *
R. Fair, Aggressive Law Enforcement	8.5	7.2	7.4
L. Timely, Accurate Road Construction, Maintenance Information	7.5	6.9	7.2
M. Free of Stressful Experiences	8.1	7.3	6.8
P. Get Help Quickly in Event of Accident, Emergency, Breakdown	9.0	7.6	6.6
J. Timely Information on Alternatives to Avoid Delays	6.8	6.9	6.5
E. Timely, Accurate Accident, Traffic and Congestion Information	7.1	7.0	6.5
F. Timely, Accurate Weather and Road Conditions	8.0	7.7	5.8
I. Safe from Accident, Injury, Theft, Violence	9.4	8.0	5.8
B. Best Route Plan Based on Specified Criteria	6.3	7.2	5.6
A. Choice of Travel Modes	5.6	6.7	5.5
G. Clear, Timely Directions to Follow Desired Route	7.8	7.7	5.4
O. Good Value for Cost	8.3	7.9	5.3
H. Get to Destination Directly Without Unnecessary Stops, Delays	8.4	8.0	5.3
K. Easy Access to Comprehensive Travel Services & Information	6.6	7.7	4.8
N. Able to Make Good Use of Travel Time	5.9	7.6	4.5
D. Travel Mode is Available Wherever Needed	8.9	8.5	4.2
C. Travel Mode is Available Whenever Needed	9.1	8.8	3.5
Q. Comfortable and Easy to Use	8.5	8.7	3.4

* Reference Section 3.3.9 for Demand Weight Formula

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Minnesota Traveler Wants and Needs: Single Occupancy Vehicle (SOV) Group	Importance (1-10)	Satisfaction (1-10)	Demand Weight *
R. Fair, Aggressive Law Enforcement	8.4	7.4	7.4
M. Free of Stressful Experiences	7.9	7.3	7.0
E. Timely, Accurate Accident, Traffic and Congestion Information	6.7	6.9	7.0
L. Timely, Accurate Road Construction, Maintenance Info	6.9	7.0	6.9
J. Timely Information on Alternatives to Avoid Delays	6.2	6.8	6.6
P. Get Help Quickly in Event of Accident, Emergency, Breakdown	8.7	7.8	6.4
F. Timely, Accurate Weather and Road Conditions Information	7.7	7.6	6.2
A. Choice of Travel Modes	5.0	6.4	6.0
I. Safe from Accident, Injury, Theft, Violence	9.3	8.1	5.9
O. Good Value for Cost	8.1	7.9	5.7
G. Clear, Timely Directions to Follow Desired Route	6.7	7.6	5.4
B. Best Route Plan Based on Specified Criteria	5.3	7.1	5.3
H. Get to Destination Directly Without Unnecessary Stops, Delays	8.5	8.3	5.0
K. Easy Access to Comprehensive Travel Services & Information	5.8	7.5	4.8
N. Able to Make Good Use of Travel Time	5.5	7.5	4.6
D. Travel Mode is Available Wherever Needed	8.7	8.8	3.6
Q. Comfortable and Easy to Use	8.4	8.9	3.1
C. Travel Mode is Available Whenever Needed	9.1	9.0	3.0

* Reference Section 3.3.9 for Demand Weight Formula

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Minnesota Traveler Wants and Needs: Carpool Group	Importance (1-10)	Satisfaction (1-10)	Demand Weight *
R. Fair, Aggressive Law Enforcement	8.4	6.3	8.7
M. Free of Stressful Experiences	8.1	6.2	8.6

P. Get Help Quickly in Event of Accident, Emergency, Breakdown	8.9	7.3	7.0
L. Timely, Accurate Road Construction, Maintenance Information	7.3	6.4	6.7
J. Timely Information on Alternatives to Avoid Delays	6.7	6.0	6.4
I. Safe from Accident, Injury, Theft, Violence	9.6	7.8	6.3
H. Get to Destination Directly Without Unnecessary Stops, Delays	8.4	7.3	5.9
F. Timely, Accurate Weather and Road Conditions Information	7.7	7.1	5.8
D. Travel Mode is Available Wherever Needed	8.9	7.8	5.6
C. Travel Mode is Available Whenever Needed	9.1	8.0	5.5
O. Good Value for Cost	8.4	7.6	5.3
E. Timely, Accurate Accident, Traffic and Congestion Information	7.1	6.8	5.2
B. Best Route Plan Based on Specified Criteria	5.9	6.5	4.6
G. Clear, Timely Directions to Follow Desired Route	6.3	7.3	4.2
Q. Comfortable and Easy to Use	8.3	8.2	3.9
A. Choice of Travel Modes	6.7	7.1	3.7
K. Easy Access to Comprehensive Travel Services & Information	5.3	6.8	3.7
N. Able to Make Good Use of Travel Time	5.9	7.2	2.9

* Reference Section 3.3.9 for Demand Weight Formula

Minnesota Traveler Wants and Needs: Public Transit/Bus Users	Importance (1-10)	Satisfaction (1-10)	Demand Weight *
D. Travel Mode is Available Wherever Needed	7.7	6.0	9.6
C. Travel Mode is Available Whenever Needed	8.6	6.5	9.5
R. Fair, Aggressive Law Enforcement	8.4	6.9	7.7
P. Get Help Quickly in Event of Accident, Emergency, Breakdown	8.6	7.2	7.4
O. Good Value for Cost	8.6	7.6	5.7
H. Get to Destination Directly Without Unnecessary Stops, Delays	8.5	7.7	5.4
F. Timely, Accurate Weather and Road Conditions Information	6.9	7.1	5.4

J. Timely Information on Alternatives to Avoid Delays	6.1	6.4	5.4
M. Free of Stressful Experiences	8.0	7.6	5.3
L. Timely, Accurate Road Construction, Maintenance Information	6.3	6.8	5.3
I. Safe from Accident, Injury, Theft, Violence	9.3	8.2	5.2
Q. Comfortable and Easy to Use	8.4	7.9	5.1
E. Timely, Accurate Accident, Traffic and Congestion Information	6.2	6.8	4.9
A. Choice of Travel Modes	7.6	7.0	4.6
G. Clear, Timely Directions to Follow Desired Route	7.1	7.4	4.6
K. Easy Access to Comprehensive Travel Services & Information	5.3	6.8	3.9
B. Best Route Plan Based on Specified Criteria	6.8	7.6	3.3
N. Able to Make Good Use of Travel Time	7.0	8.1	1.8

* Reference Section 3.3.9 for Demand Weight Formula

Minnesota Traveler Wants and Needs: Heavy Driver Group	Importance (1-10)	Satisfaction (1-10)	Demand Weight *
M. Free of Stressful Experiences	7.8	6.6	8.1
E. Timely, Accurate Accident, Traffic and Congestion Information	6.9	6.7	6.8
L. Timely, Accurate Road Construction, Maintenance Information	7.2	6.9	6.7
R. Fair, Aggressive Law Enforcement	7.9	7.2	6.6
H. Get to Destination Directly Without Unnecessary Stops, Delays	8.9	7.6	6.4
J. Timely Information on Alternatives to Avoid Delays	6.6	6.8	6.4
O. Good Value for Cost	7.9	7.4	6.3
P. Get Help Quickly in Event of Accident, Emergency, Breakdown	8.6	7.6	6.2
F. Timely, Accurate Weather and Road Conditions Information	7.7	7.5	5.7
B. Best Route Plan Based on Specified Criteria	5.7	6.7	5.7
I. Safe from Accident, Injury, Theft, Violence	9.3	8.0	5.5

N. Able to Make Good Use of Travel Time	6.8	7.5	5.0
G. Clear, Timely Directions to Follow Desired Route	7.3	7.7	4.9
A. Choice of Travel Modes	4.1	6.2	4.6
Q. Comfortable and Easy to Use	8.6	8.3	4.4
K. Easy Access to Comprehensive Travel Services & Information	5.5	7.4	4.3
D. Travel Mode is Available Wherever Needed	9.3	8.7	3.5
C. Travel Mode is Available Whenever Needed	9.4	8.9	3.1

* Reference Section 3.3.9 for Demand Weight Formula

Minnesota Traveler Wants and Needs: Employed - Non-Work Trips	Importance (1-10)	Satisfaction (1-10)	Demand Weight *
R. Fair, Aggressive Law Enforcement	8.4	7.2	7.6
P. Get Help Quickly in Event of Accident, Emergency, Breakdown	9.1	7.4	7.5
L. Timely, Accurate Road Construction, Maintenance Information	7.3	6.8	7.4
M. Free of Stressful Experiences	8.1	7.4	6.7
E. Timely, Accurate Accident, Traffic and Congestion Information	6.9	7.0	6.6
J. Timely Information on Alternatives to Avoid Delays	6.5	7.1	6.1
I. Safe from Accident, Injury, Theft, Violence	9.4	8.1	5.7
F. Timely, Accurate Weather and Road Conditions Information	7.7	7.7	5.7
B. Best Route Plan Based on Specified Criteria	6.4	7.3	5.6
A. Choice of Travel Modes	5.7	7.0	5.5
G. Clear, Timely Directions to Follow Desired Route	7.9	7.8	5.4
O. Good Value for Cost	8.3	8.1	5.1
H. Get to Destination Directly Without Unnecessary Stops, Delays	8.3	8.1	5.1
K. Easy Access to Comprehensive Travel Services & Information	6.7	7.7	4.9
N. Able to Make Good Use of Travel Time	6.0	7.7	4.5

D. Travel Mode is Available Wherever Needed	8.8	8.6	4.1
Q. Comfortable and Easy to Use	8.6	8.8	3.3
C. Travel Mode is Available Whenever Needed	9.0	8.9	3.2

* Reference Section 3.3.9 for Demand Weight Formula

Minnesota Traveler Wants and Needs: Non-Workers - All Trips	Importance (1-10)	Satisfaction (1-10)	Demand Weight *
R. Fair, Aggressive Law Enforcement	9.0	7.3	8.3
L. Timely, Accurate Road Construction, Maintenance Information	7.8	7.3	7.1
J. Timely Information on Alternatives to Avoid Delays	7.1	7.3	6.5
I. Safe from Accident, Injury, Theft, Violence	9.4	8.0	6.3
M. Free of Stressful Experiences	8.4	7.8	6.3
P. Get Help Quickly in Event of Accident, Emergency, Breakdown	9.4	8.1	6.1
E. Timely, Accurate Accident, Traffic and Congestion Information	7.6	7.6	6.1
A. Choice of Travel Modes	6.3	7.2	5.9
G. Clear, Timely Directions to Follow Desired Route	8.4	8.0	5.6
B. Best Route Plan Based on Specified Criteria	6.7	7.5	5.5
O. Good Value for Cost	8.6	8.2	5.2
F. Timely, Accurate Weather and Road Conditions Information	8.5	8.2	5.2
K. Easy Access to Comprehensive Travel Services & Information	6.9	7.8	5.1
H. Get to Destination Directly Without Unnecessary Stops, Delays	8.1	8.2	5.0
N. Able to Make Good Use of Travel Time	5.8	7.5	4.8
D. Travel Mode is Available Wherever Needed	9.2	8.5	4.5
C. Travel Mode is Available Whenever Needed	9.3	8.9	3.4
Q. Comfortable and Easy to Use	8.5	8.9	3.2

* Reference Section 3.3.9 for Demand Weight Formula

Minnesota Traveler Wants and Needs: Travel in Unfamiliar Areas	Importance (1-10)	Satisfaction (1-10)	Demand Weight *
R. Fair, Aggressive Law Enforcement	8.4	6.9	7.4
L. Timely, Accurate Road Construction, Maintenance Information	7.9	6.7	7.4
P. Get Help Quickly in Event of Accident, Emergency, Breakdown	9.1	7.5	6.6
J. Timely Information on Alternatives to Avoid Delays	7.3	6.8	6.6
M. Free of Stressful Experiences	8.3	7.3	6.5
E. Timely, Accurate Accident, Traffic and Congestion Information	7.3	7.0	6.2
F. Timely, Accurate Weather and Road Conditions Information	8.1	7.4	6.1
A. Choice of Travel Modes	6.0	6.6	5.8
I. Safe from Accident, Injury, Theft, Violence	9.4	7.9	5.7
G. Clear, Timely Directions to Follow Desired Route	8.5	7.7	5.7
B. Best Route Plan Based on Specified Criteria	7.0	7.2	5.6
H. Get to Destination Directly Without Unnecessary Stops, Delays	8.3	7.8	5.2
O. Good Value for Cost	8.3	8.0	4.8
K. Easy Access to Comprehensive Travel Services & Information	7.5	7.8	4.8
D. Travel Mode is Available Wherever Needed	8.8	8.2	4.5
C. Travel Mode is Available Whenever Needed	9.0	8.4	4.0
N. Able to Make Good Use of Travel Time	6.0	7.7	4.0
Q. Comfortable and Easy to Use	8.4	8.7	3.2

* Reference Section 3.3.9 for Demand Weight Formula

Appendix D: Demographic Analysis Tables

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Minnesota Traveler Wants and Needs Demographics Comparison: Metro -vs- Non-Metro Counties	More Important		Less Satisfied	
	Metro	Non-Metro	Metro	Non-Metro
R. Fair, Aggressive Law Enforcement				
L. Timely, Accurate Road Construction, Maintenance Information	X			
P. Get Help Quickly in Event of Accident, Emergency, Breakdown		X		
M. Free of Stressful Experiences			X	
E. Timely, Accurate Accident, Traffic and Congestion Information	X			
J. Timely Information on Alternatives to Avoid Delays	X			
I. Safe from Accident, Injury, Theft, Violence			X	
A. Choice of Travel Modes	X			
F. Timely, Accurate Weather and Road Conditions				
B. Best Route Plan Based on Specified Criteria				
O. Good Value for Cost				
G. Clear, Timely Directions to Follow Desired Route				
H. Get to Destination Directly Without Unnecessary Stops, Delays			X	
K. Easy Access to Comprehensive Travel Services & Information				
N. Able to Make Good Use of Travel Time				
D. Travel Mode is Available Wherever Needed	X			
C. Travel Mode is Available Whenever Needed	X			
Q. Comfortable and Easy to Use				

“X” indicates that the paired values are statistically different for this field.

Minnesota Traveler Wants and Needs Demographics Comparison: Commuter Miles Less Than 10 (<) -vs- Commuter Miles Greater Than 10 (>)	More Important		Less Satisfied	
	< 10	>10	<10	>10
R. Fair, Aggressive Law Enforcement				
L. Timely, Accurate Road Construction, Maintenance Information				
P. Get Help Quickly in Event of Accident, Emergency, Breakdown		X		
M. Free of Stressful Experiences				
E. Timely, Accurate Accident, Traffic and Congestion Information				
J. Timely Information on Alternatives to Avoid Delays		X		
I. Safe from Accident, Injury, Theft, Violence				
A. Choice of Travel Modes				
F. Timely, Accurate Weather and Road Conditions				
B. Best Route Plan Based on Specified Criteria				
O. Good Value for Cost				
G. Clear, Timely Directions to Follow Desired Route				
H. Get to Destination Directly Without Unnecessary Stops, Delays				X
K. Easy Access to Comprehensive Travel Services & Information				
N. Able to Make Good Use of Travel Time		X		
D. Travel Mode is Available Wherever Needed				
C. Travel Mode is Available Whenever Needed				
Q. Comfortable and Easy to Use				

“X” indicates that the paired values are statistically different for this field.

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Minnesota Traveler Wants and Needs Demographics Comparison: Peak Hour Travelers - vs- Non-Peak Hour Travelers	More Important	Less Satisfied

	Peak	Non-Peak	Peak	Non-Peak
R. Fair, Aggressive Law Enforcement				
L. Timely, Accurate Road Construction, Maintenance Information			X	
P. Get Help Quickly in Event of Accident, Emergency, Breakdown		X		
M. Free of Stressful Experiences				
E. Timely, Accurate Accident, Traffic and Congestion Information			X	
J. Timely Information on Alternatives to Avoid Delays				
I. Safe from Accident, Injury, Theft, Violence				
A. Choice of Travel Modes				
F. Timely, Accurate Weather and Road Conditions		X	X	
B. Best Route Plan Based on Specified Criteria		X		
O. Good Value for Cost		X		
G. Clear, Timely Directions to Follow Desired Route				
H. Get to Destination Directly Without Unnecessary Stops, Delays		X		
K. Easy Access to Comprehensive Travel Services & Information			X	
N. Able to Make Good Use of Travel Time				
D. Travel Mode is Available Wherever Needed				
C. Travel Mode is Available Whenever Needed				
Q. Comfortable and Easy to Use				

“X” indicates that the paired values are statistically different for this field.

Minnesota Traveler Wants and Needs Demographics Comparison: Gender	More Important		Less Satisfied	
	Male	Female	Male	Female
R. Fair, Aggressive Law Enforcement		X		
L. Timely, Accurate Road Construction, Maintenance Information		X	X	
P. Get Help Quickly in Event of Accident, Emergency, Breakdown		X		
M. Free of Stressful Experiences		X	X	
E. Timely, Accurate Accident, Traffic and Congestion Information		X	X	
J. Timely Information on Alternatives to Avoid Delays		X	X	
I. Safe from Accident, Injury, Theft, Violence		X		
A. Choice of Travel Modes		X	X	
F. Timely, Accurate Weather and Road Conditions		X	X	
B. Best Route Plan Based on Specified Criteria		X	X	
O. Good Value for Cost		X	X	
G. Clear, Timely Directions to Follow Desired Route		X	X	
H. Get to Destination Directly Without Unnecessary Stops, Delays		X	X	
K. Easy Access to Comprehensive Travel Services & Information		X	X	
N. Able to Make Good Use of Travel Time			X	
D. Travel Mode is Available Wherever Needed		X		
C. Travel Mode is Available Whenever Needed		X		
Q. Comfortable and Easy to Use		X	X	

“X” indicates that the paired values are statistically different for this field.

Minnesota Traveler Wants and Needs Demographics Comparison: Employed Travelers -vs- Non-Workers/Part Time Employees	More Important	Less Satisfied

	Emp- loyed	Non/ Part	Emp- loyed	Non/ Part
R. Fair, Aggressive Law Enforcement		X		
L. Timely, Accurate Road Construction, Maintenance Information		X		
P. Get Help Quickly in Event of Accident, Emergency, Breakdown		X	X	
M. Free of Stressful Experiences			X	
E. Timely, Accurate Accident, Traffic and Congestion Information		X	X	
J. Timely Information on Alternatives to Avoid Delays		X	X	
I. Safe from Accident, Injury, Theft, Violence				
A. Choice of Travel Modes		X		
F. Timely, Accurate Weather and Road Conditions		X	X	
B. Best Route Plan Based on Specified Criteria		X	X	
O. Good Value for Cost		X		
G. Clear, Timely Directions to Follow Desired Route		X		
H. Get to Destination Directly Without Unnecessary Stops, Delays				
K. Easy Access to Comprehensive Travel Services & Information		X	X	
N. Able to Make Good Use of Travel Time				
D. Travel Mode is Available Wherever Needed				
C. Travel Mode is Available Whenever Needed				
Q. Comfortable and Easy to Use				

“X” indicates that the paired values are statistically different for this field.

Minnesota Traveler Wants and Needs Demographics Comparison: Travelers aged 18-34 -vs- Remaining Ages	More Important		Less Satisfied	
	Rem.	18-34	Rem.	18-34
R. Fair, Aggressive Law Enforcement				
L. Timely, Accurate Road Construction, Maintenance Information				

P. Get Help Quickly in Event of Accident, Emergency, Breakdown				
M. Free of Stressful Experiences				
E. Timely, Accurate Accident, Traffic and Congestion Information				
J. Timely Information on Alternatives to Avoid Delays				
I. Safe from Accident, Injury, Theft, Violence				
A. Choice of Travel Modes				
F. Timely, Accurate Weather and Road Conditions				
B. Best Route Plan Based on Specified Criteria				
O. Good Value for Cost				
G. Clear, Timely Directions to Follow Desired Route				
H. Get to Destination Directly Without Unnecessary Stops, Delays				
K. Easy Access to Comprehensive Travel Services & Information				
N. Able to Make Good Use of Travel Time		X		
D. Travel Mode is Available Wherever Needed				
C. Travel Mode is Available Whenever Needed				
Q. Comfortable and Easy to Use				

“X” indicates that the paired values are statistically different for this field.

Minnesota Traveler Wants and Needs Demographics Comparison: Travelers aged 35-54 -vs- Remaining Ages	More Important		Less Satisfied	
	Rem.	35-54	Rem.	35-54
R. Fair, Aggressive Law Enforcement				
L. Timely, Accurate Road Construction, Maintenance Information				
P. Get Help Quickly in Event of Accident, Emergency, Breakdown				
M. Free of Stressful Experiences				
E. Timely, Accurate Accident, Traffic and Congestion Information				

J. Timely Information on Alternatives to Avoid Delays				
I. Safe from Accident, Injury, Theft, Violence				
A. Choice of Travel Modes				X
F. Timely, Accurate Weather and Road Conditions				
B. Best Route Plan Based on Specified Criteria				
O. Good Value for Cost				
G. Clear, Timely Directions to Follow Desired Route				
H. Get to Destination Directly Without Unnecessary Stops, Delays				
K. Easy Access to Comprehensive Travel Services & Information				
N. Able to Make Good Use of Travel Time				
D. Travel Mode is Available Wherever Needed				
C. Travel Mode is Available Whenever Needed				
Q. Comfortable and Easy to Use				

“X” indicates that the paired values are statistically different for this field.

Minnesota Traveler Wants and Needs Demographics Comparison: Travelers aged 55+ -vs- Remaining Ages	More Important		Less Satisfied	
	Rem.	55+	Rem.	55+
R. Fair, Aggressive Law Enforcement		X		
L. Timely, Accurate Road Construction, Maintenance Information			X	
P. Get Help Quickly in Event of Accident, Emergency, Breakdown			X	
M. Free of Stressful Experiences			X	
E. Timely, Accurate Accident, Traffic and Congestion Information			X	
J. Timely Information on Alternatives to Avoid Delays			X	
I. Safe from Accident, Injury, Theft, Violence				
A. Choice of Travel Modes				

F. Timely, Accurate Weather and Road Conditions			X	
B. Best Route Plan Based on Specified Criteria			X	
O. Good Value for Cost			X	
G. Clear, Timely Directions to Follow Desired Route				
H. Get to Destination Directly Without Unnecessary Stops, Delays			X	
K. Easy Access to Comprehensive Travel Services & Information				
N. Able to Make Good Use of Travel Time	X			
D. Travel Mode is Available Wherever Needed			X	
C. Travel Mode is Available Whenever Needed			X	
Q. Comfortable and Easy to Use			X	

“X” indicates that the paired values are statistically different for this field.

Minnesota Traveler Wants and Needs Demographics Comparison: Income Less Than \$30K/yr -vs- Remaining Incomes	More Important		Less Satisfied	
	Rem.	<\$30K	Rem.	<\$30K
R. Fair, Aggressive Law Enforcement			X	
L. Timely, Accurate Road Construction, Maintenance Information		X		
P. Get Help Quickly in Event of Accident, Emergency, Breakdown			X	
M. Free of Stressful Experiences			X	
E. Timely, Accurate Accident, Traffic and Congestion Information			X	
J. Timely Information on Alternatives to Avoid Delays		X	X	
I. Safe from Accident, Injury, Theft, Violence				
A. Choice of Travel Modes		X		
F. Timely, Accurate Weather and Road Conditions		X		
B. Best Route Plan Based on Specified Criteria		X	X	
O. Good Value for Cost		X		

G. Clear, Timely Directions to Follow Desired Route		X	X	
H. Get to Destination Directly Without Unnecessary Stops, Delays			X	
K. Easy Access to Comprehensive Travel Services & Information		X		
N. Able to Make Good Use of Travel Time		X		
D. Travel Mode is Available Wherever Needed				X
C. Travel Mode is Available Whenever Needed				X
Q. Comfortable and Easy to Use				

“X” indicates that the paired values are statistically different for this field.

Minnesota Traveler Wants and Needs Demographics Comparison: Income Between \$30K-\$50K/yr -vs- Remaining Incomes	More Important		Less Satisfied	
	Rem.	\$30-50	Rem.	\$30-50
R. Fair, Aggressive Law Enforcement				
L. Timely, Accurate Road Construction, Maintenance Information				
P. Get Help Quickly in Event of Accident, Emergency, Breakdown				
M. Free of Stressful Experiences				
E. Timely, Accurate Accident, Traffic and Congestion Information				
J. Timely Information on Alternatives to Avoid Delays				
I. Safe from Accident, Injury, Theft, Violence				
A. Choice of Travel Modes				
F. Timely, Accurate Weather and Road Conditions				
B. Best Route Plan Based on Specified Criteria				X
O. Good Value for Cost				
G. Clear, Timely Directions to Follow Desired Route				
H. Get to Destination Directly Without Unnecessary Stops, Delays				
K. Easy Access to Comprehensive Travel Services & Information				

N. Able to Make Good Use of Travel Time				
D. Travel Mode is Available Wherever Needed				
C. Travel Mode is Available Whenever Needed				
Q. Comfortable and Easy to Use				

“X” indicates that the paired values are statistically different for this field.

Minnesota Traveler Wants and Needs Demographics Comparison: Income Greater Than \$50K/yr -vs- Remaining Incomes	More Important		Less Satisfied	
	Rem.	\$50+	Rem.	\$50+
R. Fair, Aggressive Law Enforcement	X			X
L. Timely, Accurate Road Construction, Maintenance Information				X
P. Get Help Quickly in Event of Accident, Emergency, Breakdown				
M. Free of Stressful Experiences				X
E. Timely, Accurate Accident, Traffic and Congestion Information				X
J. Timely Information on Alternatives to Avoid Delays				
I. Safe from Accident, Injury, Theft, Violence				
A. Choice of Travel Modes	X			
F. Timely, Accurate Weather and Road Conditions				X
B. Best Route Plan Based on Specified Criteria	X			
O. Good Value for Cost	X			
G. Clear, Timely Directions to Follow Desired Route	X			
H. Get to Destination Directly Without Unnecessary Stops, Delays				X
K. Easy Access to Comprehensive Travel Services & Information	X			
N. Able to Make Good Use of Travel Time			X	
D. Travel Mode is Available Wherever Needed				
C. Travel Mode is Available Whenever Needed				

Q. Comfortable and Easy to Use				
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“X” indicates that the paired values are statistically different for this field.

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