

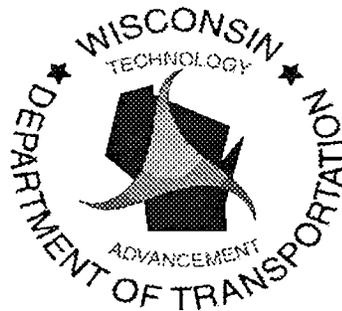


REPORT NUMBER WI/SPR-01-01

**PUBLIC PERCEPTIONS
OF THE MIDWEST'S PAVEMENTS**

EXECUTIVE SUMMARY - WISCONSIN

**FINAL REPORT
(Summary of Phases I, II and III)**



January, 2001

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<p>16. Abstract</p> <p>This report summarizes Wisconsin results of a five year, Pooled Fund study involving the Wisconsin, Iowa, and Minnesota DOTs designed to 1) assess the public's perceptions of the departments' pavement improvement strategies and 2) to develop customer-based thresholds of satisfaction with pavements on rural two lane highways in each state as related to the Departments' physical indices, such as pavement ride and condition. The primary objective was to seek systematic customer input to improve the Departments' pavement improvement policies by 1) determining how drivers perceive the departments' pavements in terms of comfort and convenience but also in terms of other tradeoffs departments had not previously considered, 2) determining relationships between perceptions and measured pavement condition thresholds (including a general level of tolerance of winter ride conditions in two of the states, including Wisconsin), and 3) identifying important attributes and issues that may not have been considered in the past. Secondary objectives were 1) to provide a tool for systematic customer input in the future and 2) provide information which can help structure public information programs.</p> <p>A University of Wisconsin-Extension survey lab conducted the surveys under the direction of a multi-disciplinary team from Marquette University. Approximately 4500 drivers in the three states participated in the three phases of the project. Researchers conducted six focus groups in each state, approximately 400 statewide telephone interviews in each state and 700-800 targeted telephone interviews in each state. Approximately 400 winter ride interviews were conducted in Wisconsin and Minnesota. A summary of the method for each survey is included.</p> <p>In Phase I, focus groups were conducted with drivers to get an initial indication of what the driving public believes in regards to pavements and to frame issues for inclusion in the more representative state-wide surveys of drivers conducted in Phase II of the project. Phase II interviews gathered information about improvement policy trade-off issues and about preliminary thresholds of improvement in terms of physical pavement indices. In Phase III, a two step recruitment and post-drive interview procedure yielded thresholds of ride and condition index summarized for each state.</p> <p>Results show that, in general, the driving public is tolerant of a poorer ride in Winter and they understand the cause. The driving public wants longer lasting pavements and are willing to pay for them. They want to minimize construction delay, improve entire sections of highway at one time but they dislike detours, and prefer construction under traffic even if it stretches out construction time. Satisfaction with pavements does not correlate directly to a high degree with physical pavement indices, but was found instead to be a complex, multi-faceted phenomenon. A psychological model (after Fishbein/Ajzen) was applied to explain satisfaction to a respectable degree (R^2 of .7) for the social sciences. Results also indicate a high degree of trust in the three DOTs which is enhanced when the public is asked for input on specific highway segments.</p> <p>Conclusions and recommendations include a three-step methodology for other state studies. Physical data thresholds based on both public satisfaction and the agreement to improve are presented for each state's physical pavement indices (ride and condition). Recommended changes to the quality ranges of the physical indices where appropriate are also made.</p>			
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Report Number: WI/SPR-01-01
WisDOT Highway Research Study #94-07

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and

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and

Minnesota Department of Transportation
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Preface

Obtaining customer input to the policies and priorities of government is essential today. This report describes a major effort to obtain public input to the pavement improvement policies and priorities of the Wisconsin DOT. Through cooperation with the Iowa, Minnesota and Wisconsin DOTs, researchers obtained input from more than 4000 drivers in the three states, over a five year period. Prior to this joint effort, no effort of this magnitude related to pavements has ever been undertaken in the US.

The report contains conclusions about drivers' perceptions as follows:

- high levels of satisfaction found with pavements on rural two lane highways*
- a high level of trust in the Wisconsin DOT;*
- a desire for longer lasting pavements and the public willingness to pay for them even though they cost more;*
- a desire to minimize construction delay, yet the dislike for detours with longer daily travel times even though it shortens overall construction time;*
- a greater tolerance of a rough ride on PCC pavements than on asphalt pavements; and*
- discussion of a model to describe what drives motorists' satisfaction with rural two lane highway pavements, its successful testing and performance for the first time on pavements and information on future testing and updating.*

Recommendations for rural two lane highways in Wisconsin indicate:

- the DOT should move toward building longer lasting pavements and conduct further market research to determine how much more the public is willing to pay;*
- reconstruct rural two lane highways under traffic rather than providing detours with longer daily travel times;*
- review current threshold levels for improvement based on IRI and PDI indices by pavement type and classification in light of this study; and*
- review quality ranges of IRI to better correlate with PDI.*

This is just a sample of what's included! There's much more!

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Public Perceptions of the Midwest's Pavements Wisconsin Executive Summary

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BACKGROUND AND INTRODUCTION

AASHO road tests in the 1950s

Data on public perceptions of pavements dates back to the AASHO Road Tests in the 1950s. A rating panel subjectively evaluated sections of differing pavement types in Ottawa, Illinois on a scale ranging from 0 to 5 and these were compared to objective ratings obtained by a profilometer. A separate model for Asphaltic Concrete (AC) and Portland Cement Concrete (PCC) pavements was developed to convert the profile data into the subjective rating (1). The sample size was quite small (less than 100 individuals). These results have been used by many states ever since.

Other studies more limited in scope

Other studies reported in the literature (2) (3), including one in Wisconsin (4) prior to the start of this project in 1995 were limited in scope or did not address the correlation between physical data and satisfaction.

In 1992, the Federal Highway Administration (FHWA) launched its National Quality Initiative (NQI) with a survey of the public's satisfaction with the nation's highway system and published results in 1996 (5). The telephone survey reached 2200 drivers and reported levels of satisfaction of the nation's highway system in general (Interstate, freeways, multi-lane and major two lane highways), along with specific elements and aspects of the highway system (i.e., pavements, maintenance, safety etc.) and summarized users' priorities for expenditures. It did not relate satisfaction to specific pavement condition indices.

WisDOT took initiative and the Iowa DOT and Minnesota DOT joined the Pooled Fund project

In 1995, the Wisconsin DOT (WisDOT) initiated a study, "Public Perceptions of the Midwest's Pavements." The FHWA's Wisconsin Division Office lent its support, and the Iowa DOT and the Minnesota DOT joined in a Pooled Fund, three- phase, multi-year project. The problem statement indicated that the departments desired to have a clear understanding of the public's perceptions of their respective highway pavements and wanted a comprehensive customer input effort undertaken. The study was limited to rural two-lane highways, which are the largest group of highways in each state.

Project Objectives

The primary objective of the study was to seek systematic customer input to improve the Departments' pavement improvement policy by:

- determining how drivers perceive the departments' pavements in terms of comfort and convenience and related tradeoffs

specific to each department not previously considered;

- determining relationships between perceptions and measured pavement condition thresholds (including a general level of tolerance of winter ride conditions in two of the states); and
- identify important attributes and issues that may not have been considered in the past.

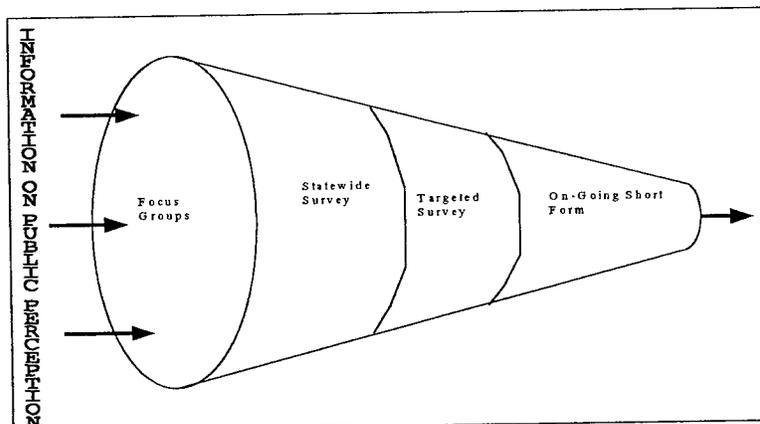
Secondary objectives were to provide a tool for systematic customer input in the future and provide information which can help structure public information programs.

A competitive solicitation of proposals resulted in selection of a multi-disciplinary team from Marquette University (MU) in Milwaukee, Wisconsin. All survey work was conducted by the University of Wisconsin Survey Research Lab (WSRL) in Madison. The research team included expertise in psychology, mass media research, statistics, marketing, and pavements.

Survey Phasing, Timing and Purpose

1996 - 2000

A three-phase study began in 1996, with Phase I (focus groups) held in the last half of 1996, Phase II (state-wide telephone surveys) in the last half of 1997 and Phase III (targeted surveys) in the last half of 1999. The delay between Phase II and III was caused by the unexpected effort required to analyze and locate the identified highway segments self-selected by drivers during the telephone surveys in Phase II. The project was conducted as three independent studies in each of the three states, each receiving separate reports for each phase. These are referenced throughout this report and are located on the web sites of (MU) and WisDOT. This report is organized around these three phases. In all cases the detailed methodology is only summarized in the interest of saving space. The three phases are best viewed as a funnel (shown below), with each phase narrowing the scope of questioning. The final phase (ongoing short form) could be a roadside interview about a single highway, but was not included in this project.



PHASE I - FOCUS GROUPS

Purpose, Methodology

Six groups around the state, 44 citizens participated

The purpose of the focus groups was to gain insights into the public's perceptions and priorities regarding the condition of the Midwest's rural, two-lane highways (hereinafter referred to as RTLH). Since regional differences in perceptions were to be explored, six focus meetings were held in six of Wisconsin's eight highway districts in the cities of Green Bay, Marshfield, Platteville, Rhinelander, Spooner and Waukesha. The focus groups ranged in size from five to nine participants, with eight participants being ideal. Participants in three cities were asked to drive a segment of State highway they regularly drove prior to coming to the meeting. Participants received \$50 if they drove and \$35 if they did not. This payment compensated them for time and expenses they incurred in order to participate. A total of 44 citizens participated.

Focus Protocol

Focus group moderators followed a script which started with broader questions and progressed to more specific evaluations of the issues. To start, participants were asked to visualize themselves driving down a stretch of RTLH. The standard protocol consisted of the following:

- a general discussion of pavement features participants liked or disliked,
- a series of questions which asked participants to choose between difficult options of improvement priorities, and
- a ranking exercise in which participants decided which factors should be considered when prioritizing the need for road repairs.

The protocol was modified after the first three groups to improve pavement terminology (ruts, grooves, ground, tining, etc.) and an explanation was included at the beginning of later focus groups to improve understanding of pavement terms.

difficulty describing specific highway segments

These were valuable sessions which raised many issues for the research team to address in the content and procedure of the telephone surveys in Phase II. It was quickly realized that participants had difficulty describing specific segments of highway they were visualizing, frequently using the limits between cities or

describing two landmarks (i.e., Joe's tavern, a particular gas station etc.) which would be difficult for the research staff of the DOTs to match with specific highway condition indices. Sufficient input was condensed to improve the design of a number of questions in the Phase II surveys. These improvements in the design of the questions allowed participants to better identify the highway segment's beginning and ending locations.

Focus groups developed terminology

Participants in all focus groups had a good understanding of pavement defects, but used a great variety of verbal and non verbal means of describing them. The focus groups generally described three levels of repair (patching, resurfacing and reconstruction) and they understood what these terms included.

"A road needs repair when you are forced to pay attention to the road surface....."

Participants were hard pressed to describe likes, focusing instead on the absence of defects. They had no trouble, however, describing an all-inclusive list of defects, like rutting, patching, bumps, inadequate shoulders. Noise and looks were minor concerns of participants. Participants had a difficult time describing just how bad the defects had to be before repair was required. They offered suggestions as to when a road needs repair, such as when you are on a first name basis with your garage mechanic replacing shock absorbers, or when the radio station changes when you hit a bump. A criterion several people identified was that a road needed repair when they were forced to pay attention to the road surface rather than other activities they were engaged in while driving.

Participants were led through an exercise listing the relative importance of features to be considered when prioritizing improvements. Traffic and highway importance were two of these. Cost was rejected by subjects as an issue that should determine priority. For nearly all participants, road repairs were a public safety concern and a matter of life and death, for a minority of participants, they were a matter of convenience and should be subject to economic considerations.

The focus group ended with participants being asked to choose between a list of difficult forced choice options to better understand how they thought different factors should be weighed in setting priorities. Specific issues included the frequency of repairs, how long pavements lasted, and if highways should be built to last longer. Some participants were skeptical about government efficiency and seemed to lack trust in government institutions. Subjects generally believed safety should come ahead of noise concerns, yet some were quite concerned about road

noise. Many could not imagine a road that was patched and rode well, but most felt that resurfacing should only occur when the ride deteriorated.

***Pavement conditon
factors affecting
“safety” used in
survey language***

At the very end of the focus group exercise, participants were given a number of stars and asked to place them adjacent to factors they had identified as important when considering improvements. Because safety always came out number one, the team agreed to substitute pavement conditions affecting safety in the telephone survey and deal with the relative importance of factors that contribute to safety that the public understands.

***“Our area receives
less attention than...”***

The survey firm (WSRL) believed that having participants drive before the focus group did not improve their ability to recall conditions. This played a role in Phase II survey methods. In trade-off exercises, discussion often centered on comparing the relative benefits and relative costs of highway improvements. Trucks impact on pavements and the amount they pay were often a point of disagreement among the participants in the groups. In general, participants believed good roads should have a high priority and were willing to pay for improvements provided funds were used efficiently and equitably. Groups in Wisconsin and all the states often thought their geographic area received less attention than the rest of the state (north vs. south, urban vs. rural) (6).

Winter Ride Survey

***40 % noticed
changes in winter
ride***

***75 % more tolerant of
poorer ride in winter***

While Phase II surveys were being designed, the WSRL included a winter ride mini survey as part of their quarterly “Wisconsin Opinion Poll” conducted from January 15 to March 15, 1997. A random-digit-dial sample of 417 Wisconsinites was surveyed. With respect to respondents’ perceptions and tolerance, almost 40 percent had noticed changes in the pavement’s ride quality since the start of winter and could link their perceptions of change to specific highway segments. Most Wisconsin respondents were predominately tolerant of the pavement’s potentially rougher ride in winter. Three-fourths of the 173 respondents who noticed a change in the pavement indicated they were more tolerant of the rougher ride in winter than they would be the rest of the year. The extent to which motorists noticed changes in a pavement was influenced by driving and vehicle characteristics. Specifically, respondents who drove more frequently on RTLH and those driving trucks, full-size vans or sport utility vehicles were more likely to notice changes. Tolerance to a rougher winter ride was greater among those who were older and drove less. Those who

Why? “Freezing changes the road”

gave poorer ratings to their vehicle’s ride were less tolerant than others. Tolerance declined as household income increased. When asked for a reason they would tolerate a rougher ride in winter, two major reasons surfaced, “freezing weather changes the road” and “nothing I can do about it.” Only 9 percent of the respondents reported avoiding specific stretches of highway due to intolerable winter ride (7).

PHASE II, STATE-WIDE SURVEYS

Purpose and Survey Design

Purpose of Phase II

The purpose of the Phase II survey was to assess perceptions and opinions about improvements of RTLH in the three states, gauge levels of satisfaction and, if possible, determine differences in these levels among regions, classes and pavement types. In addition, questions would need to be included to explain the expected variance in satisfaction among the public found in surveys such as this.

State-wide surveys with 90 + questions

The focus groups yielded a wealth of data to design a survey of public perceptions and opinions about pavement improvements. In addition, each state had certain issues they felt strongly about and wanted to include in the survey. The research team had opinions about what had to be included and finally, the WSRL had conditions that they believed essential to include, particularly the language used to ask the questions. The inputs of approximately 30 researchers and staff were considered in design of the survey. The survey included 90 questions plus explanations. Copies of the survey are available from each State DOT and are included in the Phase II report for each state (8). These are also located on the web sites of Marquette University (MU) and WisDOT. The surveys were identical in each state and included 11 screening questions, four on general driving experience, 14 involving a specific segment of road regularly driven by the participant, three on “thresholds” (explained later), four on trust in the DOTs, and 11 on behavior beliefs (pavement and non pavement) about the specific segment. The latter belief questions, along with 12 necessary for the testing of a psychological model, 10 on policy trade-offs, five on improvement priorities, 10 demographic questions and six on vehicle/licenses, completed the survey.

**Surveys 25 minutes
long without
compensation**

Methodology

What was budgeted as a 20 minute random-digit-dialing (RDD) telephone survey, utilizing the Computer Assisted Telephone Interviewing (CATI) software of the WSRL, turned out to be over 25 minutes long. Participants were not compensated. In Wisconsin 402 surveys were completed in the Fall of 1997. Each state was required to furnish data about their highway system, including maps, physical indices, such as the ride (International Roughness Index or IRI), condition and rutting for all the segments identified. Excellent cooperation was received from all three states. Staff with an interest in the results remained involved throughout the five-year process. Analyses proved to be complex and time consuming, primarily because of difficulties relating the limits of the segments described by the respondents to corresponding limits of highway segments in the State's database.

Profiles of Respondents

Gender	Percent
Male	55%
Female	45%

Age	Percent
18 - 35	29.1%
36 - 49	33.8%
50 and over	36.1%

Household Income	Percent
Less than \$30,000	27.1%
\$30,000 - \$50,000	34.1%
More than \$50,000	30.8%
No response	8.0%

Education	Percent
High School or less	42.3%
Some College	31.8%
College Graduate	25.9%

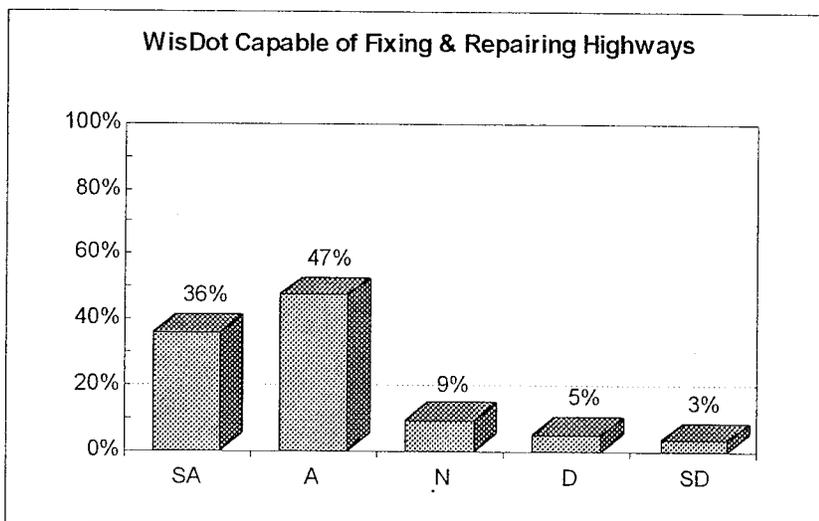
License	Percent
Regular (only)	75.9%
Commercial (CDL)	11.2 %
Motorcycle	12.9 %

Major Phase II Findings

In this section, major findings on issues of trust, pavement improvement strategies and priorities are summarized. Respondents were given choices of Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D) or Strongly Disagree (SD) on most questions. Selected results, along with paraphrased questions are shown in the following bar graphs. Complete analysis of these questions is included in the Phase II report (8) shown on the MU and WisDOT web site and published by the Transportation Research Board (TRB) in 2000 (9).

Trust in WisDOT

83 % agree WisDOT capable of fixing and repairing highways



On a second general question on trust, 61 percent agreed they trust the judgement of WisDOT in scheduling pavement improvements.

Only 43 % thought WisDOT considered their input on a given segment

In the other two questions about trust, regarding the specific highway segment selected by respondents, 75 percent agreed WisDOT officials care about the safety and convenience of drivers on the segment. Trust dropped substantially to 43 percent when drivers were asked if "the DOT considered input from drivers like me when making decisions about repairs or improvements to this stretch of highway."

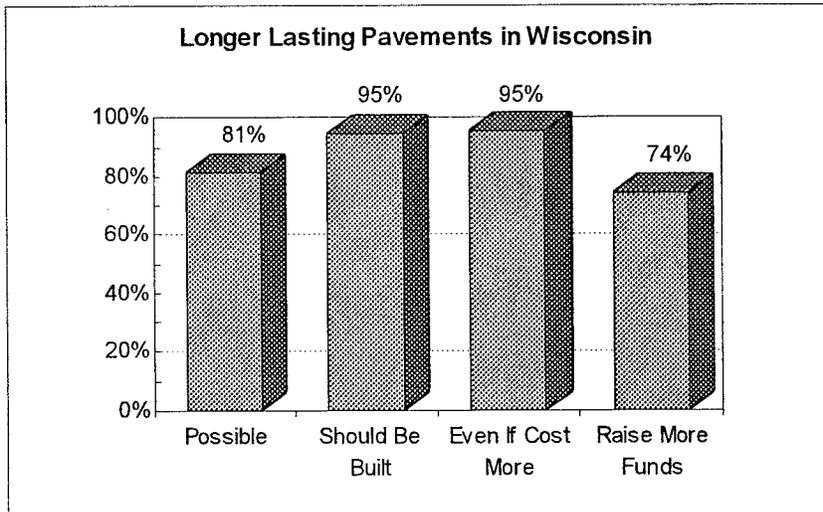
Pavement Improvement Strategies

Respondents were asked a number of questions about pavement improvement strategies and their responses are summarized in the following graphs. Improvement trade-off responses had a margin of error (+/- 5%). The first series of questions were asked about longer lasting pavements. If respondents affirmed that they believed it possible to build longer lasting pavements (329 or 81.8 %), then just those 329 were asked three follow-up questions shown to the right of the bar marked "possible" in the graph below.

81 % thought longer lasting pavements could be built, and

95 % of those thought they should be built, even if they cost more

74 % chose raise more funds to do it



States did not ask how much more the public would be willing to spend to accomplish this.

54 % agreed "provide a better ride" on more heavier traveled highways

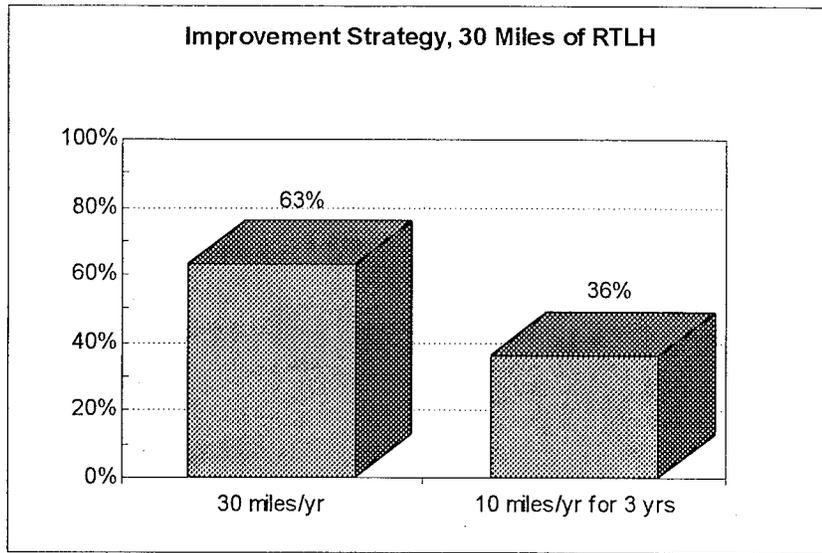
Provide shorter construction-related delays

Respondents preferred that the DOT should provide a better ride on more heavily traveled highways and would accept a bumpier ride on less traveled roads (54%), compared to those who agreed that an equal ride should be provided on all highways (44%).

When asked about preferring to improve highways every 10 - 12 years and tolerate "shorter construction delays," or every 18 - 20 years and tolerate poorer rides toward the end of life, 79 percent agreed with the shorter option and less delay. When the question was tested again in Phase III (but not in a random, state-wide survey), with consequences of shorter or longer "construction-related delay," 79 percent of the sample again chose the 10 year improvement (with shorter delay) instead of the 20 year improvement (with longer delay).

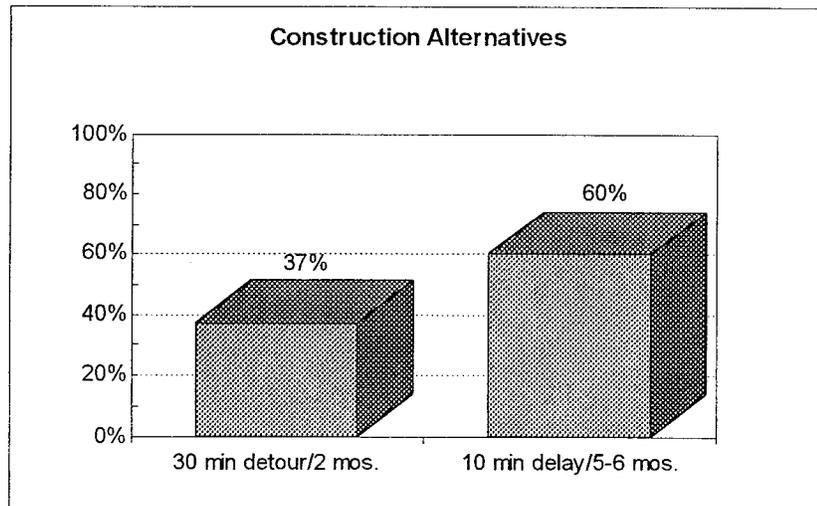
Responses (% who SA or A) about a choice of improvement strategies for a given 30 mile stretch of RTLH are shown below.

Do it all at the same time



When asked about construction with a detour or construction under traffic, the majority agreed with less daily travel delay.

Less daily travel delay for a longer duration is preferred to more delay for a shorter duration

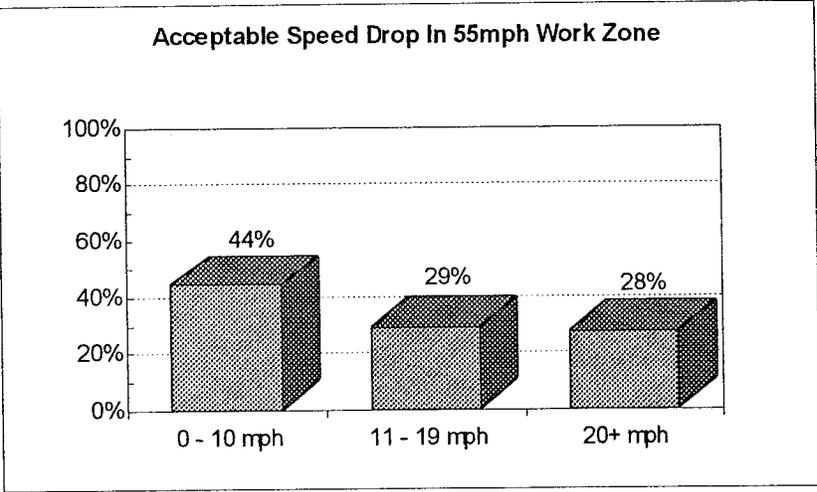


The above two responses are not necessarily incompatible. For project planning purposes, the public wants to see all segments of a highway improved during one year. For construction purposes the public prefers traveling the highway under construction with a shorter 10 minute delay rather than driving a detour with a 30 minute delay, even if the project could be completed sooner.

Two questions on travel time through a 10 mile long work zone on a 55 mph RTLH asked respondents for an acceptable and

unacceptable work zone speed limit. Since these were open ended questions in Phase II (any speed recorded), the difference between what was acceptable and unacceptable for each was calculated and the percent responses in three speed ranges are shown below.

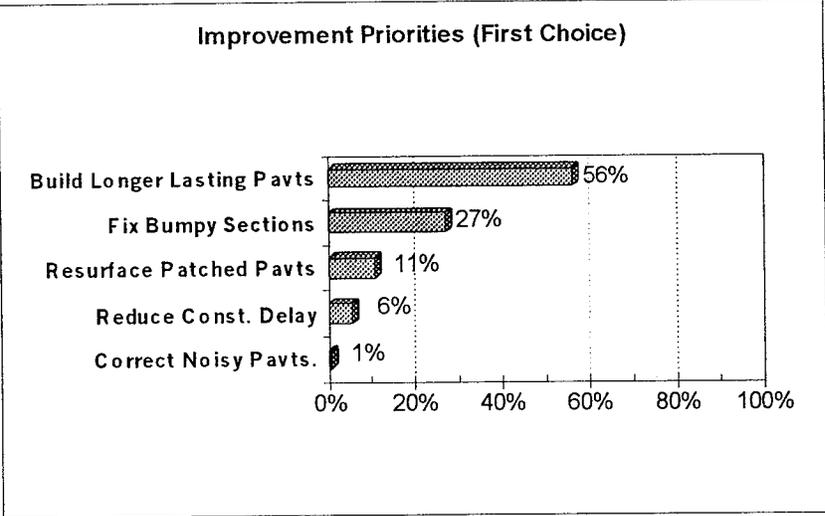
A 11 - 19 mph drop in construction zone speed limits is acceptable



When the question was tested again in Phase III (but not in a random, state-wide survey), 90 percent thought a speed limit at or below 35 mph was unacceptable.

The first choice of survey respondents, if faced with limited improvement funds, are shown below.

If funds are limited, a majority agreed: "build longer lasting pavements" is their first choice



When answering this question, the public was not given the consequences of doing this with limited funds. Earlier questions showed the public was willing to pay for longer lasting pavements, but on this question they were not told that limited funding would mean fewer roads would be repaired or that the general condition of the highway system could deteriorate under such a scenario. It is possible that may have changed the answer, but the survey's intent was to confirm the priority exercise from the focus groups, which also showed support to build longer lasting pavements if people believed they could be built.

Satisfaction With Rural Two-lane Highways in General, Phase II

The fundamental question of when drivers are satisfied with the condition of the pavement surface has important policy implications; namely, what roughness and distress levels are tolerated by the public? This question was investigated in both Phases II and III by relating ride and condition indices to the cumulative percentage of respondents who agreed with each of the three "threshold" questions related to satisfaction. In both phases, the three questions were as follows:

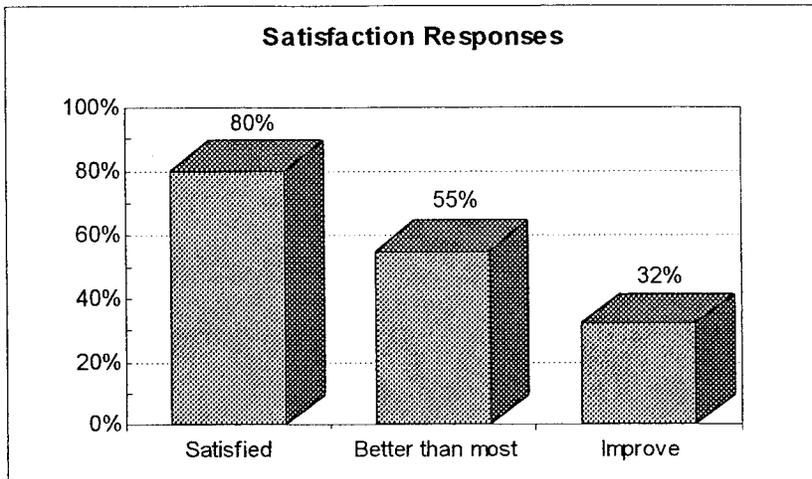
Three "satisfaction" questions

- 1) "I am satisfied with the pavement on this section of highway" ("satisfied");
- 2) "The pavement on this stretch of highway is better than most of the stretches of state highways I've driven in Wisconsin" ("better than most"); and
- 3) "The pavement on this stretch of highway should be improved" ("improve").

In this way, researchers could answer questions such as "at what ride index (IRI) value might we expect that 70 percent of drivers would be satisfied with a given stretch of highway."

In Phase II, respondents selected a highway they regularly drove and answered the three questions above. The percent of subjects who SA or A is shown on the following page. Some agreed with both "Satisfied" and "Improve" and this is explained in Phase III findings. It should be noted that in the NQI survey of FHWA, satisfaction with various pavement conditions was approximately 50 percent or below (5)

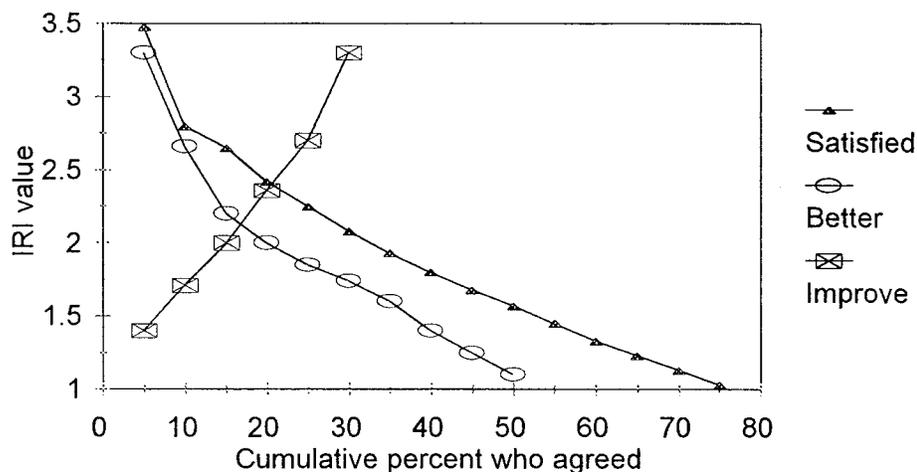
80 % satisfied in Phase II



Thresholds of Satisfaction and Need for Improvement, Phase II

WisDOT uses both a pavement ride index and a pavement condition index to assist in the determination of pavement improvement selection. The International Roughness Index (IRI), determined by a laser measurement of the pavement profile, is considered an objective ride rating. The IRI has a scale from 0 which is a perfectly smooth ride to higher numbers, with 5 or over being a very rough ride. The Pavement Distress Index (PDI) assigns a numeric index based on detailed inspections and rating by knowledgeable staff, following a manual with numerous pictures of various pavement conditions and detailed illustrations showing how they should be rated. The index ranges from 0 to 100 with higher values indicating more pavement distress. The extensive manual guidance attempts to achieve total objectivity, but there is some degree of subjective judgement involved. It is therefore considered less objective than the IRI rating. Both, however, are considered important in establishing improvement priorities, along with other non pavement issues such as safety and capacity. The physical indices of specific highway segments described by the 402 respondents were compared to these three "threshold" questions. Where segments could be identified, results in the form of the cumulative percent of respondents agreeing with the three questions and the corresponding levels of pavement indices in five percent increments were graphed. An example is shown on the following page for ride (IRI).

**Phase II
threshold
curve**



The research team thought sample bias might have influenced “satisfaction.” But Phase III results showed that was not true!

The results in Phase II were thought to be potentially biased by the self selection of highway segments by respondents. There was an over sampling of better highways, and insufficient sample size (which was anticipated) to determine if differences existed by highway classification, pavement type and region (urban-rural, north-south). Hence results in satisfaction thresholds were presented but it was acknowledged that they were only approximate because of the bias. Likewise, because of more highways in better condition being sampled, it was concluded (incorrectly) that a highway had to be in very poor condition before a significant percent would agree to improve it. The reality was that there were relatively few highways in poor or very poor condition self-selected by respondents. Since survey questions and analyses were the same in Phases II and III, the thresholds developed in Phase II will be discussed with the Phase III results, which proved to be almost identical. Hence, Phase II results were not biased!

Correlation of Satisfaction and Pavement Indices, Phase II

The direct correlations between physical indices and satisfaction were relatively low (e.g., .13 for IRI). It was believed that direct correlations between physical indices and satisfaction were low in Phase II because respondents described the limits of highway sections from memory. It was expected that these correlations would improve somewhat in Phase III, but still would not entirely explain satisfaction. Since one goal of the project was to obtain

Pavement satisfaction may be a complex, multi variate phenomenon

input for future marketing programs by WisDOT, satisfaction had to be explored in greater depth. The low correlations indicated to the team that driver satisfaction may be a complex, multi variate phenomenon. Because of this, a psychological theory was needed to explain the relationship between physical pavement characteristics and variation in driver satisfaction. That is, drivers may vary in their satisfaction with the same stretch of pavement.

A psychological model is employed to explain satisfaction

To understand the relationship between physical pavement characteristics and driver satisfaction, the team adapted relevant aspects of Fishbein's attitude model and Ajzen's theory of planned behavior. These are discussed in detail in the Phase II report (8) and in literature (10) (11) and (12). In Phase II results, the model was able to explain 63 percent of the variance (R^2 of .63) in satisfaction using hierarchical multiple regression analyses. The sizes of the coefficients testing the model are considered generally respectable for the social sciences, especially given the nature of the task, trying to predict something as complex as a person's satisfaction.

Further discussion of this model occurs in "Major Phase III Findings."

PHASE III, TARGETED SURVEYS

Purpose and Lessons Learned from Phase II

Thresholds of IRI and PDI are the main objective

The main objective for Phase III surveys was to develop thresholds of pavement indices useful to the DOTs for the purpose of predicting the public's satisfaction and in setting policy on when to improve pavement quality. It was thought that the thresholds obtained in Phase II were biased by the over sampling of better pavements and perhaps public sentiment and concern about delay during construction. The findings in Phase III indicate that this hypothesis was not born out.

Methodology

Look for "satisfaction" differences in pavement types, regions and highway classifications

The results from Phase II were used to create regional (North or South), classification (arterial or collector) or pavement type (rigid and flexible) groups to be surveyed in Phase III. In Wisconsin, it was agreed to test for differences in pavement type, classification and geographically, between North (Highway Districts 6, 7, and 8) and South (District 1). The key was to ensure a minimum sample size of 100 participants for each cell (A cell would be one

150 highway segments selected in all pavement quality categories

pavement type, in one region and in one classification). Instead of highway segments being self-selected by respondents (as in Phase II), in Phase III WisDOT selected approximately 150 highway segments, each within 10 minutes drive time of a city of 500 population or more, and which had no construction underway in 1999. WisDOT provided a stratified sample of highway segments, with pavement quality (based on IRI) varying from very good to very poor (or as poor as the system contained), and provided information about the beginning and end of each segment. This avoided the over sampling of good highways which occurred in Phase II.

Participants recruited by phone to drive and complete phone survey were given \$10 compensation

The WSRL designed a sample population and purchased phone lists from Survey Sampling, Inc. A two-step survey was conducted. In the first step, participants were obtained by random selection from telephone lists for each nearby city. They were then recruited to drive a given segment of highway if they knew where it was and could identify the beginning and end of the segment. A time was set when they could be called for completion of the survey. Subjects received \$10 compensation for expenses incurred by their participation if they agreed to drive the segment and complete the second part of the phone survey within approximately one week. The stipend improved recruitment and allowed prompt completion of approximately 2300 surveys in the three states in just six months.

800 surveys in Wisconsin, 2300 in 3 states

The WSRL was asked to complete an average of five interviews for each highway segment while the WSRL monitored each cell to maintain a balance between the various quality levels (very good to very poor) within each cell. This was not always possible. They were also able to over sample where the DOTs, in some cases, could not fill each cell with an equal number of highway segments throughout all the highway quality levels. This resulted in approximately 800 surveys. Sample size characteristics, statistical analysis of differences and summary statistics are contained in the Phase III report for Wisconsin (13) on both WisDOT and MU web sites.

It was expected that because of these changes in procedures, a greater relationship would be observed between the satisfaction measures and the pavement indices in Phase III than that which occurred in Phase II.

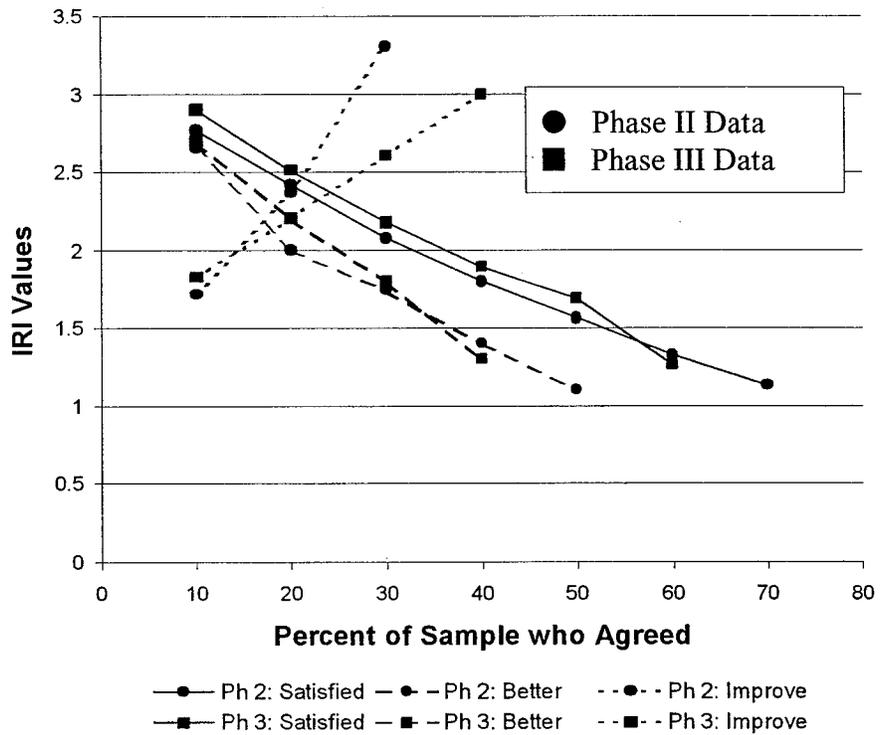
Major Phase III Findings

Threshold Results

When Phase III results were first reviewed, the similarity of threshold results surprised the team. Results from the entire sample are superimposed from Phase II and III below, for the three questions on satisfaction (“satisfied”, “better than most” and “improve”).

Phase 2 and 3 alike!

At what IRI values did X% of respondents agree with statements on "Satisfied", "Better than Most" and "Needs Improvement"?



Testing for Differences

Initially, a series of analyses of variance (ANOVAs) with F tests (for independent variables with three levels) and T-tests (for pairs) were conducted using mean ride or distress indices of those satisfied as the dependent variable and region, classification or pavement type as the independent variables. Then, the team applied judgement as to whether statistical differences were of a meaningful magnitude (a large sample size can produce a statistically significant difference of little practical meaning). If differences were found to be practical, then separate thresholds were developed in Phase III.

Phase III Approach to Thresholds

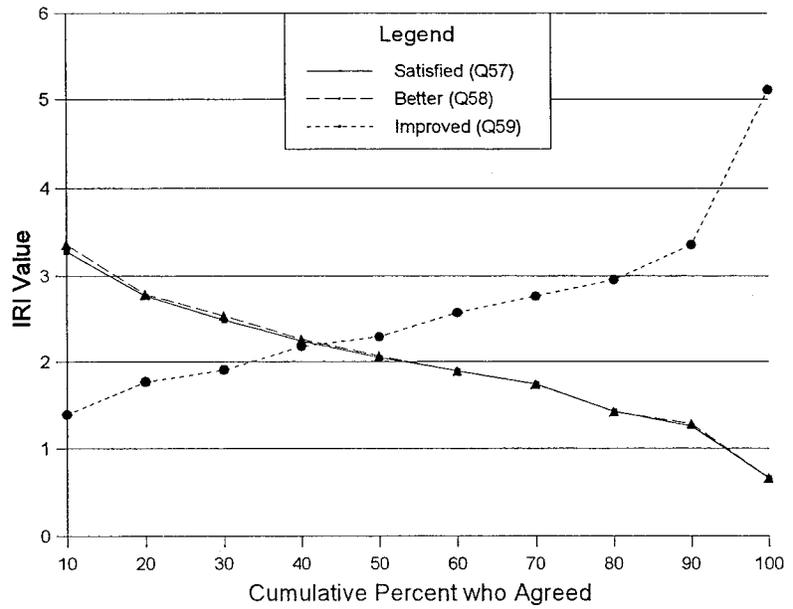
***A different approach
was necessary***

Since in Phase III the sample was stratified, with highway segments provided by WisDOT having pavements in poor quality approximately equal to those in good or very good quality, and because Phase III results paralleled those of Phase II, the team explored a different approach to interpreting the data. People were satisfied with a wide range of pavement quality. Subjects indicated being satisfied with pavements with an IRI as poor as approximately 3.3 (very poor) to an IRI as good as 0.7 (very good). Similar variations existed in the range of respondents who agreed pavements should be improved. In Phase III, however, sample size was much larger, permitting separate analysis of each question by pavement type and other differences. In these analyses, just the portion of the sample that strongly agreed or agreed with the three questions was used. Graphs of these results are provided for all pavements and for individual cells (pavement type, regions, or classifications) that the team believed to be practically different.

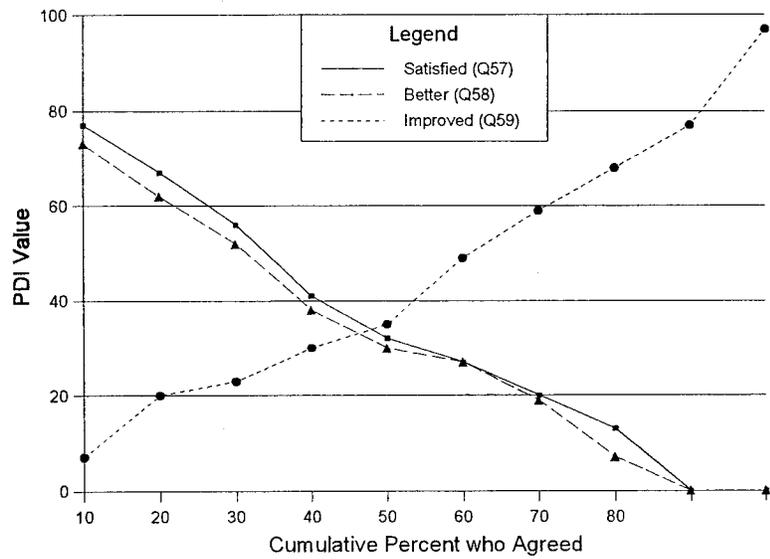
***Data statistical
accuracy very high***

The thresholds were developed from curves of the cumulative percent of only those who SA or A with the three satisfaction questions. Shown on the next page are the curves for IRI and PDI for all pavement types combined. The data accuracy of the IRI is +/- .05 at the 95 percent confidence level. Sample size is large when all pavements are included (539 for IRI, 529 for PDI). The data accuracy for PDI is +/- 2 at the 95 percent confidence level (much more accurate than the methodology of measuring PDI).

IRI threshold curves from 3 "satisfaction" questions, for all pavements



PDI threshold curves from 3 "satisfaction" questions, for all pavements



Assumptions

Assumptions about the methods are discussed here. If a pavement of a given quality was judged satisfactory by a particular respondent, it is presumed pavements of higher quality would also be judged satisfactory. That may not be true, because satisfaction is such a multi dependent variable. Likewise, if a pavement of a given quality was deemed to need improvement by a particular respondent, then it is assumed a pavement of lower quality would also be deemed to need improvement. There may be potential limitations to these assumptions, but they provide a reasonable basis for drawing useful inferences from a large sample size (383 who SA or A with “Improve”).

Drivers are slightly more tolerant of a rough ride on rigid pavements

IRI Thresholds

Since meaningful (practical) differences in IRI thresholds were only found between pavement types (and not for regions or classifications), separate thresholds were developed for rigid and flexible pavement types. Specifically, drivers are slightly more tolerant of rougher rides on rigid pavements than on flexible pavements. For example, the IRI representing 70 percent of those indicating “satisfied” with rigid pavements was 1.94 while the corresponding value for flexible pavements was 1.69. Likewise, the IRI for 70 percent of those who agreed with “improve” for rigid pavements is 2.95 while that for flexible pavements is 2.64.

PDI Thresholds

Practical differences in PDI thresholds of satisfaction were found between pavement types, north and south regions and between south collectors and south arterials. The complete results are shown in the table in Appendix 1. Results in PDI at the 70 percent level for satisfaction and improvement generally fall from slightly above to significantly above similar results for IRI in terms of quality ranges of pavements. The PDI representing 70 percent of those indicating “satisfied” with all pavements is 20 while the 70 percent “improve” level is a PDI of 59. Those drivers surveyed in the South show PDI levels for both “satisfied” and “improve” that are approximately 10 points toward higher quality than the “satisfied” and “improve” PDI levels of those surveyed in the North. This could mean that those in the more populous South expect a better pavement than those in the North. There were differences between pavement types, but the research team believes these are affected by the skew of the sample (fewer rigid pavements and most in better condition on RTLH than the flexible pavements sampled). Differences in mean PDI of those “satisfied”

Drivers in the South expect better pavements than those in the North

between south arterials and south collectors were 15 to 20 points toward higher quality for arterials but this, too, may have been the result of the sample. It makes engineering sense that arterials which carry more traffic are in better condition, and the data are consistent with this notion. However, when the public was asked if highways with more traffic should have a better ride, they split 54 percent in favor of the better ride compared to 44 percent agreeing with an equal ride on all highways, as discussed in Phase II results. Having better conditions on arterials is not a widely held public belief as expressed in Phase II policy results.

Intersection of Cumulative Percentage Satisfied and Agreeing with Improve

The research team concluded that thresholds established by the intersection of the “satisfied” and “improve” cumulative plots for IRI and PDI should be considered when developing thresholds for pavement improvement. This conclusion was reached because the survey data based on “satisfied” was substantially different than thresholds corresponding with “improve” and the thresholds currently used for pavement improvement for WisDOT. The intersection of the cumulative percent of those who were “satisfied” with the cumulative percent of those who agreed with “improve” or “X” on the Table in Appendix 1 is believed to be important by the team. This would be an “optimum” IRI, i.e., any better quality pavement (lower IRI number) would satisfy more of the public, but results in less agreeing it should be improved. Any lower quality level IRI (higher IRI number) would find more agreeing pavements needed improvement, but less being satisfied. A summary of these “X” points related to WisDOT’s quality scales is shown below for all pavements and selected groups where sample bias is not deemed to affect results.

An “optimum” IRI for improvement

WisDOT Quality Scale	IRI Flexible	IRI Rigid	IRI All Pavts.	PDI All Pavts.	PDI North	PDI South
Very Good						
Good				X		X
Fair	X		X		X	
Poor		X				
Very Poor						

For example, the IRI at the intersection of the cumulative percent of satisfaction for all pavements and the plot for cumulative percent of “improve” is 2.2. From the table in Appendix 1, this falls near the bottom of the “fair” category. Similarly, the PDI at the intersection of the same cumulative plots for all pavements is near the bottom of the “good” category. This is not necessarily inconsistent, since the quality categories for IRI shown in the appendix can be adjusted to more closely correspond with the quality categories in PDI. The PDI categories follow earlier work done by AASHO (1). The quality categories of IRI were recently converted from PSI by WisDOT. This is addressed in the recommendations.

Use of Psychological Models to Explain Satisfaction

Physical pavement indices alone do not explain the variance in satisfaction

Since physical indices alone do not determine satisfaction, or the public’s perception of a need for improvement, both Phases II and III employed a model to help WisDOT understand the complexity of driver satisfaction. Extensive analysis is documented in both Phase II (8) and Phase III (13) final reports. In Phase III, direct correlations between IRI and satisfaction increased by 50 percent, from .13 to .19. However, this still explains only approximately 5 percent of the variation in satisfaction.

The model explains 73% of the variance in satisfaction, a high level for the social sciences

Again in Phase III, pavement beliefs intervene and raise the direct correlations between pavement indices and satisfaction to respectable path coefficients of approximately .80. Questions were included in both Phase II and Phase III on pavement and non pavement beliefs, trust, and subjective norms. All were found highly significant in explaining satisfaction. The Fishbein/Ajzen model was applied to explain satisfaction; the percent of variance explained by the model (using IRI) rose from 63 percent to 73 percent (R^2 of .63 and .73 respectively). IRI showed higher values of final R^2 than PDI, probably because the measure is an objective rating. The ride index performed the best in the model applications in two of the states. The strength of relationships found are considered to be a reasonably high level in the social sciences. The model and its application are explained fully in the Phase III final report (13). A summary of the full and focused model results can be seen in Appendix 2.

Recap on Satisfaction

Pavement and non pavement beliefs as well as trust in WisDOT all help explain satisfaction

A logical question is why use pavement indices if they contribute so little to drivers' satisfaction? Physical indices can continue to be used to guide pavement improvement criteria, as long as it is recognized that other factors can, sometimes overwhelmingly, contribute to driver satisfaction. Pavement beliefs like "the pavement is bumpy" or "noisy" or "causes me to focus attention on the pavement," as well as non pavement beliefs (like adequate shoulders and paint lines), all contribute to satisfaction. Likewise trust in the DOT leads to higher levels of satisfaction. These are all things that can structure a marketing program. However, there will always be other, unmeasured variables which could account for variance in pavement beliefs and satisfaction. No doubt some of these other variables are psychological variables (i.e., personality traits), or variables related to the drivers' abilities to sense physical road and driving variables. This research showed that neither the type of vehicle nor the self-judged vehicle ride, nor the frequency of driving the stretch, affected the levels of satisfaction significantly. The use of a psychological model helps explain that. The relationship of control variables in explaining satisfaction and their statistical significance or lack thereof are shown in Appendix 2.

Special Analyses Results

A number of special analyses were performed during Phase III to show WisDOT the various ways in which the survey data can be used to answer a variety of questions.

Trust in the DOTs rose in all three states in Phase III. One explanation is the fact that participants were being asked opinions about specific highways, which can be interpreted by participants as a sign that the DOT cares about their opinions (and is therefore trustworthy). Changes in trust between Phase II and Phase III for the four questions (paraphrased) for Wisconsin are shown below, with only those who SA or A as a percent of total sample.

Trust in the DOT rose in Phase III

Trust Questions	Phase II	Phase III
"WisDOT capable of fixing and repairing pavements"	83.1%	86.5%
"Trust judgement when scheduling improvements"	60.9 %	72.3 %
"WisDOT cares about safety, convenience on this stretch"	74.9 %	80.0 %
"WisDOT considers input from people like me, on this stretch"	43.0 %	62.9 %

The results were uniform throughout all three states. Differences between states were within the margin of error of the sample.

Other analyses examined the following questions:

Vehicle ride did not affect belief on pavement roughness

1) did respondents' self-assessment of vehicle ride affect beliefs about pavement roughness and hence need for improvement (no in all three states), or

Non pavement beliefs given as a reason to improve

2) did non pavement beliefs (such as a lot of traffic or beliefs that drivers felt uncomfortable pulling onto the shoulders of a given stretch of highway) affect the decision to agree that the highway needed improvement (yes, approximately 1/3 of the time, non pavement beliefs were often given as one of the reasons for improvement when participants agreed the highway needed improvement).

Crosstab analyses

Crosstab analyses were used to explore reasons for agreement or disagreement. One of the most interesting findings is that the more satisfied the respondent was with the highway segment, the more likely the person was to trust the DOT. Since crosstabs are non-directional, they are meant to add insight to the psychological model in which trust helped explain satisfaction (i.e., the more the trust in the DOT, the more likely one is to be satisfied).

Statistically-significant crosstab analyses revealed relationships found for all four trust questions beyond the satisfaction dimension. These crosstabs from Phase II and III included statistically-significant associations for pavement and non pavement beliefs, ride quality, and some vehicle characteristics and demographics. One trust question (WisDOT cares) showed greater agreement by older drivers.

In addition to relationships with the four trust items, Phase II survey results provided key crosstab findings for the improvement priorities trade-off questions. While the Phase II report(8) and a TRB paper (12) present relevant details, a summary comment is appropriate. Respondents' choices for the trade-offs were related not only to perceived trust in WisDOT, but also to select demographic and vehicle characteristics, all of which shed further light on the patterns of trade-off responses.

Overall, the crosstab analyses in Phase II and Phase III provided important insights into the perceptions and behavior of the two

samples of Wisconsin drivers who participated in the two surveys. Since WisDOT fared well on the perceived trust items, in particular, this could well be the basis for building even better relationships with Wisconsin motorists to guide pavement improvement planning and operations. Details are provided in both the Phase II (8) and Phase III (13) reports.

CONCLUSIONS

Customer-Focused Research -Methodology for Other States Application

The three-phase process was used successfully, consisting of

Successful Survey Process

- 1) focus groups to develop language and issues to use in policy surveys and for development of targeted threshold surveys,
- 2) random surveys of approximately 400 subjects in each state were used to assess policy and improvement issues and trade-offs, and
- 3) targeted surveys of approximately 100 participants for each expected difference in a region, classification or pavement type.

Use of a professional survey organization contributed greatly to properly targeting an appropriate sample and securing the data based on that sample. A multi disciplinary team, as noted at the outset, can add considerable value to the overall project's impact.

Specific categories of questions relating to demographics, pavement and non pavement beliefs, trust, satisfaction and specific types of questions related to a psychological model are necessary to both develop thresholds and explain satisfaction. Numerous additional applications of the survey results can be used by the WisDOT to develop marketing and improvement strategies that will build trust and support improvement choices.

Policy, Improvement Issues

There is public support to build longer lasting pavements, even though they cost more. The public is willing to pay more for longer lasting pavements. The public, however, wants to minimize construction delay when confronted with trade-offs such as those

used in this project. The public wants construction completed on a given highway all in the same year, while during construction, the public wants to minimize travel time. They prefer a longer construction period and no detour to a shorter construction project with a 30 minute detour. The public will tolerate speed reductions in construction work zones on RTLH.

Satisfaction, Trust

Satisfaction with highway pavements is a multi faceted phenomenon that cannot be explained by physical indices alone. For a thorough explanation of what satisfies the public, a complex psychological model is vital. Findings revealed that there is a great degree of satisfaction with the current highway pavement systems on RTLH in the three states. There is also a good degree of trust and confidence in WisDOT which is encouraging, given the growing trend of the public's general skepticism and mistrust of government agencies on all levels. This may be Midwest-specific, however.

**Confidence in
WisDOT**

Thresholds

The methodology used in this study is satisfactory in developing thresholds of satisfaction and agreement with improvement criteria based on physical data alone. Although this study shows that the pavement indices do not explain satisfaction to any great degree, they are, nevertheless, a tool available for individual state highway departments. Thresholds of improvement based on physical condition developed in this study, along with other factors such as safety and capacity, can be used for RTLH system improvement planning.

Implications for Future Planning and Operation

Public Perceptions of the Midwest's Pavements has proven to be a significant research project in terms of both planning and operational findings and guidelines. Implications apply not only to the three state DOTs who sponsored the research but other state DOTs as well. From Phase I to date, this tri-state study has demonstrated the value of customer feedback in pavement management planning. This is totally consistent with and corroborative of existing literature on pavement management research and the FHWA National Quality Initiative (NQI).

**Customer feedback
valuable**

WisDOT's "Strategic Directions" addressed by this research

In addition, WisDOT's strategic plan ("Strategic Directions"), developed while this project was underway, has several emphasis areas, including "anticipate and meet our customer's needs," that are specifically addressed by this project. WisDOT has developed a series of "Values" that include "Accountability" (responsible to citizens), "Quality" (exceed expectations of customers), "Integrity" (confidence/trust with customers) and "Stewardship" (wise use of funds) and this project supports all those values.

Selected conclusions from these as well as papers submitted to the Transportation Research Board can be appropriately highlighted at the outset of this section.

Project findings are based on broad public input

For all three states involved in the research, the project findings strongly demonstrate that the drivers sampled definitely believed that the DOTs in the three states could and should build longer lasting highways. The respondents, moreover, indicated that they would be willing to pay for them. Also revealing were the results of the trust questions in the Phase II and Phase III surveys. These findings represent important customer feedback regarding perceived trust in WisDOT's actions and represent a value for WisDOT to build on in the future as it implements its "Strategic Directions."

At the same time, the project findings, from focus groups to targeted surveys, suggest the value to be derived from more systematic research to obtain feedback from the driving public on pavement management issues. As both the project reports and related TRB papers maintain, public input is increasingly vital to effective transportation planning. Methodology considerations, moreover, point to the importance of including trade-off questions for the driving public in statewide surveys. Phase II results clearly reflected the value of improvement priority trade-off questions to guide pavement improvement planning. Such information not only removes uncertainty for WisDOT in pavement repair planning, but also offers guidelines on specific policies, such as those indicating the public favors less construction delay.

Public prefers fewer delays

Particularly important are the Phase II and Phase III survey data which confirmed that drivers' perceptions significantly influenced their satisfaction with pavement quality. As underscored by the project findings, satisfaction is multidimensional and cannot be explained by physical indices alone. For a more thorough analysis of what satisfies the public, a rigorous psychological model is crucial. Replication of the model central to this project in other pavement satisfaction studies will enhance the base of knowledge.

RECOMMENDATIONS

Methodology

- A three phase process such as described in this report can lead to reliable data to determine thresholds of pavement improvement. The process should be continued periodically to monitor both satisfaction and trust, using the three step process, (focus groups, telephone surveys and targeted surveys after driving), depending on what is desired.
- Use of a psychological model to explain satisfaction is essential if the DOT wishes to understand what can lead to satisfaction or dissatisfaction. The Fishbein/Ajzen model performed well in describing the complex issue of satisfaction with pavements.

Pavement Improvement Policies

- WisDOT should consider a strategic plan to move toward longer lasting pavements, coupled with minimizing travel delay. There is public support to doing just that, even if it costs more. This was supported by the NQI survey of FHWA as well.
- Life Cycle costs need to take into account motorists delay in making these kinds of decisions. Evidence of other examples where this has been done need to be a part of the marketing of such a concept.
- This concept of longer lasting pavements should be explored in further market research to assess just how much the public is willing to pay to accomplish this objective.
- Attention should be paid to the impact of non pavement items such as lack of adequate shoulder and clear pavement markings which can affect the public's feelings of safety and satisfaction.
- When WisDOT plans construction on a RTLH, it should consider that the public prefers construction under traffic rather than detours. They also want the work done well and want it to last a long time, as evidenced by the NQI survey of FHWA. They will tolerate reasonable speed reductions while roads are reconstructed, but dislikes detours with longer travel times.

Public supports longer lasting pavements

Public dislikes detours

Physical Indices

- IRI Thresholds by pavement type are recommended, since IRI showed less variation by region or highway class, and since motorists appear to tolerate a poorer ride on PCC pavements.
- PDI shows variation by region of the state, but no separate thresholds are recommended for different regions. Policy responses show that 54 percent of the public favor a better ride on more heavily traveled highways, so different thresholds by highway classification, if used, should be reviewed in light of the fact that it is not as widely held belief in Wisconsin as might be expected.
- WisDOT should review its quality ranges of IRI and effect better correlation between IRI and PDI on a system-wide basis. Although only approximately 150 highways were sampled, their respective quality ranges compared in the Phase III report are quite discrepant, even for such a small sample, and even when considering that they measure different pavement characteristics. Since PDI ranges are well-established and have existed for many years, the IRI quality ranges established just before this project began should be reviewed.
- Quality ranges of IRI should be reviewed because threshold results found in Wisconsin were highly comparable for ride and condition with those used in Iowa, but each state has different IRI quality ranges, even though it is measured the same.

IRI and PDI were not well correlated in the sample

Thresholds

- WisDOT should examine its system-wide pavement index thresholds to determine what, if any, changes should be made. That includes setting different thresholds by pavement type and for different classifications. This is a current policy that should be reviewed based on this research. However, it makes sense and perhaps needs to be better explained in a marketing approach as well.
- No change in threshold policy to include regional differences is recommended. Although there were some differences between regions, these may also be due to traffic density, which was not measured (except by combinations of highway classification).

Updates of Satisfaction and Public Perception

- Future use of the results of the modeling on satisfaction can be used by WisDOT to periodically update the results of this study. A short form of roadside interview which was deleted from the project may still be developed and tested by WisDOT to monitor both satisfaction and thresholds. The questions that would need to be included are on page 64, under Model Summary in the Phase III report (13).

Trust

- Since greater trust leads to greater satisfaction, and asking opinions of the public also leads to greater trust, particularly on a project-level basis, continued emphasis on obtaining public input should be pursued by WisDOT.

Satisfaction

- Greater satisfaction exists with pavements in Wisconsin and the other two states than what FHWA found in the NQI study. Wisconsin can build on that as a guide to its “Strategic Directions” and their future efforts to “anticipate and meet our customer’s needs.” The more the public is exposed to the logic in pavement improvements, the greater the potential for trust and satisfaction.

Wisconsin Citizens’ satisfaction with pavements greater than National study findings

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APPENDIX 1

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Comparison of 70 percent Thresholds with Wisconsin DOT Quality Levels

IRI Scale	IRI - All Pavts	IRI - Flex	IRI - Rigid	PDI Scale	PDI - All Pavts	PDI - All North	PDI - All South	PDI - Flex	PDI - Rigid	PDI - South Arterials	PDI - South Collectors
WisDOT				WisDOT							
Very Good 0.7				Very Good 0					0 S,B	0 B 3 S	
1				10			7 S,B				
1.2				15							
1.44				19	19 B						
Good 1.45				Good 20	20 S				22 X		
1.5				25		23 S,B		23 S,B			23 S, B
1.6				30			30 X		30 I	30 X	
1.7	1.74 S,B	1.69 S,B		35	34 X						
1.8				39							
Fair 1.81				Fair 40		40 X					40 X
2		2.0 X	1.94 S	46						48 I	
2.1			2.05 B	52			50 I				
2.25	2.2 X			59	59 I						
Poor 2.26 2.70			2.6 X	Poor 60 70		61 I		61 I			63 S
2.9	2.76 I	2.64 I		79							
Very Poor >2.90			2.95 I	Very Poor >80							

S = Q 57 "Satisfied"
 X = Intersection of Cumulative Percent Plots, Q 57 ("Satisfied") and Q 59 ("Improve")
 B = Q 58 "Better than Most"
 I = Q 59 "Improve"

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APPENDIX 2

Table 5.1 on the next page is taken from the Final Phase III report (12). A complete explanation of the model and the hierarchical regression analyses used in developing the table is described in the report. **Table 5.1** is based on the full model using path analytic multiple regression analyses and all the variables, entered in the order in which they are listed in **Table 5.1**. The terms “beta” and “Cronbachs alpha” are used in the table and their definitions shown in the footnotes below.

To streamline the analysis, forward step-wise regression was performed to maintain R^2 while limiting the number of variables in the analysis (referred to as the “focused” analysis). This is shown in **Figure 5.4** from the Phase III report (12) showing the path coefficients for this “focused” model.

¹ Beta is a coefficient like a correlation coefficient that can range from -1 to +1 and is the product of a regression analysis in which the measures are standardized (universal scale of -1 to +1).

² Cronbach’s alpha (α) is a standard measure of the internal consistency or reliability of a summated scale. The statistic measures the extent to which the items which comprise the scale co-vary and form a scale with a single underlying dimension. A high Cronbach’s alpha indicates a unidimensional scale (i.e. the component items all seem to be measuring the same underlying construct). Alpha can range from -1 through +1. Unacceptable alphas are any negative alpha or positive alphas less than 0.5. Marginal alphas range from 0.5 to about 0.75. Good alphas are 0.75 or above (some say 0.8 or above). The stronger the positive correlation among the items that comprise the scale, the higher the internal consistency of the scale, the higher the Cronbach’s alpha value, and the lower the measurement error in the index. Generally, acceptable alpha values are .5 or above and superb values are .8 or above.

In this project, both pavement beliefs (cognitive structure) and the three questions on satisfaction have been summated and used as a single scale. Both are above .8 in Phase III.

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Table 5.1: Relationship of control variables and IRI to cognitive structure and satisfaction with pavement conditions (full model)
Multiple regression analyses (betas ¹)

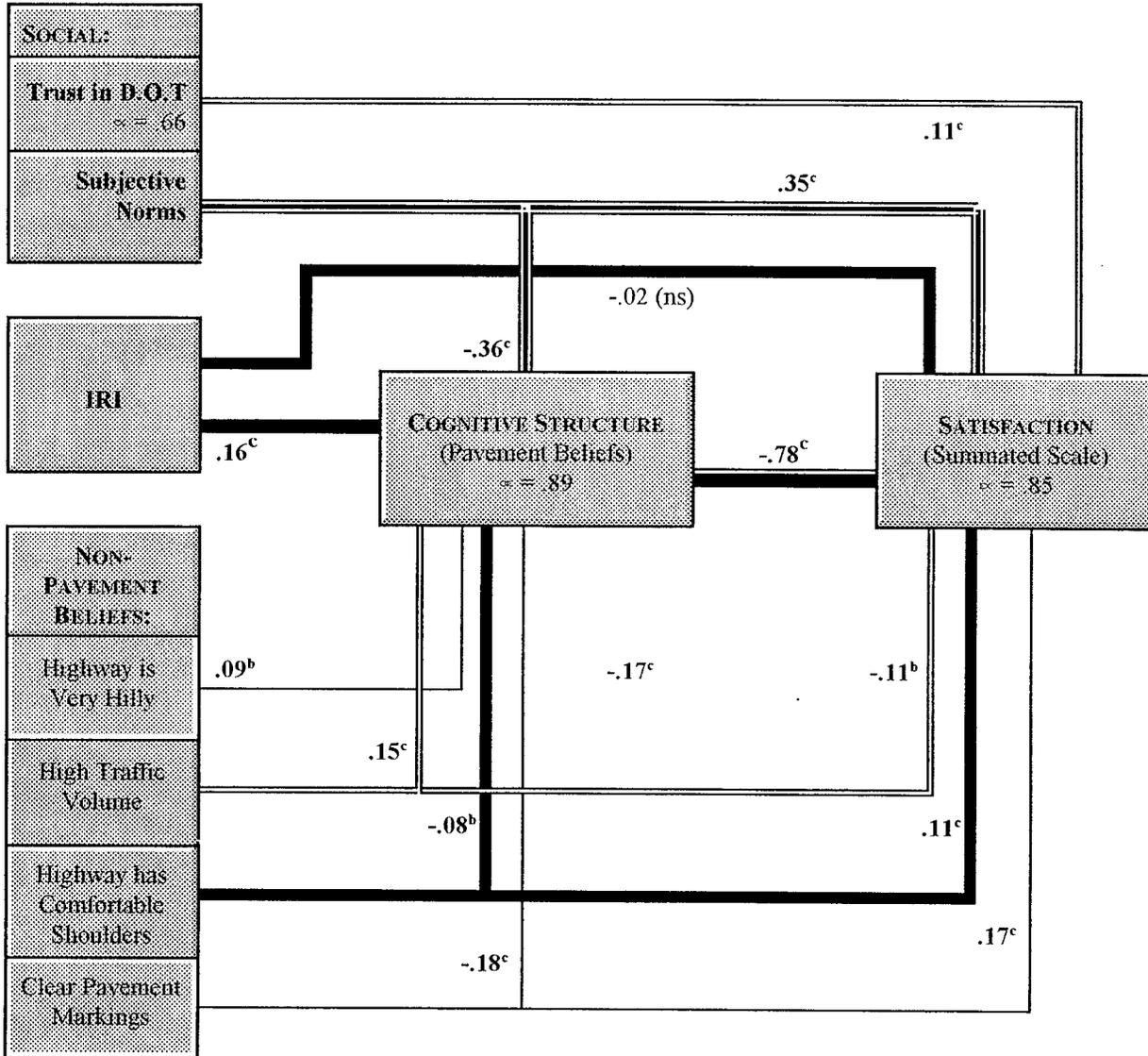
<i>DEPENDENT VARIABLE:</i>	<i>All Pavements</i>		<i>Flexible Only</i>		<i>Rigid Only</i>	
	<i>Cognitive Structure</i> $\alpha = .89^2$	<i>Satisfaction</i> $\alpha = .85$	<i>Cognitive Structure</i>	<i>Satisfaction</i>	<i>Cognitive Structure</i>	<i>Satisfaction</i>
DEMOGRAPHIC:						
Education	-.03	-.02	-.01	-.01	.00	-.07
Female Sex	-.01	-.01	-.05	-.00	.04	-.05
Age	-.02	-.01	-.03	-.02	-.00	-.00
<i>R² change</i>	.00	.00	.00	.00	.00	.01
EXPERIENTIAL:						
Cycle driving frequency	.05	-.03	.09	-.04	-.04	.01
Vehicle "ride"	.07	-.04	.05	-.03	.12	-.08
Frequency of driving stretch	.02	-.02	.04	-.03	-.03	.02
<i>R² change</i>	.01	.00	.01	.00	.02	.01
SOCIAL:						
Trust in transportation dept. $\alpha = .66$	-.05	.14***	-.04	.11***	-.09	.20***
Subjective norms	-.35***	.35***	-.38***	.40***	-.29***	.27***
<i>R² change</i>	.13***	.17***	.15***	.19***	.10***	.13***
PERCEIVED BEHAVIORAL CONTROL						
	-.01	.05	-.01	.06	.01	.02
<i>R² change</i>	.00	.00	.00	.00	.00	.00
NON-PAVEMENT BELIEFS						
Very hilly	.08**	-.06	.08	-.05	.11	-.12
Very curvy	.01	.05	.00	.06	.04	.04
Scenic	-.01	.00	-.02	.00	-.04	.04
High traffic volume	.15***	-.11***	.14***	-.10**	.16***	-.17**
Comfortable shoulders	-.08*	.15***	-.07	.14***	-.19**	.19**
Clear pavement markings	-.18***	.17***	-.25***	.22***	.03	.03
<i>R² change</i>	.07***	.07***	.09***	.08***	.08***	.07***
INTERNATIONAL ROUGHNESS INDEX (IRI)						
	.16***	-.02	.10**	.01	.34***	-.03
<i>R² change</i>	.02***	.01	.01**	.01	.10***	.01
COGNITIVE STRUCTURE						
		-.79***		-.77***		-.79***
<i>R² change</i>		.47***		.44***		.44***
Multiple R	.49***	.86***	.52***	.85***	.55***	.88***
Adjusted R ²	.22	.73	.25	.72	.24	.76
	790	790	583	583	207	207

Two-tailed significance key: *p \leq .05 **p \leq .01 ***p \leq .001

¹ Beta and ² Cronbach's alpha (α) are explained on the Appendix 2 page preceding this Table 5.1

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Figure 5.4: Partial path analysis -----
Predictors of satisfaction with pavement conditions
 based on focused model, using IRI, all pavements
Path Coefficients



Two-tailed significance key: a = $p \leq .05$ b = $p \leq .01$ c = $p \leq .001$

Note: Bold lines are not more important than other less bold

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