PUBLIC PERCEPTIONS OF THE MIDWEST'S PAVEMENTS -

Executive Summary - Iowa

Final Report

(Summary, Phases I, II and III)

Iowa DOT

January, 2001

1. Report Number	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
Public Perceptions of the Midwest's Pavements - Executive Summary - Iowa	January 2001
	6. Performing Organization Code CHTE

7. Author(s)	8. Performing Organization Report No.
David A. Kuemmel, P.E.; Richard K. Robinson, PhD; Robert J. Griffin, PhD; Ronald C. Sonntag, P.E.; James K. Giese, PhD	CHTE 2001-02

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Marquette University Dept. of Civil & Environmental Engineering P.O. Box 1881 Milwaukee, WI 53201-1881	11. Contract or Grant No. WisDOT SPR # 0092-45-59

12. Sponsoring Agency Name and Address	13. Type or Report and Period Covered
Wisconsin Department of Transportation; DTID, BHC, Technology Advancement Unit 3502 Kinsman Blvd., Madison, WI 53704 **Iowa** Department of Transportation; Research Management Division 800 Lincoln Way, Ames, IA 50010 **Minnesota** Department of Transportation; Office of Materials and Road Research 395 John Ireland Blvd., St. Paul, MN 55155	Final Report 1995 - 2000
	14. Sponsoring Agency Code WisDOT Study # 94-07

15. Supplementary Notes

16. **Abstract**

This report summarizes Iowa 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), 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.

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.

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.

Results show that, in general, 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.

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). Recommendations for changes to the quality ranges of the physical indices where appropriate are also made.

17. Key Words	18. Distribution Statement
Public perceptions, rural two-lane highways, satisfaction with highways, trust in the DOTs, thresholds of ride and condition, improvement priorities, construction delay, improvement under traffic.	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
None	None	39	

PUBLIC PERCEPTIONS OF THE MIDWEST'S PAVEMENTS
EXECUTIVE SUMMARY - IOWA

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

WisDOT Highway Research Study #94-07

by

David A. Kuemmel, P.E., Principal Investigator
Richard K. Robinson, PhD, Co-Principal Investigator
Robert J. Griffin, PhD, Director, Center for Mass Media Research
Ronald C. Sonntag, P.E., Director, Center for Highway and Traffic Engineering
James K. Giese, PhD, Post-Graduate Researcher, Center for Mass Media Research
Marquette University
Department of Civil & Environmental Engineering
P.O. Box 1881, Milwaukee, WI 53201

Pooled Fund Study

for

Wisconsin Department of Transportation
Division of Transportation Infrastructure Development
Bureau of Highway Construction
Technology Advancement Unit
3502 Kinsman Blvd., Madison, WI 53704

and

Iowa Department of Transportation
Research Management Division
800 Lincoln Way, Ames, IA 50010

and

Minnesota Department of Transportation
Office of Materials and Road Research
395 John Ireland Blvd., St. Paul, MN 55155

JANUARY 2001

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 Iowa 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 Iowa 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.***

A model to describe what drives motorists' satisfaction with rural two lane highway pavements is developed and tested for the first time and performs very well. Guidance for future testing and updating is also provided.

Recommendations for rural two lane highways indicate that the Iowa DOT should do the following:

- ***move toward building longer lasting pavements and conduct further market research to determine how much more the public is willing to pay;***
- ***give more attention to adequate shoulders as this affects drivers' satisfaction and their agreement a highway needs to be improved;***
- ***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 PCI indices by pavement type;***

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

Public Perceptions of the Midwest's Pavements -

Iowa Executive Summary

MARQUETTE
UNIVERSITY

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 (pavements, maintenance, safety, etc. for example) and summarized users' priorities for expenditures. It did not relate satisfaction to specific pavement condition indices.

WisDOT took the initiative and the Iowa DOT and MnDOT joined the Pooled Fund Project

In 1995, the Wisconsin DOT (WisDOT) initiated a study, "The 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 Department's pavements in terms of comfort and convenience and related tradeoffs; specific to each department not previously considered;

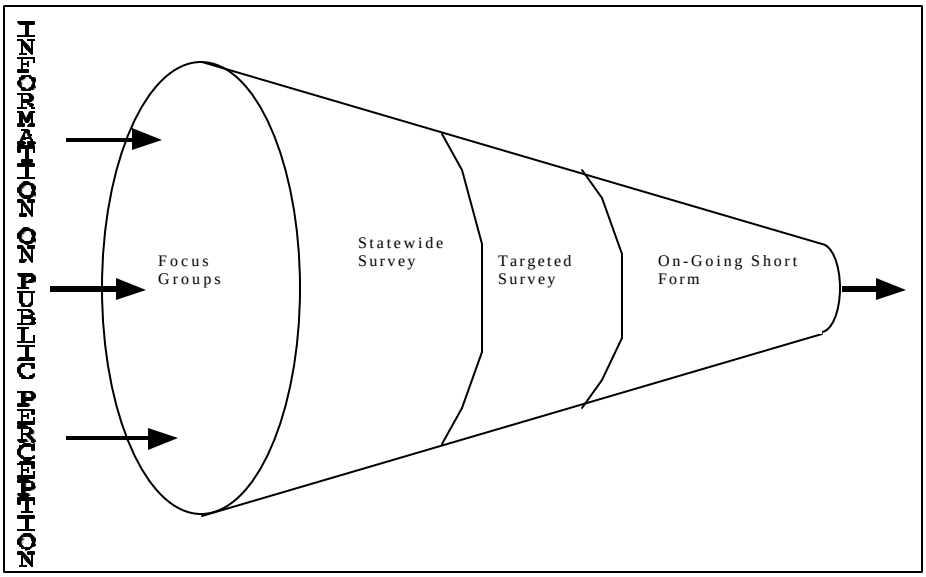
- determining relationships between perceptions and measured pavement condition thresholds (including a general level of tolerance of winter ride conditions in two of the states); and
- identify important attributes and issues that may not have been considered in the past.

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

Survey Phasing, Timing and Purpose

1996 - 2000

A three-phase study began in 1996, with Phase I (focus groups) 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. This report is organized around these three phases. In all cases the detailed methodology is only summarized in this document in the interest of saving space. The three phases are best viewed as a funnel, with each phase narrowing the scope of questioning. The final phase (ongoing short form) could be a roadside survey about a single highway, but was not included in this project. The funnel concept is shown below.



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

PHASE I - FOCUS GROUPS

Purpose, Methodology

Six groups around the state, 60 persons

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 groups were held, one in each of the Iowa DOT's Districts, in the cities of Atlantic, Decorah, Maquoketa, Marshalltown, Ottumwa and Storm Lake. The geographically diverse focus groups ranged in size from 5 to 12 participants, with 8 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 60 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 in the first state 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 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 condition 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 surveys 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 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 all the states often thought their geographic area received less attention than the rest of the state (north vs. south, urban vs. rural). In Iowa, there was less of this, the only exception being those in the western section who believed they did not receive the same attention as those in the east (6).

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 the 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 (7). These are also located on the web sites of Marquette University (MU) and the Iowa DOT. The survey questions were identical in each state (except for identification of each state) and included 11 screening questions, 4 on general driving experience, 14 involving a specific segment of road regularly driven by the participant, 3 on "thresholds" (explained later), 4 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, 5 on improvement priorities, 10 demographic questions and 6 on vehicle/license type completed the survey.

Methodology

Surveys 25 minutes long without compensation

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 Iowa 384 usable 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 ride (International Roughness Index or IRI) and condition (Pavement Condition Index or PCI) 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.

Profile of Respondents

Gender	Percent
Male	55%
Female	45%

Age	Percent
18 - 35	30.8%
36 - 49	35.0%
50 and over	33.9%

Household Income	Percent
less than $30,000	45.3%
$30,000 - $50,000	28.3%
more than $50,000	8.7%
No response	17.7%

Education	Percent
High School or less	47.4%
Some College	30.1%
College Graduate	22.5%

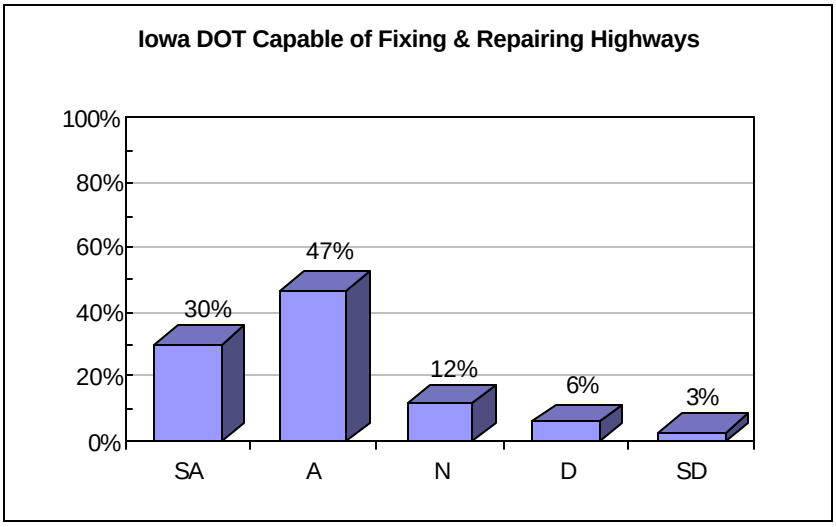
License	Percent
Regular only (Approx.)	63.0%
Commercial (CDL)	19.0%
Motorcycle	16.3%

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 (7) shown on the MU and the Iowa DOT web site and published by the Transportation Research Board (TRB) in 2000 (primarily with data from Wisconsin) (8).

Trust in the Iowa DOT

77 % agree the Iowa DOT capable of fixing and repairing highways



On a second general question on trust, 64 percent agreed they trust the judgement of the Iowa DOT in scheduling pavement improvements.

Only 38 % thought the Iowa DOT considered their input on a given segment

In the other two questions about trust, regarding the specific highway segment selected by respondents, 78 percent agreed the Iowa DOT officials care about the safety and convenience of drivers on the segment. Trust dropped substantially to 38 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."

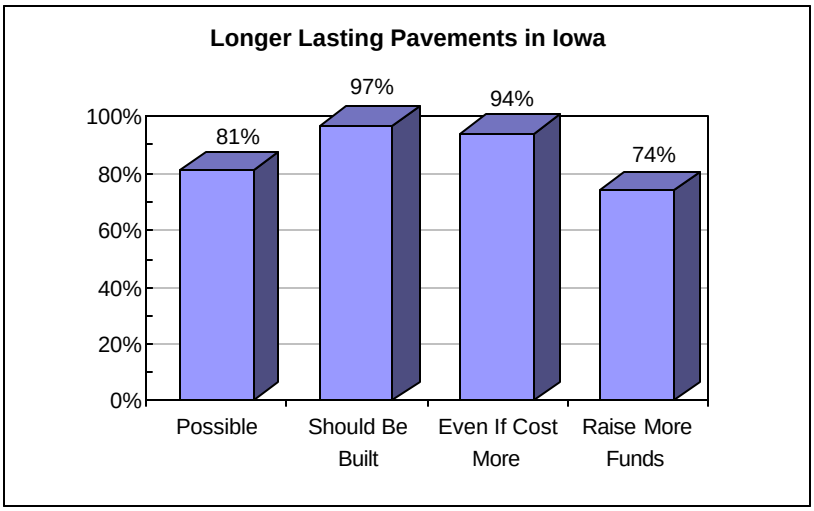
Pavement Improvement Strategies

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

94% 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.

49% agreed "provide an equal ride" on all highways and 49% agreed "provide a better ride on heavier traveled highways

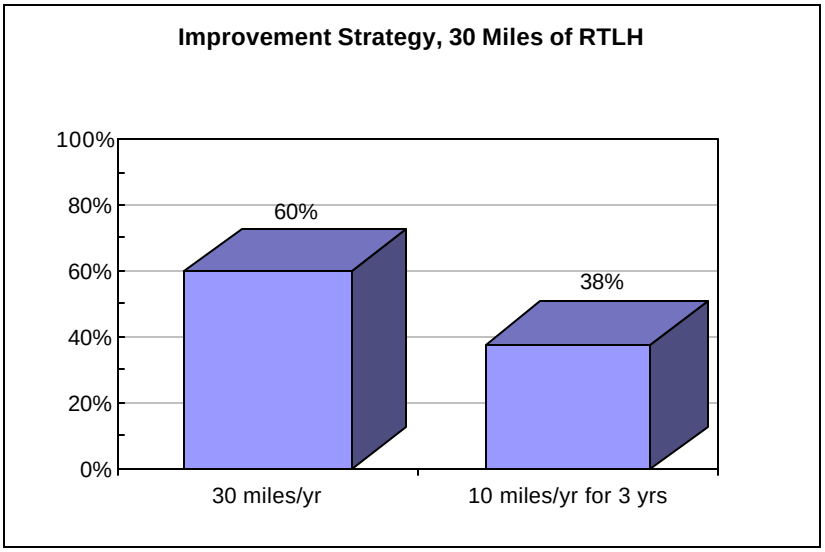
Respondents were equally split in agreeing the DOT should provide an equal ride on all highways (49 %) compared to those (49%) who chose providing a better ride on more heavily traveled highways and would accept a bumpier ride on less traveled roads.

Provide shorter delays during reconstruction

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, 80 percent agreed with the shorter option and less delay. When the question was tested again in Phase III (only in Wisconsin and not in a random, state-wide survey), with consequences of shorter or longer "construction related delay," the percentage stayed the same as in Phase II.

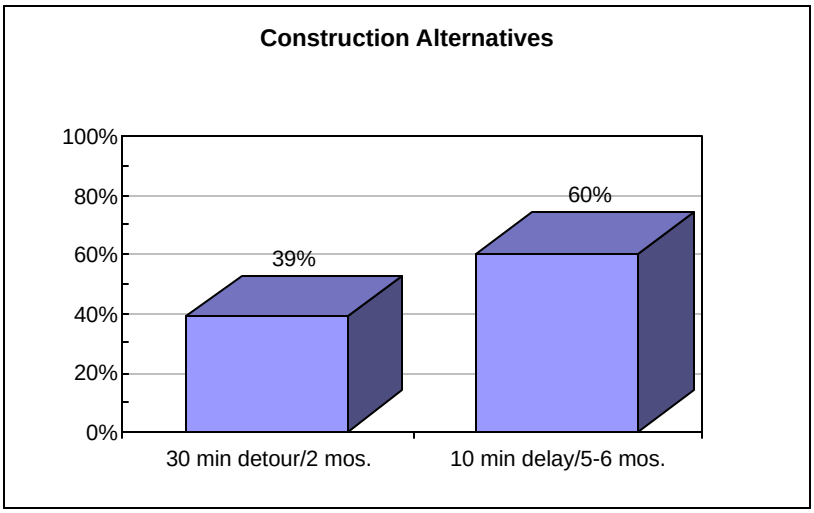
Responses (% who SA or A) about a choice of improvement strategies for a given 30 mile stretch of RTLH are shown below.

Do it all at the same time



When asked about construction with a detour or construction under traffic, again the majority wanted less delay.

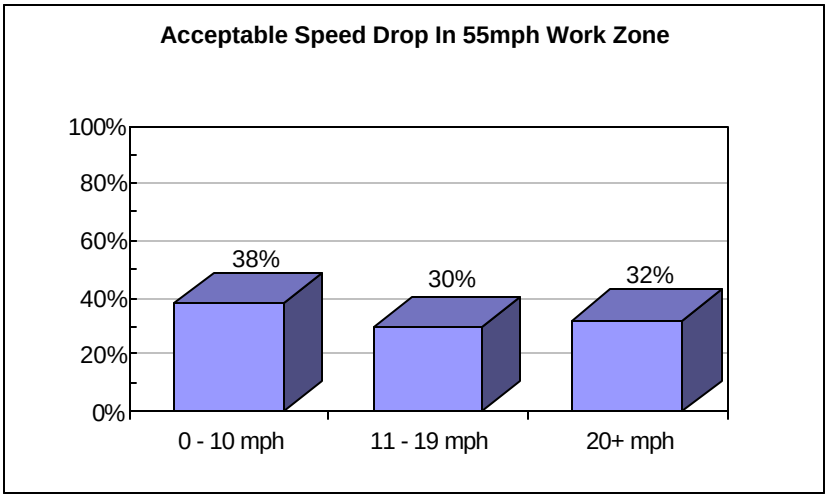
Less daily travel delay for a longer duration is preferred to more delay for a shorter time



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.

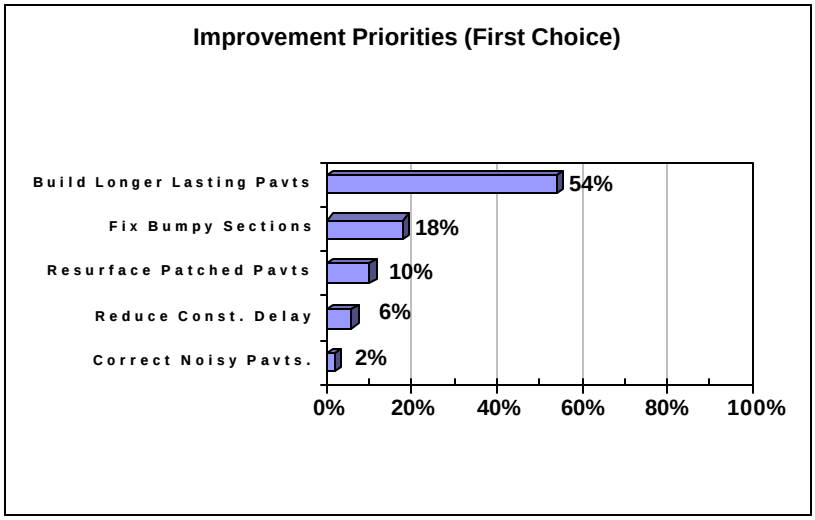
A 11- 19 mph drop in construction zone speed limit is acceptable



When the question was tested again in Phase III in Wisconsin, (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");

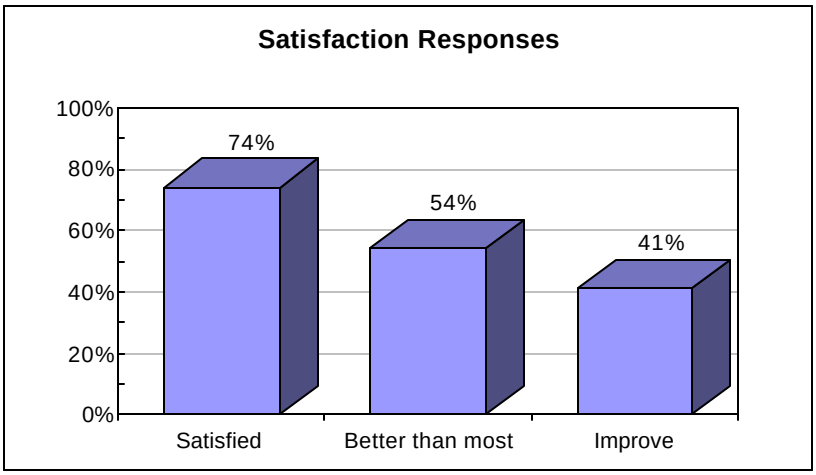
2) "The pavement on this stretch of highway is better than most of the stretches of state highways I've driven in Iowa" ("better than most");

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 three questions above. The percent of subjects who SA or A are shown on the following page. Some agreed with both "satisfied" and "improve" and this is explained in Phase III. It should be noted that in the NQI survey of FHWA, satisfaction with various pavement conditions was approximately 50 percent or below (5)

74 % satisfied in Phase II

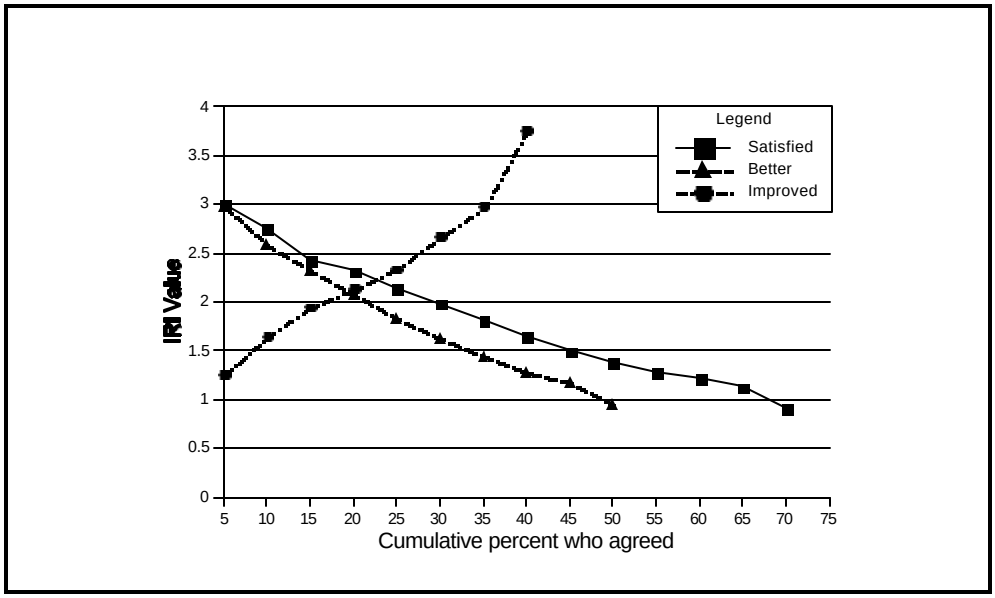


Thresholds of Satisfaction and Need for Improvement, Phase II

The Iowa DOT 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 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 Condition Index (PCI) 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 100 to 0 with lower values indicating a poorer condition. It is somewhat objective, but less so than IRI. Both, however, are considered important in establishing improvement priorities, along with other non-pavement issues such as safety and capacity.

The indices of specific highway segments described by respondents who agreed with the three "threshold" questions were provided by the Iowa DOT. The cumulative percent of respondents agreeing with the three questions and the corresponding levels of pavement indices at these percentages were graphed for three pavement indices, ride, condition and patch. 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. .23 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 input to future marketing programs by the Iowa DOT, satisfaction had to be explored in greater depth. The

Pavement satisfaction may be a complex, multi-variate phenomenon

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 (7) and in literature (9) (10) and (11). In Phase II results, the model was able to explain 63 percent of the variance 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 PCI are the main objective

The main objective for Phase III surveys was to develop thresholdsof 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 and regions

The results from Phase II were used to create regional (urban or rural), or pavement type groups to be surveyed in Phase III. In Iowa, it was agreed to test for differences in region and pavement type. Three pavement types were identified, Portland cement (PC), asphaltic concrete (AC) and composite pavements consisting of an AC overlay of a Portland cement pavement (COMP). The key was to ensure a minimum sample size of 100 participants for each cell (A cell would be one pavement type in one region).

152 segments selected in all pavement quality categories

Instead of highway segments being self-selected by respondents (as in Phase II), in Phase III, the Iowa DOT selected 152 highway segments each within 10 minutes drive time of a city of 500 population or more, and which had no construction underway in 1999. The Iowa DOT provided a stratified sample of highway segments with pavement quality (based on PCI) 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 a $10 stipend 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.

700 surveys in Iowa, 2300 total in three states

The WSRL was asked to complete an average of 5 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 700 surveys. Sample size characteristics, statistical analysis of differences and summary statistics are contained in the Phase III report for Iowa (12) on both the Iowa DOT and MU web sites.

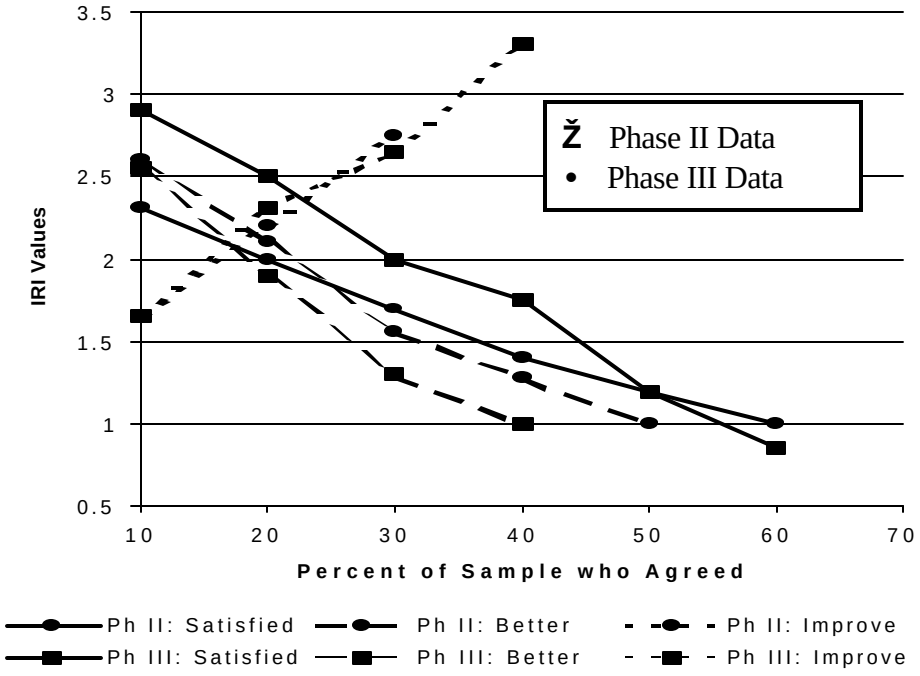
It was expected that because of these changes in procedures, a greater relationship would be observed between the satisfaction measures and the pavement indices in Phase III than that which occurred in Phase II.

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").

Phases II and III alike!



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 (IRI) or condition (PCI) indices of those satisfied as the dependent variable and region 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 the Iowa DOT 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 approximately 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 analyses of each question by pavement type and other differences. In these analyses, just the portion of the sample that SA or A with the three satisfaction questions was used. Graphs of the results are provided for all pavements and for individual cells (regions, or pavement types) that the team believed to be significantly different.

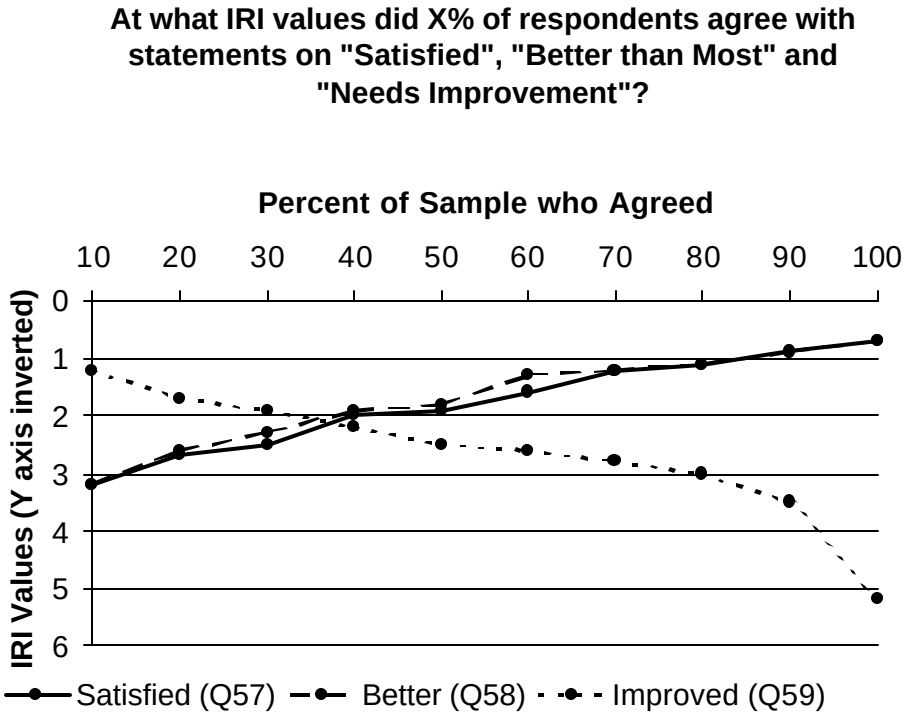
Data statistical accuracy very high

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 page 19 are the curves for IRI and PCI for all pavements combined. The data accuracy of the IRI is +/-0.1 at the 95 percent confidence level. Sample size is large when all pavements are included (539 for IRI). The data accuracy for PCI is +/- 2 at the 95 percent confidence level.

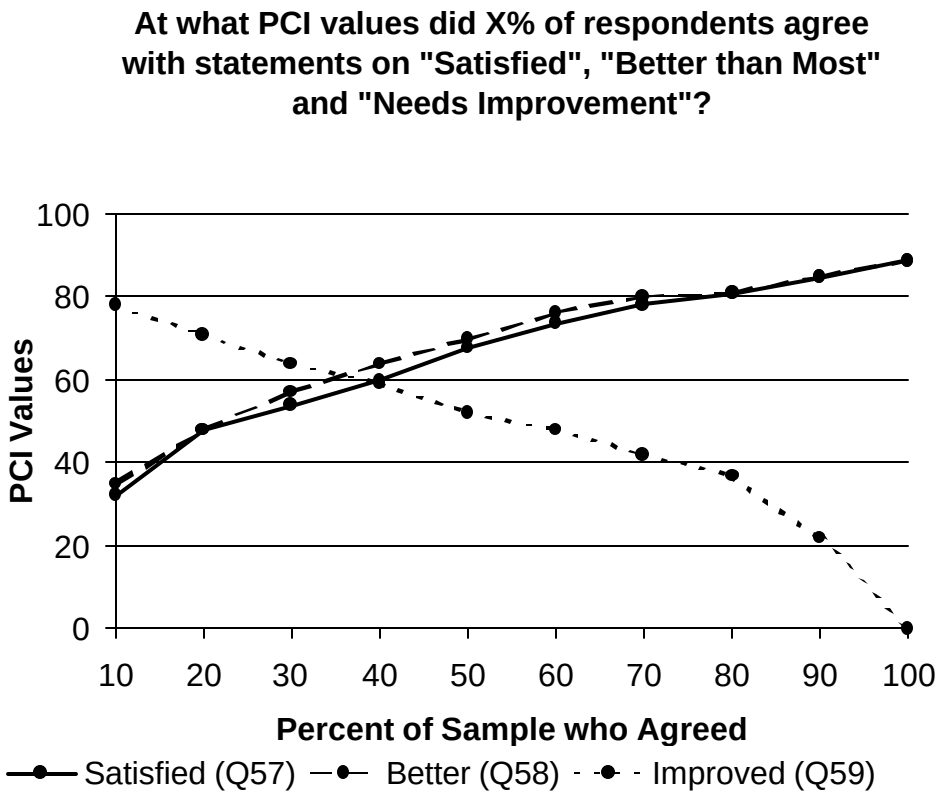
Assumptions

Assumptions about the methods used are discussed here. If a pavement of a given quality was judged satisfactory by a particular respondent, it is presumed a pavement 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 (299 who SA or A with "Improve").

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



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



IRI Thresholds

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

Since meaningful (practical) differences in IRI thresholds were found between pavement types, separate thresholds were developed for PC and for AC and COMP (combined) pavement types. Specifically, drivers are slightly more tolerant of rougher rides on PC pavements than on AC and COMP pavements. For example, the IRI representing 70 percent of those satisfied for PC pavements is 1.9 while that of AC and COMP pavements was 1.0. Likewise, the IRI for 70 percent of those who agreed with "improve" for PC pavements is 3.0 while that for AC and COMP pavements is 2.6.

PCI Thresholds

No differences found in PCI by region or pavement type

Although no statistical or practical differences in PCI thresholds of satisfaction or improvement were found between pavement types or regions, separate thresholds were developed for the two pavement groups analyzed for IRI. The complete results are shown in the table in Appendix 1. Results in PCI at the 70 percent level for "satisfied" and "improve" generally fall in the same quality range as did the results for IRI. The PCI representing 70 percent of those "satisfied" for all pavements is 78 while the 70 percent level to "improve" is 42. The research team believes the differences between pavement types in thresholds of PCI are within the measuring error of PCI.

Intersection of Cumulative Percentage Satisfied and Agreeing with Improve

An "optimum" IRI for improvement

The research team concluded that thresholds established by the intersection of IRI and PCI cumulative plots should be considered when developing thresholds for pavement improvement. This conclusion was reached because the survey data based upon "satisfied" was substantially different than thresholds corresponding with "improve" and the thresholds currently used for pavement improvement by the Iowa DOT. The intersection of the cumulative percent of those who agreed with "satisfied" and 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 the Iowa DOT's quality scales is shown below for all pavements and selected groups.

Iowa DOT Quality Scale	IRI AC and COMP	IRI PC	IRI All Pavts.	PCI All Pavts.	PCI AC and COMP	PCI PC
Very Good						
Good	**X**		**X**	**X**	**X**	
Fair		**X**				**X**
Poor or Very Poor						

For example, the IRI at the intersection of the cumulative percent of "satisfied" 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 "good" category. Similarly, the PCI at the intersection of the same cumulative plots for all pavements is about 1/3 of the way from the bottom of the "good" category." category. This is not necessarily inconsistent, since they are very close. It appears both can be used for threshold purposes and yield thresholds very close to each other. In fact these thresholds are very close to those developed for Wisconsin, for both ride and condition.

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 the Iowa DOT understand the complexity of driver satisfaction. Extensive analysis is documented in both Phase II (7) and Phase III (12) final reports. In Phase III, direct correlations between IRI and satisfaction increased by 50 percent, from .23 to .36 as predicted, with IRI correlations slightly above PCI. However, this still explains only approximately 13 percent of the variation in satisfaction.

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

The Fishbein/Ajzen model was applied to explain satisfaction; the percent of variance explained by the model (using PCI) rose from 62 percent to 73 percent. The ride index performed the best in the model applications in the other two states, but in Iowa the PCI performed just slightly higher and was used for model testing. 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 (12). A summary of the full model results can be seen in Appendix 2.

Recap on Satisfaction

Pavement and non pavement beliefs as well as trust in the Iowa DOT 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 frequency of driving the stretch affected the levels of satisfaction significantly. And although the self-judged vehicle ride did not affect satisfaction for all pavements together, it did contribute slightly in explaining satisfaction for PC pavements. 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 the Iowa DOT the various ways in which the survey data can be used to answer a variety of questions.

When asked for input by driving and being surveyed, overall trust in the Iowa DOT increased

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 Iowa are shown below, with only those who SA or A as a percent of total sample.

Trust Questions	Phase II	Phase III
"The Iowa DOT is capable of fixing and repairing pavements"	**77.6%**	**80.5%**
"Trust judgement when scheduling improvements"	**64.1%**	**67.9%**
"The Iowa DOT cares about safety, convenience on this stretch"	**77.6%**	**81.1%**
"The Iowa DOT considers input from people like me, on this stretch"	**37.5%**	**56.4%**

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

Vehicle ride did not affect belief on pavement roughness

Other analyses examined the following questions:

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 1/3 of the time

2) did non-pavement beliefs (such as a lot of traffic, lack of clear pavement markings 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, non-pavement beliefs were often given as one of the reasons for improvement approximately 1/3 of the time 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 (the Iowa DOT cares) showed greater agreement for drivers who felt safe pulling onto the shoulder as well as 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(7) presents relevant details, a summary comment is appropriate. Respondents' choices for the trade-offs were related not only to perceived trust in the Iowa DOT, 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 Iowa drivers who participated in the two surveys. Since the Iowa DOT fared well on the perceived trust items, in particular, this could well be the basis for building even better relationships with Iowa motorists to guide pavement improvement planning and operations. Details are provided in both the Phase II (7) and Phase III (12) reports.

CONCLUSIONS

Customer-Focused Research -Methodology for Other States Application

Successful Survey Process

The three-phase process was used successfully, consisting of

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, also adds considerable value to the process.

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 Iowa DOT 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

Confidence in the Iowa DOT

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 the Iowa DOT, 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.

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 completely explain satisfaction, they are, never the less, a very useful 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

Customer Feedback Valuable

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).

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 represent important customer feedback regarding perceived trust in the Iowa DOT's actions and represent a value for the Iowa DOT to build on in the future.

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 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 the Iowa DOT 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

Public supports longer lasting pavements

- The Iowa DOT 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 (5) as well as this project.

- 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 adequate shoulders and clear pavement markings to add to the feeling of safety and satisfaction with the public.

Public dislikes detours

- When the Iowa DOT plans construction on a RTLH, it should consider that the public prefers construction under traffic rather than detours. They will tolerate reasonable speed reductions while roads are reconstructed, but dislike detours with longer travel times.

Physical Indices

- Thresholds by pavement type are recommended, since levels of satisfaction differed for IRI by pavement type, and since motorists appear to tolerate a poorer ride on PC pavements.

- PCI shows lesser variation by region or pavement type, but no separate thresholds are recommended for different regions.

- Policy responses show that a majority of the public wants an equal ride, so different thresholds by highway classification if used in Iowa should be reviewed in light of that perception.

- The Iowa DOT's quality ranges of IRI and PCI seem to yield similar results and either can be used and both are deemed accurate. Although only approximately 152 highways were sampled, their respective quality ranges of each index compared in the Phase III report are quite close in yielding results.

- Threshold results found in Iowa were highly comparable for ride and condition with those found in Wisconsin, although each state uses different quality ranges for IRI, even though it is measured the same. No change in pavement quality ranges is recommended in Iowa.

Thresholds

- The Iowa DOT 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.

- No change in threshold policy needs to be made to differentiate between urban and rural two-lane highways, as there were little to no differences in mean IRI or PCI satisfaction levels between urban and rural regions.

- Differences in satisfaction by classification were not studied.

Updates of Satisfaction and Public Perception

- Future use of the results of the modeling on satisfaction can be used by the Iowa DOT 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 the Iowa DOT to monitor both satisfaction and thresholds. The questions that need to be included are on page 52, under Model Summary in the Phase III report (12).

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 the Iowa DOT.

Satisfaction

Iowa Citizens' satisfaction with pavements greater than National study

- Greater satisfaction exists with pavements in Iowa and the other two states than what FHWA found in the NQI study. Iowa can build on that as a guide to its future efforts at reaching out. The more the public is exposed to the logic in pavement improvements, the greater the potential for trust and satisfaction.

REFERENCES

(1) WisDOT "*Briefing Paper PSI to IRI Conversion*," Wisconsin DOT, 3502 Kinsman Blvd., Madison, WI 53704, date unknown.

(2) INDOT "*Correlation of IRI to Public Perception of Pavement Roughness*," Indiana DOT Division of Research, PO Box 1205, West Lafayette, IN 47906, 1993.

(3) Arterburn, S, Suprenant, B, "*Public Perception of Pavement Rideability,*" Report CDOH-UCB-R-90-10, Colorado Department of Highways, 4201 East Arkansas Ave., Denver, CO 80309, 1990.

(4) Garg, A, Horowitz, A. and Ross, F., "Establishing Relationships Between Pavement Roughness and Perceptions of Acceptability," *Transportation Research Record 1196,* TRB, National Research Council, Washington, D.C., 1988.

(5) Coopers and Lybrand, L.L.P., "*National Highway User Survey National Quality Initiative*" Steering Committee, FHWA, 400 Seventh St. S.W., Washington, D.C. 20590.

(6) Wisconsin Survey Research Lab, *"Public Perceptions of the Midwest's Pavements, Focus Group Content Analysis - Iowa, Public Perception of the Midwest's Pavements"*. Available on the Marquette University web site at http://chte.marquette.edu and the the Iowa DOT web site.

(7) Marquette University Center for Highway & Traffic Engineering, *"Public Perceptions of the Midwest's Pavements - Phase II Report, Iowa,*" PO Box 1881, Milwaukee, WI 53201-1881, May, 1999. Available on the Marquette University web site at http://chte.marquette.edu and the the Iowa DOT web site.

(8) Robinson, R, Kuemmel, D, Sonntag, R, Shober, S,and R. Griffin, Wisconsin Pavements and Improvement Tradeoffs, *Transportation Research Record 1699*, TRB, National Academy of Science, Washington, D.C. 20418, pp 66-71.

(9) Ajzen, I., Attitudes, Personality, and Behavior. Milton Keynes, UK: Open University Press, 1988.

(10) Ajzen, I, and Fishbein, M.., Understanding Attitudes and Predicting Social Behavior. Englewood Cliffs, NJ: Prentice Hall, 1980.

(11) Fishbein, M. & Ajzen, I., Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research. Reading, MA: Addison-Wesley, 1975.

(12) Marquette University Center for Highway & Traffic Engineering, *"Public Perception of the Midwest's Pavements - Phase III Report - Iowa,*" PO Box 1881, Milwaukee, WI 53201-1881, July, 2000. Available on the Marquette University web site at http://chte.marquette.edu and the Iowa DOT web site.

APPENDIX 1

Table 4.3 Comparison of 70% Thresholds with Iowa DOT Quality Levels

IRI Scale Iowa DOT	IRI - All Pavts.	IRI - PC Pavts.	IRI - AC & COMP Pavts.	PCI Scale Iowa DOT	PCI - All Pavts.	PCI - PC Pavts.	PCI - AC & COMP Pavts.
V.Good 0.0				**Exc.** 100			
0.8			**1.0 B**	92			
1.0	**1.2 B**		**1.0 S**	88			
1.2	**1.2 S**			84			**80 B**
1.4				80	**80 B**		**80 S**
Good 1.41				**Good** 79	**78 S**	**78 B**	
1.6				76		**74 S**	
1.8		**1.9 B**	**1.8 X**	72			
2.0		**1.9 S**		68	**66 X**		
2.2	**2.2 X**			64			**62 X**
				60			
Fair 2.21				**Fair** 59		**58 X**	
2.4				56			
2.6		**2.6 X**		52			
2.8	**2.8 I**		**2.6 I**	48			
3.0		**3.0 I**		44	**42 I**	**44 I**	
				40			**41 I**
Poor 3.01				**Poor** <39			
3.2							
3.4							
3.6							
3.8							
V. Pr. >3.81							

S = Q 57 "Satisfied" B = Q 58 "Better than most" I = Q 59 - "Improve"

X = Intersection of Cumulative Percentage Plots, Q 57 ("Satisfied") and Q 59 ("Improve")

(Note: Taken from page 37, Phase III report (12)

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 hierarchial 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. Sample size is 676 for all pavements, 245 for PC only and 431 for AC and Comp. Two tailed significance key in **Table 5.1**is:

* p #.05 **p #.01 ***p #.001

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 (**%**) 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.

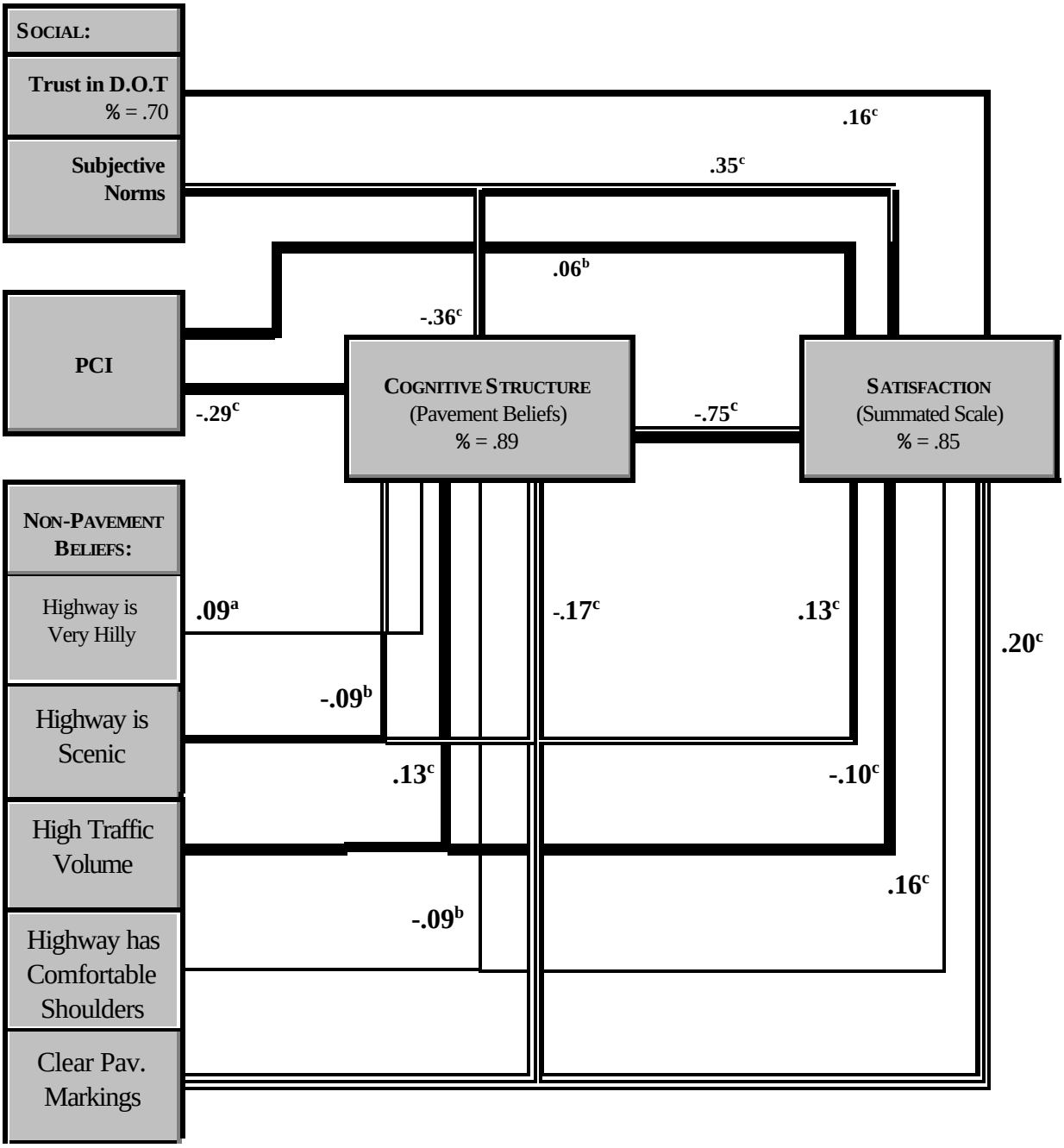
In this project, both pavement beliefs (cognitive structure) and the three questions on satisfaction have been summated and used as a single scale. Both were above .8 in Phase III.

Table 5.1: Relationship of control variables and PCI to cognitive structure and satisfaction with pavement conditions (full model)

Multiple regression analyses (betas)

	All Pavements		*PC Only*		*AC and Comp.*	
DEPENDENT VARIABLE:	**Cognitive Structure ✖ = .89**	**Satis-faction ✖ = .85**	**Cognitive Structure**	**Satis-faction**	**Cognitive Structure**	**Satis-faction**
DEMOGRAPHIC:						
Education	-.02	-.02	-.03	.02	-.01	-.04
Female Sex	-.04	.07	-.05	.08	-.04	.07
Age	-.01	.01	-.02	.05	-.01	-.04
R^2 change	**.00**	.00	.00	.07	**.00**	.00
EXPERIENTIAL:						
Cycle driving frequency	.04	-.03	-.04	.02	.08	-.06
Vehicle "ride"	.06	-.06	**.19****	**-.18****	-.02	**.01***
Frequency of driving stretch	-.01	.00	.01	-.03	-.03	.03
R^2 change	**.01**	.00	**.04***	**.03***	**.00**	.00
SOCIAL:						
Trust in transportation dept. %=.70	**-.05**	**.16*****	**.02**	.07	**-.09**	**.20*****
Subjective norms	**-.36*****	**.36*****	**-.40*****	**.40*****	**-.34*****	**.32*****
R^2 change	**.14*****	**.18*****	**.15*****	**.17*****	**.14*****	**.18*****
PERCEIVED BEHAVIORAL CONTROL	.00	.05	-.09	**.16****	.06	-.01
R^2 change	.01	.00	.01	**.03****	.00	.00
NON-PAVEMENT BELIEFS						
Very hilly	**.09***	-.03	**.16****	-.11	.04	.02
Very curvy	.04	-.01	.01	-.03	.05	.00
Scenic	**-.10****	**.13*****	-.07	.11	**-.11****	**.15*****
High traffic volume	**.14*****	**-.11*****	**.06**	-.10	**.17*****	**-.11****
Comfortable shoulders	**-.09****	**.17*****	-.04	**.17****	**-.12*****	**.17*****
Clear pavement markings	**-.17*****	**.20*****	**-.15***	**.19*****	**-.16*****	**.39*****
R^2 change	**.07*****	**.11*****	**.06****	**.11*****	**.08*****	**.11*****
PAVEMENT CONDITION INDEX (PCI)	**-.29*****	**.06****	**- .26*****	**.07**	**-.29****	**.06***
R^2 change	**.07*****	**.00**	**.06*****	**.00**	**.08*****	**.00**
COGNITIVE STRUCTURE		**-.75*****		**-.72*****		**-.76*****
R^2 change		**.44*****		**.38*****		**.45*****
Multiple R	**.54*****	**.86*****	**.56*****	**.86*****	**.55*****	**.86*****
Adjusted R^2	.28	.73	.27	.72	.29	.73

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



Two-tailed significance key: **a** = p # .05 **b**= p # .01 **c**= p # .001