Civil Engineering Studies
Transportation Engineering Series No. 130
Traffic Operations Lab Series No. 10

UILU-ENG-2004-2001

ISSN-0917-9191

Analyses of Drivers' Opinions about Railroad Grade Crossings Traffic Control Devices and Safety: Background Survey

By:
Rahim F. Benekohal
Murat F. Aycin

A study Report for:
The Pilot Study of Advisory On-Board Vehicle Warning Systems at Railroad Grade Crossings

A study conducted by:
Department of Civil and Environmental Engineering
University of Illinois at Urbana-Champaign

Prepared for:
Illinois Department of Transportation
ITS Program Office

March 2004

Technical Report Documentation Page

1. Report No, FHWA-IL/UI-TOL-10	2. Government Accession No.	3. Recipient's Catalog No
4. Title and Subtitle Analyses of Drivers' Opinions about Railroad Grade Crossings Traffic Control Devices and Safety: Background Survey		5. Report Date March 2004 6. Performing Organization Code
7. Author(s) Rahim F. Benekohal and Murat F. Aycin		8. Performing Organization Report No. UILU-ENG-2004-2001
9. Performing Organization Name and Address Department of Civil and Environmental Engineering University of Illinois at Urbana-Champaign 205 N. Mathews Ave. Urbana, Illinois 61801		10. Work Unit (TRAIS) 11. Contract or Grant No. 13. Type of Report and Period Covered Final Report 2000-2004
12. Sponsoring Agency Name and Address The Illinois Department of Transportation ITS Program Office		14. Sponsoring Agency Code

15. Supplementary

16. Abstract

This first survey obtained background information and opinions/experiences on participating drivers about railroad crossings. A total of 752 professional drivers representing 34 companies participated in the survey. Drivers gave an average effectiveness rating of 4.7 for crossing gates, 4.5 for flashing lights, 3.5 for clanging bell, 3.3 for train horn, 3.1 for crossbuck signs, and 3.0 for advance warning signs (5 means very high and 1 means very low). About 47% of the drivers said that railroad crossings present a significant driving hazard above normal driving conditions, but 46% said they do not. Seventy four percent of the drivers said that most railroad crossings are adequately protected/have adequate safety warning devices. However, 22% said that the crossings need more protection/more warning devices. The perception of hazards does not depend on the frequency of crossing railroad tracks or the number of times the drivers stop at the crossings. The perception of hazards does not influence the rating of the effectiveness of the warning devices. However, the perception of hazards influences the drivers' views on the current standard of railroad grade crossing devices. The precautions drivers take when crossing the tracks are influenced by their perception of hazards and the adequacy of the current standard of warning devices. Drivers who thought crossings needed more protective warning devices rely on the train horn and advance warning signs more than other groups of drivers. Their view of the current standard of railroad warning devices also depends on the type of vehicle they drive. A higher proportion of the drivers in the group that thinks that railroad crossings need more protection drove a bus most frequently.

17. Key Words	18. Distribution Statement
Driver opinion survey, On-board warning system, in-vehicle receiver (IVR), ITS, railroad grade crossing safety, traffic control devices,	

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	64	

`Form DOT F 1700.7 (8-72)

ACKNOWLEDGMENT AND DISCLAIMER

The authors would like to thank the members of Project Management Committee and Technical Oversight Committee for their suggestions, comments and cooperation throughout this study. In particular we appreciate invaluable assistance and cooperation of Mr. Charles Sikaras and Mrs. Claire Jonak of IDOT. Also, we would like to thank Carmen Rawls and Dr. Yoassry Elzohairy former students at the University of Illinois for their assistance with this study.

TABLE OF CONTENTS

1. INTRODUCTION

This report provides the background information about participating drivers in the Pilot Study of Advisory On-Board Vehicle Warning Systems at Railroad Grade Crossings. It summarizes the results of the first of four surveys that were distributed to the drivers to get their opinions regarding the Advisory On-Board Vehicle Warning System. The first survey aims to obtain background information and opinions/experiences of participating drivers about the railroad crossings. A total of 752 surveys were collected from drivers representing 34 companies. These companies were selected because their drivers regularly utilized the five railroad crossings where the trackside equipment for the Advisory On-Board Vehicle Warning System was installed. All crossings were located on the Chicago-Metra Milwaukee North line. These crossings include: Beckwith Road in Morton Grove, Chestnut Street in Glenview, Shermer Road and Dundee Road in Northbrook, and Greenwood Avenue in Deerfield.

The Pilot Study of Advisory On-Board Vehicle Warning Systems at Railroad Grade Crossings was sponsored by the Illinois Department of Transportation (IDOT), Intelligent Transportation Systems Program Office. This pilot study sought to provide roadway vehicles approaching railroad grade crossings with an on-board/advisory warning of a train approaching or occupying the crossing. The primary emphasis of the study was to evaluate driver perceptions of the on-board warning system's effectiveness, including the in-vehicle receiver position, warning display methods, and overall system reliability.

IDOT selected a contractor team led by Raytheon Company to design, install, operate, and maintain the Grade Crossing Advisory Warning System. Raytheon Company subcontracted with Cobra Electronics, which designed and provided the in-vehicle receiver and roadside transmitters for the project. Raytheon Company also subcontracted with two other firms: Metro Transportation Group (MTG) for design and operation of the trackside control cabinet, and Calspan SRL for human factors analysis of placement of the in-vehicle receivers. The University of Illinois at Urbana-Champaign is the independent evaluator of the Pilot Study. This evaluation will emphasize the drivers' perceptions of the advisory warning information that was provided and its understandability.

2. SYSTEM DESIGN SUMMARY

The system was composed of a trackside transmitter assembly and the in-vehicle receiver. The trackside assembly was responsible for sending the K-band signal to the receiver when a train was approaching or present at the crossing. The trackside system was activated by the existing Metra grade crossing controller. When the gates were activated, the trackside transmitter emitted a dual carrier radio frequency

signal for the duration of the grade crossing event. This dual carrier signal was used to reduce the likelihood of false alarms.

The trackside subsystem consisted of a trackside controller (TC) assembly and transmitter assembly. The trackside controller assembly was an Eagle EPAC300 actuated unit. The transmitter was designed by Cobra Electronics. Once the Metra controller determined that a train was within the warning range, the TC received 110 volts of AC current for the duration of the controller's signal cycle. The receipt of the signal triggered a relay to the on position, which energized the transmitter via a 24-volt DC current to the transmitter assembly. The transmitter then transmitted an omni-directional, dual carrier K-Band (24.1 Ghz) warning signal. The designed-for-broadcast range of the transmitter was 800 to 1200 feet from the transmitter. The trackside controller could record up to 40 events, including input signals from the Metra controller or a failure alarm. Battery backup provided continuous operation for a minimum of 6 hours if power was lost. A remotely located computer monitored and archived all the activity at the trackside subsystem.

3. SURVEY INSTRUMENT DESIGN AND DATA COLLECTION

The survey instrument was designed to determine the driver perceptions/reactions to the system. The drivers' opinion surveys were used to address the following issues:

- Perception/reaction of drivers to the information provided in their vehicles
- Comprehensibility of this information
- Drivers acceptance and trust of on-board warning device
- Drivers' opinions on the warning over an extended period of time
- Reliability and effectiveness of the pilot system
- Comparisons of audible and visual displays or a combination of the two
- Human interface of vehicle operators with the warning system
- Experience of false alarms

The survey instrument was designed in collaboration with IDOT and the Technical Oversight Committee. A copy of the survey is given in Appendix A.

3.1. Data Collection

Drivers from 34 companies participated in this survey. Members of the IDOT staff and on a few occasions representatives of the University of Illinois (UI) visited these companies at prearranged times to train the drivers and distribute the surveys. The system was briefly described and surveys were distributed to the participating drivers. The drivers were assured that their answers would remain confidential. The survey tracking process used numerical codes and did not include the names of the survey respondents. The survey took about 15 minutes to complete. After the completed surveys were collected from the drivers, a videotape (several minutes) that described the in-vehicle receiver and its function was shown to the drivers. The survey and training process took approximately 30 minutes.

3.2. Data Reduction

The collected survey results were coded into a spreadsheet. The drivers' responses were then examined to identify unreasonable and inconsistent answers. The consistency checks involved comparing the following:

1. A driver's age and experience must be consistent. For example, a person who is 30 years old cannot have 20 years of driving experience.
2. The number of times that a person crossed the railroad crossings should not be less than the summation of the times that a person crossed each of the five crossings.
3. Each driver was expected to respond to almost all of the questions. Those drivers who answered very few questions were not used for further analysis.

As a result of the consistency checks, two surveys were not found useful because the drivers did not respond to most of the questions. Thus, the analyses are performed using the responses from 750 drivers. After performing the consistency checks, the spreadsheet was transferred to a Statistical Analysis System (SAS) program to perform the statistical analysis. As a first level, the frequencies and bar charts of the drivers' responses to every question were obtained. In the second level analysis, the survey results were analyzed to examine the behaviors of groups of drivers such as bus drivers. Furthermore, the relationships between answers to different questions and the resulting groupings were analyzed. An example of this type of analysis is the group of drivers who find the crossings dangerous and need more protection/warning devices at grade crossings versus the rest of the drivers in the survey. At the third level analysis, drivers are grouped according to their responses to more than two questions. The resulting groups of drivers are analyzed for their responses.

4. FIRST-LEVEL STATISTICAL ANALYSIS

In the first level analysis, a frequency distribution of the drivers' responses to each question was obtained. The numbers inside the parentheses in the subtitle indicate the question number in the survey.

4.1. Background Information

4.1.1. Age, Experience, and Gender (Q24, Q18, Q23)

The participants' ages varied from 20 to 76 years with an average age of 41.3 years. Figure 4.1 shows the age distribution of the participating drivers. The age group of 40, which includes the drivers between ages 37 and 42, was the largest age group and includes 18% of the drivers. About 90% of the drivers were less than 56 years old, and only 10% of the drivers were less than 28 years old.

The average experience of the participants was 13.9 years. The cumulative distribution plot of the drivers' experience is presented in Figure 4.2. Approximately 10% of the drivers had no more than 2 years of experience and 90% had fewer than 27 years of experience.

Of the drivers surveyed, 89.5% were male and 9.5% were female. The remaining 1% of the drivers did not respond to this question.

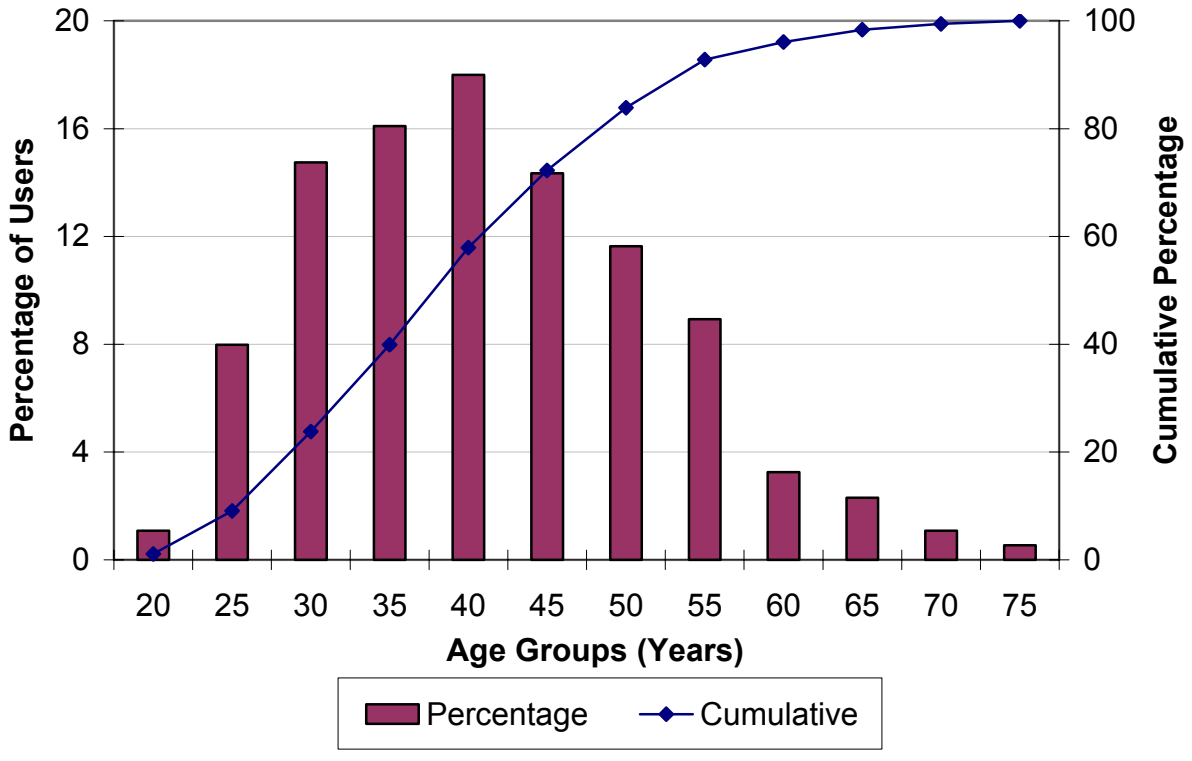


Figure 4.1: Age distribution of participating drivers (Q24).

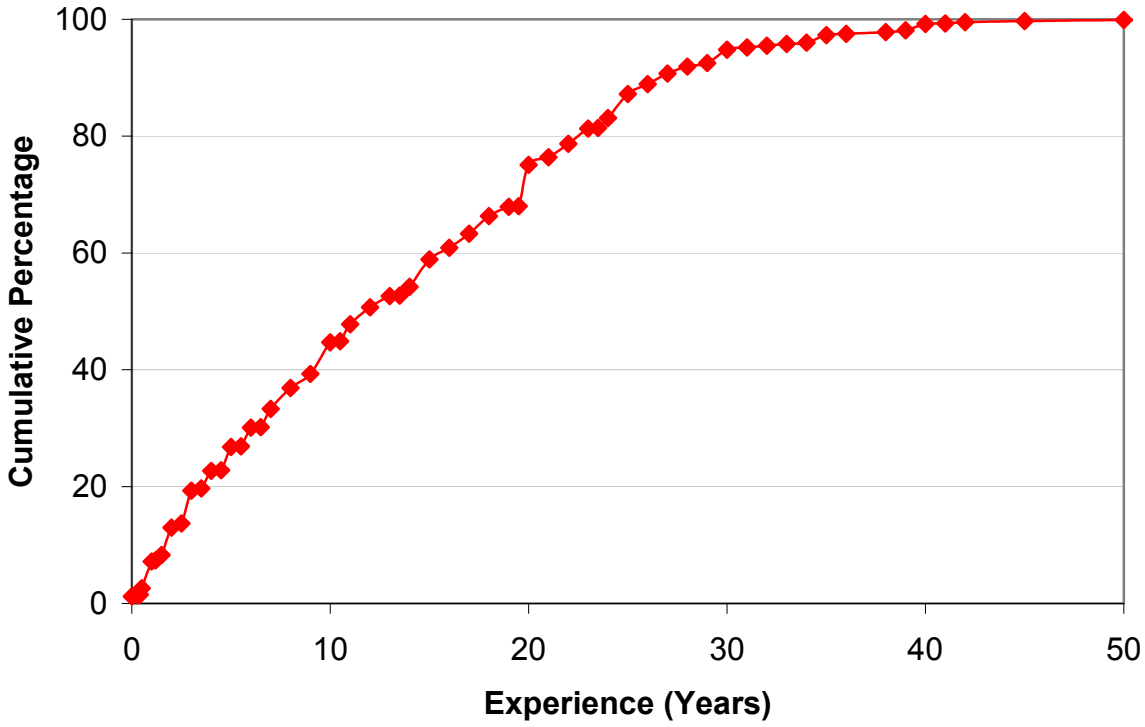


Figure 4.2: Experience distribution of the participating drivers (Q18)

4.1.2. Miles Driven (Q17)

The drivers who responded to this question drove an average of 13,690 miles the previous year. Figure 4.3 presents the cumulative percentage of miles driven by the participating drivers. Approximately 10% of the drivers drove less than 175 miles, and 90% of them drove less than 30,000 miles the previous year. The highest reported value was 300,000 miles. One hundred forty-nine drivers did not respond to this question.

4.1.3. Vision or Hearing Aids (Q20)

Forty-five percent of the drivers in the survey used vision aids, whereas only 0.7% of the drivers used hearing aids while driving. These drivers said that their vision and hearing were "very good" or "good" with the vision and hearing aids.

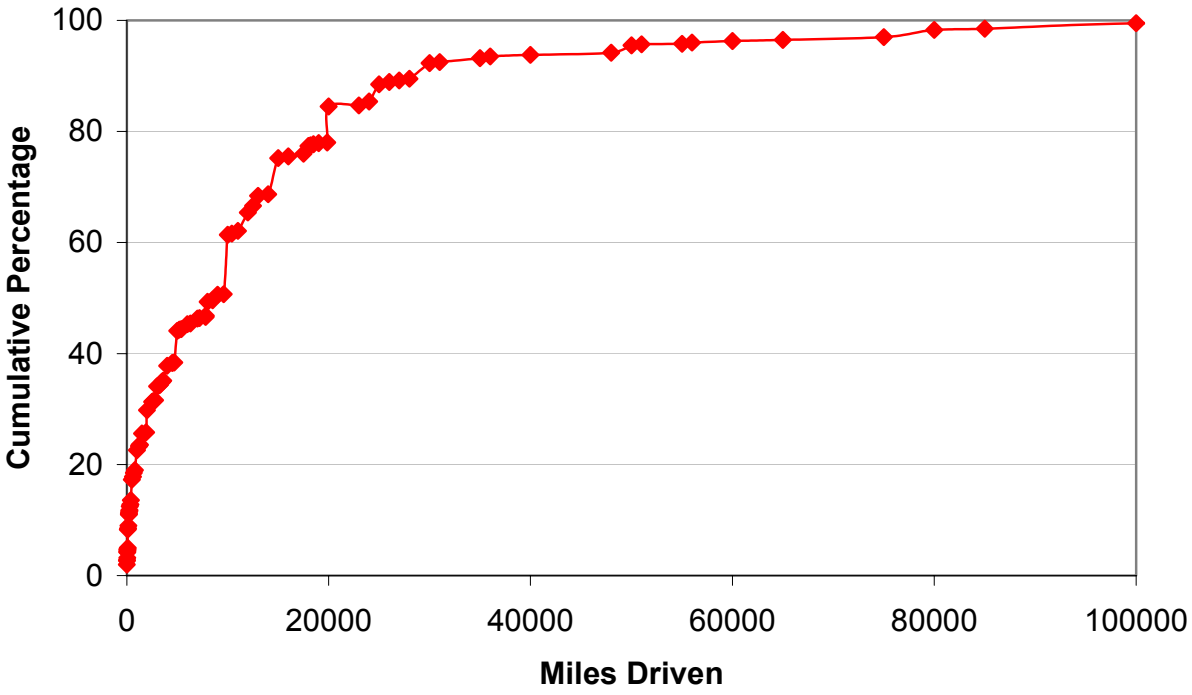


Figure 4.3. Cumulative percentage plot of the miles driven by the participating drivers (Q17)

4.1.4. Vehicle Type (Q16)

Drivers could select from ten different vehicle types as the type of vehicle they most frequently drove. These similar vehicle types were then regrouped into seven types to increase the size of a group. Table 4.1 presents the frequency for each vehicle group. The largest group was emergency service vehicles, followed by van/pick-up trucks. The combined groupings are as follows:

1. Bus
2. Van + Pick-up Truck
3. Emergency Service Vehicle
4. Tractor-Trailer Truck
5. Passenger Sedan + Taxi + Long-Life Vehicle (LLV)
6. Single-Unit Truck (S.U. Truck) + Step Van
7. Other

Table 4.1: Distribution of Responses by Vehicle Types				
Vehicle Type	**Count**	**(%)**	**Regrouped Count**	**Percentage %**
Bus	118	15.74	118	15.74
Van	153	20.40	194	25.87
Pick-up Truck	41	5.47		
Emergency Vehicle	240	32.00	240	32.00
Tractor-Trailer Truck	37	4.94	37	4.94
Car	33	4.40	62	8.26
Taxi	7	0.93		
LLV	22	2.93		
Step-Van	31	4.13	71	9.46
Single Unit Truck	40	5.33		
Other *	28	3.73	28	3.73
Total	750	100%	750	100%

* Includes no answer, more than one answer, and vehicle types other than those listed.

4.2. Railroad Crossing Related Questions

4.2.1. How Many Times Do You Cross Railroad Tracks per Week (Q1)

On the average, the drivers crossed railroad tracks 31 times per week while they were working. The cumulative frequency plot of crossing the tracks is given in Figure 4.4. Approximately 10% of the drivers crossed railroad tracks up to four times per week, while 90% of the drivers crossed the tracks less than 60 times per week. Two drivers reported that they crossed the tracks 500 times per week.

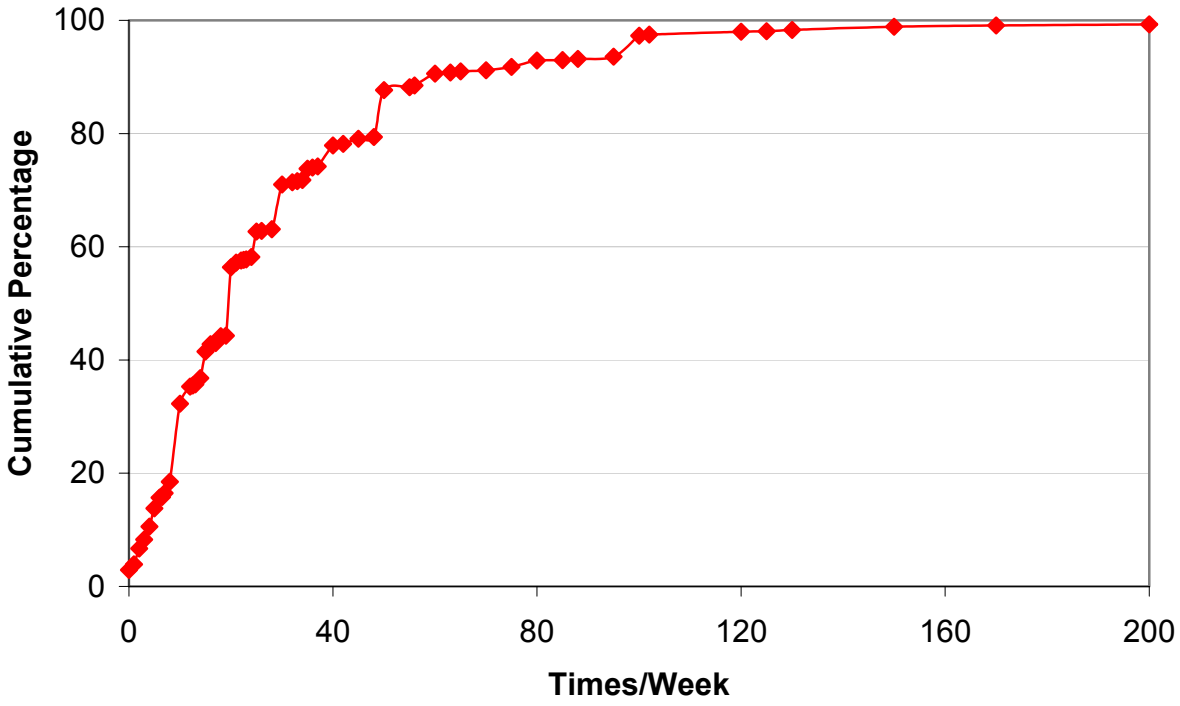


Figure 4.4: Average number of times the drivers crossed railroad tracks in one week (Q1)

4.2.2. How Many Times Must You Stop at Grade Crossings for an Approaching Train (Q2)

On the average, the participants stopped at the railroad crossings seven times per week because of a train approaching/passing. The cumulative percentage distribution of the number of times the drivers stopped at the railroad crossings is presented in Figure 4.5. Almost 6% of the drivers did not stop at railroad crossings, and 9% of the drivers stopped only once per week. Ninety percent of the drivers stopped less than 17 times per week. The highest number reported was 100 times per week.

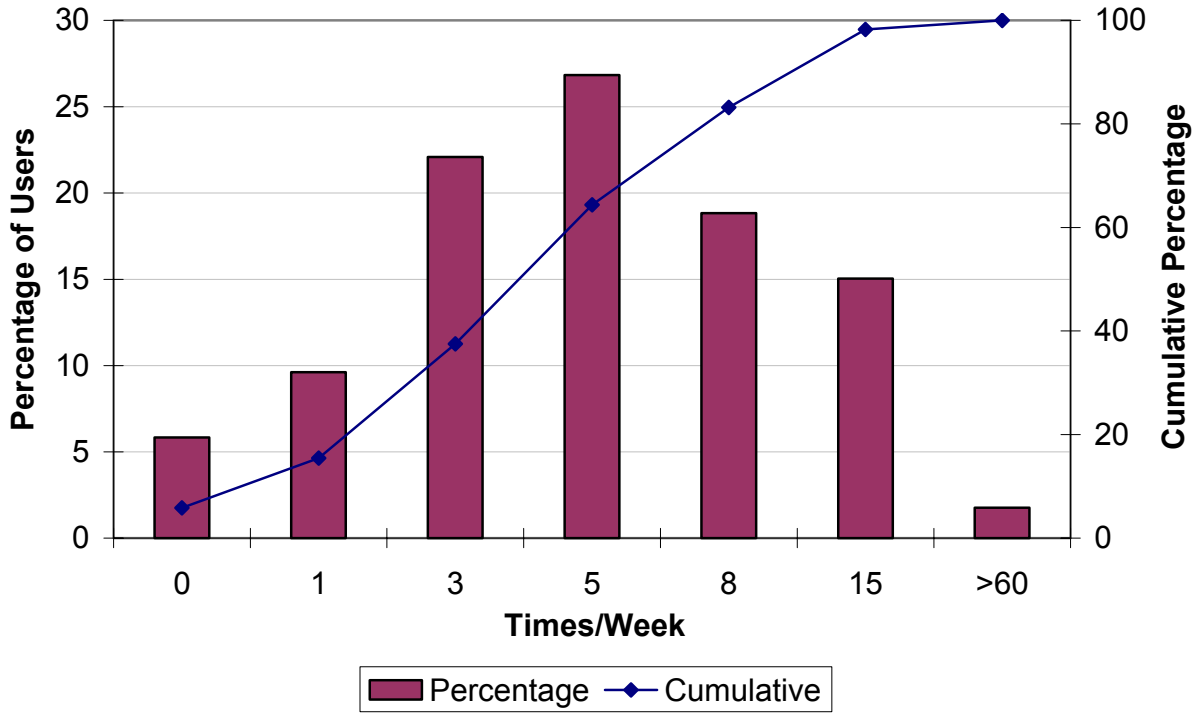
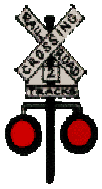
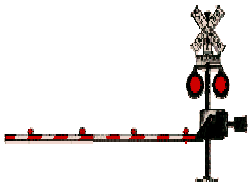


Figure 4.5: Average number of times the drivers have to stop at the railroad tracks in one week (Q2)

4.2.3. Rank the Railroad Grade Crossing Warning Devices in the Order in Which You Rely on Them for Train Crossing Information (1st means rely on the most) (Q3)

The responses from 597 drivers who were able to properly rank the warning devices were utilized in this part. Crossing gates were ranked as "1" by the largest percentage of drivers (42%). Approximately 33% of the drivers ranked flashing lights as "1". The advance warning sign was ranked as "1" by 19% of drivers. Table 4.2 and Figure 4.6 show the railroad warning device rankings versus percentage of drivers. The average ranking for each device is also presented in Table 4.3.

Table 4.2: Device Rankings Selected by the Drivers							
Warning Device	**Ranking**						**Sum**
	1	**2**	**3**	**4**	**5**	**6**	
	19.3%	3.5%	10.9%	21.1%	18.8%	26.4%	100%
	2.5%	11.9%	22.8%	27.5%	26.3%	9.0%	100%
	32.7%	45.7%	14.7%	5.4%	1.0%	0.5%	100%
	42.0%	30.2%	13.7%	11.1%	2.5%	0.5%	100%
Clanging bell	1.5%	7.0%	32.2%	15.6%	32.8%	10.9%	100%
Train Horn	2.0%	1.7%	5.7%	19.4%	18.6%	52.6%	100%

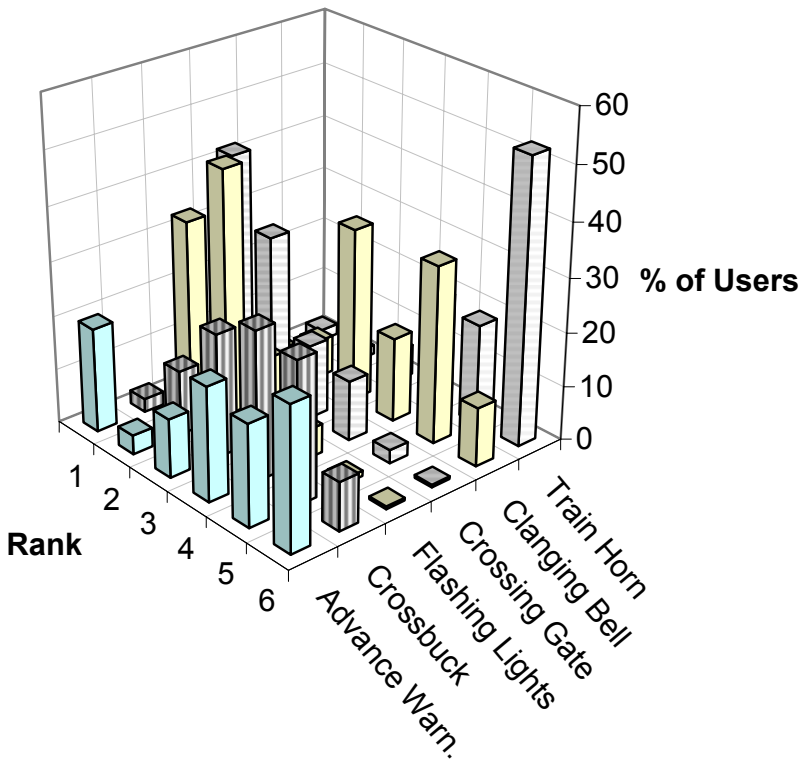


Figure 4.6: Rankings of warning devices (Q3)

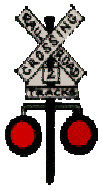
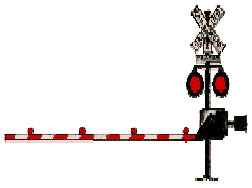
Table 4.3. Average Rankings of Railroad Crossing Warning Devices					
Advance Warning Sign	**Crossbuck Sign**	**Flashing Lights**	**Crossing Gate**	**Clanging Bell**	**Train Horn**
4.0	3.9	2.0	2.0	4.0	5.1

The average rankings show that flashing lights and crossings gates were equally important, and drivers relied on them the most, followed by the crossbuck sign, the advance warning sign, and the clanging bell. The train horn was last in the rankings of railroad crossing warning devices. Over half of the drivers said they relied on train horn the least among the devices.

4.2.4. Rate the Effectiveness of the Railroad Crossing Warning Devices (5 is very high, 1 is very low) (Q4)

Survey results showed that the effectiveness of the crossing gate was selected as "very high" by almost 81% of the drivers. Approximately 62% of the drivers selected the effectiveness of the flashing lights as "very high". The effectiveness of the clanging bell and train horn were selected as very high by approximately 31% and 29% of the drivers, respectively. Table 4.4 shows the effectiveness of the devices versus the percentage of drivers. The percentage plot showing the effectiveness of railroad crossing warning devices is given in Figure 4.7. The average effectiveness of each device is given in Table 4.5.

Table 4.4: Device Effectiveness Selected by the Participants

Warning Device	Effectiveness						Sum
	0	1	2	3	4	5	
	3.0%	12.1%	18.2%	33.3%	14.5%	18.9%	100%
	1.4%	8.8%	16.2%	40.0%	22.7%	10.9%	100%
	0.5%	1.2%	0.9%	6.9%	28.2%	62.3%	100%
	0.3%	0.7%	0.8%	4.5%	13.1%	80.6%	100%
Clanging bell	1.2%	8.1%	12.0%	22.1%	25.9%	30.7%	100%
Train Horn	1.9%	11.5%	14.7%	23.3%	19.8%	28.8%	100%

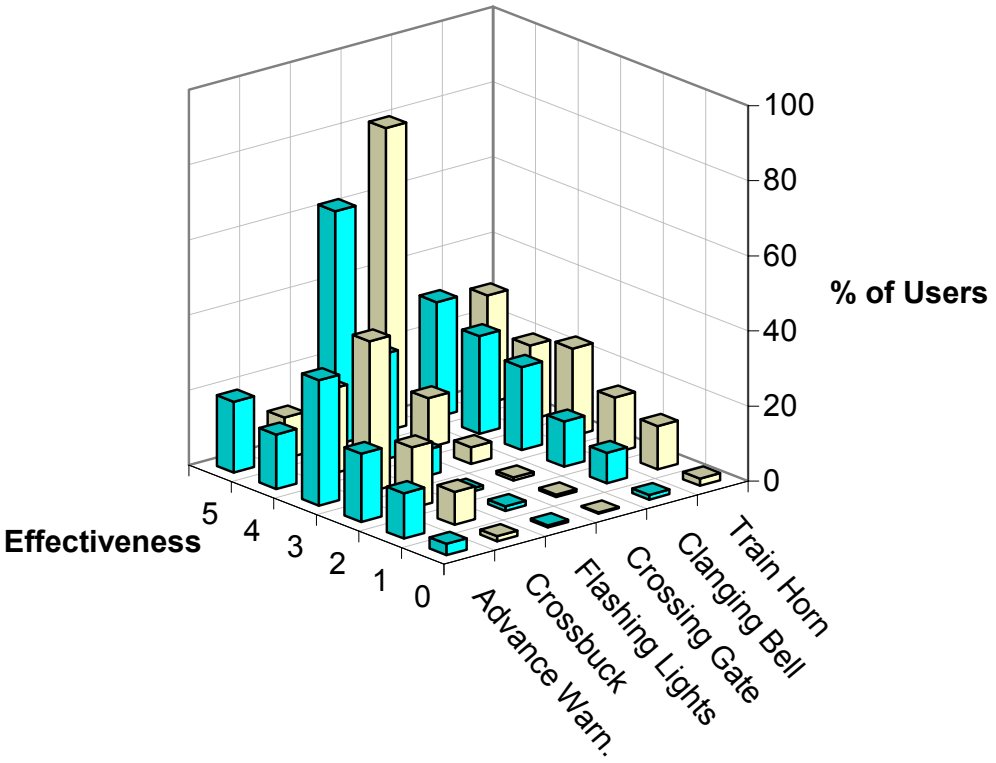


Figure 4.7: Effectiveness of warning devices (Q4)

Table 4.5. Average Effectiveness of Railroad Crossing Warning Devices					
Advance Warning Sign	**Crossbuck Sign**	**Flashing Lights**	**Crossing Gate**	**Clanging Bell**	**Train Horn**
3.0	3.1	4.5	4.7	3.5	3.3

The average effectiveness results indicated that the effectiveness of the crossing gates was "very high", while the effectiveness of the flashing lights was "high" to "very high". The clanging bell and train horn were selected as having "medium" to "high" effectiveness, and the advance warning sign and crossbuck sign were selected as having "medium" effectiveness. Note that none of the railroad crossing warning devices was selected as having "low" or "very low" effectiveness.

4.2.5. Do Railroad Crossings Represent a Significant Driving Hazard above Normal Driving Conditions (Q5)

Forty-seven percent of the drivers said that railroad crossings presented a significant driving hazard above normal driving conditions. On the other hand, 46% of the drivers said that railroad crossings did not present a significant driving hazard above normal driving conditions. Approximately 6% had no opinion to this question, and 1% did not provide an answer. The results are summarized in Figure 4.8.

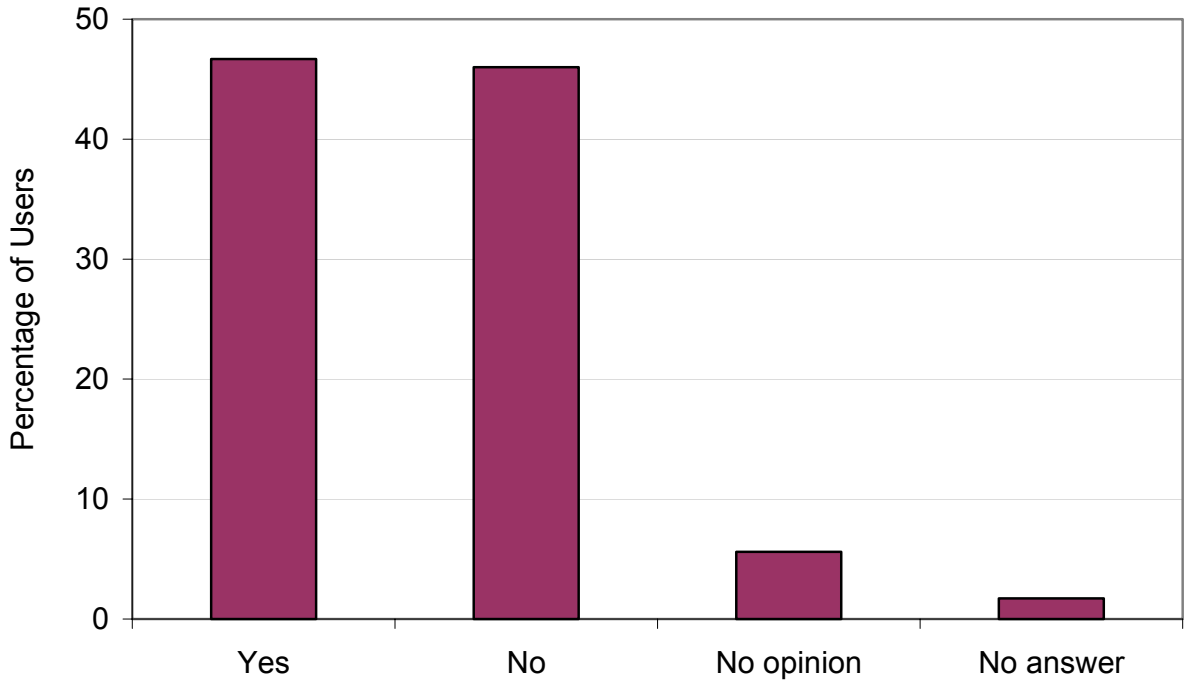


Figure 4.8: Do railroad crossings represent a significant driving hazard (Q5)?

4.2.6. Which Statement Best Describes Your View of the Current Standard of Railroad Grade Crossing Warning Devices (Q6)

Seventy-four percent of the drivers said that most railroad crossings were adequately protected/had adequate safety warning devices. However, 22% said that the crossings need more protection/more warning devices. Only 1% of the participants thought the crossings were over protected/had too many warning devices. Figure 4.9 shows the distribution of the drivers' opinions.

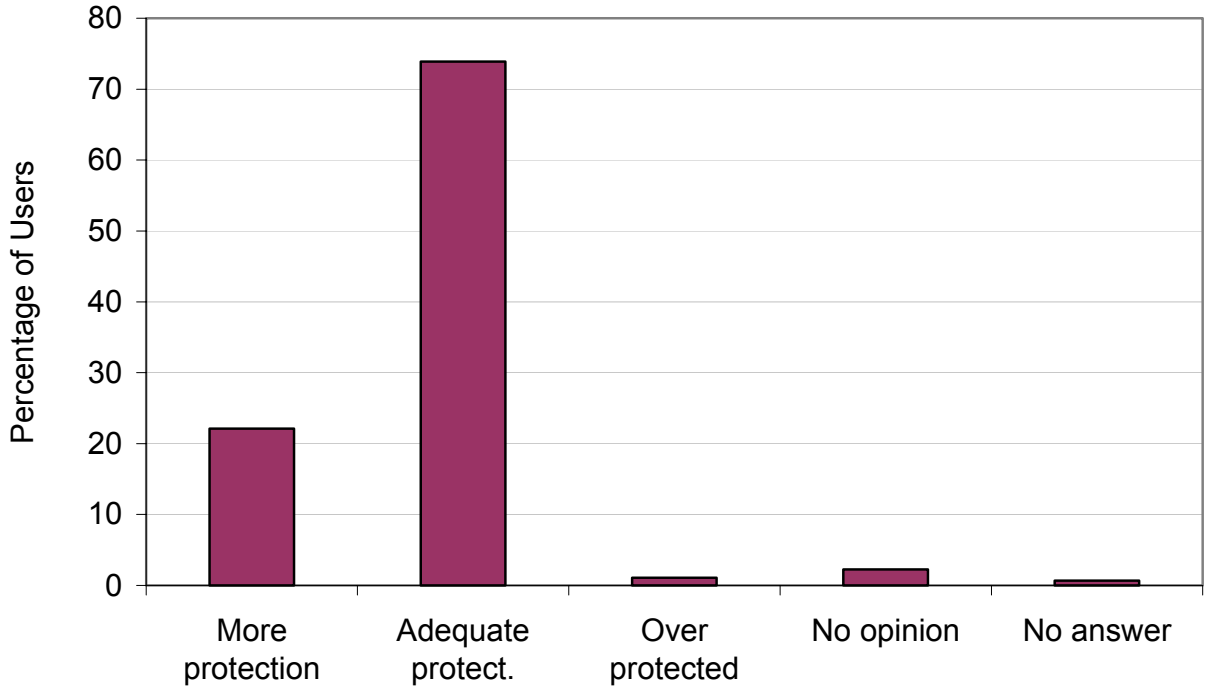


Figure 4.9: Which statement best describes your view of railroad crossing warning devices (Q6).

4.2.7. What Precautions Do You Take When Crossing a Railroad Track (Q7)

Approximately 88% of the drivers looked both ways when crossing railroad tracks. Almost 33% said that they came to a complete stop, and 24% said that they open windows. It should be noted that 15% of the survey participants were bus drivers, who are required to stop at railroad grade crossings. This was a "Circle all that apply" type of question. Since the drivers could choose more than one answer, the sum of percentages is greater than 100%. Figure 4.10 shows the precautions taken by the drivers in the study. Table 4.6 lists the frequency of "other" precautions drivers took. The most frequent response in this category was slowing down, followed by opening the door.

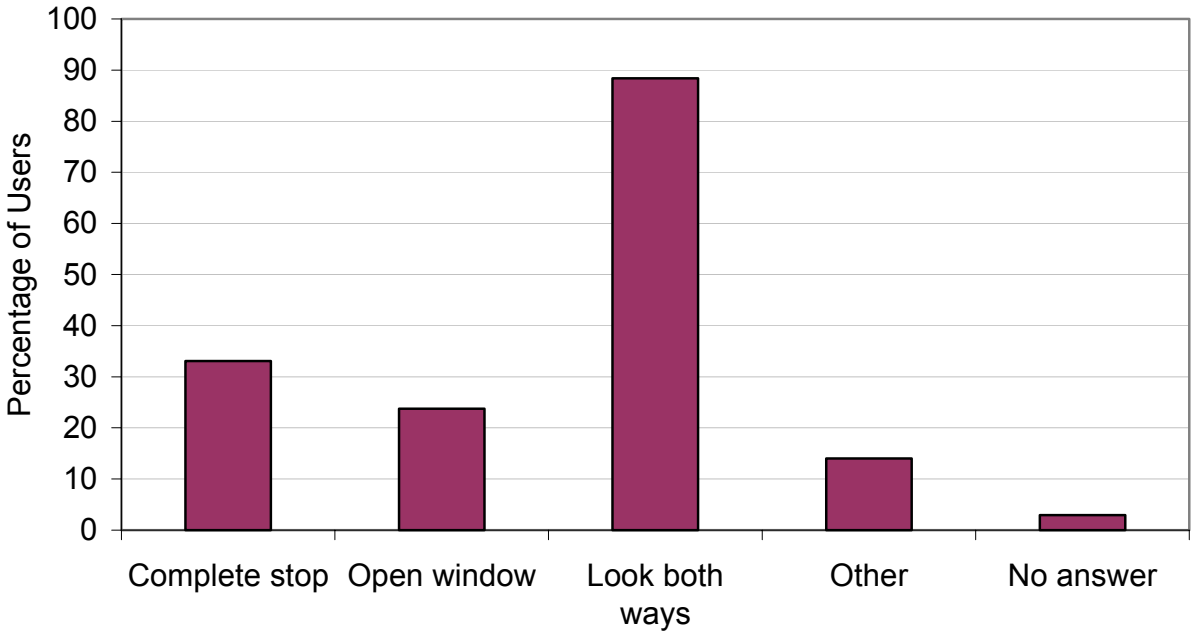


Figure 4.10: What precautions do you take when crossing railroad tracks (Q7)?

Table 4.6: What Other Precautions Do You Take When Crossing a Railroad Track (Q7)?

Precaution	Frequency
Slow down	36
Open door	17
Rely on warning signs	10
Hazard lights	7
Rely on lights flashing	7
Low gear	3
Rely on gate	3
Look to see if I have proper spacing on the other side	2
Miscellaneous	11

4.2.8. In the Past Year, Have You Ever Crossed the Tracks When the Signals Were Flashing (Q8)

As shown in Figure 4.11, the majority of drivers (76%) said that they did not cross railroad tracks when signals were flashing. However, 21% of the drivers crossed the tracks when signals were flashing. The next question, Q9, asked the drivers the reasons why they crossed the tracks when the signals were flashing.

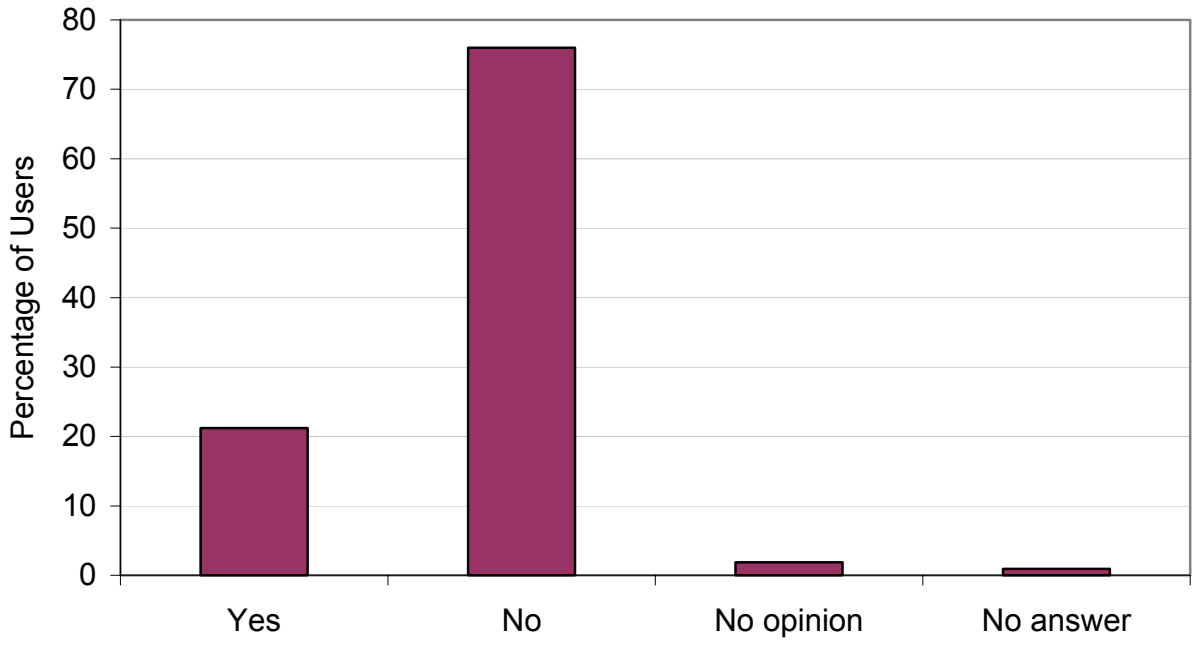


Figure 4.11: Have you ever crossed tracks when signals were flashing (Q8)?

4.2.9. If Crossed the Tracks with Signals Flashing, What Was the Reason (Q9)

Approximately 67% of the participants who crossed the tracks when signals were flashing reported that the signals were malfunctioning. About 41% reported that no trains were in sight, and 28% said they crossed because the train was stopped. Only 4% stated that they crossed the tracks because other vehicles were crossing. Participants were asked to "Circle all that apply" to this question. Since the drivers could choose more than one answer, the sum of percentages is greater than 100%. Figure 4.12 shows the reasons for crossing the tracks while signals were flashing. Approximately 9% of the participants gave other reasons for crossing the tracks when signals were flashing. The reasons given by this group are listed in Table 4.7. The most frequent reason was crossing due to responding to an emergency call, followed by police directing traffic.

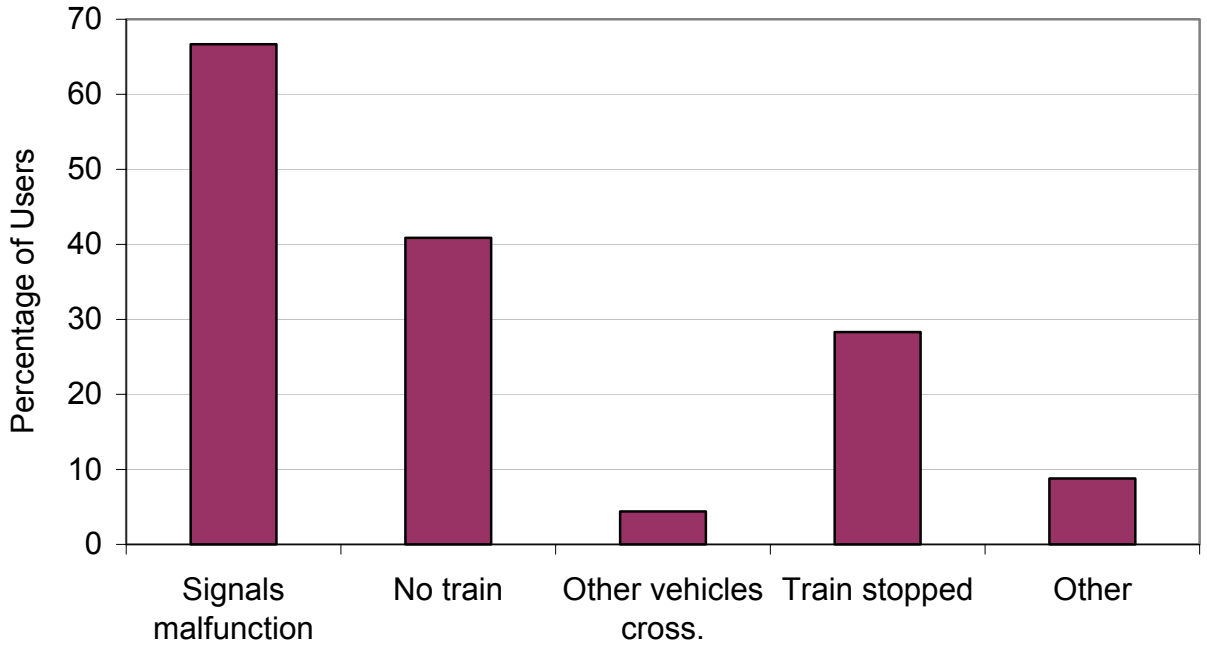


Figure 4.12: Indicate reasons for crossing tracks when signals flashing (Q9).

Table 4.7: Verbatim Reasons for Crossing the Tracks When Signals Flashing (Q9)

Summary of Most Frequent Comments	Frequency
Police direction	5
Emergency	7
Maintenance vehicle on track	2
Signal started after I began crossing	3
Lights flashing	1
Long time from when gates go down to when train crosses	1
Miscellaneous	6

4.2.10. In the Past Year While on Job, Have You Ever Been Involved in an Unsafe Driving Situation When Crossing a Railroad Track (Q10 and Q 11)

Ninety-four percent of the drivers said that they had not been involved in an unsafe situation in the past year, but 5.3%, (40 drivers) said they had. These 40 drivers had been in an unsafe situation an average of 2.6 times in the past year. The highest frequency was 20 times in the past year. The drivers who were involved in an unsafe driving situation were asked to explain the unsafe situation. Table 4.8 gives descriptions of these unsafe situations. These comments show that the most common cause of an unsafe

driving situation was other vehicles maneuvering around the driver's vehicle. Approximately 0.7% of the drivers had no opinion or did not respond to this question.

Table 4.8: Frequency and Description of Unsafe Driving Situation When Crossing Railroad Tracks (Q11).

Most frequent comments	Frequency
Gate malfunctions	2
Signal malfunction	3
Vehicles maneuvering around driver's vehicle/cutting off clear space	7
2 trains coming in opposite directions	2
View obstructed*	3
Car in front of me stalls just past the tracks	2

* at Beckwith, Dundee, Golf Rd., and when trains parked on track

Other comments (Verbatim)
Going around crossing gates
Stopped completely, but did not see train until arms came down
Not enough warning time before gates go down
Gates came down as I was crossing
Trains parked on one set of tracks make it difficult to see other set
Beckwith-tracks dangerously close to stop sign
Tried to make the light while train was approaching
Stuck on tracks waiting for green as train was coming
Slippery tracks
Fire engine approaching
Was rear-ended
Making a left turn crossing railroad tracks and trying to stop for train with vehicles behind me
Gates down, lights flashing, warning bell ringing, no train in sight. I was first in line and did not cross, but others did. I could not turn around. It went on for 20 min.
Gates started coming down while crossing. We have to go slow over tracks. Arms came down fast and nearly hit us.
Made stop for crossing at crossing gate
Green light is on when gates start lowering and I am forced to stop and block intersection
Left turn at stop lite with green with a no left turn lite when train short distance after turn left on to tracks train coming visualized gate coming down too close for comfort.
Gate came down on bus before clanging bell sounded
Car drove through a down gate and was struck by a train.
About once a month while I am driving cars ahead have red light and sometimes I can not judge whether there is enough room on other side of track for my car

4.3. Questions Related to Railroad Crossing Warning Devices

This section describes the actions drivers thought they should take when they saw a particular railroad crossing warning device.

4.3.1. Advance Warning Sign (Q12a)

As shown in Figure 4.13, about 93% of the drivers responded that they would continue driving but be prepared to stop at the railroad crossing coming up, about 1% responded that they would continue driving without any concern or added caution, and about 3% said they would come to an immediate stop at the warning sign. Approximately 3% of the drivers selected "other" or did not answer this question.

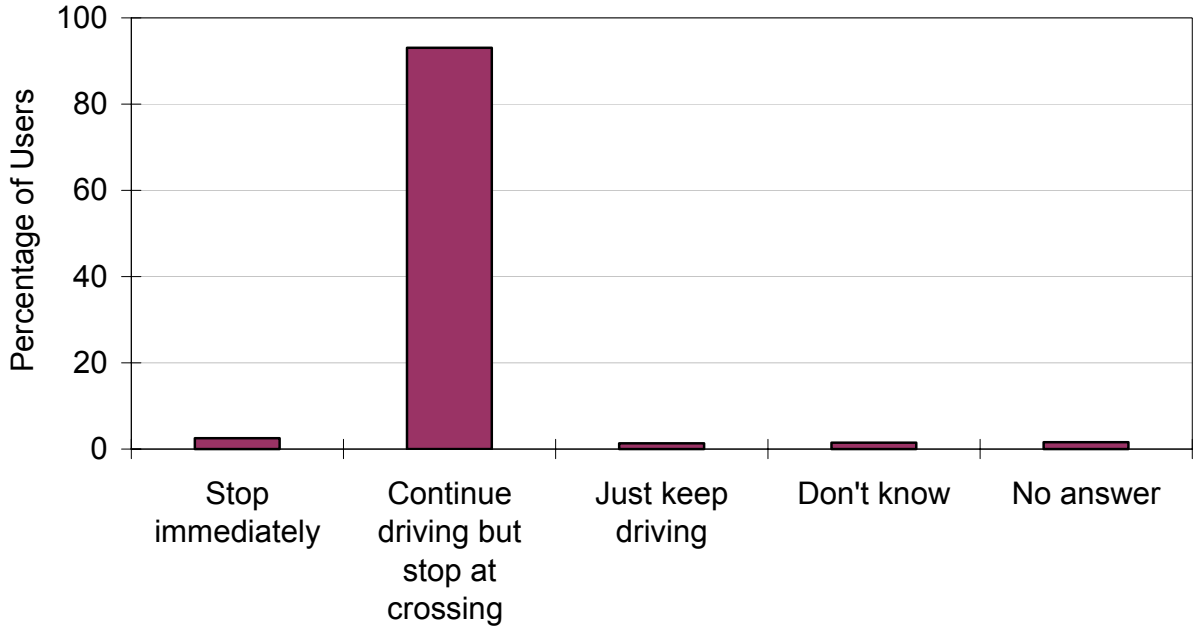


Figure 4.13: What do you do when you come to an Advance Warning Sign (Q12a)?

4.3.2. Railroad Crossing Sign (crossbuck) (Q12b)

As shown in Figure 4.14, approximately 69% of the drivers said they should slow down and prepare to yield for a train, while 27% said they should come to a complete stop. The percentage of drivers that came to a complete stop is greater than the percentage of bus drivers in the survey. This finding shows that drivers of other vehicles also come to a complete stop at a railroad crossing sign. Approximately 4% had no opinion or did not answer this question.

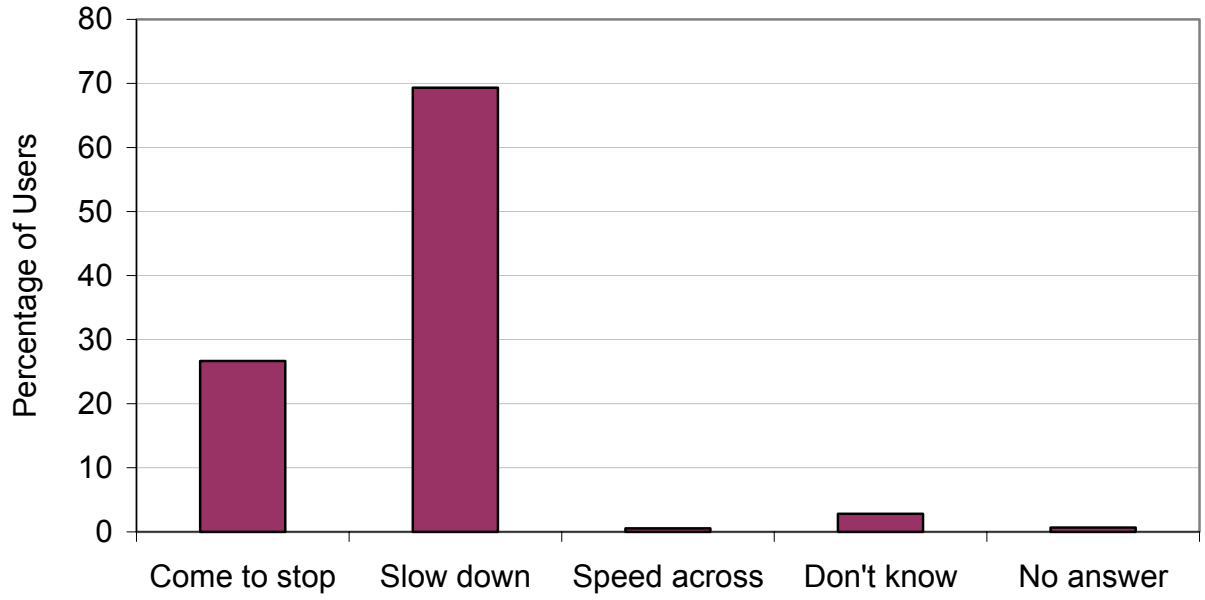


Figure 4.14: What do you do when you come to a Railroad Crossing Sign (Q12b)?

4.3.3. Railroad Crossing Flashing Lights (Q12c)

As shown in Figure 4.15, approximately 94% of the drivers said they should come to a complete stop, while 3% of the drivers said they should slow down and cautiously cross the track. Only 1 driver said he should speed across. Approximately 3% had no opinion or did not answer this question.

4.3.4. Railroad Crossing Gates (Q12d)

As shown in Figure 4.16, approximately 97% of the drivers said they should come to a complete stop and wait for the train to pass. Less than 1% of the drivers (6 drivers) said that they should come to a stop and proceed around the gates if a train is not present. The response for the remaining 2% was as follows: Two drivers said that they should slow down and then go around the gates. Three drivers had no opinion, and nine drivers did not answer this question.

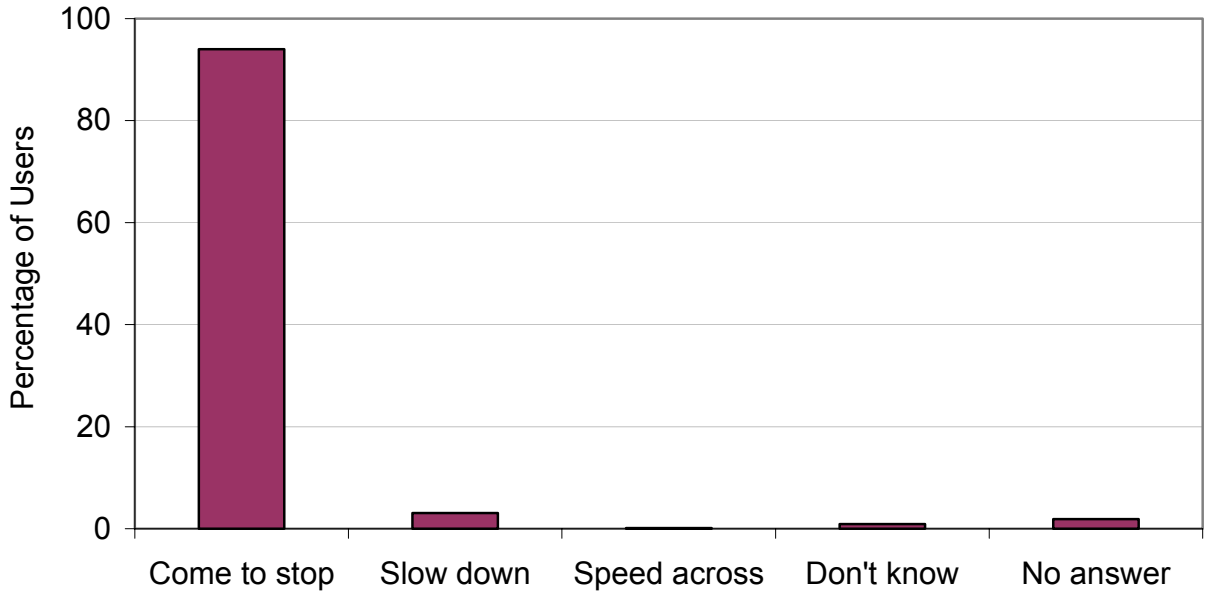


Figure 4.15 : What do you do when railroad crossing lights are flashing (Q12c)?

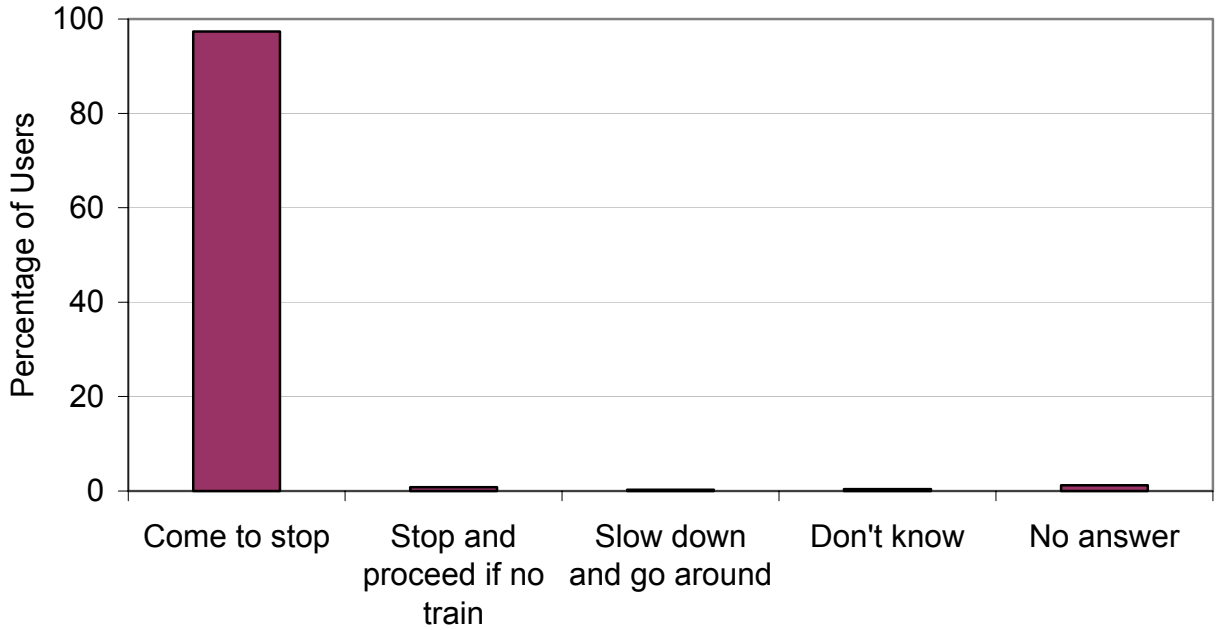


Figure 4.16: What do you do when you see the crossing gates (Q12d)?

4.4. Recent Operating Experience Questions

4.4.1. Frequency of Using the Equipped Crossings (Q13)

The participants indicated whether or not they used a Pilot Study equipped railroad crossing. A large portion (26%-39%) did not respond to this question, but the remaining indicated by "Yes" or "No". About 43% of drivers did not use the Beckwith Road crossing, and 41% did not use the Greenwood Avenue crossing. A high percentage of drivers (40-45%) said they used the two crossings in Northbrook. A lower percentage used the two crossings at Beckwith Road and Greenwood Avenue. Table 4.9 shows the percentage of the drivers that crossed the five railroad grade crossings in the study.

Among those who responded "Yes", it is important to know the frequency of using the crossings. Table 4.10 presents the percentage of participants crossing all the locations in the study. It shows that the largest number (42.7%) of the participants crossed only one crossing in the study. Approximately 20% of the drivers crossed only two out of the five crossings in the study. Only 3% of drivers (23 drivers) utilized all five crossings in the study. A large number of drivers (15.9%) stated that they did not cross any of the crossings in the study.

Table 4.9: Percentage of Drivers That Crossed Railroad Grade Crossings in the Study

Jurisdiction	Crossing	No (%)	Yes (%)	No Response (%)
Morton Grove	Beckwith Road	42.5	18.3	39.2
Glenview	Chestnut Street	32.3	35.4	32.3
Northbrook	Shermer Road	30.4	40.5	29.1
Northbrook	Dundee Road	29.1	45.1	25.8
Deerfield	Greenwood Ave.	41.3	19.9	38.8

Table 4.10: Percentage of Drivers Utilizing the Crossings in the Study

	All 5 crossings	Only 4	Only 3	Only 2	Only 1	None
Percentage	3.1%	5.7%	12.9%	19.7%	42.7%	15.9%
(Number)	(23)	(43)	(97)	(148)	(320)	(119)

Morton Grove/Beckwith Road: Figure 4.17 shows the frequency of usage of the crossing by the drivers. Of the 137 drivers who used this crossing, approximately 85% crossed up to 16 times per week, and 24% crossed up to two times per week. On the average, this location was used 8.3 times per week. The maximum number of times used was 60 times per week.

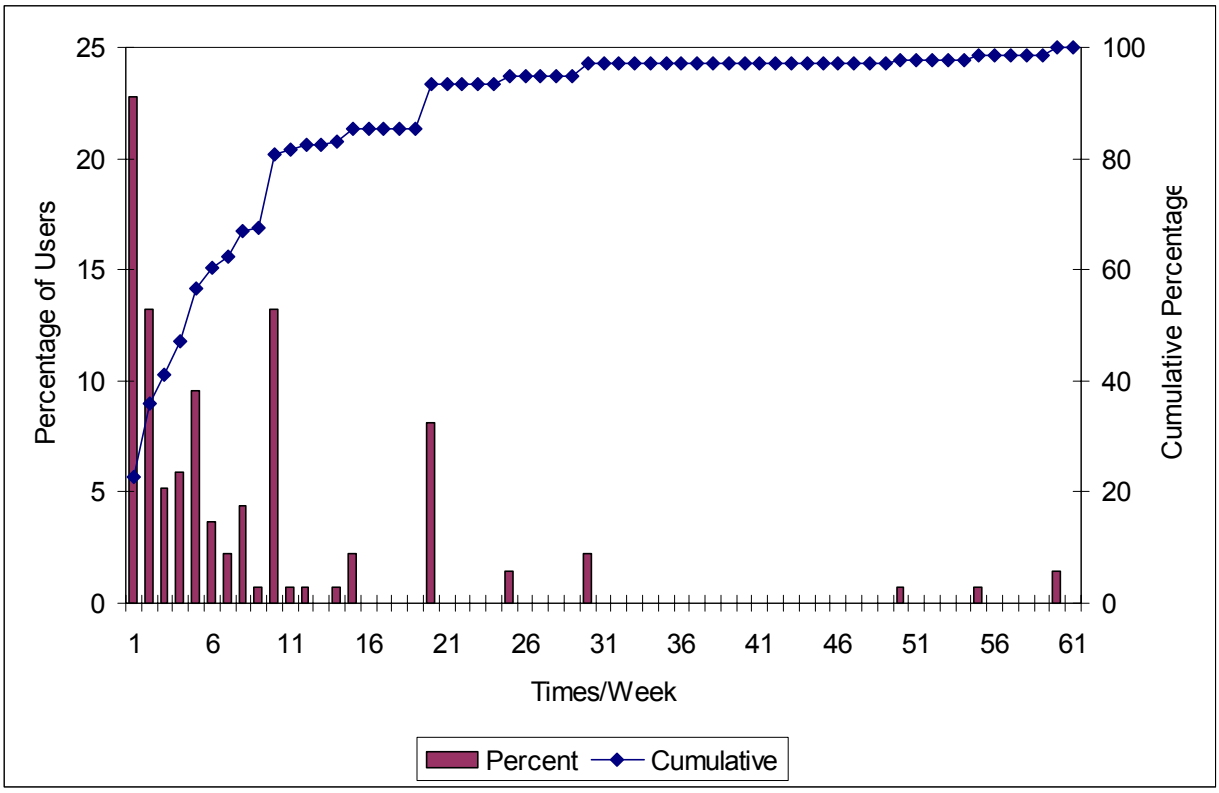


Figure 4.17: Distribution of number of times drivers used Beckwith Road crossing in Morton Grove (Q13a)

Glenview/Chestnut Street: Figure 4.18 shows the frequency of usage of the crossing by the drivers. Of the 266 drivers who used this crossing, approximately 87% crossed up to 16 times per week, and 15% crossed up to two times per week. On the average, this location was used 8.0 times per week. The maximum number of times used was 50 times per week.

Northbrook/Shermer Road: Figure 4.19 shows the frequency of usage of the crossing by the drivers. Of the 304 drivers who used this crossing, approximately 83% crossed up to 16 times per week, and 9% crossed up to two times per week. On the average, this location was used 11.1 times per week. The maximum number of times used was 100 times per week.

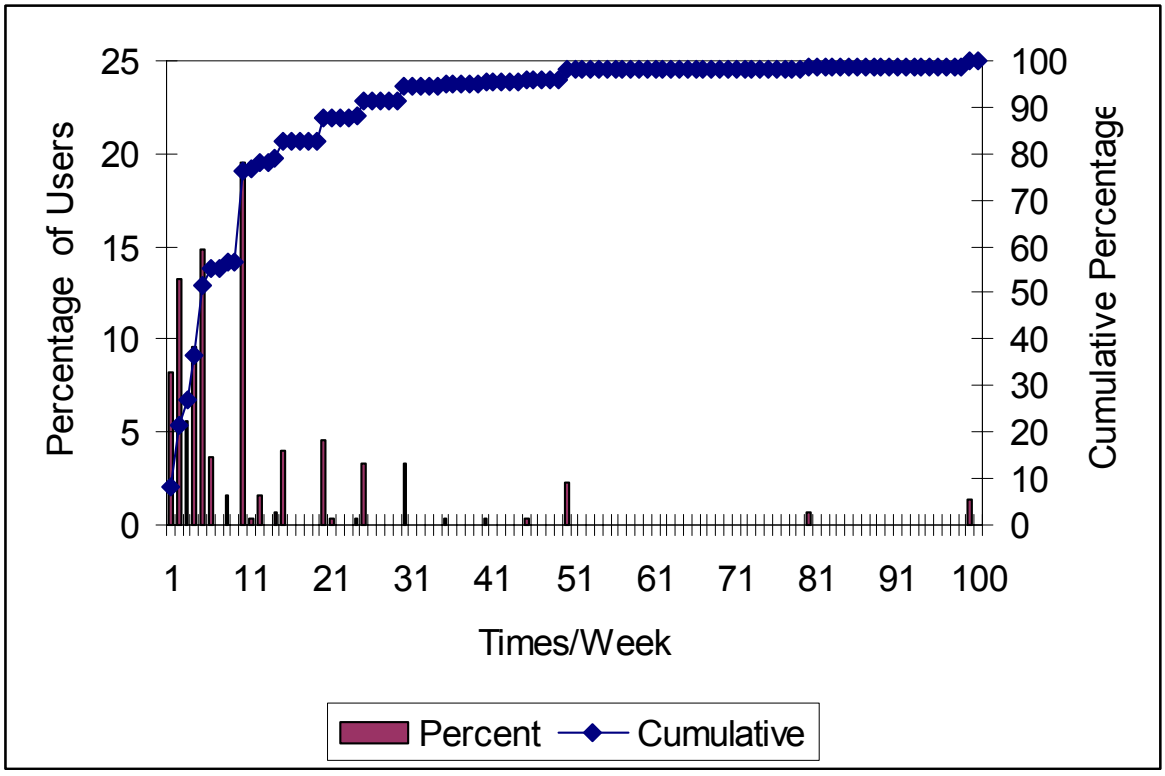


Figure 4.18: Distribution of number of times drivers used Chestnut Street crossing in Glenview (Q13b)

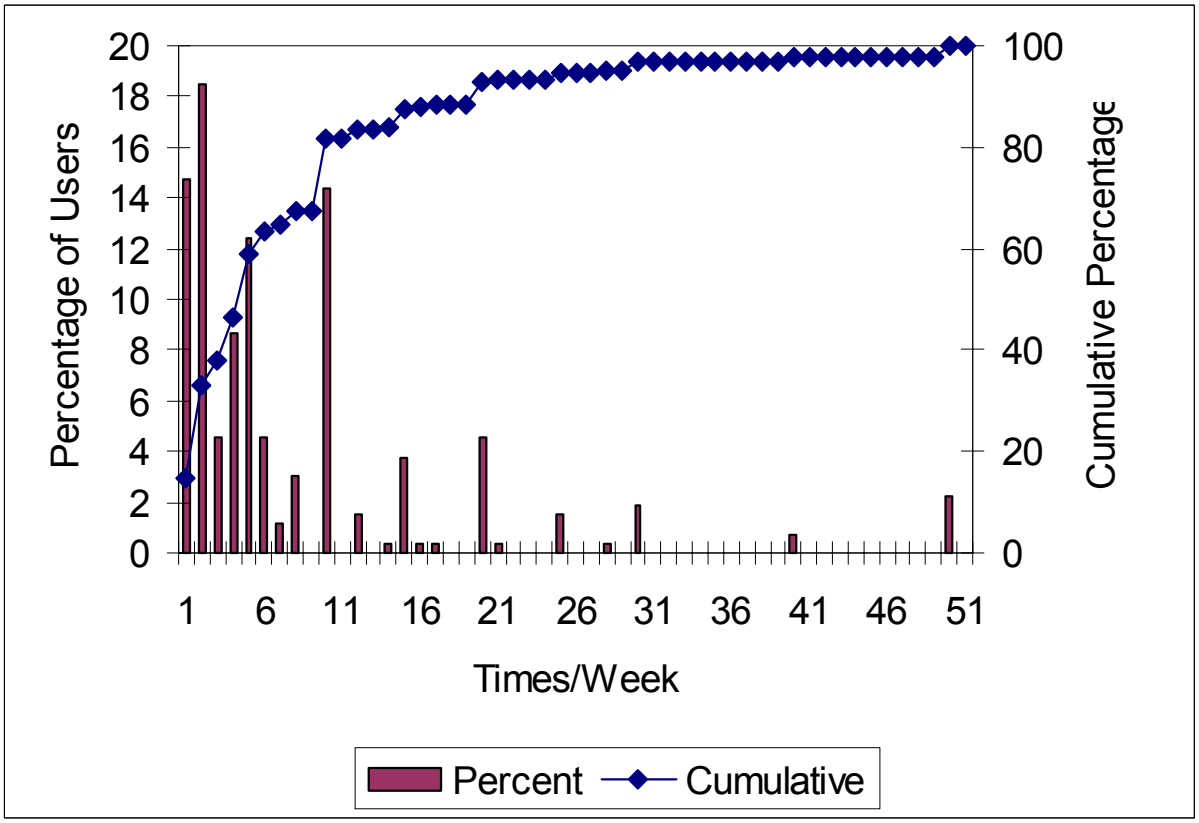


Figure 4.19: Distribution of number of times drivers used Shermer Road crossing in Northbrook (Q13c)

Northbrook/Dundee Road: Figure 4.20 shows the frequency of usage of the crossing by the drivers. Of the 338 drivers who used this crossing, approximately 84% crossed up to 16 times per week, and 10% crossed up to two times per week. On the average, this location was used 10.6 times per week. The maximum number of times used was 100 times per week.

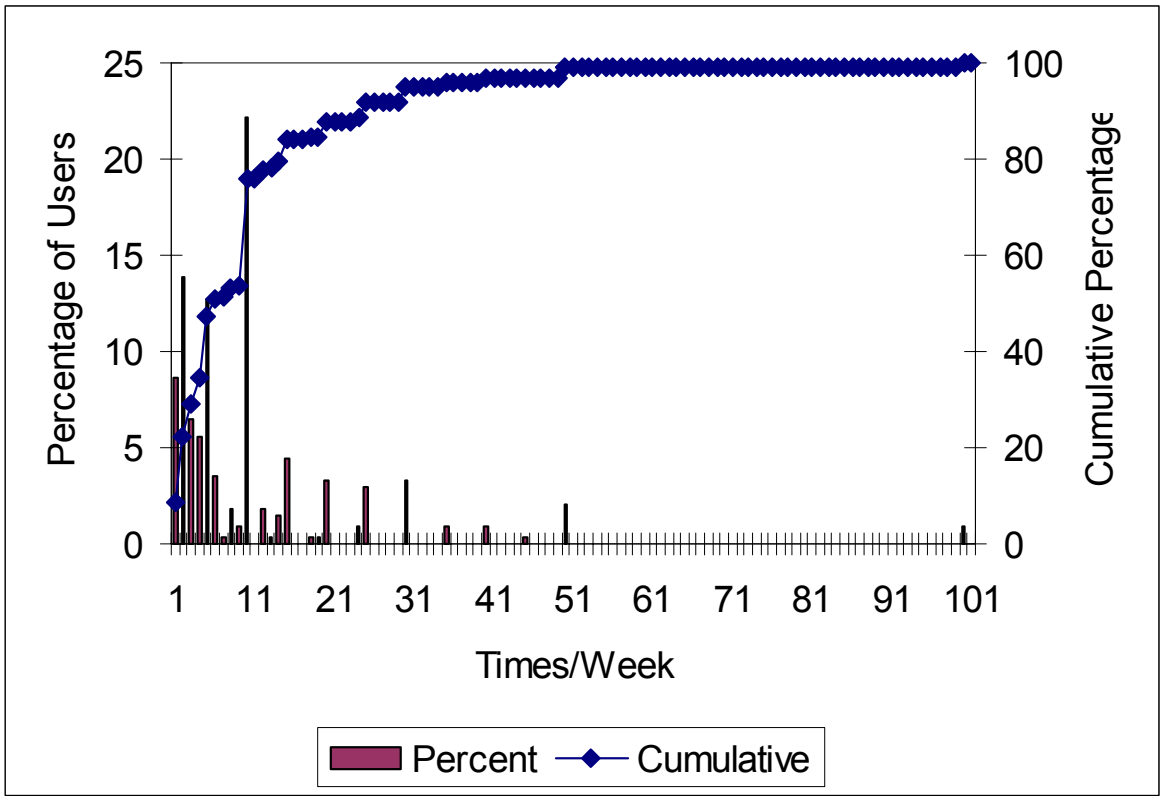


Figure 4.20: Distribution of number of times drivers used Dundee Road crossing in Northbrook (Q13d)

Deerfield/Greenwood Avenue: Figure 4.21 shows the frequency of usage of the crossing by the drivers. Of the 149 drivers who used this crossing, approximately 81% crossed up to 16 times per week, and 25% crossed up to two times per week. On the average, this location was used 9.6 times per week. The maximum number of times used was 75 times per week.

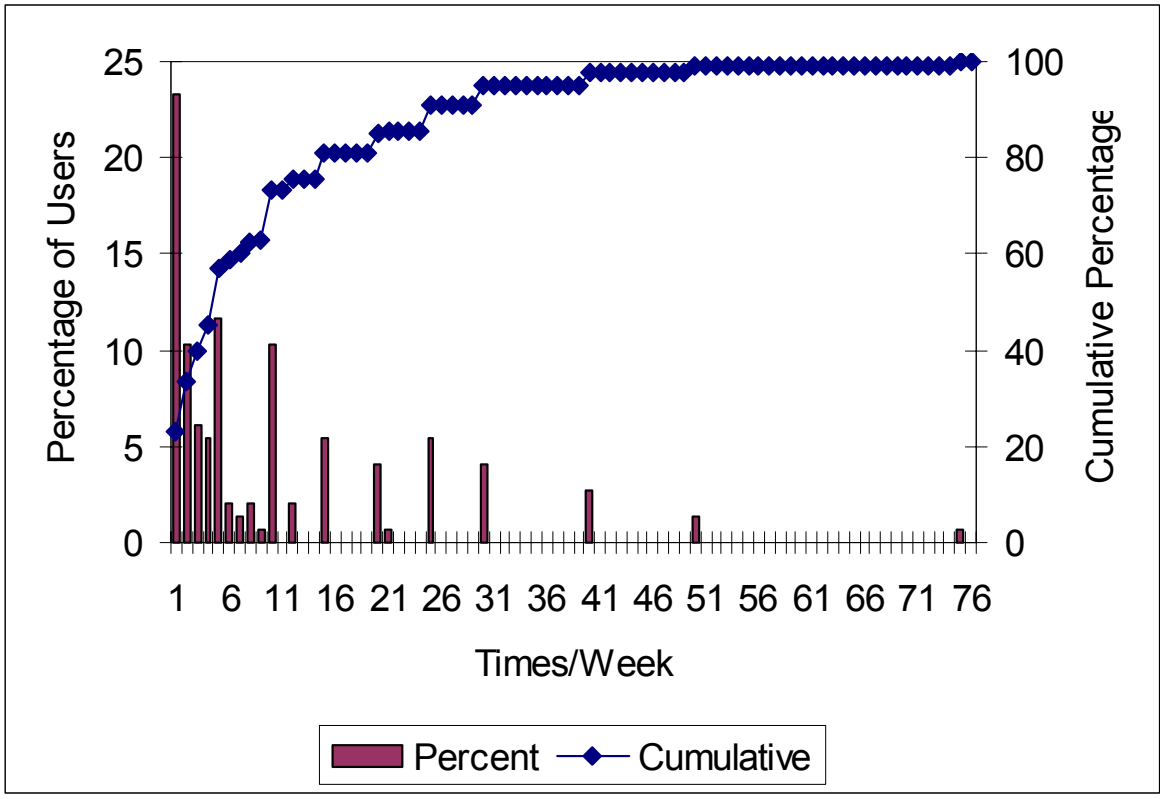


Figure 4.21: Distribution of number of times drivers used Greenwood Avenue crossing in Deerfield (Q13e)

4.4.1. Are Any of the Above Crossings Unusually Dangerous (Q14)

As shown in Figure 4.22, approximately 14% of the drivers responded that the crossings in the study were unusually hazardous, whereas 69% of the drivers responded that none of the crossings were unusually hazardous. Approximately 13% of the drivers had no opinion, and 4% did not answer this question. The verbatim comments of the drivers who said that the crossings were unusually hazardous is provided in Appendix B. The drivers said that the gates malfunctioned occasionally at Morton Grove/ Beckwith Road crossing. The drivers also said that the stop sign was dangerously close to the tracks. In addition, obstacles at the Beckwith Road crossing inhibited the view. Similarly, the drivers said that the visibility was limited at Glenview/Chestnut Street. At the Chestnut Street crossing, malfunctioning gates were said to be causing hazardous conditions. The drivers said that the bad angle of the intersection and sight distance were the reasons why Northbrook/Shermer Road crossing was hazardous. On the other hand, the traffic volume and speed were said to be causing hazardous conditions at Northbrook/Dundee Road crossing. The drivers also said that the gates were frequently knocked down some causing delays to the motorists. The close proximity of the intersections to the crossing was mentioned as the reason why the Deerfield/Greenwood crossing was dangerous.

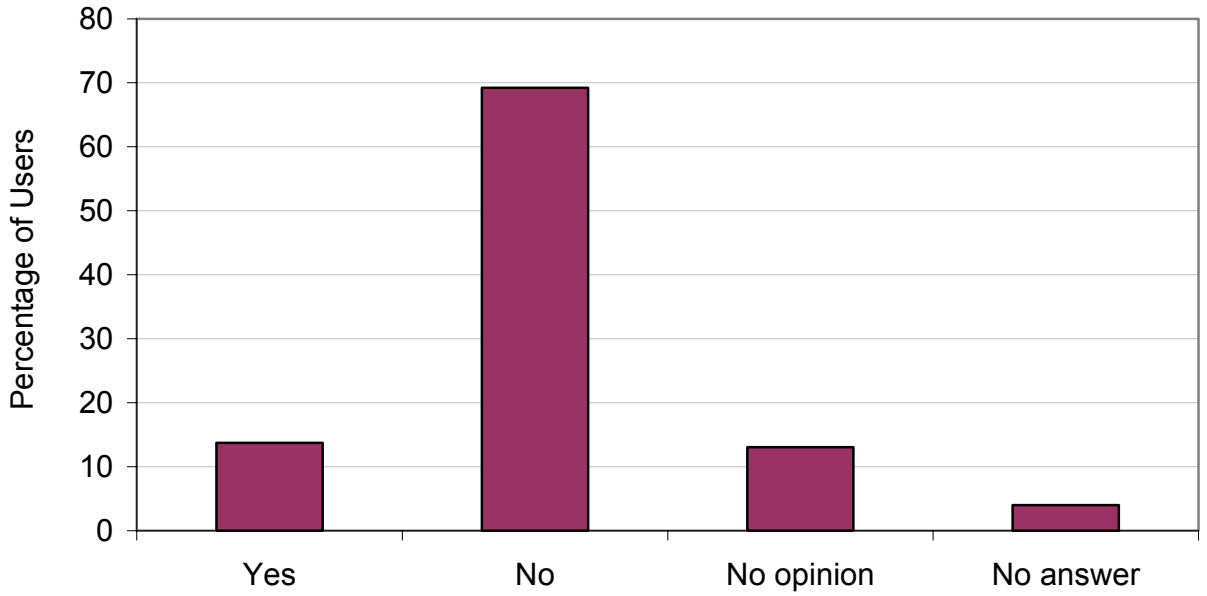


Figure 4.22: Are any of the five crossings in the study unusually hazardous (Q14)?

4.5. Visual/Audible Distractions

Figure 4.23 shows the visual distractions the drivers experienced during driving. Approximately 30% of the drivers said the visual distractions came from passengers, 49% reported to be distracted by light sources, and 22.5% were distracted by interior warning lights. Approximately 31% of the drivers did not report any visual distractions. Other comments from this question are given in Appendix C. A small percentage (less than 1%) of the drivers said that they were also distracted by computers and pedestrians.

Figure 4.24 shows the percentages of the drivers experiencing audible distractions. Approximately 43% of the drivers were distracted by background noise from radio/tape, while 26% of the drivers were distracted by passengers. The largest audible distraction (49.5%) in the group resulted from sirens/horns. About 34% of the drivers reported to be distracted by loud engines. Other answers given to this question are presented in Appendix C. Note that this was a "Circle all that apply" type question and the above percentages do not add up to 100%.

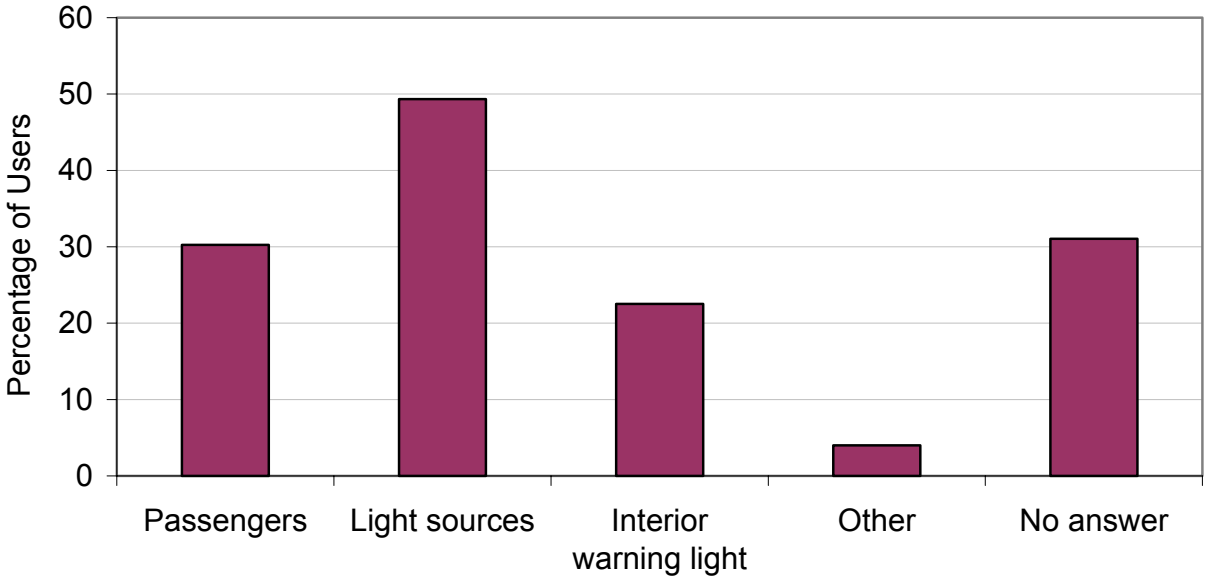


Figure 4.23: Visual distractions drivers experience during driving (Q19)

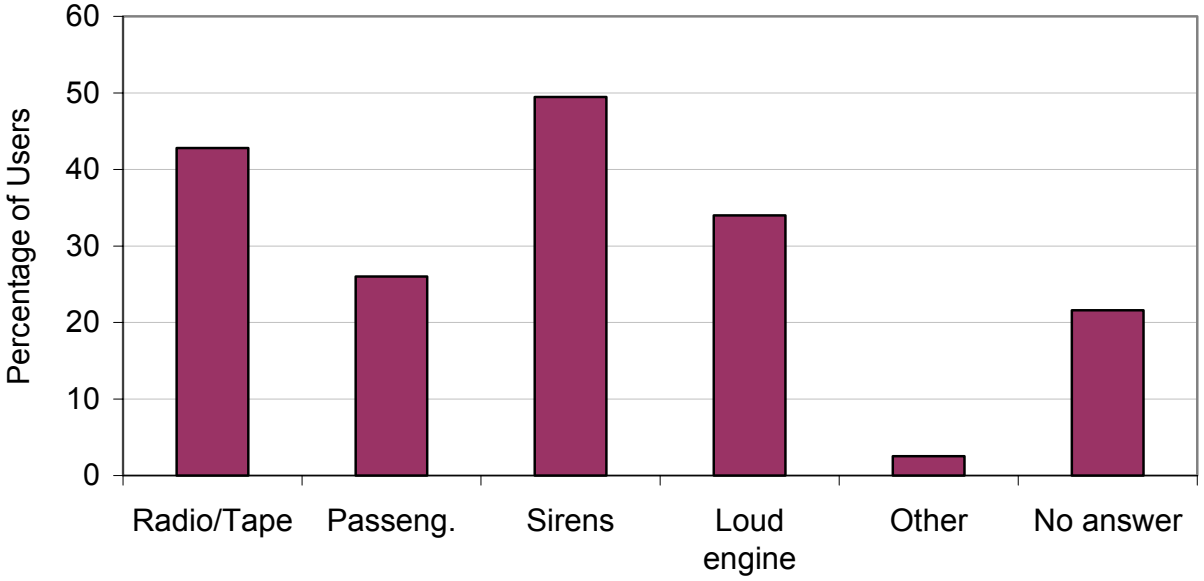


Figure 4.24: Audible distractions drivers experience during driving (Q19)

5. SECOND LEVEL STATISTICAL ANALYSIS

In previous sections, we looked at the responses to a given question without dividing them into subsets. In the second level analysis, we will examine the responses of a subset of drivers, which means that drivers will be grouped into two or more groups. The results will be analyzed separately for each group. The analysis groups are formed by the answers the drivers gave. The analysis groupings are as follows:

Group 1: The group of drivers who thought that railroad crossings presented a significant driving hazard above the normal driving conditions versus the group of drivers who did not think railroad crossings presented a greater driving hazard (Q5).

Group 2: The group of drivers who thought that railroad crossings needed more protection/warning devices versus the group of drivers who thought that railroad crossings were adequately protected (Q6).

Group 3: Drivers grouped by the vehicle type they drove (Q16).

Table 5.1 presents the questions analyzed in the second level analysis and the significant results. Only the statistically significant results are presented in this report.

5.1 Analysis of Results for Group 1

5.1.1. Do Railroad Crossings Represent a Significant Driving Hazard Above Normal Driving Conditions (Q5)

The drivers were split on this question. About half of the drivers (337 drivers) thought that crossings represented a significant driving hazard above normal driving conditions. The other half of the drivers (332 drivers) thought that crossings did not represent a significant driving hazard. We wanted to know if the drivers' responses to other questions were influenced by their perception of crossings being a driving hazard. We used a chi-square test for this purpose. The chi-square analysis of the answers of these two groups of drivers to survey questions at a significance level of 0.05 yielded the results discussed in the following sections.

Table 5.1. Matrix of Questions Analyzed			
Survey Questions	**Questions Analyzed** YES means the result is statistically significant and there is a description for it in the text. N/A means not applicable		
	Q5	**Q6**	**Q16**
Q1	YES	YES	YES
Q2	YES	YES	YES
Q3	YES	YES	YES
Q4	YES	YES	YES
Q5	N/A	N/A	NO
Q6	YES	N/A	N/A
Q7	YES	YES	YES
Q8	NO	NO	YES
Q10	YES	YES	YES
Q12b	NO	YES	YES
Q14	YES	YES	YES
Q16	NO	YES	N/A
Q17	YES	YES	YES
Q18	YES	YES	YES
Q20	NO	NO	NO
Q23	NO	NO	YES

5.1.1.1. Does the Perception of Crossings as a Hazard Depend on the Frequency of Using or Stopping at Crossings (Q1, Q2)

The average values of the drivers' answers in these two groups are given in Table 5.2. Although the drivers who thought that crossings represented a significant driving hazard crossed the tracks more often than the drivers who did not think so, the difference was not statistically significant. Similarly, even though the drivers who thought that crossings represented a significant driving hazard stopped for a train more often than the drivers who did not think so, the difference was not statistically significant. Therefore, the perception of crossings as a driving hazard does not depend on the frequency of crossing railroad tracks or the number of times the drivers stop at the crossings.

Table 5.2: Responses of Drivers Who Did and Did Not Think That Crossings Represented a Significant Driving Hazard to Q1 and Q2

	Drivers who thought that crossings represented a significant driving hazard	**Drivers who did not think that crossings represented a significant driving hazard**	**Test Statistic (Significant if > |1.96|)**
How many times do you cross tracks?	31.3	27.9	1.24
How many times do you stop for train?	7.7	6.8	1.44

5.1.1.2. Does the Perception of Crossings as a Hazard Influence the Ranking and Effectiveness of Railroad Warning Devices (Q3, Q4)

The average values the participants gave to the ranking and effectiveness of warning devices are given in Table 5.3. The results show that the ranking and rating of the effectiveness of warning devices are not significantly different for all groups, except for the crossing gate and the clanging bell. Z-tests performed on the responses of the two driver groups showed that the drivers who did not think that crossings were a significant driving hazard ranked the crossing gates significantly higher than the other group of drivers. The drivers who did not think that crossings were a significant driving hazard ranked the clanging bell significantly lower than the other group of drivers. On the other hand, the effectiveness of the crossing gate and the clanging bell were not statistically different for the drivers that did and did not think that crossings represented a driving hazard. Therefore, the perception of the crossings as a driving hazard does not influence the perception of the effectiveness of the warning devices. It did, however, influence the rankings of crossing gates and the clanging bell.

Table 5.3. Responses of Drivers Who Did and Did Not Think That Crossings Represented a Significant Driving Hazard to the Ranking and Effectiveness of Warning Devices						
	Drivers who thought that crossings represented a significant driving hazard		**Drivers who did not think that crossings represented a significant driving hazard**		**Test for Ranking**	**Test for Effectiveness**
Warning Device	**Ranking (1 is highest)**	**Effectiveness (5 is very high)**	**Ranking (1 is highest)**	**Effectiveness (5 is very high)**	**(Significant if > |1.96|)**	
Advance Warning Sign	3.70	2.99	3.80	2.96	-0.82	0.28
Crossbuck	3.70	3.00	3.80	3.09	-1.23	-0.68
Flashing Lights	2.00	4.40	1.90	4.53	0.49	-1.24
Crossing Gate	2.14	4.70	1.90	4.77	2.29	-1.55
Clanging Bell	3.73	3.64	3.90	3.47	-2.04	1.67
Train Horn	4.70	3.34	4.80	3.33	-1.05	0.09

5.1.1.3. Does the Perception of Crossings as a Hazard Influence the Views of Drivers on the Current Standard of Railroad Grade Crossing Devices (Q6)

In this section, the chi-square test was performed to statistically quantify if the perception of the crossings as a hazard influences the drivers' view of the current standard of railroad crossing devices. We analyzed the responses of 2 groups of drivers: a) those who thought that railroad crossings needed more protection/warning devices, and b) those who thought that railroad crossings had adequate protection/warning devices.

a) Are the views of drivers who think that railroad crossings need more protection/more warning devices influenced by the perception of crossings as a hazard?

Approximately 31% of the drivers who thought railroad crossings represented significant driving hazard indicated that more protection/railroad warning devices were needed. The expected value was 22%, which is significantly lower than 31%. On the other hand, 13.5% of the drivers who thought that

railroad crossings did not represent a significant driving hazard indicated a need for more protection. The expected value was 22%, which is significantly greater than 13.5%. Therefore, a lower proportion of drivers in the group that thought that railroad crossings did not represent a significant driving hazard responded that the railroad crossings need more protection.

b) Does the perception of crossings as a hazard influence the views of drivers on the current standard of railroad grade crossing devices?

Approximately 67% of the drivers who thought that railroad crossings represented a significant driving hazard thought that railroad crossings are adequately protected. The expected value was 74%, which is significantly greater than 67%. However, 82% of the drivers who thought that railroad crossings did not represent a significant driving hazard thought that railroad crossings are adequately protected. The expected value was 74%, which is significantly less than 82%. Therefore, a lower proportion of drivers in the group that thought that railroad crossings represented a significant driving hazard responded that the railroad crossings are adequately protected; and a higher proportion of the drivers in the group that thought that railroad crossings did not represent a significant driving hazard responded that the railroad crossings are adequately protected. The results show that the perception of crossings as a hazard influences the drivers' views on the current standard of railroad grade crossing devices. The drivers who thought that crossings represented a significant driving hazard above normal driving conditions wanted more protection/more warning devices.

5.1.1.4. Does the Perception of Crossings as a Hazard Affect the Precautions Drivers Take When Crossing a Railroad Track (Q7)

In this section, the chi-square test was performed to statistically quantify if the perception of crossings as a hazard affects the precautions drivers take when crossing a railroad track. We analyzed the responses of the drivers who come to a complete stop before the tracks.

Approximately 24% of the drivers who thought that railroad crossings represented a significant driving hazard came to a complete stop before the tracks. The expected value was 18%, which is significantly less than 24%. Approximately 13% of the drivers who thought that railroad crossings did not represent a significant driving hazard came to a complete stop before the tracks. The expected value was 18%, which is significantly greater than 13%. Therefore, a higher proportion of the drivers in the group that thought that railroad crossings represented a significant driving hazard came to a complete stop before the tracks; and a lower proportion of the drivers in the group that thought that railroad crossings did not represent a

significant driving hazard came to a complete stop before the tracks. The results show that the precautions drivers take when crossings the tracks are influenced by the perception of a hazard at railroad crossings.

5.1.1.5. Is the Perception of Crossings as a Hazard Related to the Past History of Being Involved in an Unsafe Driving Situation at a Railroad Grade Crossing (Q10)

A chi-square test was performed to statistically quantify if the perception of crossings as a hazard is related to the past history of being involved in an unsafe situation. Approximately 8% of the drivers who thought railroad crossings represented a significant driving hazard had been involved in an unsafe situation when crossing a railroad track. The expected number was 6%, which is significantly lower than 8%. On the other hand, 3% of the drivers who thought that railroad crossings did not represent a significant driving hazard had been involved in an unsafe situation when crossing a railroad track. The expected value was 6%, which is significantly greater than 3%. Therefore, a higher proportion of the drivers in the group that thought that railroad crossings were hazardous had been involved in unsafe driving situations when crossing a railroad track; and a lower proportion of the drivers in the group that thought that railroad crossings were not hazardous had been involved in unsafe driving situations when crossing a railroad track. The results show that the perception of crossings as a hazard is related to the past history of being involved in an unsafe driving situation at a railroad grade crossing.

5.1.1.6. Does the Perception of a Hazard at Railroad Crossings Influence the Views of Drivers Regarding a Hazard at the Five Crossings in the Study (Q14)

A chi-square test was performed to statistically quantify if the perception of a hazard at railroad crossings affects the views of drivers about hazards at the five crossings in the study. Approximately 22% of the drivers who thought railroad crossings represented a significant driving hazard responded that some of the crossings in the study were hazardous. The expected value was 14%, which is significantly lower than 22%. On the other hand, 6% of the drivers who thought that railroad crossings did not represent a significant driving hazard responded that some of the crossings in the study were hazardous. The expected value was 14%, which is significantly greater than 6%. Therefore, a higher proportion of the drivers in the group that thought that railroad crossings were hazardous responded that some of the crossings in the study were hazardous; and a lower proportion of the drivers in the group that thought that railroad crossings were not hazardous responded that some of the crossings in the study were hazardous. The results show that the perception of a hazard at railroad crossings influenced the views of drivers regarding a hazard at the five crossings in the study.

5.1.1.7. Is the Perception of Crossings as a Hazard Related to the Miles Driven and the Driving Experience (Q17, Q18)

There was no significant difference between the drivers who did and did not believe that crossings represented a significant driving hazard in terms of the miles they drove the previous year. The drivers who did not think that crossings represented a significant driving hazard had more professional experience than the drivers who thought that crossings represented a significant driving hazard. However, this difference is not statistically significant. The drivers' answers in these two groups are given in Table 5.4.

Table 5.4 Responses of Drivers Who Do and Do Not Think That Crossings Represented a Significant Driving Hazard to Q17 and Q18.

	Drivers who thought that crossings represented a significant driving hazard	**Drivers who did not think that crossings represented a significant driving hazard**	**Test Statistic (Significant if > |1.96|)**
How many miles did you drive last year?	13,542	13,555	-0.00682
How many years have you been a professional driver?	13.51	14.37	-1.09

5.2. Analysis of Results for group 2

5.2.1. Which Statement Describes the Current Standard of Railroad Grade Crossing Warning Devices (Q6)

The drivers in the survey were divided into two groups depending on their answers to this question. There were 118 drivers who wanted more protection/more warning devices. On the other hand, 402 drivers thought that crossings were adequately protected. We wanted to know if the drivers' responses to other questions were influenced by their perception of the current standard of railroad crossing warning devices. The chi-square test was used for the analyses at a significance level of 0.05. Only the significant results are presented.

5.2.1.1. Does the Perception of the Current Standard of Railroad Crossing Warning Devices Depend on the Frequency of Using or Stopping at Crossing (Q1, Q2)

The results indicate that the drivers who thought crossings needed more protection/more warning devices and the drivers who thought crossings were adequately protected used the crossings at the same frequency. On the other hand, with a slightly lower confidence level (90%), drivers who thought crossings needed more protection/warning devices stopped for passing trains more often than the drivers who thought crossings were adequately protected. The drivers' answers in these two groups are given in Table 5.5.

Table 5.5: Responses of Drivers Who Thought That Crossings Needed More Protection and Who Thought That Crossings Were Adequately Protected to Q1 and Q2

	Drivers who thought that crossings needed more protection/ warning devices	**Drivers who thought that crossings were adequately protected**	**Test statistic (Significant if > |1.96|)**
How many times do you cross tracks?	29.3	29.3	0
How many times do you stop for train?	8.4	6.9	1.88

5.2.1.2. Does the Perception of the Current Standard of Railroad Warning Devices Influence the Ranking or Effectiveness of Railroad Warning Devices (Q3, Q4)

The average values the participants gave to the ranking and effectiveness of warning devices are given in Table 5.6. The results indicate that the drivers who thought that crossings needed more protection ranked the train horn significantly higher than the other group of drivers. With a slightly lower confidence level (90%), this indicates that drivers who thought crossings needed more protective warning devices rely on the train horn more than other groups of drivers. The same argument is true about the advance warning signs. However, effectiveness ratings of the train horn and advance warning sign were not statistically different for the drivers who thought that crossings needed more protection/warning devices and the drivers who thought that crossings were adequately protected. The drivers who thought that crossings needed more protection rated the effectiveness of the flashing lights and crossing gates significantly lower than the other group of drivers. However, the ranking of the flashing lights and crossing gates were not statistically different for the two groups of drivers. The results show that the drivers' perceptions of the

current standard of railroad warning devices influence the effectiveness rating of flashing lights and crossings gates and the ranking of the train horn.

Table 5.6: Responses of Drivers Who Thought That Crossings Needed More Protection and Who Thought that Crossings Were Adequately Protected to Ranking and Effectiveness of Warning Devices.

	Drivers who thought that crossings needed more protection/warning devices		Drivers who thought that crossings were adequately protected		Test for Ranking	Test for Effectiveness
Warning Device	**Ranking (1 is highest)**	**Effectiveness (5 is very high)**	**Ranking (1 is highest)**	**Effectiveness (5 is very high)**	**(Significant if > |1.96|)**	
Advance Warning Sign	3.5	3.0	3.8	3.0	-1.85	0.08
Crossbuck	3.7	3.1	3.8	3.1	-0.98	-0.18
Flashing Lights	2.1	4.4	1.9	4.5	1.48	-2.09
Crossing Gate	2.2	4.6	2.0	4.8	1.59	-2.7
Clanging Bell	3.8	3.7	3.8	3.6	–0.61	0.85
Train Horn	4.6	3.4	4.9	3.3	-2.01	0.31

5.2.1.3. Does the Perception of the Current Standard of Railroad Warning Devices Affect the Precautions Drivers Take When Crossing a Railroad Track (Q7)

A chi-square test was performed to statistically quantify if the perception of the current standard of railroad warning devices affects the precautions drivers take when crossing a railroad track. We analyzed the responses of the drivers who came to a complete stop before the tracks. Approximately 35% of the drivers who thought railroad crossings needed more protection came to a stop when crossing the railroad tracks. The expected value was 20%, which is significantly less than 35%. However, only 15% of the drivers who thought that railroad crossings were adequately protected came to a stop when crossing railroad tracks. The expected value was 20%, which is significantly greater than 15%. Therefore, a higher proportion of the drivers who thought that railroad crossings needed more protection came to a stop when crossing railroad tracks; and a lower proportion of the drivers who thought that railroad crossings were adequately protected came to a stop when crossing railroad tracks. The results indicate that the

precautions drivers take when crossing the tracks are influenced by the perception of the current standard of railroad warning devices.

5.2.1.4. Is the Perception of the Current Standard of Warning Devices Related to the Past History of Being Involved in an Unsafe Driving Situation When Crossing a Railroad Track (Q10)

A chi-square test was performed to statistically quantify if the perception of the current standard of warning devices is related to the past history of being involved in an unsafe situation. Approximately 10% of the drivers who thought railroad crossings needed more protection had been involved in an unsafe situation when crossing railroad tracks. The expected value was 6%, which is significantly less than 10%. Therefore, a higher proportion of the drivers who thought that railroad crossings needed more protection had been involved in an unsafe situation when crossing railroad tracks.

5.2.1.5. Does the Perception of the Current Standard of Railroad Warning Devices Affect the Behavior of Drivers When They See a Crossbuck Sign (Q12b)

A chi-square test was performed to quantify statistically if the perception of the current standard of warning devices affects the behavior of drivers when they see a crossbuck sign. Approximately 34% of the drivers who thought that railroad crossings needed more protection came to a stop when they saw a crossbuck sign. The expected value was 27%, which is significantly less than 34%. Therefore, a higher proportion of the drivers who thought that railroad crossings needed more protection came to a stop when they saw a crossbuck sign.

5.2.1.6. Does the Perception of the Current Standard of Railroad Warning Devices Influence the Views of Drivers about a Hazard at the Five Crossings in the Study (Q14)

A chi-square test was performed to statistically quantify if the perception of the current standard of railroad warning devices affected the views of drivers about a hazard at the five crossings in the study. Approximately 24% of the drivers who thought that railroad crossings needed more protection thought that some of the crossings in the study were hazardous. The expected value was 14%, which is significantly less than 24% at a significance level of 0.05. However, only 10% of the drivers who thought that railroad crossings were adequately protected thought some of the crossings in the study were hazardous. The expected value is 14%, which is significantly greater than 10%. Therefore, a higher proportion of the drivers who thought that railroad crossings needed more protection thought that some of the crossings in the study were hazardous; and a lower proportion of the drivers who thought that railroad

crossings were adequately protected responded that some of the crossings in the study were hazardous. The results indicate that the perception of the current standard of railroad warning devices influences the drivers' views on the five crossings in the study.

5.2.1.7. Does the Perception of the Current Standard of Railroad Warning Devices Depend on the Type of Vehicle Driven (Q16)

A chi-square test was performed to statistically quantify if the perception of the current standard of railroad warning devices depends on the type of vehicle participants most frequently drove. Approximately 24% of the drivers who thought railroad crossings needed more protection drove a bus most frequently. The expected value was 17%, which is significantly less than 24%. Approximately 20% of the drivers who thought railroad crossings needed more protection drove emergency vehicles most frequently. The expected value was 33%, which is significantly greater than 20%. Therefore, a higher proportion of the drivers in the group that thought that railroad crossings needed more protection drove a bus most frequently; and a lower proportion of the drivers who thought that railroad crossings needed more protection drove emergency vehicles most frequently. The results show that the perception of the current standard of railroad warning devices depends on the type of vehicle driven.

5.2.1.8. Is the Perception of the Current Standard of Warning Devices Related to the Miles Driven and Experience (Q17, Q18)

The averages of the responses of the drivers in these two groups are given in Table 5.7. The drivers who thought that crossings needed more protection/warning devices drove more than the drivers who thought that crossings were adequately protected. However, the difference is not significant. In addition, the drivers in both groups had approximately equal years of professional driving experience. Therefore, the perception of the current standard of warning devices does not depend on the miles driven and driving experience.

Table 5.7: Responses of Drivers Who Thought That Crossings Needed More Protection and Who Thought That Crossings Were Adequately Protected to Q17 and Q18.			
	Drivers who thought that crossings needed more protection/ warning devices	**Drivers who thought that crossings were adequately protected**	**Test Statistic (Significant if > |1.96|)**
How many miles did you drive last year?	15,823	13,046	1.14
How many years have you been a professional driver?	13.24	13.87	-0.72

5.3. Analysis of Results for Group 3

5.3.1. Are There any Differences between Drivers of Different Vehicle Types in Terms of the Frequency of Using or Stopping on the Tracks (Q1, Q2)

The average responses of drivers of different vehicle types are given in Table 5.8. The results indicate that bus drivers crossed tracks more often than drivers of any other vehicle type. On the other hand, tractor-trailer drivers stopped more often for a passing train than drivers of any other vehicle type.

Table 5.8: The Average Responses of Drivers of All Vehicle Types to Q1 and Q2		
Vehicle Type	**How many times do you cross tracks?**	**How many times do you stop for a train?**
Bus	37.6	9.4
Van &Pick-up Truck	24.2	6.7
Emergency Vehicle	31.5	6.3
Tractor-Trailer truck	25.4	11.4
Car & Taxi & LLV	36.4	8.4
Step-Van & S.U. Truck	20.7	5.3

5.3.2. Do the Rankings of the Warning Devices Differ for Drivers of Different Vehicle Types (Q3)

In this section, the chi-square test was performed to statistically quantify if drivers of different vehicle types ranked the warning devices differently. The drivers who properly ranked the railroad crossing warning devices are utilized for this analysis.

Advance Warning Sign

Approximately 45% of bus drivers, compared to the expected of value of 23%, ranked the advance warning sign as "1". Approximately 7% of emergency vehicle drivers, compared to the expected value of 23%, ranked the advance warning sign as "1". Therefore, a higher proportion of bus drivers ranked the advance warning sign as "1" compared to drivers of other vehicles; and a lower proportion of emergency vehicle drivers ranked the advance warning sign as "1" compared to drivers of other vehicles.

Crossbuck Sign and Flashing Lights

The rankings of drivers of various vehicle types for these warning devices did not statistically differ from each other.

Crossing Gates

Approximately 29% of bus drivers, compared to the expected value of 45%, ranked crossing gates as "1". Therefore, a lower proportion of bus drivers ranked crossing gates as "1" compared to drivers of other vehicles.

Clanging Bell

Approximately 11% of bus drivers, compared to the expected value of 6%, ranked the clanging bell as "1". About 1.2% of emergency vehicle drivers, compared to the expected value of 6%, ranked the clanging bell as "1". Therefore, a higher proportion of bus drivers ranked the clanging bell as "1" compared to drivers of other vehicles; and a lower proportion of emergency vehicle drivers ranked the clanging bell as "1" compared to drivers of other vehicles.

Train Horn

Approximately 10% of bus drivers, compared to the expected of value of 6%, ranked the train horn as "1". Approximately 2% of emergency vehicle drivers compared to the expected of value of 6% ranked the train horn" as "1". Therefore, a higher proportion of bus drivers ranked the train horn as "1" compared to drivers of other vehicles; and a lower proportion of emergency vehicle drivers ranked the train horn as "1" compared to drivers of other vehicles.

Summary

A higher proportion of bus drivers ranked the advance warning sign, clanging bell, and train horn as "1" compared to drivers of other vehicles. On the other hand, a lower proportion of bus drivers ranked crossing gates as "1" compared to drivers of other vehicles. A lower proportion of emergency vehicle drivers ranked the advance warning sign, clanging bell, and train horn as "1" compared to drivers of other vehicles.

5.3.3. Is the Effectiveness of the Warning Devices Different for Drivers of Different Vehicle Types (Q4)

A chi-square test was performed to statistically quantify if drivers of different vehicle types rate the effectiveness of the warning devices differently.

Advance Warning Sign

Approximately 55% of bus drivers rated the effectiveness of the advance warning sign as high or very high, compared to the expected value of 33%. Approximately 19% of emergency vehicle drivers rated the effectiveness of the advance warning sign as high or very high, compared to the expected value of 34%. Therefore, a higher proportion of bus drivers rated the effectiveness of the advance warning sign as high or very high; and a lower proportion of emergency vehicle drivers rated the effectiveness of the advance warning signs as high or very high.

Crossbuck Sign

Approximately 47% of bus drivers rated the effectiveness of the crossbuck sign as high or very high, compared to the expected value of 33%. Approximately 19% of emergency vehicle drivers rated the

effectiveness of the crossbuck sign as high or very high, compared to the expected value of 33%. Therefore, a higher proportion of bus drivers rated the effectiveness of the crossbuck sign as high or very high; and a lower proportion of emergency vehicle drivers rated the effectiveness of the crossbuck sign as high or very high.

Crossing Gates and Flashing Lights

The effectiveness ratings given to these warning devices by drivers of various vehicle types did not differ from each other statistically.

Clanging Bell

Approximately 70% of bus drivers rated the effectiveness of the clanging bell as high or very high, compared to the expected value of 56%. Therefore, a higher proportion of bus drivers rated the effectiveness of the clanging bell as high or very high.

Summary

A higher proportion of bus drivers rated the effectiveness of the advance warning sign, crossbuck sign, and clanging bell as high or very high compared to drivers of other vehicles. A lower proportion of emergency vehicle drivers rated the effectiveness of the advance warning sign and crossbuck sign as high or very high compared to drivers of other vehicles. The drivers rated the effectiveness of crossing gates and flashing lights as high or very high, regardless of the vehicle type they drove.

5.3.4. Are the Precautions Drivers Take When Crossing Railroad Tracks Different for Drivers of Different Vehicle Types (Q7)

A chi-square test was performed to statistically quantify if drivers of different vehicle types take different precautions when crossing railroad tracks. Approximately 69% of the bus drivers came to a stop before the tracks, compared to the expected value of 19%. Approximately 1% of the emergency vehicle drivers came to a complete stop before the tracks, compared to the expected value of 19%. Therefore, a higher proportion of bus drivers came to a complete stop than any other vehicle drivers (It should be noted that bus drivers are required by law to stop at all railroad tracks); and a lower proportion of emergency vehicle drivers came to a stop before the tracks than any other vehicle drivers.

5.3.5. Are there any Differences between Drivers of Different Vehicle Types in terms of Crossing Tracks with Signals Flashing (Q8)

A chi-square test was performed to statistically quantify if there were any differences between drivers of different vehicle types in terms of crossing tracks with signals flashing. Approximately 33% of emergency vehicle drivers crossed the tracks when the signals were flashing, compared to the expected value of 21%. Approximately 13% of bus drivers crossed the tracks when the signals were flashing, compared to the expected value of 21%. Therefore, a higher proportion of emergency vehicle drivers crossed the tracks with signals flashing than any other vehicle drivers; and a lower proportion of bus drivers crossed the tracks with signals flashing than any other vehicle drivers.

5.3.6. Are there any Differences between Drivers of Different Vehicle Types in Terms of Being Involved in an Unsafe Driving Situation (Q10)

A chi-square test was performed to statistically quantify if there were any differences between drivers of different vehicle types in terms of being involved in an unsafe driving situation. Approximately 19% of bus drivers responded that they have been involved in an unsafe driving situation when crossing railroad tracks, which is significantly higher than the expected value of 6%. Twenty-one bus drivers provided a description of the unsafe driving situation. Descriptions of the unsafe driving situations given by the bus drivers are presented in Table 4.8. Only 2.5% of emergency vehicle drivers responded that they have been involved in an unsafe driving situation when crossing railroad tracks, which was significantly lower than the expected value of 6%. Therefore, a higher proportion of bus drivers have been involved in unsafe driving situations compared to drivers of other vehicles; and a lower proportion of emergency vehicle drivers have been involved in unsafe driving situations compared to drivers of other vehicles.

5.3.7. Do the Drivers of Different Vehicle Types React Differently When They See the Crossbuck Sign (Q12b)

A chi-square test was performed to statistically quantify if drivers of different vehicle types approach the railroad crossbuck sign differently. Approximately 86% of bus drivers responded that they come to a stop when they see a crossbuck sign, which was significantly higher than the expected value of 27%. Only 12.5% of emergency vehicle drivers responded that they come to a stop when they see a crossbuck sign, which was significantly lower than the expected value of 27%. Therefore, a higher proportion of bus drivers come to a stop when they see a crossbuck sign compared to drivers of other vehicles; and a lower proportion of emergency vehicle drivers stop when they see a crossbuck sign compared to drivers of other vehicles.

5.3.8. Do the Drivers' Perceptions about the Crossings in the Study Depend on the Type of Vehicle they Drive (Q14)

A chi-square test was performed to statistically quantify if the drivers' perceptions about the crossings in the study depend on the vehicle type they drive. Approximately 31% of bus drivers thought that some of the crossings in the study were hazardous, which was significantly higher than the expected value of 13.5%. Only 7% of van drivers thought that some of the crossings in the study were hazardous, which was significantly lower than the expected value of 13.5%. Only 5.6% of step-van and single unit truck drivers thought that some of the crossings in the study were hazardous, which was significantly lower than the expected value of 13.5%. Thus, a higher proportion of bus drivers thought that some of the crossings in the study were hazardous compared to drivers of other vehicles; and a lower proportion of step-van and single unit truck drivers thought that some of the crossings in the study were hazardous compared to drivers of other vehicles.

5.3.9. Are there any Differences between Drivers of Different Vehicle Types in Terms of the Miles Driven and Experience (Q17, Q18)

The answers of drivers in these two groups are given in Table 5.9. Tractor-trailer drivers drove more miles than drivers of any other type of vehicle. Step-van and single-unit truck drivers had the least driving experience.

Table 5.9: The Answers of Drivers of all Vehicle Types to Q17 and Q18

Vehicle Type	How many miles did you drive last year?	How many years have you been a professional driver?
Bus	23,527	15.0
Van & Pick-up Truck	11,655	13.9
Emergency Vehicle	8,604	14.5
Tractor-Trailer truck	24,245	14.5
Car & Taxi & LLV	15,513	15.0
Step-Van & S.U. Truck	16,881	7.5

5.3.10. Are there any Differences between Drivers of Different Vehicle Types in Using Vision or Hearing Aids (Q20)

In this section, the chi-square test was performed to statistically quantify if there were any differences between drivers of different vehicle types in using vision or hearing aids. Approximately 22% of the tractor-trailer truck drivers used glasses while driving, which was significantly lower than the expected value of 45%. Therefore, a lower proportion of tractor-trailer truck drivers used glasses compared to drivers of other vehicles.

5.3.11. Are there any Differences between Drivers of Different Vehicle Types in Terms of Their Gender (Q23)

Approximately 20% of bus drivers were females, which was significantly higher than the expected value of 9%. Only 1.6% of emergency vehicles drivers were females, which was significantly lower than the expected value of 9%. Therefore, a higher proportion of bus drivers were females compared to drivers of other vehicles; and a lower proportion of emergency vehicle drivers were females compared to drivers of other vehicles.

6. THIRD LEVEL STATISTICAL ANALYSIS

In this section, the responses from a group of drivers who thought railroad crossings represented a significant driving hazard and drivers who thought that railroad crossings needed more protection/warning devices are analyzed. This sub-group of drivers selected “a” in both Q.5 and Q.6. There were 80 drivers in this sub-group.

6.1. Did the Sub-Group Use Railroad Crossings More Frequently than Other Drivers (Q1, Q2)

The drivers who thought that crossings represented a significant driving hazard and that crossings needed more protection/warning devices crossed the tracks an average of 30.6 times. The sub-group drivers stopped for a passing train an average of 8.2 times. As shown in Table 6.1, the statistical analysis results showed that there are no significant differences between the drivers in the sub-group and the rest of the drivers.

Table 6.1. Responses of Sub-group Drivers Compared to Other Drivers for Q1 and Q2			
	Sub-group Drivers	**Other Drivers**	**Test statistic (Significant if > |1.96|)**
How many times do you cross tracks?	30.6	30.6	0
How many times do you stop for a train?	8.19	7.46	0.9

6.2. Did Sub-Group Drivers Rate Effectiveness and Rank Warning Devices Different than other Drivers (Q3&Q4)

Table 6.2 presents the average ranking and effectiveness rating of the warning devices given by the sub-group drivers. Statistical analysis showed that there are no significant differences between the sub-group drivers and the rest of the drivers.

Table 6.2 Average Ranking and Effectiveness of Warning Devices for the Third Group						
Warning Device	**Sub-group drivers**		**Other drivers**		**Test Statistic (Significant if > |1.96|)**	
	Ranking	**Effectiveness**	**Ranking**	**Effectiveness**	**Ranking**	**Effectiveness**
Advance Warning Sign	3.8	3.0	4	3.0	-0.79	-0.33
Crossbuck	3.8	3.0	3.9	3.1	-0.51	-0.9
Flashing Lights	2	4.5	2.0	4.5	0.36	-1.58
Crossing Gates	2	4.7	2.0	4.7	0.6	-1.68
Clanging Bell	3.8	3.6	4.0	3.5	-1.57	0.62
Train Horn	4.8	3.4	5.1	3.3	-1.33	-0.26

6.3. Did the Sub-Group Drivers Take Different Precautions at Crossings than other Drivers (Q7)

In this section, the chi-square test was performed to statistically quantify if there were any differences between drivers in the sub-group and the rest of the drivers in terms of the precautions taken when they crossed railroad tracks. A higher proportion of drivers in the sub-group made precautionary stops at a

railroad crossing than the rest of the drivers. Approximately 37% of the drivers in this sub-group came to a stop before the tracks, which was significantly higher than the expected value of 19%.

6.4. Have the Drivers in the Sub-Group been Involved in More Unsafe Driving Situations (Q10)

In this section, the chi-square test was performed to statistically quantify if there were any differences between drivers in the sub-group and the rest of the drivers in terms of their involvement in unsafe driving situations. A higher proportion of drivers in the sub-group have been involved in unsafe driving situations than the rest of the drivers. Approximately 11.4% of the sub-group drivers have been involved in unsafe situations while crossing railroad tracks, which was significantly higher than the expected value of 5.7%.

6.5. What Do the Drivers in the Sub-Group Do When They See the Crossbuck Sign (Q12b)

The chi-square test was performed to statistically quantify if there were any differences between drivers in the sub-group and the rest of the drivers in terms of their actions when they saw a crossbuck sign. A higher proportion of drivers in the sub-group came to a stop at a railroad crossing sign or crossbuck. Approximately 34% of the drivers responded that they came to a stop and prepared to yield for a train at a crossbuck sign, which was significantly higher than the expected value of 27%.

6.6. Is Perception of the Sub-Group Drivers on Hazard of Crossings in Study Area Different From the Rest of Drivers (Q14)

In this section, the chi-square test was performed to statistically quantify if there were any differences between responses from the sub-group and the rest of the drivers in terms of their perception of hazards at the crossings in the study area. A higher proportion of drivers in the sub-group thought that the crossings in the study were unusually hazardous. Approximately 31% of the drivers in the group thought that the crossings in the study were hazardous, which was significantly higher than the expected value of 13.6%.

6.7. What Type of Vehicle do the Drivers in the Sub-Group Drive Most Frequently (Q16)

The chi-square test was performed to statistically quantify if there were any differences between drivers in the sub-group and the rest of the drivers in terms of the type of vehicles they drove. A higher proportion of sub-group drivers drove buses most frequently. Approximately 27% of the drivers in the sub-group drove buses, which was significantly higher than the expected value of 16%. A higher proportion of drivers in the sub-group drove tractor-trailers most frequently. Approximately 9.5% of the

drivers in the sub-group drove tractor-trailers, which was significantly higher than the expected value of 5.1%.

6.8. How Many Miles did You Drive Last Year and How Many Years Have You Been a Professional Driver (Q17, Q18)

The drivers' answers are given in Table 6.3. There are no significant differences between the sub-group and the rest of the drivers in terms of the miles they drove the previous year and their driving experience.

Table 6.3. Responses of Sub-group Drivers Compared to other Drivers for Q17 and Q18.

	Sub-group	**Other Drivers**	**Test Statistic (Significant if > |1.96|)**
How many miles did you drive last year?	13,604	13,690	0.55
How many years have you been a professional driver?	13.8	13.9	-0.8

7. SUMMARY AND CONCLUSIONS

7. 1. First Level Analysis

On the average, the drivers crossed railroad tracks 31 times per week while they were working and stopped at the railroad crossings seven times per week because of a train approaching/passing. In terms of relying on the warning device to provide the train crossing information, crossing gates were ranked as "1" (1 means rely the most), by 42%, flashing lights by 33%, advance warning signs by 19%, crossbuck signs by 2.5%, train horn by 2%, and clanging bell by 1.5%. The average rankings were 2.0 for crossing gates, 2.0 for flashing lights, 3.9 for crossbuck signs, 4.0 for advance warning signs, 4.0 for clanging bell, and 5.1 for train horn. The average rankings show that flashing lights and crossings gates were equally important, and drivers relied on them the most, followed by crossbuck signs, advance warning signs, clanging bell, and train horn. Over half of the drivers said they relied on train horn the least.

Drivers rated the effectiveness of warning devices (5 means very high and 1 means very low) and the average ratings were: 4.7 for crossing gates, 4.5 for flashing lights, 3.5 for clanging bell, 3.3 for train horn, 3.1 for crossbuck signs, and 3.0 for advance warning signs. The results indicate that the effectiveness of the crossing gates was "very high", while the effectiveness of the flashing lights was "high" to "very high". The clanging bell and train horn were selected as having "medium" to "high" effectiveness, and the advance warning sign and crossbuck sign were selected as having "medium" effectiveness. Note that none of the railroad crossing warning devices was selected as having "low" or "very low" effectiveness.

The drivers had a mixed opinion on whether there was a significant driving hazard at railroad crossings above normal driving conditions. Forty-seven percent of the drivers said that railroad crossings presented a significant driving hazard above normal driving conditions, however, 46% said they did not. Seventy-four percent of the drivers said that most railroad crossings were adequately protected/had adequate safety warning devices. However, 22% said that the crossings needed more protection/more warning devices. Only 1% of the participants thought the crossings were over protected/had too many warning devices. About 76% said that they did not cross railroad tracks when signals were flashing. However, 21% of the drivers crossed the tracks when signals were flashing. Approximately 67% of the drivers who crossed the tracks when signals were flashing reported that the signals were malfunctioning, 41% said no trains were in sight, and 28% said they crossed because the train was stopped. Only 4% stated that they crossed the tracks because other vehicles were crossing. Approximately 9% of the participants gave other reasons for crossing the tracks when signals were flashing. The most frequent

reason was crossing due to responding to an emergency call, followed by police directing traffic. Ninety-four percent of the drivers said that they had not been involved in an unsafe situation in the past 12 months, but 5.3%, (40 drivers) said they had. These drivers had been in an unsafe situation an average of 2.6 times in the past 12 months.

While almost all of the drivers correctly understood the meaning of the railroad crossing warning devices, there were very small percentages that did not. About 2% said they should come to an immediate stop when they see a railroad crossing advance warning sign, 3% said they should slow down and cautiously cross the tracks when flashing lights are on. About 1% of drivers said that they should slow down or come to a stop and go around the gates if a train is not present.

Drivers were asked questions that were specific to the five equipped crossings in the study area. About 18%-45% of drivers used the equipped railroad crossings, 29%-43% did not use them and 26%-39% did not respond to this question. Among those who responded, "Yes", 43% crossed only one of five and 3% crossed all five equipped crossings in the study. A large number of drivers (15.9%) stated that they did not cross any of the crossings in the study. Approximately 14% of the drivers responded that the equipped crossings were unusually hazardous, whereas 69% of the drivers responded that the crossings were not unusually hazardous.

7. 2. Second Level Analysis

Tests were conducted to see if the drivers' responses were influenced by their perception of driving hazards at crossings. The perception of hazards does not depend on the frequency of crossing railroad tracks or the number of times the drivers stop at the crossings. The perception of hazards does not influence the rating of the effectiveness of the warning devices. It does, however, influence the rankings of crossing gates and the clanging bell. Furthermore, the perception of hazards influences the drivers' views on the current standard of railroad grade crossing devices. The drivers who thought that crossings represented a significant driving hazard above normal driving conditions wanted more protection/more warning devices. The precautions drivers take when crossing the tracks are influenced by the perception of hazards. The results show that the perception of hazards are related to the past history of being involved in an unsafe driving situation at a railroad grade crossing.

Tests were conducted to examine if the drivers' responses to other questions were influenced by their views of protection provided by the current standard of railroad crossing warning devices. The results indicated that with a slightly lower confidence level (90%), drivers who thought that crossings needed more protection/warning devices came to a stop at crossings more often than the drivers who thought that crossings were adequately protected. The drivers who thought that crossings needed more protection ranked the train horn significantly higher than the other group of drivers. With a slightly lower

confidence level (90%), this indicates that drivers who thought crossings needed more protective warning devices rely on the train horn more than the other group of drivers. The same argument is true about the advance warning signs. The drivers who thought that crossings needed more protection rated the effectiveness of the flashing lights and crossing gates significantly lower than the other group of drivers. The precautions drivers take when crossing the tracks are influenced by the perception of the current standard of railroad warning devices. A higher proportion of drivers who thought that railroad crossings needed more protection have been involved in an unsafe situation when crossing railroad tracks. A higher proportion of drivers who thought that railroad crossings needed more protection came to a stop when they saw a crossbuck sign. Their view of the current standard of railroad warning devices depends on the type of vehicle they drive. A higher proportion of the drivers in the group that thought that railroad crossings needed more protection drove a bus most frequently. On the other hand, a lower proportion of the drivers who thought railroad crossings needed more protection drove emergency service vehicles most frequently.

Tests were performed to quantify if drivers of different vehicle types ranked the warning devices differently. A higher proportion of bus drivers ranked the advance warning sign, clanging bell, and train horn as "1" compared to drivers of other vehicles. On the other hand, a lower proportion of bus drivers ranked crossing gates as "1" compared to drivers of other vehicles. A lower proportion of emergency vehicle drivers ranked the advance warning sign, clanging bell, and train horn as "1" compared to drivers of other vehicles. A higher proportion of bus drivers rated the effectiveness of the advance warning sign, crossbuck sign, and clanging bell as high or very high compared to drivers of other vehicles. A lower proportion of emergency vehicle drivers rated the effectiveness of the advance warning sign and crossbuck sign as high or very high compared to drivers of other vehicles. The drivers rated the effectiveness of crossing gates and flashing lights as high or very high, regardless of the vehicle type they drive.

A higher proportion of bus drivers came to a complete stop than any other vehicle drivers. It should be noted that bus drivers are required by law to stop at all railroad tracks. A lower proportion of emergency vehicle drivers came to a stop before the tracks than any other vehicle drivers. A higher proportion of emergency vehicle drivers crossed the tracks with signals flashing than any other vehicle drivers and a lower proportion of bus drivers crossed the tracks with signals flashing than any other vehicle drivers. Also, a higher proportion of bus drivers and a lower proportion of emergency service vehicles drivers were involved in unsafe driving situations when crossing a railroad track compared to drivers of other vehicles. A higher proportion of bus drivers came to a stop when they saw a crossbuck sign compared to drivers of other vehicles, and a lower proportion of emergency vehicle drivers stopped when they saw a crossbuck sign compared to drivers of other vehicles.

7. 3. Third Level Analysis

The responses from a sub-group of drivers who thought railroad crossings represented a significant driving hazard and drivers who thought that railroad crossings needed more protection/warning devices were compared to the responses from the rest of drivers. A higher proportion of drivers in the sub-group that made precautionary stops at a railroad crossing, had been involved in unsafe driving situations, stopped at a railroad crossing with crossbuck signs, thought that the crossings in the study were unusually hazardous, droves buses and tractor-trailers most frequently than the other drivers.

APPENDIX A

Survey of Professional Drivers' Opinions for Pilot Study of Advisory On-Board Vehicle Warning Systems at Railroad Grade Crossings

Instructions: *PLEASE COMPLETE AND RETURN IN THE ENCLOSED ENVELOPE*
This survey is conducted by the University of Illinois at Urbana-Champaign. All information is confidential. Your driving record will not be affected in any way by your completion of this questionnaire. Your opinions of this pilot study are critical to the project. Please fill in the blanks or circle the response that best answers each question. ***THANK YOU FOR YOUR HELP***.

Railroad Crossing Experience

1) When you are working, how many times do you cross railroad tracks on an average day?
_____ Times / day

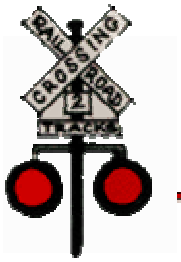
2) On average, how many times must you stop at grade crossings for a passing/approaching train?
_____ Times / day

3) Please rank (1st, 2nd, 3rd, 4th, 5th, and 6th) the following railroad grade crossing warning devices in the order in which you rely on them for train crossing information. (1st = Rely on the MOST, …, 5th rely on the LEAST)

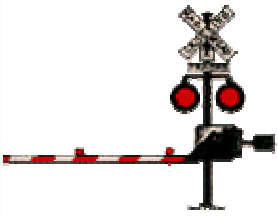
Device	Reliance Rank
a) Advance Sign	_____
b) Crossbuck sign	_____
c) Flashing lights	_____
d) Crossing gate	_____
e) Clanging bell	_____
f) Train horn	_____

Advance Warning Sign

Crossbuck



Lights & Bell


Crossing Gate

4) Please rate the effectiveness of the following railroad grade crossing warning devices:

	EFFECTIVENESS					
	Very High	High	Medium	Low	Very Low	No Opinion
a) Advance Warning Sign	5	4	3	2	1	0
b) Crossbuck sign	5	4	3	2	1	0
c) Flashing lights	5	4	3	2	1	0
d) Clanging bell	5	4	3	2	1	0
e) Crossing gate	5	4	3	2	1	0
f) Train horn	5	4	3	2	1	0

5) In your opinion, do railroad crossings represent a significant driving hazard above normal driving conditions?

a) Yes b) No c) No opinion

6) Which statement best describes your view of the current standard of railroad grade crossing warning devices?

   a) Most crossings need more protection / more warning devices
   b) Most crossings are adequately protected / have adequate safety warning devices
   c) Most crossings are over protected / have too many warning devices
   d) No opinion

7) What precautions do you take when crossing a railroad track? (circle all that apply)

   a) Come to a complete stop before tracks
   b) Open window to listen for trains
   c) Look both ways down track for trains
   d) Other _____

8) In the past year while on the job, have you ever crossed train tracks with signals flashing?

   a) Yes b) No (Skip to Question 10) c) No opinion (Skip to Question 10)

9) (If Yes): indicate reasons for crossing tracks when signals were flashing:

   a) Signals were malfunctioning
   b) No train was in sight
   c) Other vehicles were crossing
   d) Train stopped sufficient distance away from crossing
   e) Other

10) In the past year while on the job, have you ever been involved in an unsafe driving situation when crossing a railroad track?

   a) Yes b) No (Skip to Question 12) c) No opinion (Skip to Question 12)

11) (If Yes): please give frequency: ____ Times/last year, and describe the situation:_____

_____

_____

_____

_____

12) Based upon the vehicle you drive most frequently while on your job, please answer Questions a through d:

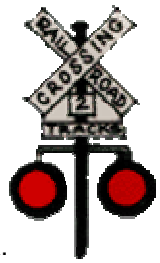
   a) An advance railroad crossing warning sign (see the picture) is typically located 100-850 feet before a railroad crossing. What should you do when you see this sign? **(Circle one)**

      1) Come to an immediate stop at the warning sign
      2) Continue driving but be prepared to stop at a crossing ahead
      3) Continue driving without any concern or added caution
      4) Don't know / No opinion

b) A railroad crossing sign (see the picture) also called a "crossbuck" is typically located next to a railroad track. What should you do when you see this sign? **(Circle one)**

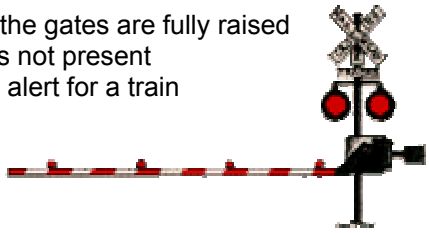
1) Come to a complete stop and prepare to yield for a train
2) Slow down and prepare to yield for a train
3) Speed across the track as quickly as possible
4) Don't know / no opinion

c) Railroad crossing flashing lights (see the picture) are typically located next to a railroad track. What should you do when you see the lights flashing? **(Circle one)**



1) Come to a complete stop, look for a train, and proceed only if you can do safely
2) Slow down and cautiously cross the track, alert for a train
3) Speed across the track as quickly as possible
4) Don't know / no opinion

d) Railroad crossing gates (see the picture) are typically located next to a railroad track. What should you do when the gates are down? **(Circle one)**



1) Come to a complete stop, wait for a train to cross, and make sure the gates are fully raised
2) Come to a complete stop and proceed around the gates if a train is not present
3) Slow down and cautiously go around the gate and cross the track, alert for a train
4) Don't know / no opinion

Recent Operating Experience

13) Do you use any of the following railroad grade crossings? For a "Yes" response please give frequency.

	Community	Crossing			
a)	Morton Grove	Beckwith Road/Lehigh Ave	No	Yes	_____ Times/day
b)	Glenview	Chestnut Street/Lehigh Ave	No	Yes	_____ Times/day
c)	Northbrook	Shermer Road	No	Yes	_____ Times/day
d)	Northbrook	Dundee Road (near Waukegan Rd)	No	Yes	_____ Times/day
e)	Deerfield	Greenwood Ave/ Park Ave	No	Yes	_____ Times/day

14) In your opinion, are any of these five crossings unusually hazardous?

a) Yes b) No (Skip to Question 16) c) No opinion (Skip to Question 16)

15) (If Yes): identify which crossings are unusually hazardous and describe why? _____

_____

_____

_____

Background Information

16) What type of vehicle do you drive most frequently for your job? (**Circle one)**
   a) Bus
   b) Van
   c) Emergency Vehicle
   d) Tractor Trailer Truck
   e) Pick-up Trucks
   f) Passenger Sedan
   g) Taxi
   h) Other _____

17) How many miles did you drive for your employer last year? _____ Miles

18) How many years have you been a professional driver? _____ Years

19) From the following list of visual and audible distractions, please circle all that apply to your daily driving conditions: **(Circle all that apply)**

Visual Distractions	Audible Distractions
a) Visual distractions from passengers	a) Background noise from radio/tape
b) Exterior light sources	b) Background noise from passengers
c) Interior warning lights	c) Sirens/horns
d) Other _____	d) Loud engine
	e) Other _____

Other than visual or audible distractions
Please describe _____

20) Do you use any aids to improve your vision and/or hearing while driving? **(Circle all that apply)**

   a) Yes - glasses/contacts b) Yes - hearing aid c) No (Skip to Question 23)

21) How would you rate your vision (with glasses or contact lenses if you wear them)? (**Circle one**)

   a) Very Good b) Good c) Fair d) Poor e) Very Poor

22) How would you rate your sense of hearing (with a hearing aid if you use one)? **(Circle one)**

   a) Very Good b) Good c) Fair d) Poor e) Very Poor

23) What is your gender? a) Male b) Female

24) In what year were you born? 19____

Thank you very much for your participation

APPENDIX B

Q14- Why are these crossings hazardous?

VERBATIM

Morton Grove

1. Gate malfunctions occasionally.
2. Queue extends too far past stop sign.
3. Stop sign dangerously close to tracks.
4. Tracks too close to stop sign-need stoplight.
5. Obstacles inhibit view.
6. Crossing blind from north.
7. At Morton Grove, lights and gate always malfunction.

Glenview

1. Glenview-people stop on tracks during red lights.
2. Speeding trains and passengers boarding in both directions from intersection.
3. People stop between tracks.
4. Difficult to see when turning at sharp angle.
5. Short approach from west, stopped traffic backs up.
6. Broken gates.
7. Angle of intersection.
8. Area is congested w/stoplights & pedestrians.
9. Train moves too fast.
10. At Chestnut you can't see if train is coming unless you're on the tracks.
11. Visibility limited when turning to Chestnut.
12. In Chestnut, left turn at stop lite with green with a no left turn lite when train short distance after turn left on to tracks train coming visualized gate coming down too close for comfort.
13. Chestnut Lehigh fast/frequent trains crossing located at a busy intersection.

Norhbrook/Shermer

1. Stoplights at Chestnut + Shermer cause traffic to overflow onto tracks.

2. Shermer Road-stoplights are too close to tracks.
3. Shermer area is congested with traffic + pedestrians.
4. Shermer crossing gates sometimes go down late.
5. Multiple trains at Shermer.
6. Building obstructions.
7. Bad angle of intersection--blind view.
8. Pedestrians, sight distance, noise.
9. Area is congested w/stoplights & pedestrians.
10. Blind train approach.
11. Vision obstructed.
12. Visibility poor.
13. Sight obstruction.
14. Fast trains.
15. Trucks backed up.
16. Blind spots, unsafe lane merges, traffic backup.
17. Trucks backed up.
18. Blind spots, unsafe lane merges, traffic backup.
19. Commuters walking to/from trains at Shermer.
20. Shermer has low visibility down tracks.
21. Shermer there is a building going north.
22. Shermer road, no railroad crossing gates.
23. Shermer crossing is dangerous due to traffic congestion and the close proximity of traffic lights at Meadow/Shermer and at Walters/Shermer. Also there is a lot of pedestrian traffic at times.
24. Shermer opposing train traffic crossing within seconds of each other clearing crossing, false reactivation of gates after NB train leave crossing- approx. 20-30 seconds after gates clear they reactivate and come down and then go back up.

Northbrook/Dundee

1. Steep grade leading into crossing.
2. Road is on a slope, makes it difficult to stop.
3. Can't see train coming from south at Dundee.
4. Obstacles inhibit view.
5. High traffic volume and speed.

6. People jump gates.
7. Dundee road near Waukegan I have seen cops there a few times directing traffic through there while the bells are ringing and the lights are flashing.
8. Gates at Dundee meadow are always being knocked down. We spend a great deal of time directing traffic at the scene.
9. Dundee road near Waukegan going eastbound your vision to the left is very limited due to bushes trees, very hazardous.
10. Dundee, Northbrook people drive around gates, this is a main e-w road. If gates are down for a long time people won't wait, they just go.
11. Dundee Rd, Norhbrook, vehicle fail to slow, stop at crossing hesitation whether to proceed through or not.
12. Dundee setting sun blinds WB traffic from seeing gates operating
13. Dundee road the gates are frequently knocked down, causing delays and dangers to motorists.

Deerfield

1. Gate/signals malfunction.
2. Foliage obstructs view.
3. Blind spot.
4. Trains switch tracks at crossing.
5. Close proximity of intersections and depot station.
6. Greenwood park proximity to intersection.

Other Comments (general)-Includes all crossings

1. Difficult to see if there are any cars running along Greenbay Road on the other side of tracks.
2. Temporary stop sign instead of signals.
3. When traffic gets backed up at Walters & Meadow.
4. Pedestrian traffic.
5. Cars go around me while gates are going down.
6. Not enough warning time at all sections.
7. Cross-traffic after bus crosses tracks.
8. Impossible to see other side of tracks when approaching.
9. Some RR crossings don't have a gate.
10. Passengers running to catch train.
11. Trains switch tracks.

12. Crossings have limited view because of obstructions.
13. Sight obstructions.
14. Can't see down tracks.
15. All-angles & sight obstructions.
16. Vehicles drive around gates.
17. Other motorists go around gates.
18. Multiple gate malfunctions.
19. People themselves do not obey the signs or keep behind the gates. The kids are lose, they have no respect for the size of the train or the laws.

APPENDIX C

Q19- Visual and Audible Distractions Other Than Those Listed

VISUAL	
Summary of most frequent comments	**Frequency**
Computers	5
Interior lights	3
Pedestrians	2
Headlights	2
Radar	4
Other comments	
Checking rear view mirror	
Sun	
Girls	
Trees	
Other vehicles	
Mirror brackets	
Police radios	
No defogger	
Patrol	

AUDIBLE	
Summary of most frequent comments	**Frequency**
Radio	6
Headphones	3
Cell phone	3
Truck noise, fan, windshield wipers	4
Other Comments	
Music	
Dispatch	
Heat	
All of above	
Pager	
Radar unit, doppler	
Multiple radios to monitor and answer	
Inclement weather	
Freight moving/falling in truck	

OTHER

Summary of most frequent comments	Frequency
Computer	4
Sun	3
Headlights	3
Children	2
Cell phones	3
Careless/bad drivers	2

Other Comments
Stress due to nature of emergency response
Dispatchers
Dog
On patrol-constantly monitoring
Crew members talking
Headsets
In a hurry
Advertisements that darken window
Loud motor
LLV's have a blind spot to backing and at stop signs
Slow drivers in left hand lane
Reading map and size-up books
Other vehicles, traffic signals, rough roads
Large mirrors on the side and frame of bus.
High speed
Kids and people on bikes
Responding to criminal activities
My boss pages me a lot
The job