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Analyses of Drivers' Responses to In-Vehicle Receiver (IVR) after Experiencing Two Modes of Operation

By:
Rahim F. Benekohal
Carmen G. Rawls

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

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16. Abstract

This report contains the results of the third survey (out of four surveys) that was conducted six months after the IVR system was operational. Drivers who had the IVR in the audible (visual) mode for the first three months would have switched to the visual (audible) mode for the next three months. The audible and visual groups gave similar average effectiveness ratings to all of the warning devices except the flashing lights, clanging bell, and IVR. The audible group rated these three devices higher than the visual group. The IVR average effectiveness rating from the audible group was 3.8 using a 5.0 scale, significantly higher than 2.7 from the visual group. The visual warning message from the visual IVR was not as effective in attracting attention of the drivers as the beeping sound from the audible IVR. This is reflected in its effectiveness rating. The effectiveness rating for the audible mode of IVR was significantly higher than that of the advance warning and the crossbuck signs, similar to that of the train horn, and lower than that of the flashing lights, the crossing gate, and the clanging bell. The effectiveness rating for the visual IVR was significantly lower than that of all other warning devices, except the advance warning sign. The effectiveness rating of the visual IVR was similar to that of the advance warning sign. A significantly higher proportion of the audible group (72%) compared to the visual group (47%) trusted the IVR to give an accurate warning of a train approaching/occupying the equipped crossings.

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INTRODUCTION

This report analyzes driver perceptions and understanding of the advisory on-board warning information after having the system in operation for approximately six months. The Pilot Study of Advisory On-Board Vehicle Warning Systems at Railroad Grade Crossings sought to provide the equipped roadway vehicles approaching railroad selected grade crossings with an on-board/advisory warning of a train approaching or occupying the grade crossing. More details on the system performance are given in another report (1). The system design was composed of a trackside transmitter assembly (TTA) and the IVR. The TTA sent a K-band signal to the IVR when a train was approaching or occupying the crossing. The TTA was installed at five railroad grade crossings equipped with a combination of flashers and gates along the Metra-Milwaukee North line (in Chicago area). The crossings handle Amtrak and freight train movements in addition to significant Metra commuter train movements. There are between 70 and 115 train movements per crossing on a typical weekday.

The location, jurisdiction and characteristics of the sites in the pilot study were as follows:

1- Beckwith Road/Lehigh Avenue, Morton Grove: Residential Area
2- Chestnut Street/Lehigh Avenue, Glenview: Industrial Area
3- Shermer Road, Northbrook: Commercial Area
4- Dundee Road, Northbrook: Major Arterial
5- Greenwood Avenue/Chestnut and Park, Deerfield: Residential Area

Approximately 300 IVR units were installed in the vehicles of participating organizations. These organizations were chosen based on their close proximity to the study area and number of movements over the five designated crossings. A mix of public and private organizations participated in the pilot study. Private sector firms were selected by contacting the local chambers of commerce. The selection of school bus companies was based on information provided by the IDOT Division of Traffic Safety. Local governmental agencies for each of the pilot study area communities agreed to participate. A total of thirty-eight organizations participated in the pilot study.

A human factors study was conducted in order to determine the ideal placement and optimal mounting technique for the IVR. Since the vehicle types differed among the

participating organizations, on-site vehicle fleet evaluations were conducted in order to determine specific installation requirements. Installation recommendations for each vehicle type were determined according to the dashboard configuration, the driver's field of vision constraints, vehicle vibration considerations and fleet equipment restrictions. The IVR was placed within the driver's cone of vision as recommended in the human factors study and on-site vehicle evaluations.

Surveys were utilized to document drivers' perceptions of the advisory warning system. Their perceptions represent the foundation of the evaluation effort. The final evaluation is based on four surveys distributed during the pilot study. These surveys included: the base line survey distributed prior to deployment and three surveys distributed during the course of the pilot study. The baseline survey sought background information from the drivers such as their age, work experience and perception of existing railroad crossing devices (2). The other three surveys were related to the drivers' experience with the advisory warning system (3, 4).

The third survey (Survey 3) was conducted six months after the IVR system was turned on for full implementation and evaluation purposes. The third survey was conducted about three months after the second survey. At the time of the third survey, the majority of the participating drivers were expected to have had experience with both the audible and visual IVR modes. Drivers who had the IVR in the audible (visual) mode for the first three months would have switched to the visual (audible) mode for the next three months. The survey was conducted mainly in September 2000. The questionnaire for Survey 3 is identical to the questionnaire for Survey 2. A copy of Survey 3 is given in Appendix A.

Survey 3 contains responses from the drivers who had the IVR in the visual or audible modes. The surveys came from 152 drivers in the audible and 139 drivers in the visual group. The surveys from the drivers who had less than 1 month or more than 12 months of driving experience with an IVR-equipped vehicle were not used in this analysis. Also, the surveys from the drivers who did not cross any of the 5 railroad crossings (drivers who confirmed that they did not cross or those who did not respond to this question) were not used. The reason for deleting these surveys was that the drivers with less than 1 month experience with the IVR device, or who did not cross any of the crossings did not have adequate experience with the IVR system. A few drivers who stated that they had experience of driving a vehicle with an IVR for greater than 12 months in the year 2000 clearly did not understand the question well, so their responses were not

considered in the analysis. The remaining 119 surveys from the audible group and 74 surveys from the visual group were analyzed and their results are reported in this section. The audible and visual survey responses are presented together unless there was a statistically significant difference between the responses from these two groups. When the difference was significant, the results were reported for each group separately.

STATISTICAL ANALYSES

In the Year 2000, How Long Have You Driven a Vehicle with the In-Vehicle Receiver (Q1)?

The total number of drivers who responded to this question was 193. The distribution of the number of months that the participants had the IVR is given in Figure 1. On the average, they drove an IVR-equipped vehicle for 6.1 months. Approximately 19.2% of the drivers drove an IVR-equipped vehicle for two months or less. The largest group of drivers (22.3%) drove an IVR-equipped vehicle for 3 months. The remaining drivers had more than three months of experience. On the average, the audible group drove an IVR-equipped vehicle for a period of 6.3 months and the visual group for 5.7 months. T-tests showed that the difference was not statistically significant.

Do You Use any of the Following Railroad Grade Crossings (Q2)?

The responses to this question came from 193 drivers who used at least one of the crossings. The participants were asked to state the frequency of usage of the five crossings. The percentages of drivers who used each of the crossings are given in Table 1. The crossing used by the highest number of participants was the Chestnut Street crossing (47.2%), followed by Shermer Road (39.4%), Dundee Road (38.3%), and Beckwith Road (16.6%) crossings. The crossing used by the least number of the participants was the Greenwood Avenue crossing, where only 14.5% of the drivers traversed it. The percentages of drivers who did not use at least

one of the crossings varied from 15.0% for the Chestnut Street to 27.5% for the Beckwith Road crossing. A large portion of the respondents (37.8%-58.5%) did not answer this question.

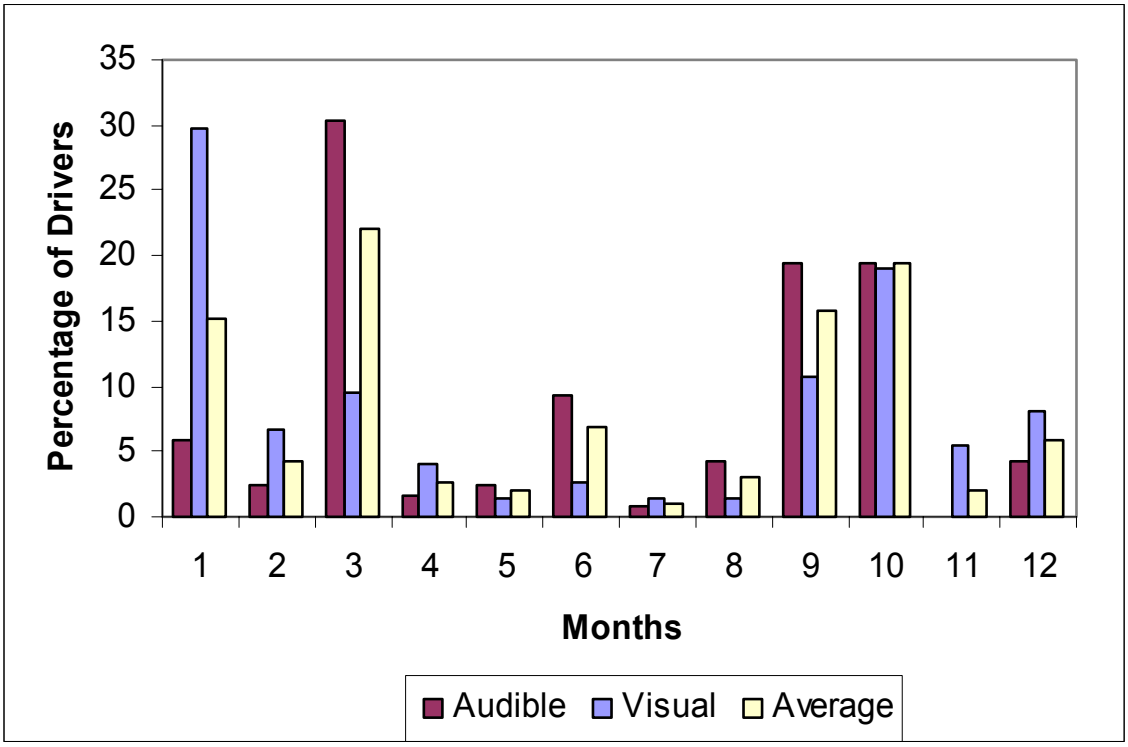


Figure 1: In the year 2000, how long have you driven a vehicle with the IVR?

Table 1. Percentage of drivers who used the railroad crossings in the study area

Jurisdiction	Crossing	No (%)	Yes (%)	No Response (%)
Morton Grove	Beckwith Road	27.5	16.6	56.0
Glenview	Chestnut Street	15.0	47.2	37.8
Northbrook	Shermer Road	18.7	39.4	42.0
Northbrook	Dundee Road	19.2	38.3	42.5
Deerfield	Greenwood Ave.	26.9	14.5	58.5

Not all the participants used all the crossings. About 1.6% of the drivers used all five crossings, 7.3% used only four, 13.5% used only three, and 33.7% used only two out of the five crossings. Thus, about 56.1% of the drivers used at least two of the crossings. Table 2 presents the number and percentage of participants that used the crossings.

Table 2. Number and percentage of drivers who used the crossings in the study area

	Drivers who crossed				
	All 5 crossings	**Only 4**	**Only 3**	**Only 2**	**At least 1**
Frequency	3	14	26	65	193
Percentage	1.6%	7.3%	13.5%	33.7%	100.0%

Beckwith Road in Morton Grove: A total of 32 drivers reported using the Beckwith Road crossing. Figure 2 shows the frequency of usage of the crossing by the drivers. On the average, the drivers used this location 7.3 times per week. The percentage of the drivers who used this crossing up to two times per week was 40.6%. A great majority of the drivers (93.8%) used this location up to 20 times per week. The maximum usage reported for this crossing was 30 times per week.

Chestnut Street in Glenview: A total of 91 drivers reported using the Chestnut Street crossing. Figure 3 shows the frequency of usage of the crossing by the drivers. On the average, this location was used 6.1 times per week. The percentage of the drivers who used this crossing up to two times per week was 38.5%. A great majority of the drivers (91.2%) used this location up to 15 times per week. The maximum usage reported for this crossing was 30 times per week.

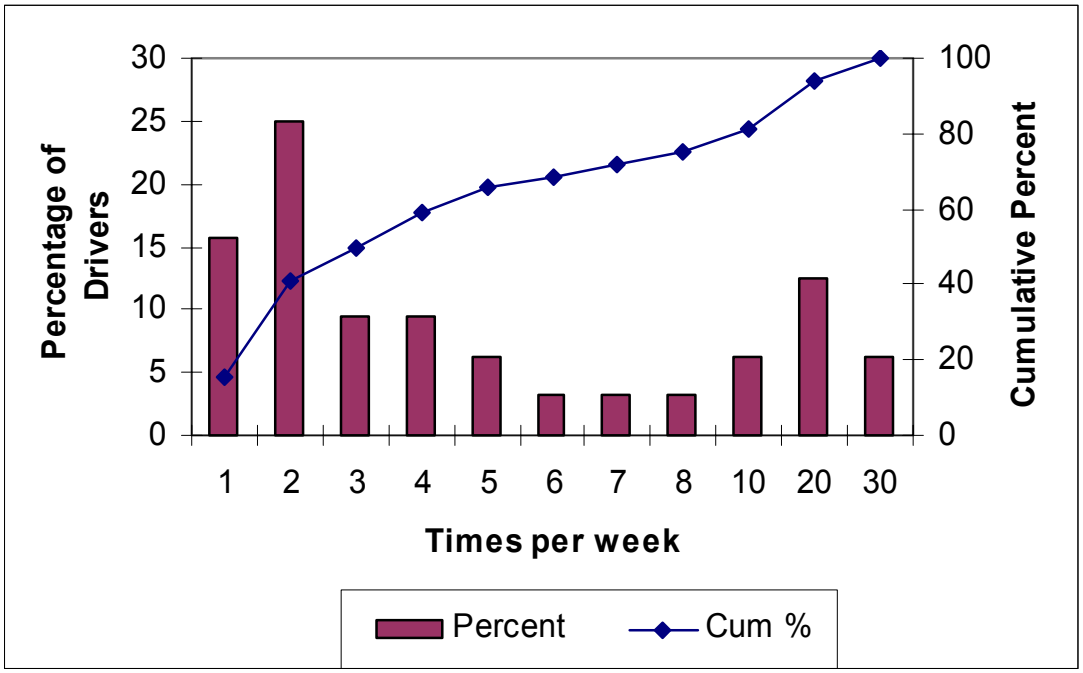


Figure 2: Distribution of number of times the drivers crossed Morton Grove/Beckwith Road crossing.

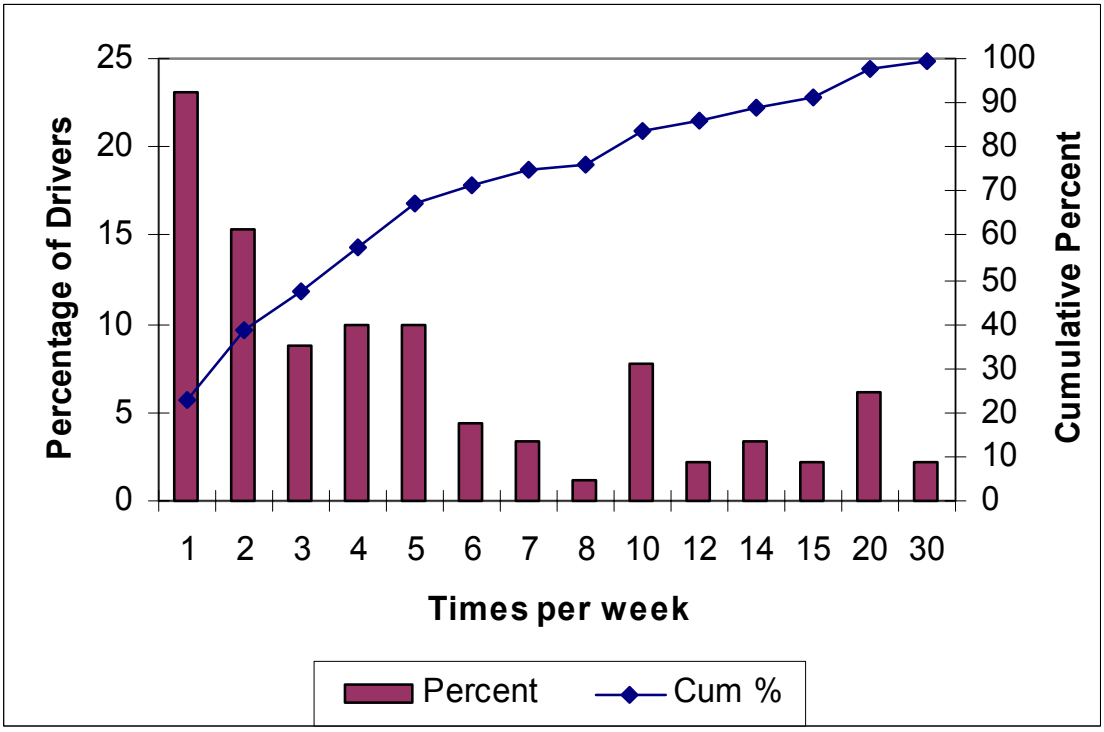


Figure 3: Distribution of number of times the drivers crossed Glenview/Chestnut Street crossing.

Shermer Road in Northbrook: A total of 76 drivers reported using the Shermer Road crossing. Figure 4 shows the frequency of usage of the crossing by the drivers. On the average, this location was used 5.8 times per week. The percentage of the drivers who used this crossing up to two times per week was 23.7%. A great majority of the drivers (93.4%) used this location up to 12 times per week. The maximum usage reported for this crossing was 30 times per week.

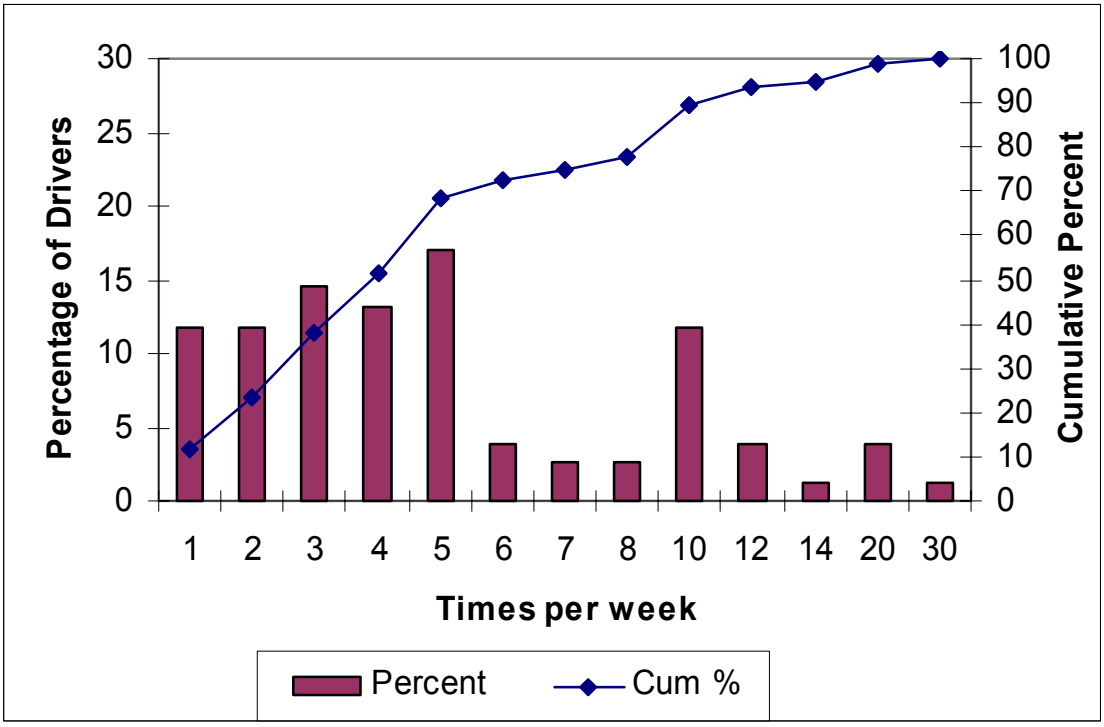


Figure 4: Distribution of number of times the drivers crossed Northbrook/Shermer Road crossing.

Dundee Road in Northbrook: A total of 74 drivers reported using the Dundee Road crossing. Figure 5 shows the frequency of usage of the crossing by the drivers. On the average, this location was used 7.1 times per week. The percentage of the drivers who used this crossing up to two times per week was 27.0%. A great majority of the drivers (90.5%) used this location up to 13 times per week. The maximum usage reported for this crossing was 20 times per week.

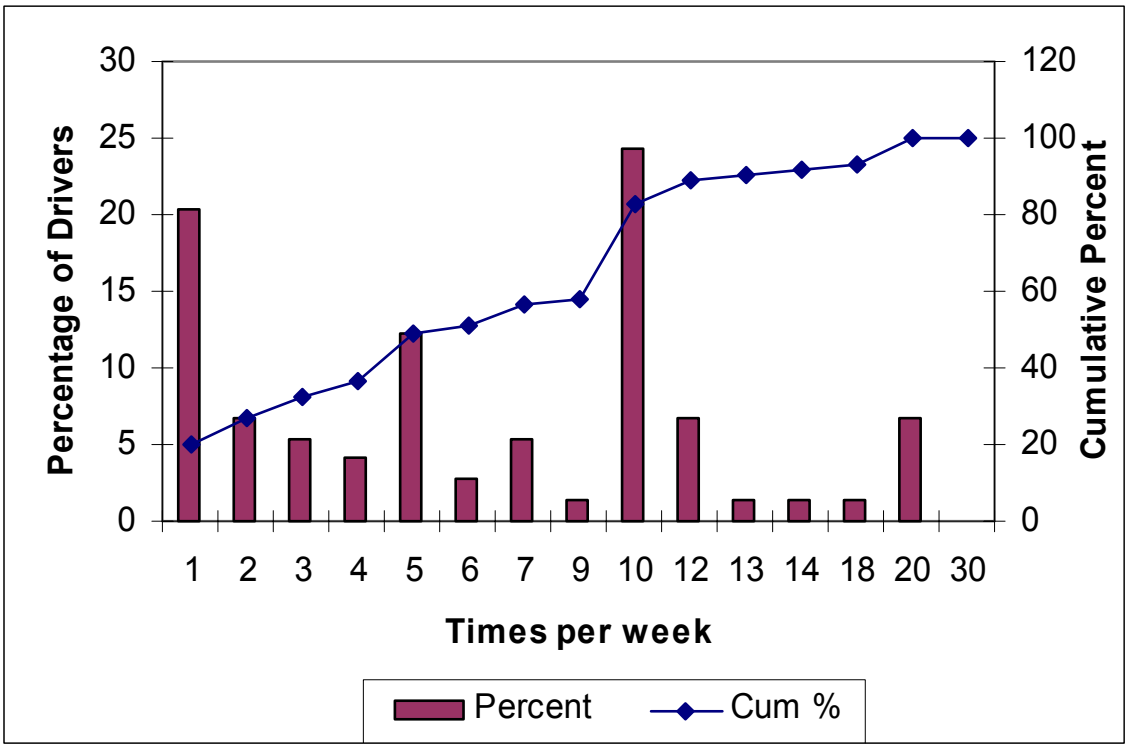


Figure 5: Distribution of number of times the drivers crossed Northbrook/Dundee Road crossing.

Greenwood Avenue in Deerfield: A total of 28 drivers reported using the Greenwood Ave. crossing. Figure 6 shows the frequency of usage of the crossing by the drivers. On the average, this location was used 9.3 times per week. The percentage of the drivers who used this crossing up to two times per week was 35.7%. A great majority of the drivers (89.3%) used this location up to 20 times per week. The maximum usage reported for this crossing was 30 times per week.

Rate the Effectiveness of the R.R. Crossing Warning Devices (Q3)

The number of drivers who answered this question varied from 158 to 181 depending on the warning device. The drivers were asked to select one of the five rating categories: very high (5 points), high (4 points), medium (3 points), low (2 points), and very low (1 point). Table 3 presents the distribution of the responses given by the drivers. Note that the percentage of drivers who had no opinion was based on the total number of drivers (193). In order to represent the distribution of the drivers' responses, the percentages per rating category were based on the number of drivers who rated the device.

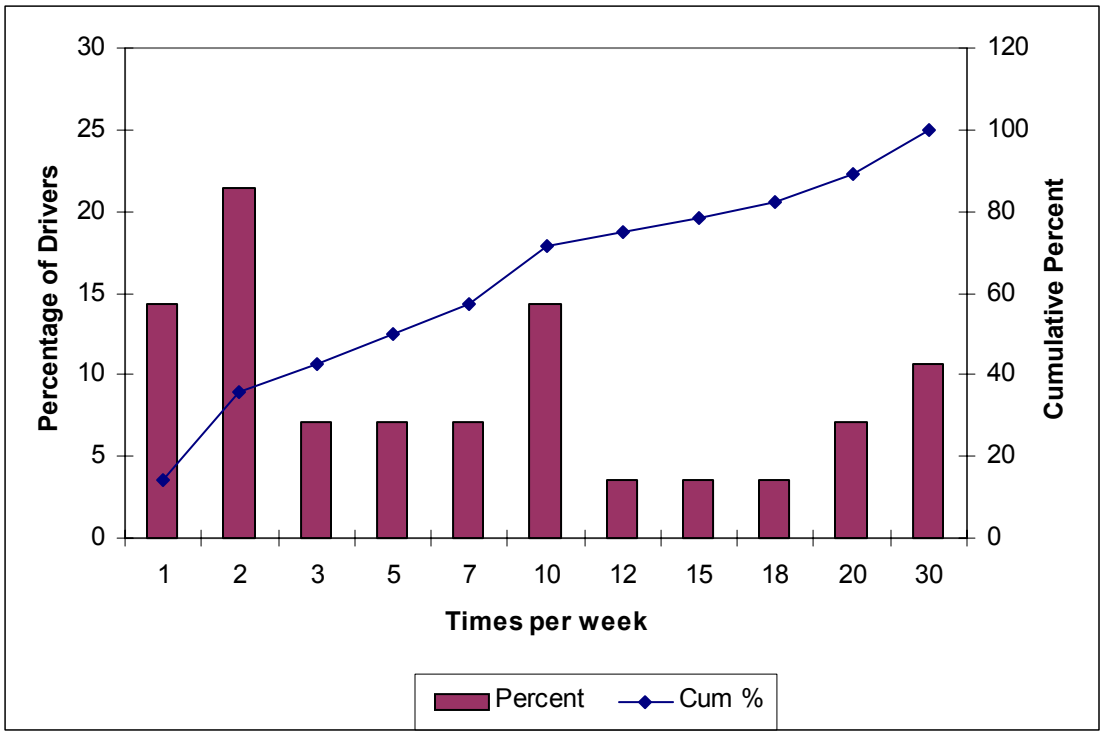


Figure 6: Distribution of number of times the drivers crossed Deerfield/Greenwood crossing.

The results showed that the crossing gate is perceived as the most effective warning device. As shown in Table 3, about 75.7% of the drivers rated its effectiveness as "very high". Approximately 54.9% of the drivers said the effectiveness of the flashing lights was "very high". The effectiveness of train horn and clanging bell were rated as "very high" by 37.7% and 35.3% of the drivers, respectively. Approximately 29.7% of the drivers rated the effectiveness of the IVR "very high." The effectiveness of the advance warning sign, and crossbuck sign, were rated "very high" by 19.7% and 15.1% of the drivers, respectively. The distributions of the effectiveness ratings are given in Figure 7 and Table 3. The figure shows that the crossing gates and the flashing lights were considered highly effective by a large majority of the drivers, but that was not the case for the other devices. In Table 3, the no opinion group for the IVR was the largest of all other warning devices. This is understandable since the IVR was new compared to the other warning devices.

The average effectiveness for each device is given in Table 3. The highest score is 5. The average effectiveness results indicated that the effectiveness of crossing gates was the highest followed by the flashing lights, clanging bell, train horn, IVR, crossbuck, and the advance warning sign. The average effectiveness rating for the IVR was "medium". Tables 3a and 3b show the distribution of the responses for each mode.

The effectiveness of the IVR was rated "very high" by 29.7%, "high" by 16.5% and medium by 29.7%. About 8.9% and 15.2% rated its effectiveness "low" and "very low", respectively, while 13.2% had no opinions on its effectiveness. Thus, over 46% of the drivers considered the effectiveness of the IVR "high" or "very high", while over 24% rated it "low" or "very low". The effectiveness rating for the IVR is much less than the ratings for the active warning devices. This is partially due to the fact that the IVR was not the primary warning device at these crossings. The IVR was supplementary to the active warning devices that were present at the crossings.

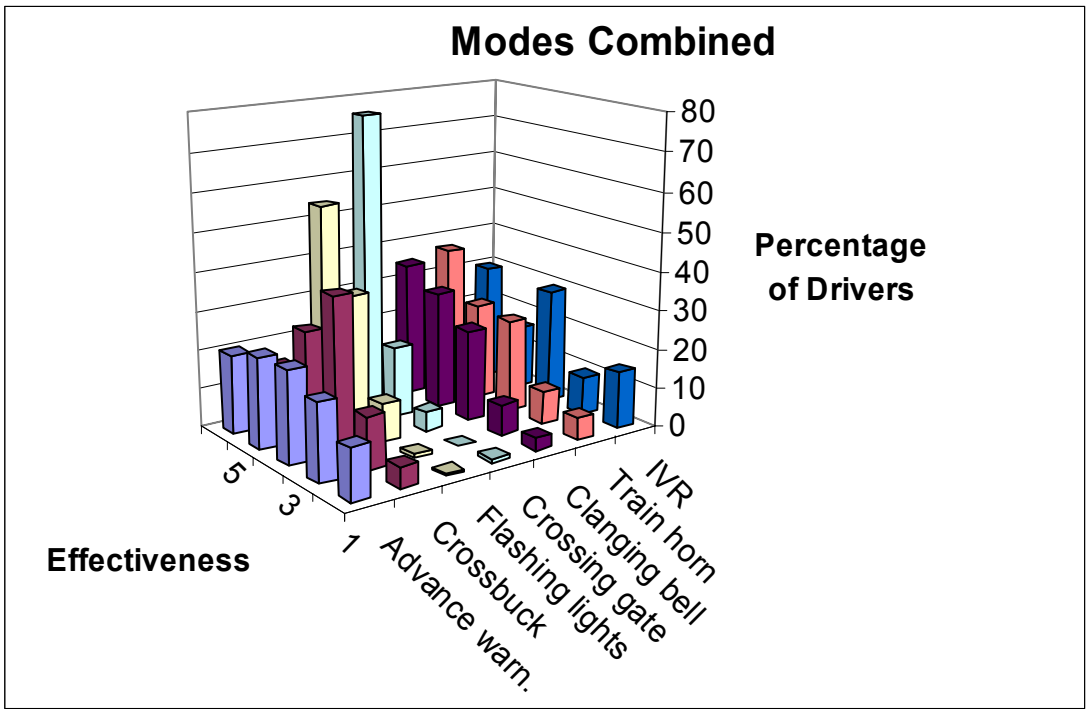


Figure 7: Percentage of all the drivers who participated in the survey, rating effectiveness of each railroad warning device.

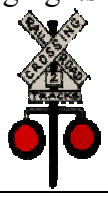
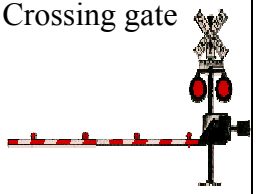
Table 3. Percentages of drivers and ratings of effectiveness of warning devices								
Warning Device	**No opinion**	**Effectiveness**						**No. of drivers**
		1	**2**	**3**	**4**	**5**	**Average**	
Advance warning sign 	7.2	13.7	19.6	24.4	22.6	19.7	3.1	168
Crossbuck sign 	6.8	5.5	13.9	39.4	26.1	15.1	3.3	165
Flashing lights 	3.9	0.6	1.2	9.8	33.5	54.9	4.4	173
Crossing gate 	2.2	1.1	0.0	5.0	18.2	75.7	4.7	181
Clanging bell	5.0	3.5	7.6	22.4	31.2	35.3	3.9	170
Train Horn	7.2	6.0	8.4	23.3	24.6	37.7	3.8	167
IVR	13.2	15.2	8.9	29.7	16.5	29.7	3.4	158

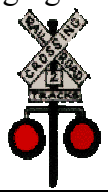
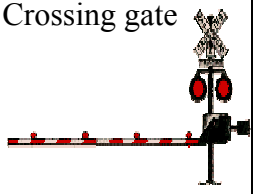
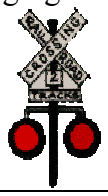
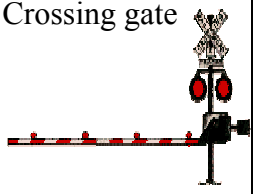
Table 3a. Percentages of drivers and ratings of effectiveness of warning devices for AUDIBLE mode								
Warning Device	**No opinion**	**Effectiveness**						**No. of drivers**
		1	**2**	**3**	**4**	**5**	**Average**	
Advance warning sign 	4.6	12.5	17.3	26.0	23.1	21.1	3.2	104
Crossbuck sign 	3.8	4.9	13.7	37.3	29.4	14.7	3.4	102
Flashing lights 	1.9	0.0	0.0	8.6	31.4	60.0	4.5	105
Crossing gate 	0.9	0.0	0.0	4.5	21.6	73.9	4.7	111
Clanging bell	2.8	2.9	5.8	17.5	31.1	42.7	4.0	103
Train Horn	4.7	6.9	10.8	18.6	24.5	39.2	3.8	102
IVR	8.3	8.0	6.0	30.0	20.0	36.0	3.7	100

Table 3b. Percentages of drivers and ratings of effectiveness of warning devices for VISUAL mode								
Warning Device	**No opinion**	**Effectiveness**						**No. of drivers**
		1	**2**	**3**	**4**	**5**	**Average**	
Advance warning sign 	11.1	15.6	23.4	21.9	21.9	17.2	3.0	64
Crossbuck sign 	11.3	6.3	14.3	42.9	20.6	15.9	3.3	63
Flashing lights 	6.9	1.5	2.9	11.8	36.8	47.0	4.3	68
Crossing gate 	4.1	2.9	0.0	5.7	12.9	78.5	4.6	70
Clanging bell	8.2	4.5	10.5	29.8	31.3	23.9	3.6	67
Train Horn	11.0	4.6	4.6	30.8	24.6	35.4	3.8	65
IVR	20.6	27.6	13.8	29.3	10.3	19.0	2.8	58

A comparison between the effectiveness of the IVR with respect to the other warning devices was conducted using 133 drivers who provided a rating to all the warning devices. With a significance level of 0.05, the devices that were rated significantly different than the IVR were the flashing lights, the crossing gate, the clanging bell, and the train horn. The warning devices that had an effectiveness rating similar to the IVR were the crossbuck and advance warning signs. These results are presented in Table 4 along with the mean differences between the devices, the standard deviations, the T – distribution values and their respective probabilities. The average effectiveness of these devices is presented in Table 5. The ratings for each mode are analyzed separately in the next section. Some of these drivers had the audible and others had the visual mode of the IVR.

Table 4: T-test results for audible and visual groups together (133 drivers)

Difference	Mean difference	Standard Deviation	T	Prob. T
Advance warning – IVR	-0.23	1.73	-1.55	0.1230
Crossbuck sign – IVR	-0.02	1.56	-0.17	0.8678
Flashing lights – IVR	1.01	1.45	7.99	0.0001
Crossing gate – IVR	1.35	1.48	10.56	0.0001
Clanging bell –IVR	0.50	1.44	4.02	0.0001
Train horn – IVR	0.45	1.70	3.05	0.0027

IVR Effectiveness Ratings by the Visual and Audible Groups

In the previous section, we discussed the IVR effectiveness ratings for the audible and visual groups combined. In this section, the responses from the audible and visual groups were analyzed separately. Figures 8 and 9 (also Tables 3a and 3b) present the distributions of the effectiveness ratings for the warning devices given by the audible and visual groups. The average effectiveness ratings were summarized in Table 5. The T-test results show that the audible and visual drivers gave significantly different ratings to the clanging bell and the IVR.

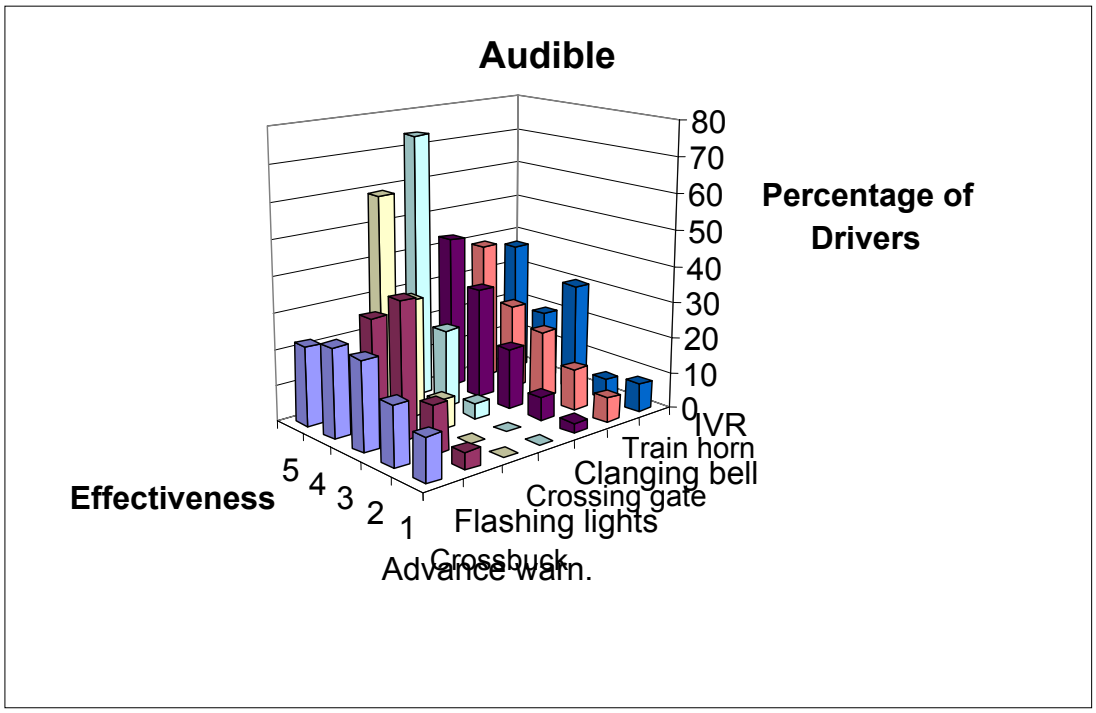


Figure 8: Percentage of drivers using audible mode, rating effectiveness of each railroad warning device.

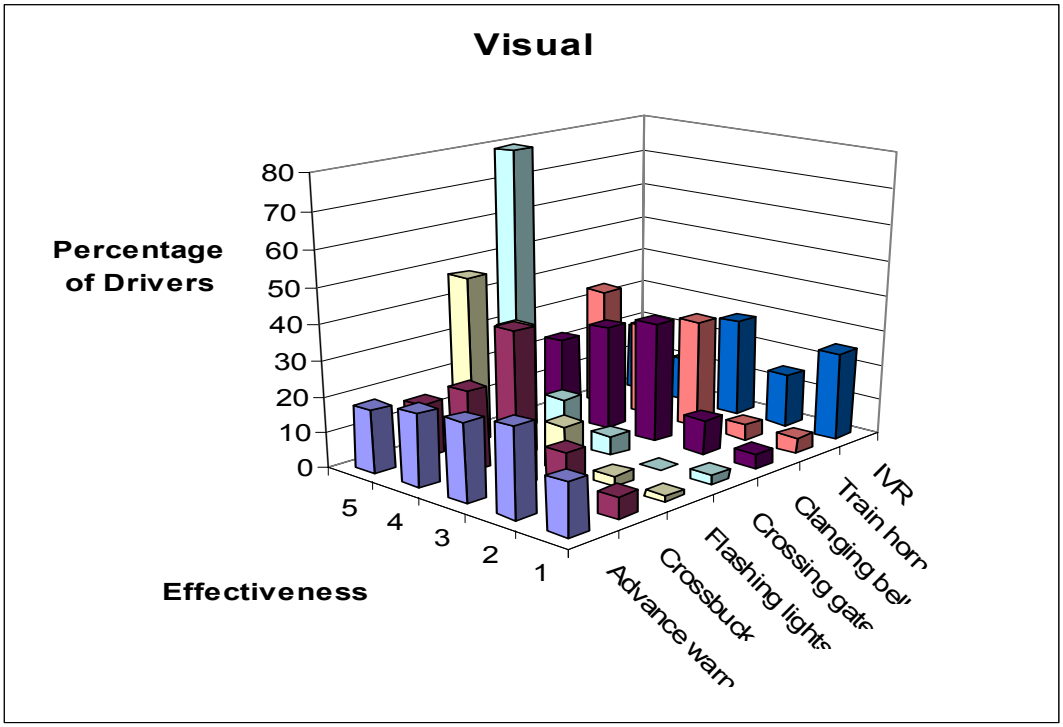


Figure 9: Percentage of drivers using visual mode, rating effectiveness of each railroad warning device.

The IVR average effectiveness rating from the audible group (3.8) was significantly higher than that of the visual group (2.7) with a 0.05 significance level. One logical explanation for this is that the audible IVR beeped and thereby attracted the attention of the drivers. Drivers could not ignore the beeping sound of the audible IVR, but that was not the case with the visual IVR. Previously, the visual group had the audible IVR and they were used to hearing it rather than looking at the IVR message. If a driver was not looking directly at the visual IVR, he/she could miss the warning message. Also, the visual warning message from the visual IVR is not as prominent in getting attention of the drivers as the beeping sound from the audible IVR. Thus, the drivers in the visual group gave a lower effectiveness rating for the IVR than the audible group.

Table 5: T-test results comparing audible and visual groups for every warning device (83 drivers in Audible and 50 drivers in Visual = 133 drivers)

Warning Device	Mean		Standard Deviation		T	Prob. T
	A*	V*	A	V		
Advance warning	3.2**	3.0	1.31	1.39	0.82	0.4132
Crossbuck sign	3.4	3.3	1.02	1.18	0.61	0.5456
Flashing lights	4.5	4.2	0.65	0.97	1.90	0.0609
Crossing gate	4.8	4.7	0.51	0.79	0.63	0.5304
Clanging bell	4.1	3.4	0.95	1.13	3.85	0.0002
Train horn	3.8	3.8	1.18	1.18	0.20	0.8379
IVR	3.8	2.7	1.24	1.44	4.31	0.0000

* Notation: A = Audible mode, V = Visual mode

** Ratings are based in a 5 unit scale, 1 is low and 5 is very high

The comparisons of the effectiveness ratings between the warning devices and the IVR are presented in Tables 6 and 7. These responses correspond to 83 drivers using the audible IVR mode and 50 drivers using the visual IVR mode. Table 6 shows that the effectiveness of the train horn is equal to the audible mode of the IVR, with 95% confidence. The ratings for the audible

IVR were significantly higher than that of the advance warning and the crossbuck signs, but significantly lower than the flashing lights, the crossing gate, and the clanging bell.

Table 6: T-test results for audible mode of IVR with other devices (83 drivers)				
Difference	Mean difference	Standard Deviation	T	Prob. T
Advance warning – IVR	-0.54	1.63	-3.02	0.0033
Crossbuck sign – IVR	-0.36	1.44	-2.29	0.0244
Flashing lights – IVR	0.73	1.34	4.98	0.0001
Crossing gate – IVR	1.00	1.35	6.74	0.0001
Clanging bell – IVR	0.38	1.43	2.46	0.0161
Train horn – IVR	0.08	1.59	0.48	0.6295

Table 7: T-test results for visual mode of IVR with other devices (50 drivers)				
Difference	Mean difference	Standard Deviation	T	Prob. T
Advance warning – IVR	0.28	1.78	1.11	0.2727
Crossbuck sign – IVR	0.54	1.61	2.38	0.0214
Flashing lights – IVR	1.46	1.53	6.75	0.0001
Crossing gate – IVR	1.94	1.50	9.12	0.0001
Clanging bell – IVR	0.70	1.46	3.38	0.0014
Train horn – IVR	1.06	1.73	4.33	0.0001

Table 7 presents the results of the T-test between the effectiveness of the visual IVR mode and the warning devices. The only device that has a similar rating to the IVR, with 95% confidence, is the advance warning sign. The rating for the visual IVR is significantly lower than that of the other warning devices.

Do You Trust Your IVR to Give an Accurate Warning of a Train Approaching/Occupying the Equipped Crossings (Q4)?

All 193 drivers answered this question. Overall, 18.1% of the drivers said they trusted the IVR very much, 39.4% of the drivers said they trusted the IVR to some degree, and 33.7% said they did not trust it. Approximately 8.8% of the drivers did not have an opinion. The distribution of the drivers' responses to this question is presented in Figure 10.

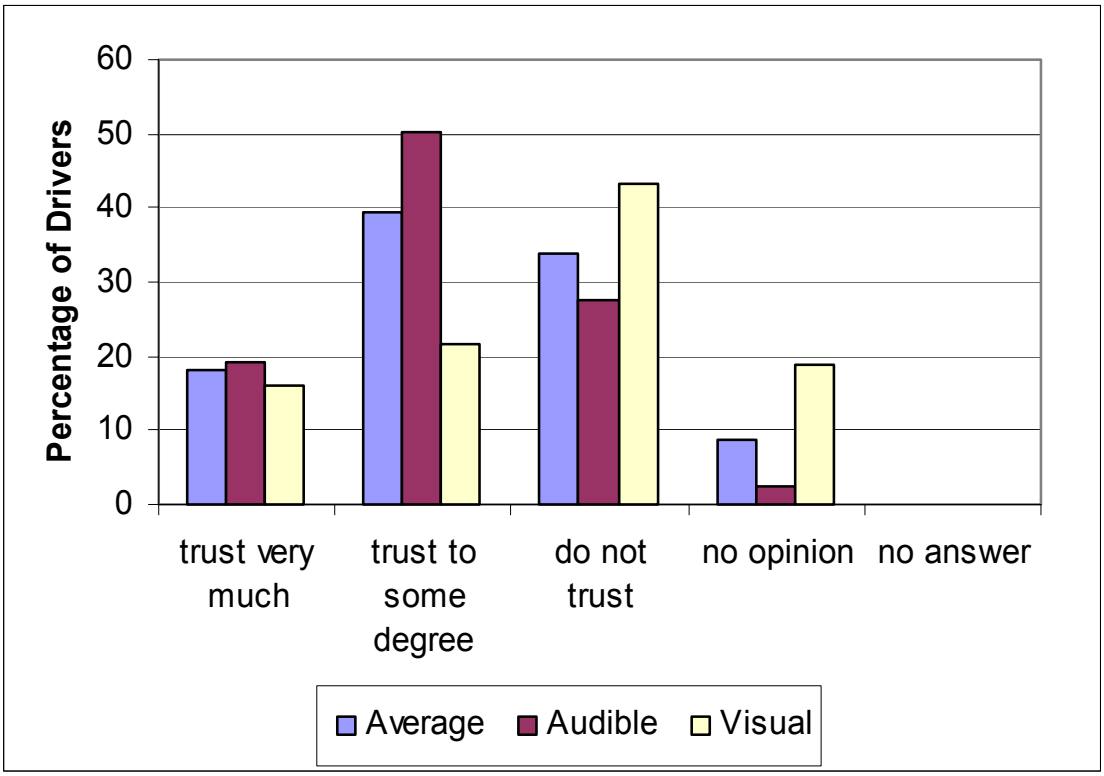


Figure 10: Percentage of drivers that trust the IVR to give an accurate warning of a train approaching or occupying equipped crossings.

An analysis was performed to determine whether the trust level depended on the type of IVR the drivers had. The total number of drivers used in the chi-square analysis ended up to be 176, after deleting the 17 no opinion responses. The drivers in the visual mode did not trust the IVR as much as the drivers in the audible mode. The chi-square test between the drivers in the audible and visual groups shows that a higher proportion of the drivers in the visual group did not trust the IVR. Thirty-two drivers said they did not trust the IVR when we were expecting 22

drivers to say that. Similarly, a lower than expected proportion of the drivers in the visual group said they trusted the IVR to some degree. There were 16 drivers in this group versus the expected number of 26 drivers. In contrast, in the audible mode, more drivers than expected trusted the IVR to some degree. The number of drivers who trusted the IVR to some degree was 60 versus the expected number of 50. The chi-square test, with 95% confidence, rejected the hypothesis that the trust level of the audible and visual groups was the same. The results of the chi-square test are presented in Table 8.

Table 8: Chi-square test results
(116 drivers in Audible and 60 drivers in Visual)

		Trust very much		Trust to some degree		Do not trust	
		A	V	A	V	A	V
Observed	Frequency	23	12	60	16	33	32
	Percent	19.8	20.0	51.7	26.7	28.4	53.3
Expected	Frequency	23.1	11.9	50.1	25.9	42.8	22.2
	Percent	19.9	19.8	43.2	43.2	36.9	37.0

In the sample of 176 drivers who expressed an opinion, approximately 19.8% of the drivers using the audible mode trusted the IVR very much and 51.7% trusted the IVR to some degree. In contrast, 20.0% of the visual drivers trusted the IVR very much and only 26.7% trusted the IVR to some degree.

Have You Experienced Any Problems with IVR Powering On Properly (Q5)?

A total of 191 drivers answered this question. Approximately 52.3% of the drivers said that they did not have any problems with the IVR powering on properly. Approximately 19.7% of the drivers experienced problems with the IVR powering on. Approximately 26.9% of the drivers did not have an opinion and two drivers did not respond to this question. Figure 11 presents the distribution of the responses. Comparing the responses given by the 119 drivers operating in audible mode and the 72 drivers in visual mode, 54.6% of the drivers in audible mode and 48.6% of the drivers in the visual mode did not encounter any problems operating the

IVR. However, 26.1% in the audible group and 9.5% in the visual group indicated having problems with the IVR powering on properly. This could be the result of the audible IVR attracting the drivers' attention.

The drivers were requested to write the number of times they experienced power-on problems. A total of 25 drivers provided the numeric response. The average number of times these drivers had power-on problems was 7.0 times in three months. Twenty-one of these drivers were using the audible and four drivers were using the visual mode. Visual IVR drivers reported that power-on problems occurred an average of 5.2 times, while audible IVR drivers reported that power-on problems occurred, an average of 7.4 times in three months. The minimum and maximum values for the audible IVR were 1 and 40. The minimum and maximum values reported by the visual IVR drivers were 2 and 10, respectively. The difference is not statistically significant based on the analysis obtained from a T-test with 95% confidence.

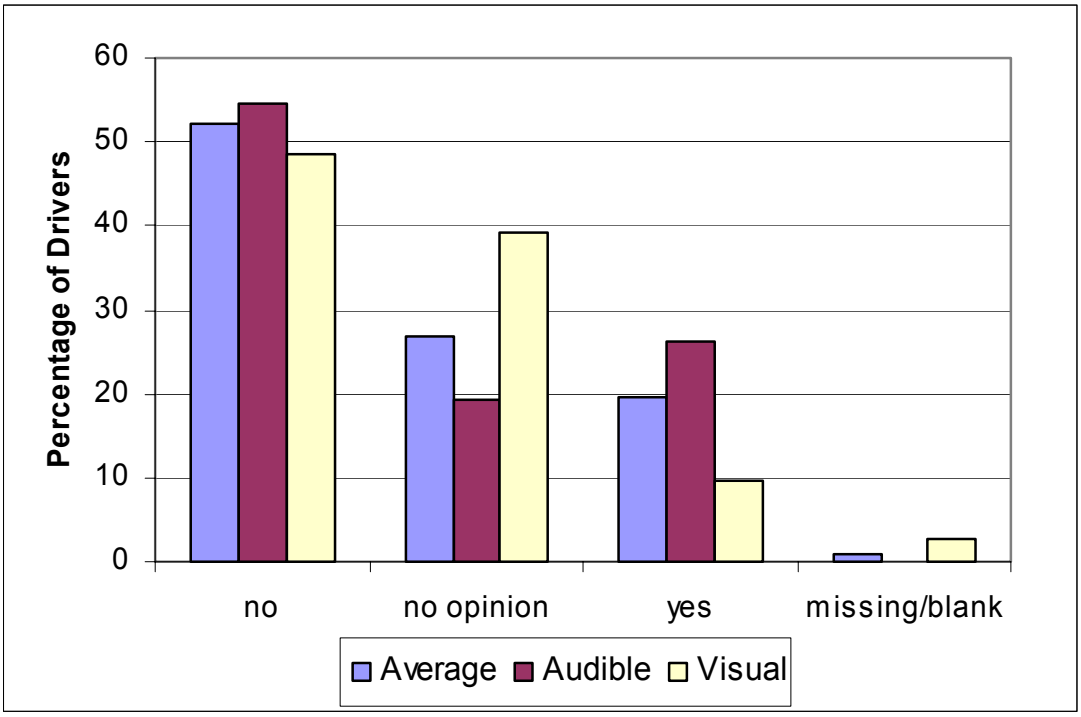


Figure 11: Distribution of drivers that experienced power-on problems.

A comparison of the responses given by the drivers operating an IVR in the audible and visual modes is presented in Table 9. The chi-square value is 13.424 with a p-value of 0.001. The chi-square test shows that the audible and visual responses were different with 95% confidence. A higher proportion of the audible group did not have power-on problems. The chi-square test showed that the visual group was over-represented in the no opinion group.

Table 9: Chi-square test results
(119 drivers in Audible and 72 in Visual)

		No power-on problems		Don't recall/No opinion		Yes, had power-on problems	
		A	V	A	V	A	V
Observed	Frequency	65	36	23	29	31	7
	Percent	54.6	50.0	19.3	40.3	26.1	9.7
Expected	Frequency	62.9	38.1	32.4	19.6	23.7	14.3
	Percent	52.8	52.9	27.2	27.2	20.0	19.9

How Many Times Has Your IVR Given You a Warning When a Train Was Not Approaching/Occupying the Equipped Crossings (Q6)?

This question requested a numeric response, however, a large number of drivers did not give a number instead responded with words like "many" and "numerous". Only 91 drivers provided numeric responses and they are analyzed here. On the average, the drivers received a warning when a train was not approaching/occupying the equipped crossings 3.7 times in three months. The minimum and maximum values reported by the drivers were 0 and 60. Twenty-nine drivers used the IVR in visual and 62 used the IVR in audible mode. The visual IVR group reported 2.1 false alerts whereas the audible group reported 4.4 false alerts in three months. This difference is statistically significant with 95% confidence. Based upon interaction with the drivers during orientation and focus group sessions, it is believed that the actual number of false alerts was much higher than these averages.

How Many Times Has Your IVR Failed to Give You a Warning When a Train Was Approaching/Occupying Equipped Crossings (Q7)?

On the average, the 95 drivers who answered this question stated that the IVR failed to give a warning 1.1 times in three months. Of these, 68 drivers were driving with the IVR in the audible mode, which failed to give a warning on average of 1.4 times in three months. The range of the responses was from 0 to 15. Twenty-seven drivers with the IVR in visual mode determined that the IVR failed to give a warning approximately 0.3 times in three months. The range of the responses was from 0 to 4. The highest number reported for IVR failures to give a warning message when a train was approaching was 15 during a three month period. This number was reported by a driver in the audible group. It is questionable whether this driver responded carefully to the question. This difference is statistically significant with 95% confidence. Also, none of the missed alerts were reported to the contractor's hotline that was established for system operational shortcomings.

What Percentage of the Time has Your IVR Provided a Warning When a Train Was Approaching/Occupying the Equipped Crossings (Q8)?

A total of 121 drivers answered this question. On the average, the IVR provided a warning 79.2% of the time when a train was approaching/occupying the equipped crossings. Of these, 37 drivers were using the visual and 84 the audible IVR mode. The averages for the drivers using visual and audible IVR were 69.3% and 83.6%, respectively. This difference is statistically significant using a t-test with 95% confidence. However, it is suspected that some of the drivers did not understand the question. Responses such as 0% and 2% were observed in both categories.

Has the IVR Given You a Signal that You Did Not Understand (Q9)?

A total of 193 drivers responded to this question. Of these, only 21 drivers stated that they received a signal that they did not understand. These drivers were also asked to provide a description of the signal given. The actual statements of these drivers are given in Table 10. These drivers reported the false alerts they received as signals they did not understand.

Table 10: Verbatim of the messages the drivers did not understand
Activates near shopping malls, Walgreen's, etc.
Signal sets off by police radar
Signal sets off by door openers
Several sharp beeps with several higher pitched beeps that are more often
Loud, continuous signals, loud/soft signal. Once it just kept going till I turned off the truck and restarted it (in front of a hotel)

RESPONSES SPECIFIC TO VISUAL MODE

Visual Distractions During Daily Driving Conditions (Q10)

A total of 55 drivers using the visual mode answered this question. A large percentage of the drivers (42.0%) said that they were distracted by passengers during daily driving. Approximately 32.6% said that they were distracted by exterior light sources and 37.7% complained about the interior warning lights. The distribution of the visual distractions is presented in Figure 12. Approximately 4.2% of the drivers complained about other visual distractions. Approximately 25.7% of the drivers did not provide a response to this question. Note that this was a "circle all that apply" question. Therefore, the percentages do not add up to 100%. The list of additional distractions indicated by the drivers is presented in Table 11.

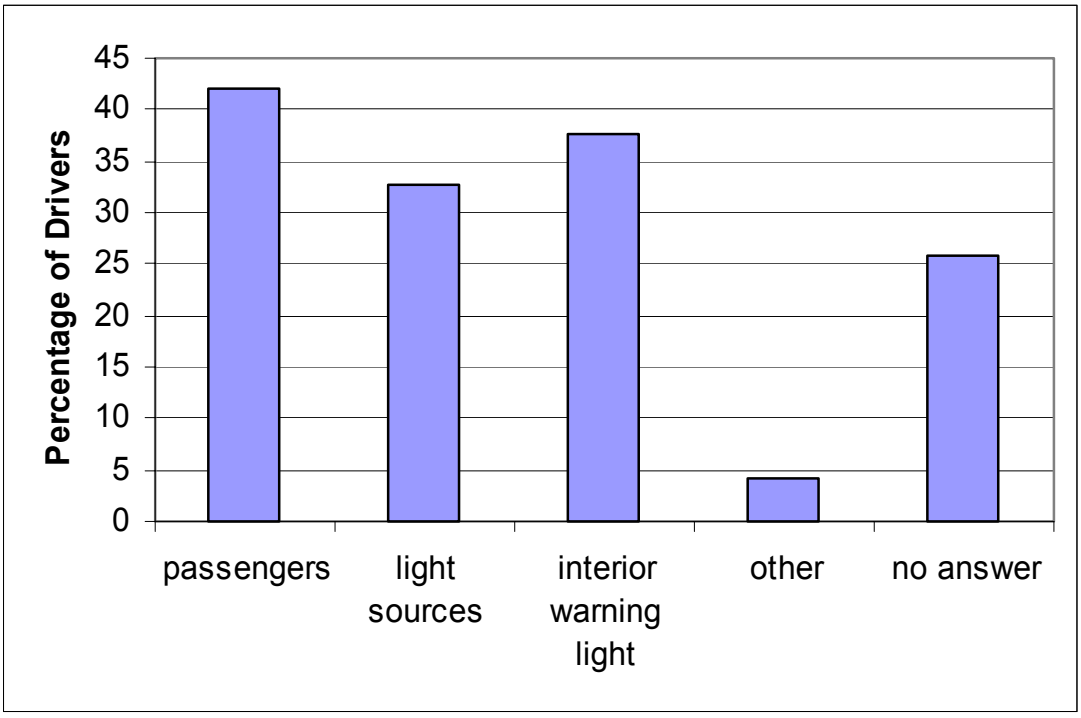


Figure 12: Visual distractions drivers experienced while driving.

Table 11: Additional visual distractions
police cars
trees and shrubs along the way
the sun

During Daytime and Nighttime, How Well Can You See the Visual Display (Q11)?

Sixty-nine and 61 drivers responded to the questions related to the visual display during daytime and nighttime, respectively. The distributions of the responses are presented in Figure 13. During day light, approximately 50.0% of the drivers said that the brightness of the visual display was just right, 25.7% had no opinions, 14.9% said it was too dim, 2.7% said that it was too bright, and 6.7% left this question blank.

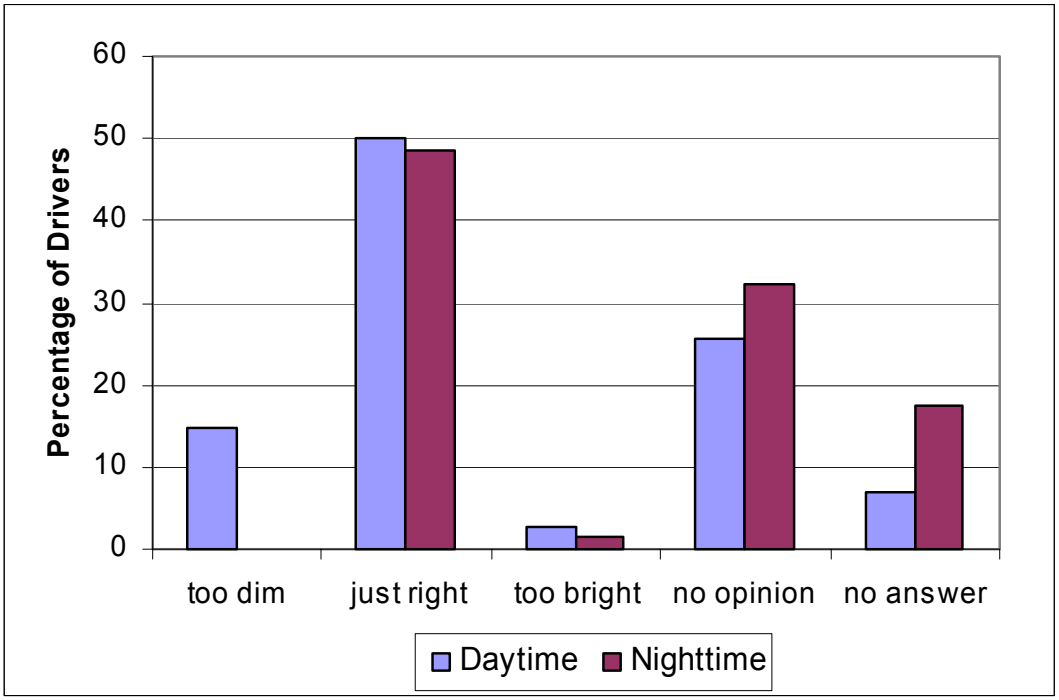


Figure 13: Percentage of how well drivers can see the visual display during daytime and nighttime.

During nighttime, none of the drivers found the display too dim. A large portion of the drivers (48.6%) said that the visual display was just right. The second largest group (32.4%) did not state an opinion. Only one driver (1.4%) found the display too bright and approximately 17.6% of the drivers left this question blank.

Is the Size of the Lettering on the Visual Display Easy to Read (Q12)?

A total of 70 drivers responded to this question. The distribution of the responses is given in Figure 14. Approximately 63.5% of the drivers said that the lettering was easily readable and 6.8% said the lettering was too small. The drivers who did not state an opinion and the ones who left this question blank accounted for approximately 29.7% of the drivers.

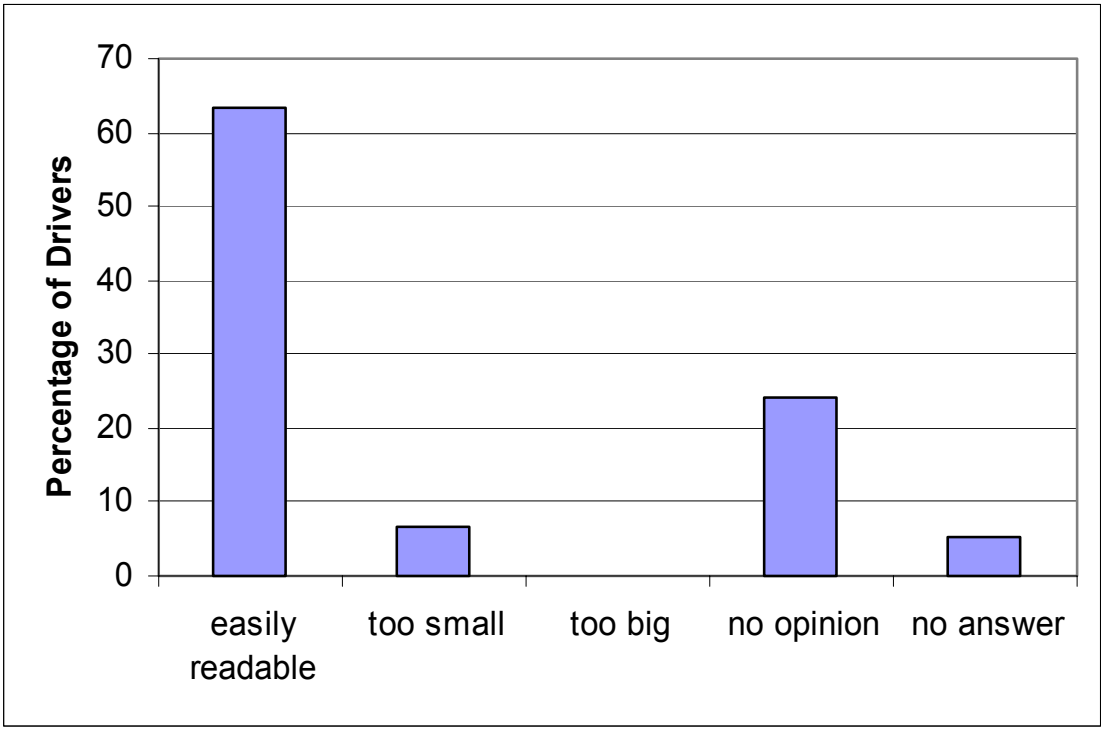


Figure 14: Distribution of the drivers' opinions on the size of the lettering on the visual display.

How Does the Blinking Rate Affect Readability (Q13)?

A total of 71 drivers responded to this question. Figure 15 presents the distribution of their responses on the blinking rate of the visual message. Approximately 48.6% of the drivers said that the visual message blinked at the right speed. The second largest group (39.2%) of the drivers did not have an opinion. Only 8.1% of the drivers said the message blinked too fast. Approximately 4.1% of the drivers did not respond to this question.

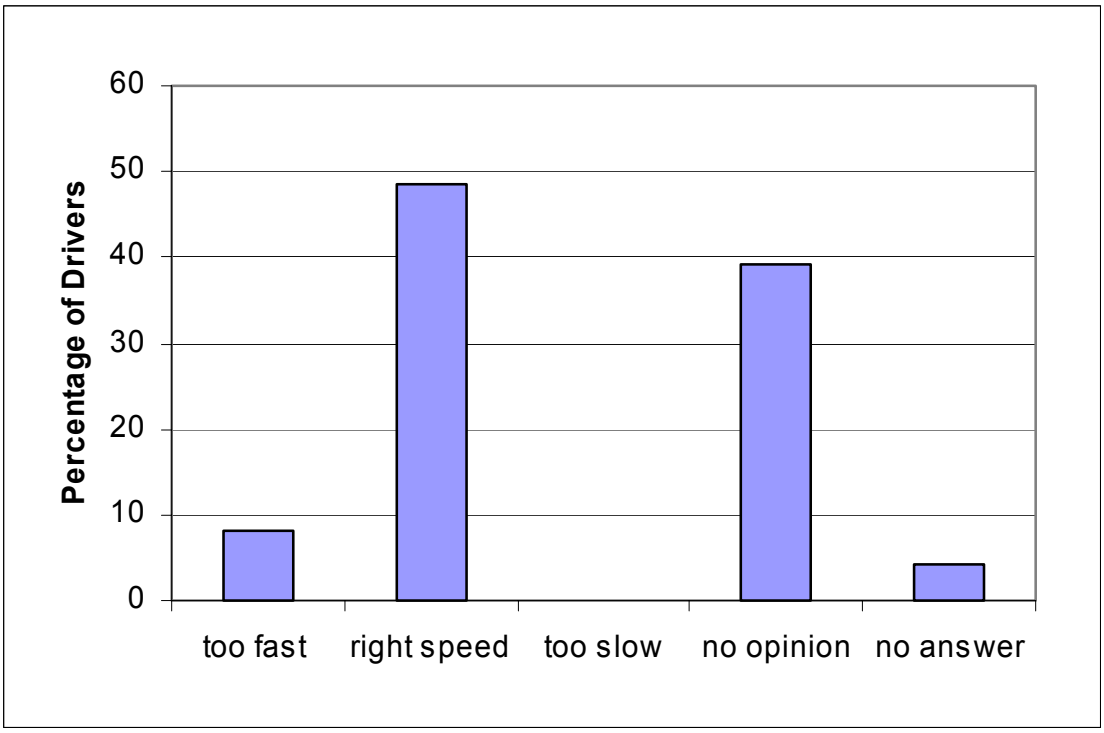


Figure 15: Distribution of the drivers' opinions on the visual message-blinking rate.

Is the Color of the Visual Warning Message Easily Noticed (Q14)?

A total of 71 drivers answered this question. Approximately 66.2% of the drivers said the color of the message was easily noticed. Only 5.4% of the drivers suggested another color, red or

orange, should be used instead. The other 28.4% either did not have an opinion or left this question blank.

Is the Visual Warning Message Easily Noticed (Q15)?

A total of 71 drivers responded this question. Figure 16 presents the distribution of the driver responses. A large portion of the drivers (50.0%) said the visual warning message was noticeable. Approximately 17.6% stated that the visual message was not noticeable. About 4.0% of the drivers left this question blank and 28.4% did not state an opinion. While nearly half of the drivers said the visual message was noticeable, one out of six drivers said it was not noticeable. This may confirm why there are some differences between the audible and visual groups.

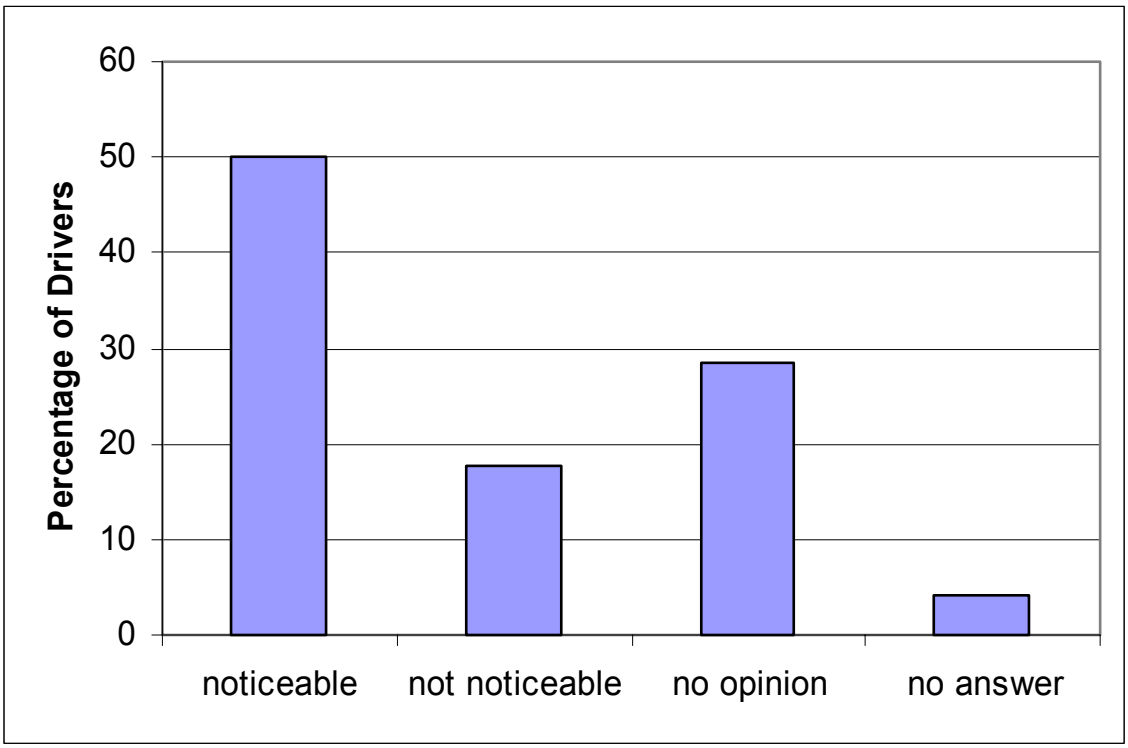


Figure 16: Is the visual message noticeable from other visual cues you receive while driving?

How Would You Rate the Overall Quality of the Visual Message You Received from Your IVR (Q16)?

A total of 70 drivers rated the overall quality of the IVR in the visual mode. The distribution of the responses is presented in Figure 17. A large percentage of drivers (33.8%) rated the quality of the message either good or excellent. Approximately 21.6% said it was fair and 14.9% stated that the quality of the IVR message was poor. Only 5.4% left this question blank and 24.3% did not have an opinion.

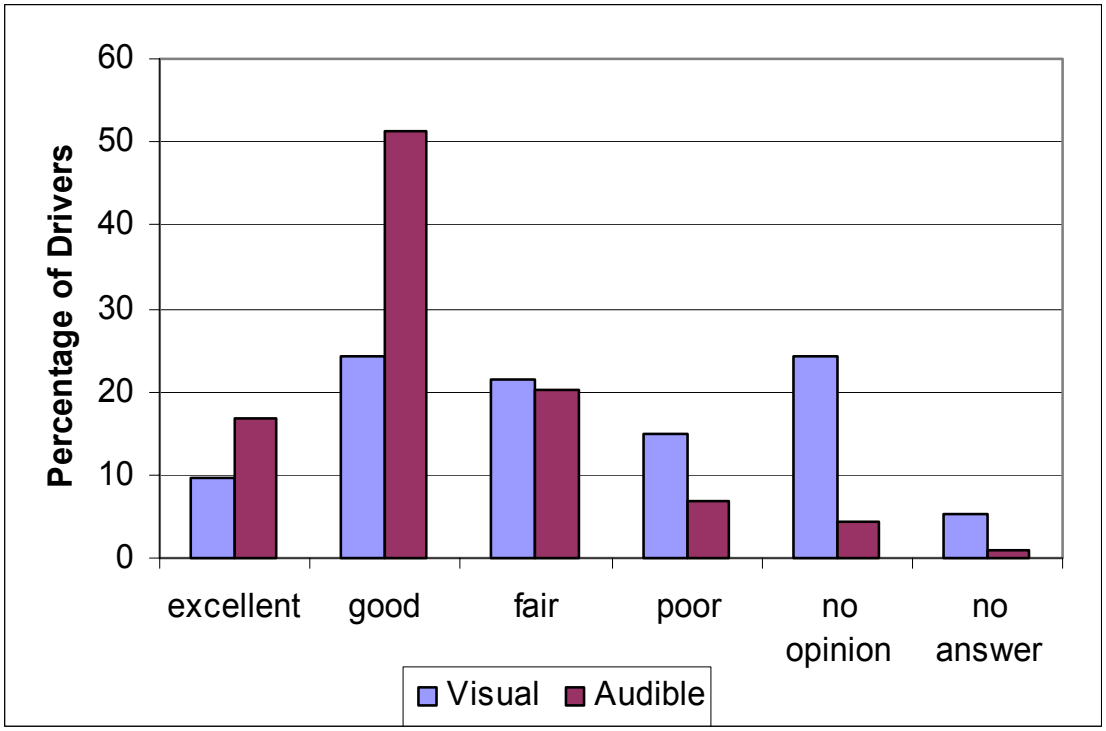


Figure 17: Ratings on the overall quality of the visual and audible messages.

RESPONSES SPECIFIC TO AUDIBLE MODE

Audible Distractions That Apply During Daily Driving Conditions (Q10)

A total of 98 drivers responded to this question. Figure 18 presents the distribution of the responses. A large portion (45.5%) of the drivers chose background noise from radio/tape as an audible distraction. Approximately 46.4% chose the sirens/horns, 32.9% chose the background noise from passengers, 34.6% selected the loud engine noise, and 1.6% said other sources were audible distractions. Approximately 17.6% of the drivers did not provide an answer. Note that this question was a "circle all that apply" type, so the percentages do not add up to 100%. Other distractions mentioned by the drivers are presented in Table 12.

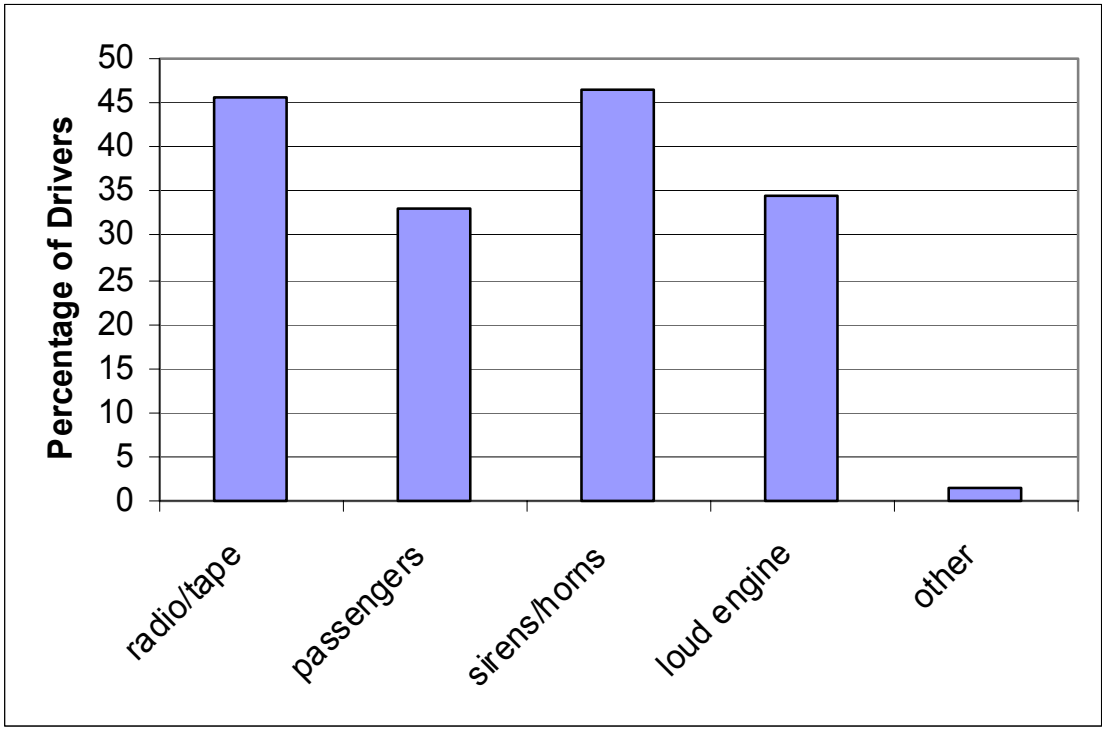


Figure 18: Audible distractions drivers experience while driving.

Table 12: Additional Audible Distractions
dispatch radio
poor drivers
fire radio
road/wind noise
police radar
traffic

How Well Can You Hear the Warning Tone from the IVR (Q11)?

A total of 118 drivers provided an answer for this question. Figure 19 presents the distribution of the drivers' responses. About three-quarters (73.1%) of the drivers said they could hear the warning tone just right, 19.3% said it was too loud, and 5.0% said it was too soft. The remaining 2.6% of the drivers had no opinion or did not answer this question.

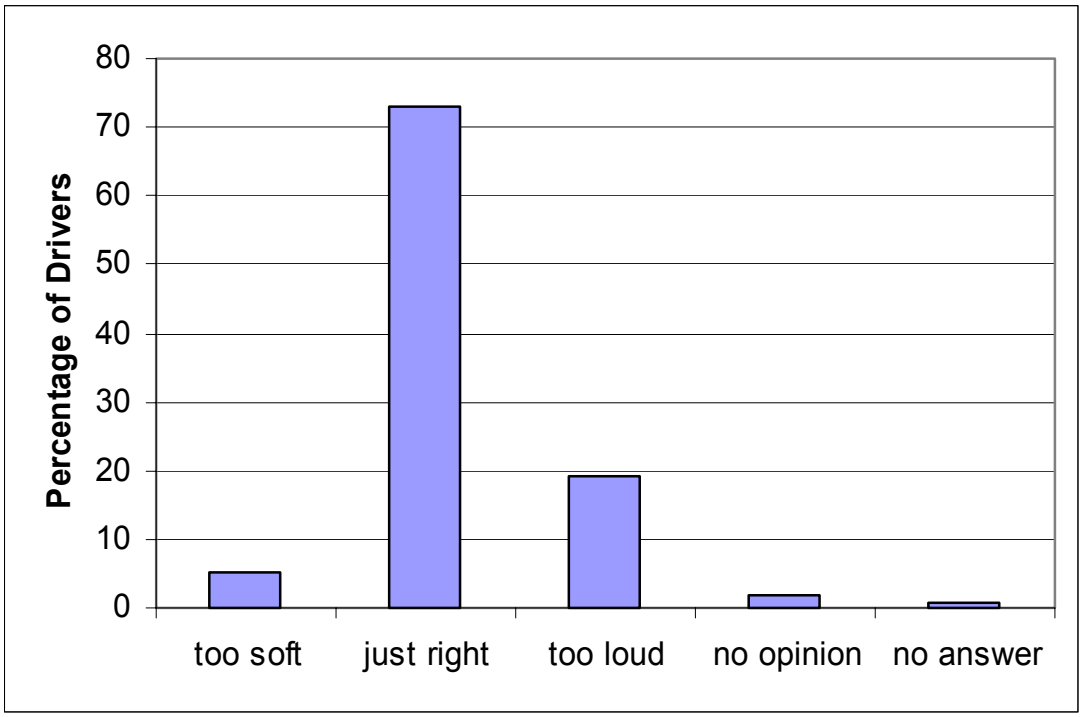


Figure 19: How well can the drivers hear the warning tone?

How is the Quality of the Warning Tone (Q12)?

Approximately 118 drivers responded to this question. Figure 20 presents the distribution of the drivers' responses. Approximately 69.7% said that the quality of the warning tone was just right, but 19.3% said that it was too harsh. Only 3.4% said it was too dull/plain. Approximately 6.7% of the drivers did not have an opinion and 0.9% left this question blank.

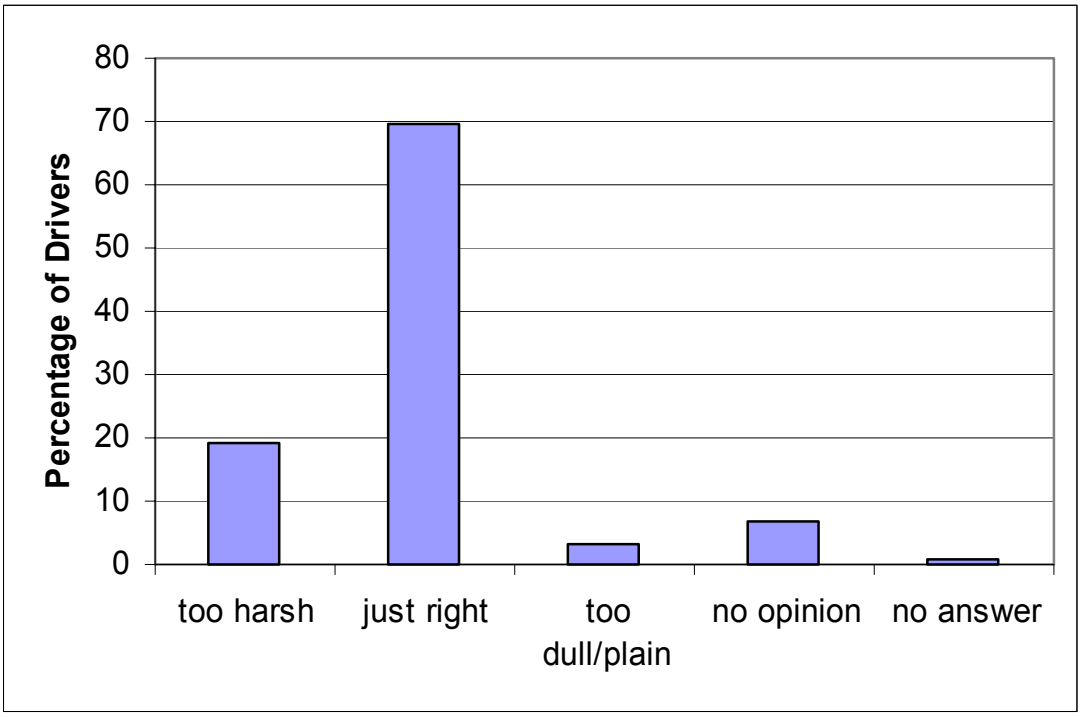


Figure 20: How is the quality of the warning tone?

How is the Length of the Warning Tone (Q13)?

A total number of 118 participants answered this question. Figure 21 presents the distribution of the drivers' responses. Approximately 59.7% said that the length of the warning tone was just right, 23.5% said it was too long, and 3.4% said it was too short. About 12.6% of the drivers did not have an opinion and 0.8% left this question blank.

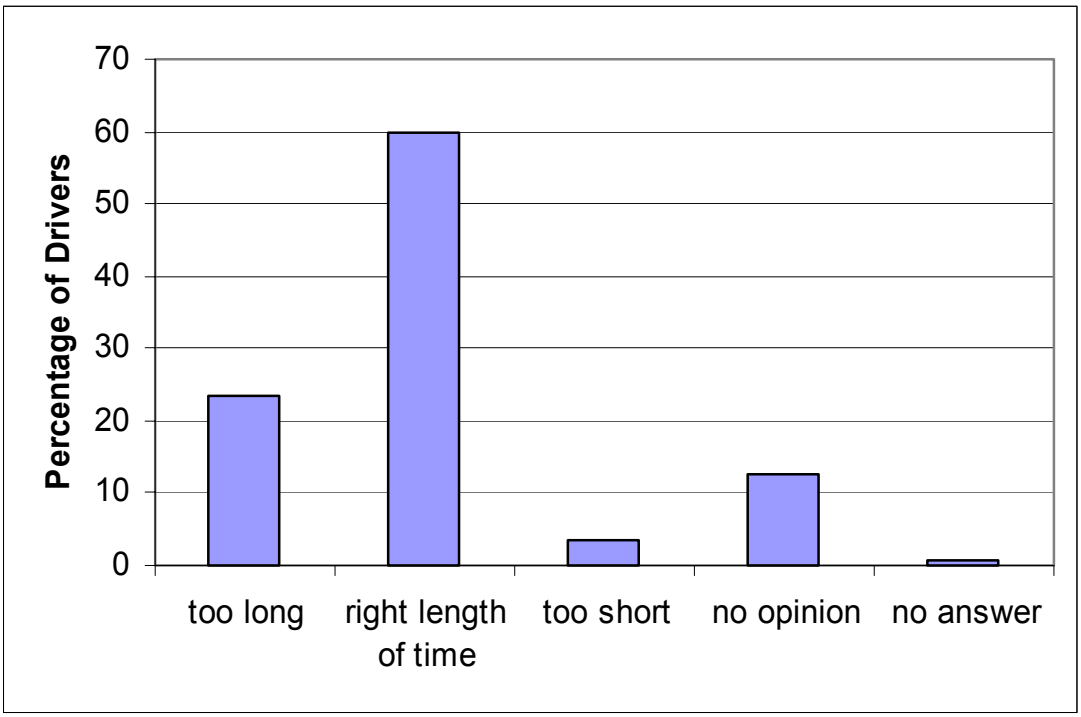


Figure 21: How is the length of the warning tone?

Is the Warning Tone Noticeable from Other Cues You Receive while Driving (Q14)?

A total of 117 drivers responded to this question. Figure 22 presents the distribution of the answers provided by the drivers. A large percent (90.8%) of the drivers said that the warning tone was noticeable compared to the other cues they received while driving, but 2.5% said it was not noticeable. About 5.0% did not have an opinion and 1.7% did not answer this question.

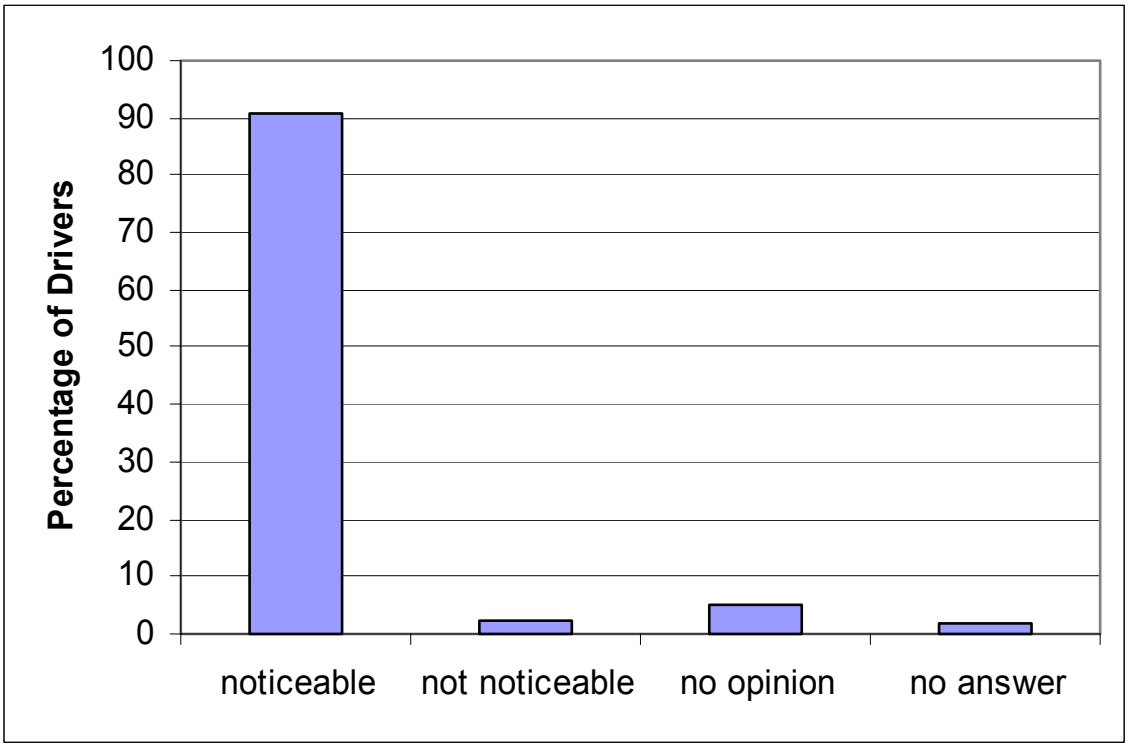


Figure 22: Is the warning tone noticeable from other audible cues you receive while driving?

How Would You Rate the Overall Quality of the Audible Message You Received from Your IVR (Q15)?

A total number of 118 drivers answered this question. Figure 17 also presents the distribution of the drivers' responses for the quality of the audible message. The majority of the drivers (68.1%) found the quality of the audible warning message either good or excellent, 20.2% said it was fair, and a small group (6.7%) of drivers said that it was poor. Approximately 4.2% of the drivers did not have an opinion and 0.8% left this question blank. Figure 17 showed that more drivers in the audible mode rated the quality of the warning message as good or excellent compared to the visual mode. Also, it shows that a very small portion of the audible group had no opinions about the question compared to approximately 25% of drivers in the visual group.

SUGGESTIONS/COMMENTS

The comments drivers made regarding the IVR operation in the visual and audible mode are presented in Table 13.

Table 13: Verbatim of the Drivers' Comments Related the IVR Operation

Visual IVR Related Comments

1. There is too much other distractions to pay attention to, so I hardly notice the IVR and it could be in a better spot so driver can see it without looking away from the road. Just turn it.
2. Bad idea. Get better crossing gates.
3. Not worth having.
4. I think it is waste of money.
5. It would be better if it also beeped.
6. In daytime hours when sun is present it is very hard to read.
7. Visual message is not a good idea.
8. This mechanism is useless. It malfunctions and it is more effective detecting mini-malls.
9. Still goes off in malls parking lots.
10. Some railroad have bushes or shrubs or trees that block view.
11. No good in daytime. Needs sound with visual.
12. Did not notice visual at all. Mostly is a train was coming and the gates were down I would look to the receiver to see if it was working.
13. Goes off even when I am not close to a train crossing.
14. Visual mode is useless, by itself, in daylight. Not noticeable unless you look right at display. Does not attract the eye. Can not say how often it did or did not activate due to above.
15. Visual only sucks.
16. I prefer audio, visual together. I don't always notice the visual mode. Audio gets the attention right away.
17. I have not seen it work (not enough driving time with IVR).
18. The message is good if you don't have a dash with a lot of lights.

19. I have not been in a vehicle long enough to give a really good evaluation.
20. All my no opinion answers are because the only time I heard or seen this unit work is when I start vehicle. Never had it go off because of train.
21. For the test to be meaningful, we should use the crossing at Glenview Road and Chestnut Avenue.
22. During the time when I was driving, I did not witness a train approaching the indicated crossing.
23. I am watching the road, not looking at visual display.
24. Visual only is not very effective. In emergency equipment, it is dangerous for driver to take eyes off road to look display.
25. IVR placement is bad.

Audible IVR Related Comments

1. It is my opinion that the visual combined with the audible warning is most effective.
2. Warning tone signals at odd times.
3. Long train means prolonged signal from IVR. Can be very irritating. Perhaps could change tone or make more intermittent once alarm sounds.
4. The audible cue was more effective than the warning message.
5. Why can't the sending unit be mounted in the train engine instead of many ground mounted stations?
6. The tone scares me when it sounds.
7. Because the cab drivers start the engine many times during the day the device sounds while turning on is unacceptable.
8. Adjust the sound level to match the train movement when train is present softer when train is approaching or leaving the Xing.
9. Why does it have to beep all the time when the train is passing? It is very annoying.
10. IVR is activated at Walgreens, Banks, Stores and shopping malls.
11. Works very well-could save many lives. Was proud to be part of your study.
12. Some IVRs work some don't.
13. It is not additional help.

14. The IVR had many false warning from police radar and alarms.
15. Keep the audible signal. The visual signal is unnecessary once you know what the audible signal is for. Also don't mount the receiver where it blocks the view of the turn signal.
16. I regard the system as useless and generally ignore it. The reasons are: It constantly gives false warnings particularly around Walgreens. Second, it sometimes does not activate when there is actually a train at the equipped crossing I use.
17. Try to create more advanced warning.
18. If it would work, it would be all right.
19. On school days, the noise on the bus would increase and I don't know if the sound on the IVR would be loud enough.
20. It is no good. Gives false signals all the time and sometimes does not work when it should.
21. Placement below the visor puts the IVR in a field of view more accommodating to a driver observing the road. At its present position near the instrument cluster, it is only in view with conscious effort
22. Has only worked the last month or so. It is stupid to have.
23. At Chestnut and Lehigh. When gates were down and train coming but no warning. Happened twice.
24. This thing is another example of a waste of tax payers money.
25. Too many false alarms. I rarely use crossings in the study, yet the stupid receiver goes off all the time at Jewel/Osco, driving past Walgreen's, parked in front of Club hotel. Can't stand the stupid receiver going off every time I start the vehicle. It is extremely annoying, defeats the purpose as one learns to ignore the signal to preserve sanity.
26. Except for all the false alarms at numerous shopping centers, it is a great idea and could be very effective if they work the bugs out.

CONCLUSIONS

About 46.2% of the drivers considered the effectiveness of the IVR high or very high, while 24.1% rated it low or very low. The average effectiveness rating for the IVR is much less than the average ratings for the active warning devices. This is partially due to the fact that the IVR was not the primary warning device. It was supplementary to the active warning devices that were present at the crossings.

The audible and visual groups gave similar average effectiveness ratings to all of the warning devices except the flashing lights, clanging bell, and IVR. The audible group gave significantly higher ratings to the clanging bell and the IVR than the visual group, with 95% confidence. Similarly, with slightly less confidence (93%), the audible group gave a significantly higher rating to the flashing lights than the visual group. The IVR average effectiveness rating from the audible group was 3.8, significantly higher than 2.7 from the visual group. The visual warning message from the visual IVR was not as effective in attracting attention of the drivers as the beeping sound from the audible IVR. This is reflected in its effectiveness rating. It is interesting to note that, the visual group previously drove vehicles that were equipped with the audible IVR. It appears that drivers were accustomed to listening to instead of looking at the IVR message.

With 95% confidence, the effectiveness rating for the audible mode of IVR was significantly higher than that of the advance warning and the crossbuck signs, similar to that of the train horn, and lower than that of the flashing lights, the crossing gate, and the clanging bell. With 95% confidence, the effectiveness rating for the visual IVR was significantly lower than that of all other warning devices, except the advance warning sign. The effectiveness rating of the visual IVR was similar to that of the advance warning sign.

A significantly higher proportion of the audible group (71.5%) compared to the visual group (46.7%) trusted the IVR to give an accurate warning of a train approaching/occupying the equipped crossings. Likewise, a higher proportion of the drivers in the visual group did not trust the IVR. A comparison of the responses given by the drivers operating an IVR in the audible and visual modes shows that the audible group was over represented in no power-on problems category, while the visual group was over-represented in the no opinion category.

On the average, a false alert rate of 3.7 in three months (the range 0 to 60) was reported, but the false alert rate was significantly higher for audible group (4.4 times in three months) compared to the visual group (2.1 times in three months). The false alert figures the drivers gave in the survey are generally lower than what was reported in the focus group meetings and in driver training/orientation sessions. Drivers stated that the IVR failed to give a warning when a train was approaching/occupying the equipped crossings on average of 1.1 times in three months. The missed alert rate was significantly higher for the audible group (1.4 times in three months) compared to the visual group (0.3 times in three months). These missed alerts were never reported.

The drivers in general were satisfied with the quality of the message from their IVR. Among the visual group, 33.8% of the drivers rated the overall quality of the visual message as excellent or good, 21.6% said it was fair, 14.9% said it was poor, 24.3% did not have an opinion, and 5.4% did not respond. Among the audible group, 68.1% rated the overall quality of the audible message excellent or good, 20.2% said it was fair, 6.7% said it was poor, 4.2% did not have an opinion, 0.8 % did not respond. More drivers in the audible mode rated the quality of the warning message as good or excellent than the visual mode. Also a very small portion of the audible group had no opinions about the question compared to approximately 25% of the drivers in the visual group. About one-fifth to one-quarter of drivers in the audible group said either the tone was too loud, too harsh or piercing, or it beeped too long.

REFERENCES

1. Aycin, M. F. and Benekohal, R. F. "Performance Evaluation of the Pilot Study of Advisory On-board Vehicle Warning Systems at Railroad Grade Crossings", Report No, FHWA-IL/UI-TOL-4, May 20, 2002, University of Illinois at Urbana-Champaign.

2. Benekohal, R.F. and Aycin, M. F. "Analyses of Drivers' Opinions about Railroad Grade Crossings Traffic Control Devices and Safety: Background Survey", Report No, FHWA-IL/UI-TOL-10, March 2004, University of Illinois at Urbana-Champaign.

3. Benekohal, R.F. and Rawls, C. G., "Analyses of the Drivers' Responses to the In-Vehicle Receiver (IVR) After Experiencing One Mode of Operation", Report No, FHWA-IL/UI-TOL-11, March 2004, University of Illinois at Urbana-Champaign.

4. Benekohal, R.F. and Rawls, C. G., "Analyses of the Drivers' Responses in Final Surveys to the In-Vehicle Receiver (IVR), FHWA-IL/UI-TOL-13, March 2004, University of Illinois at Urbana-Champaign.

Appendix A

VISUAL MODE ONLY

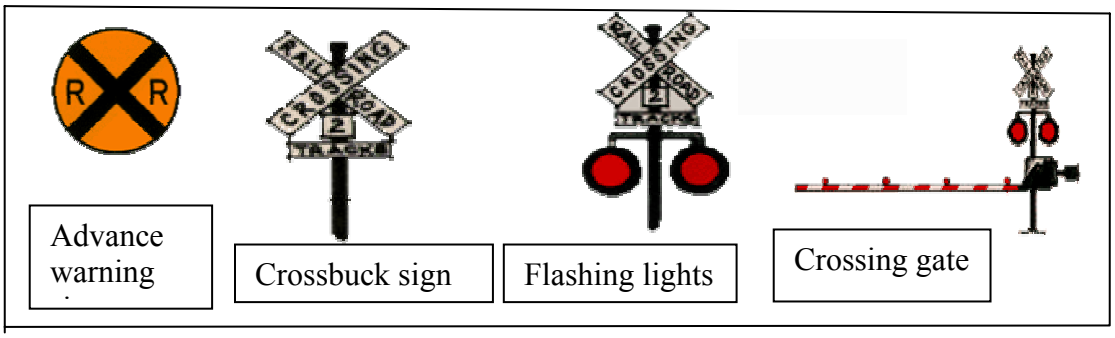
Survey of Professional Drivers' Opinions for Pilot Study of
Advisory On-Board Vehicle Warning Systems at Railroad Grade Crossings

Instructions: The University of Illinois at Urbana-Champaign is conducting this survey for IDOT. Your responses will be kept confidential. This survey covers the time period your In-Vehicle Receiver was operating in VISUAL mode only. *PLEASE COMPLETE AND RETURN IN THE ENCLOSED ENVELOPE.* ***THANK YOU FOR YOUR HELP****.*

1) In the year 2000, how long have you driven a vehicle with the In-Vehicle Receiver?
   a) 1 month b) 2 months c) 3 months 4) Others (specify)_____months

2) 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/week
b)	Glenview	Chestnut Street/Lehigh Ave	No	Yes	_____ Times/week
c)	Northbrook	Shermer Road	No	Yes	_____ Times/week
d)	Northbrook	Dundee Road (near Waukegan Rd)	No	Yes	_____ Times/week
e)	Deerfield	Greenwood Ave/ Park Ave	No	Yes	_____ Times/week



3) For the above five crossings, 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)	Crossing gate	5	4	3	2	1	0
e)	Clanging bell	5	4	3	2	1	0
f)	Train horn	5	4	3	2	1	0
g)	In-Vehicle Receiver	5	4	3	2	1	0

4) Do you trust your In-Vehicle Receiver to give an accurate warning of a train approaching or occupying the equipped crossings in Question 2?

a) Yes, I trust it very much
b) Yes, I trust it to some degree
c) No, I do not trust it
d) Don't recall/No opinion

5) In the past 3 months that your In-Vehicle Receiver (IVR) was operating in VISUAL mode, have you experienced any problems with the IVR powering on properly?

a) No b) Don't recall/No opinion c) Yes, how many times did this occur?_____

6) In the past 3 months that your In-Vehicle Receiver (IVR) was operating in VISUAL mode, how many times has your IVR given you a warning when a train WAS NOT approaching or occupying the equipped crossings in Question 2?

a) _____ Times b) Don't recall/No opinion

7) In the past 3 months that your In-Vehicle Receiver (IVR) was operating in VISUAL mode, how many times has your IVR failed to give you a warning when a train WAS approaching or occupying the equipped crossings in Question 2?

a) _____ Times b) Don't recall/No opinion

8) In the past 3 months that your In-Vehicle Receiver (IVR) was operating in VISUAL mode, what percentage of the time has your IVR provided you a warning when a train WAS approaching or occupying the equipped crossings in Question 2?

a) _____ Percent of the time b) Don't recall/No opinion

9) In the past 3 months that your In-Vehicle Receiver (IVR) was operating in VISUAL mode, has the IVR given you a signal that you did not understand?

a) No b) Don't recall/No opinion
c) Yes, how many times?_____ Please describe the nature of the signal._____
_____
_____
_____

10) From the following list of visual distractions, please circle ALL that apply to your daily driving conditions:

a) Visual distractions from passengers
b) Exterior light sources
c) Interior warning lights
d) Other (please specify) _____

Visual warnings from the In-Vehicle Receiver

11V) During daytime and nighttime, how well can you see the **visual** display (the flashing message) on the In-Vehicle Receiver?

Daytime	Nighttime
a) Too dim	a) Too dim
b) Just right	b) Just right
c) Too bright	c) Too bright
d) No opinion	d) No opinion

12V) Is the size of the lettering for the warning message on the visual display easy to read?

a) Yes, easily readable
b) No, lettering too small
c) No, lettering too big
d) No opinion

13V) How does the blinking rate of the warning message affect readability?

a) Blinks too fast
b) Blinks at right speed
c) Blinks too slow
d) No opinion

14V) Is the color of the visual warning message easily noticed?

a) Yes b) No, it should use the color _____ instead c) No opinion

15V) Overall, is the visual warning message noticeable from other visual cues you receive while driving?

a) Yes, visual warning is noticeable b) No, visual warning is not noticeable c) No opinion

16V) How would you rate the overall quality of the visual message you received from your In-Vehicle Receiver?

a) Excellent b) Good c) Fair d) Poor e) No opinion

17V) Do you have any comments/suggestions_____

_____
_____
_____
_____
_____
_____
_____
_____
_____

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Please mail to:

Professor R. F. Benekohal
University of Illinois at Urbana-Champaign
205 N. Mathews Ave.
Urbana, Illinois 61801

AUDIBLE MODE ONLY

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

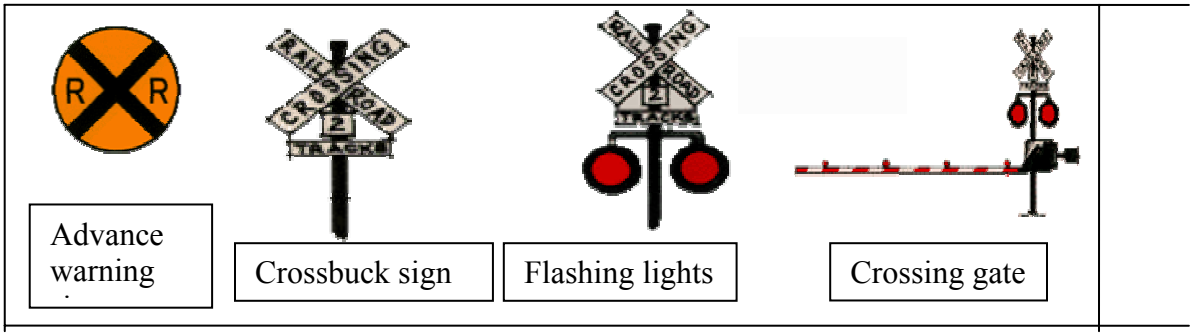
Instructions: The University of Illinois at Urbana-Champaign is conducting this survey for IDOT. Your responses will be kept confidential. This survey covers the time period your In-Vehicle Receiver was operating in **AUDIBLE** mode only. *PLEASE COMPLETE AND RETURN IN THE ENCLOSED ENVELOPE.* ***THANK YOU FOR YOUR HELP.***

1) In the year 2000, how long have you driven a vehicle with the In-Vehicle Receiver?

a) 1 month b) 2 months c) 3 months 4) Others (specify)_____months

2) 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/week
b)	Glenview	Chestnut Street/Lehigh Ave	No	Yes	_____ Times/week
c)	Northbrook	Shermer Road	No	Yes	_____ Times/week
d)	Northbrook	Dundee Road (near Waukegan Rd)	No	Yes	_____ Times/week
e)	Deerfield	Greenwood Ave/ Park Ave	No	Yes	_____ Times/week



3) For the above five crossings, 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)	Crossing gate	5	4	3	2	1	0
e)	Clanging bell	5	4	3	2	1	0
f)	Train horn	5	4	3	2	1	0
g)	In-Vehicle Receiver	5	4	3	2	1	0

4) Do you trust your In-Vehicle Receiver to give an accurate warning of a train approaching or occupying the equipped crossings in Question 2?

a) Yes, I trust it very much
b) Yes, I trust it to some degree
c) No, I do not trust it
d) Don't recall/No opinion

5) In the past 3 months that your In-Vehicle Receiver (IVR) was operating in AUDIBLE mode, have you experienced any problems with the IVR powering on properly?

a) No b) Don't recall/No opinion c) Yes, how many times did this occur?_____

6) In the past 3 months that your In-Vehicle Receiver (IVR) was operating in AUDIBLE mode, how many times has your IVR given you a warning when a train WAS NOT approaching or occupying the equipped crossings in Question 2?

a) _____ Times b) Don't recall/No opinion

7) In the past 3 months that your In-Vehicle Receiver (IVR) was operating in AUDIBLE mode, how many times has your IVR failed to give you a warning when a train WAS approaching or occupying the equipped crossings in Question 2?

a) _____ Times b) Don't recall/No opinion

8) In the past 3 months that your In-Vehicle Receiver (IVR) was operating in AUDIBLE mode, what percentage of the time has your IVR provided you a warning when a train WAS approaching or occupying the equipped crossings in Question 2?

a) _____ Percent of the time b) Don't recall/No opinion

9) In the past 3 months that your In-Vehicle Receiver (IVR) was operating in AUDIBLE mode, has the IVR given you a signal that you did not understand?

a) No b) Don't recall/No opinion
c) Yes, how many times?_____ Please describe the nature of the signal._____
_____
_____
_____

10) From the following list of audible distractions, please circle ALL that apply to your daily driving conditions:
a) Background noise from radio/tape
b) Background noise from passengers
c) Sirens/horns
d) Loud engine
e) Other (please specify) _____

Audible Warnings from the In-Vehicle Receiver

11A) How well can you hear the warning tone (beeping sounds) from the In-Vehicle Receiver?

a) Too soft
b) Just right
c) Too loud
d) No opinion

12A) How is the quality of the warning tone?

a) Too harsh/piercing
b) Just right
c) Too dull/plain
d) No opinion

13A) How is the length of the warning tone?

a) Beeps too long
b) Beeps right length of time
c) Beeps too short
d) No opinion

14A) Overall, is the warning tone noticeable from other audible cues you receive while driving?

a) Yes - the warning tone is noticeable
b) No - the warning tone is not noticeable
c) No opinion

15A) How would you rate the overall quality of the audible message you received from your In-Vehicle Receiver?

a) Excellent b) Good c) Fair d) Poor e) No opinion

16A) Do you have any comments/suggestions_____

_____
_____
_____
_____
_____
_____
_____
_____

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Please mail to:

Professor R. F. Benekohal
University of Illinois at Urbana-Champaign
205 N. Mathews Ave.
Urbana, Illinois 61801