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**Analyses of the Drivers' Responses in Final Surveys  
to the In-Vehicle Receiver (IVR)**

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

A study conducted by:  
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<p>The drivers who received a combined audible and visual message (combination group) responded that the average effectiveness rating of the IVR was 3.6 using a 5.0 scale. This was higher than the 2.5 rating from the drivers who received only a visual message throughout the study (visual-plus group). The combination group gave the IVR a rating that was similar to the clanging bell and the train horn, lower than the ratings for the crossing gate and flashing lights, but higher than the ratings for the advance warning and crossbuck signs. The visual-plus group gave IVR a rating that was similar to the advance warning sign, but was lower than the ratings of the other warning devices. About 61% of the combination group trusted the IVR to give an accurate warning of a train presence compared to 33% for the visual-plus group.</p> <p>For participating drivers who had experience with the audible, visual, and combination modes, the IVR had a high or very high ability to attract the attention of 71.0% using the audible mode, 26.7% using the visual mode, and 77.2% using the combination mode. Approximately 54.9% of the drivers preferred the combination mode, 20.1% of the drivers preferred the audible mode, and 3.7% preferred the visual mode. About 58.5% of the drivers indicated that none of the warning methods was a significant distraction while driving. However, the IVR distracted 7.3% of the drivers in the combination mode, 4.9% in the visual mode, and 15.2% in the audible mode.</p> <p>Overall, 47.1% of the drivers were in favor of the IDOT installing IVR systems at more railroad crossings, while 31.1% were not, and about 21.8% did not have an opinion or did not answer this question. Given a choice, 44.7% of the drivers said they would continue to use the IVR, 42.2% said they would not, and 12.7% gave no opinion.</p>					
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The contents of this report reflect the views of the authors who were responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Illinois Department of Transportation. This report does not constitute a standard, specification, or regulation.

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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 nine 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. The results of three surveys conducted, one before the system was installed, one after three months, and the third one after six months of operation, are discussed in separate reports (1, 2, and 3). More details on the system performance are given in another report (4). The system design was composed of a trackside transmitter assembly (TTA) and the in-vehicle receiver (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 the 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: Central Business District
- 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 proximity to the study area and number of movements their drivers made 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 Illinois Department of Transportation (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 location 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.

Questionnaires were used to obtain drivers' perceptions of the advisory warning system. Four surveys were 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 was conducted before the IVR system was operational. It gathered background information such as age, work experience, driving history and experience, and perception of existing railroad crossing devices. Surveys 2 and 3 were conducted after three and six months of experiencing the IVR in operation. The final survey was conducted about nine months after the IVR system was deployed. Copies of the final questionnaires are given in Appendix A.

The final survey consisted of two different questionnaires. It was the fourth survey for the drivers of the vehicles that had the IVR in the combination mode. This survey is referred to as Survey 4 or Combination Survey. It was the second survey for the drivers that had the IVR in the visual mode during the entire study period. This survey is referred to as Visual-Plus Survey. The visual-plus group at most completed one baseline survey and one survey at the end of the study period. Some of the questions in the combination and visual-plus surveys were identical. Thus, the responses analyzed in this report are coming from one group of the drivers that had the IVR in the combination mode and the other group that had the IVR in the visual mode throughout the study period.

A total of 371 drivers participated in the final surveys, with 266 using the combination and 105 using the visual-plus IVR mode. The surveys from the drivers that had less than one month and more than 36 months driving experience with the IVR were not used in the analysis. Also, the surveys from the drivers who did not cross any of the five railroad crossings (drivers who reported 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 one month experience with the IVR device, or who did not cross any of the crossings, did not have adequate experience with the IVR system. The remaining 244 surveys comprised of 164 in the combination and 80 in the visual-plus modes are analyzed in this section. The results for the common questions in the combination and visual-plus surveys are presented together unless there was a significant difference between the responses of the two groups. When the difference was significant, the results are reported for each group separately.

## STATISTICAL ANALYSES

### Q1. In the year 2000, how long have you driven a vehicle with the IVR?

The total number of drivers who responded to this question was 244, 164 with the IVR in the combination mode and 80 in the visual-plus mode. On the average, they drove an IVR-equipped vehicle for 6.3 months. The responses on the average number of months that the drivers had the IVR were significantly different for the visual-plus and the combination groups. The distribution of the number of months that the participants had the IVR is shown in Figure 1. Approximately 7.9% of the drivers had the IVR in the combination mode for one month, compared to 5.0% of the drivers with the visual-plus mode. More than 90% of the drivers had the IVR for a period up to 12 months for both the visual and combination modes. The average number of months the drivers had the IVR was 5.7 months for the combination and 7.5 months for the visual-plus group.

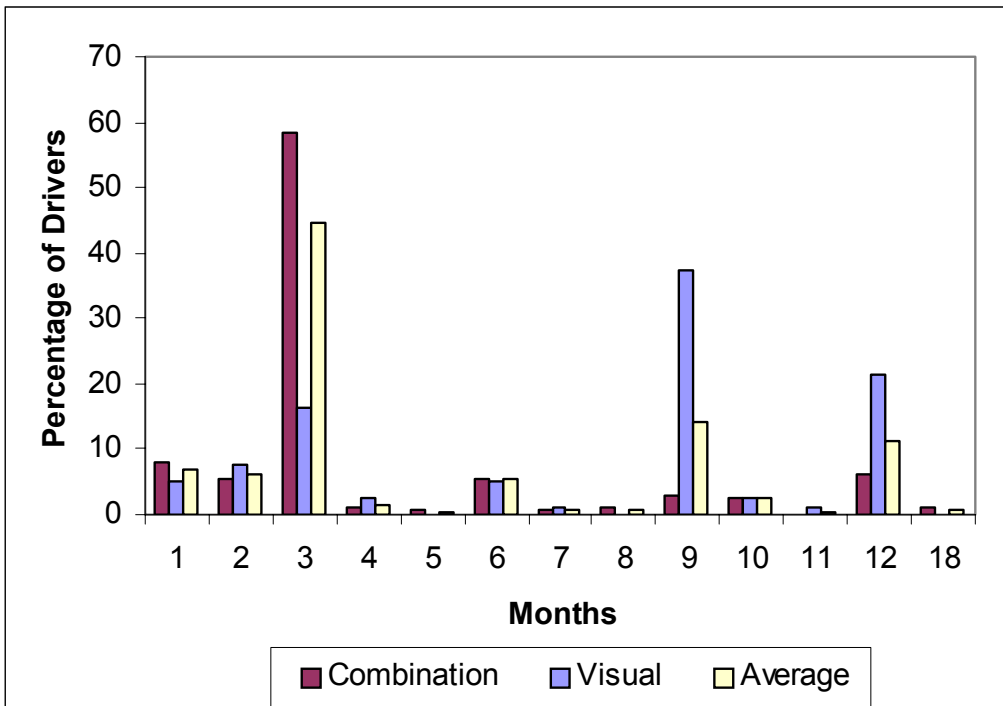


Figure 1: In the year 2000, how long have you driven a vehicle with the IVR?



**Q2. Do you use any of the following railroad crossings?**

The responses to this question came from 202 drivers who used at least one of the crossings. The participants were asked to state the frequency of usage of the five grade crossings. The percentage of drivers who used each of the crossings is given in Table 1. The crossing used by the highest number of participants was Dundee Road (52.9%), followed by Shermer Road (45.5%), Chestnut Street (29.5%), and Greenwood Avenue (24.6%). The crossing used by the least number of the participants was Beckwith Road, where only 13.5% of the participants traversed it. The percentage of drivers who did not use at least one of the crossings varied from 11.5% to 26.2%. A large portion of the respondents (35.7% - 60.2%) did not answer this question.

**Table 1: Percentage of drivers that crossed railroad grade crossings in the study.**

<b>Jurisdiction</b>	<b>Crossing</b>	<b>No (%)</b>	<b>Yes (%)</b>	<b>No Response (%)</b>
Morton Grove	Beckwith Road	26.2	13.5	60.2
Glenview	Chestnut Street	18.0	29.5	52.5
Northbrook	Shermer Road	14.3	45.5	40.2
Northbrook	Dundee Road	11.5	52.9	35.7
Deerfield	Greenwood Ave.	20.1	24.6	55.3

Not all the participants used all the crossings. About 2.9% of the drivers used all five crossings, 5.4% used only four, 11.5% used only three, and 46.3% used only two out of the five crossings. Thus, about 66.1% of the drivers used at least two of the crossings, 19.8% used at least three of the crossings, and 8.3% used at least four of the crossings. Table 2 presents the percentage of participants that used the crossings.

Table 2: Percentage of drivers utilizing crossings in the study					
	Drivers who cross:				
	all 5 crossings	only 4	3	2	at least 1
Percentage (frequency)	2.9% (7)	5.4% (13)	11.5% (28)	46.3% (113)	100.0% (244)

**Beckwith Road in Morton Grove:** A total of 33 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 6.2 times per week. The average responses obtained from the drivers in the combination and visual-plus groups were significantly different with a significance level of 0.05. None of the drivers in the visual-plus group ever crossed Beckwith Road. Approximately 42.4% of the drivers using the combination mode crossed Beckwith Road no more than two times per week. About 90.9% of the participants using the combination mode crossed Beckwith Road no more than 10 times per week. The maximum usage reported was 30 times per week.

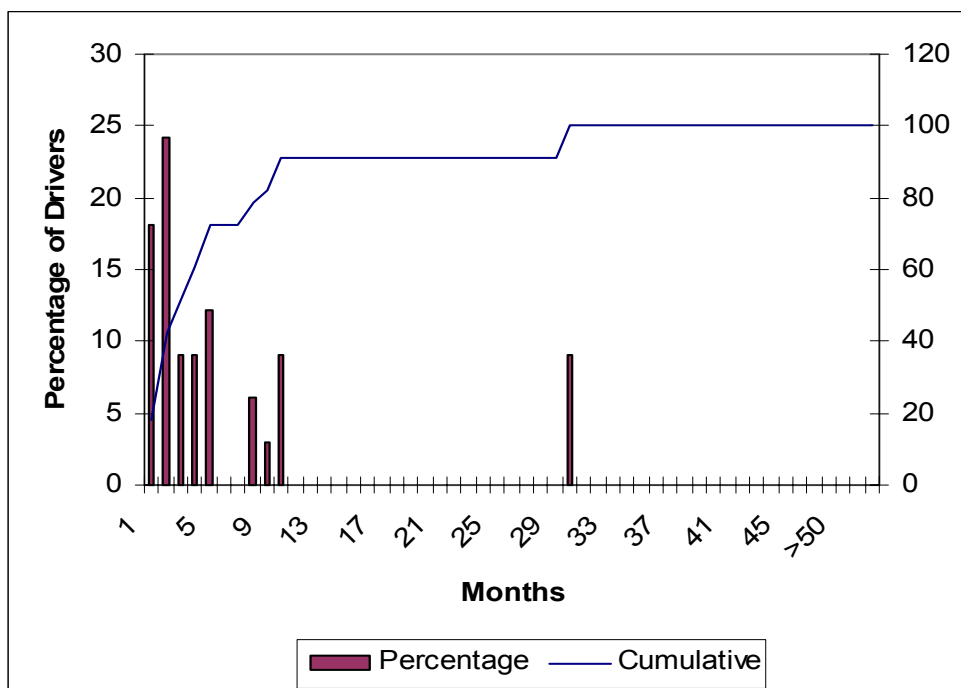


Figure 2: Distribution of number of times the drivers crossed the Beckwith Road crossing.

**Chestnut Street in Glenview:** A total of 72 drivers reported using the Chestnut Street crossing, 71 were in combination and one in the visual-plus group. Figure 3 shows the frequency of usage the crossing by the drivers. On the average, the drivers used this location 5.4 times per week. Approximately 28.2% of the drivers using the combination mode crossed Chestnut Street one time while over 90% crossed no more than 10 times per week. On the average for the combination mode, the participants crossed Chestnut Street 5.4 times a week. The maximum usage reported for this crossing was 80 times per week. The driver in the visual-plus group used the crossing once per week.

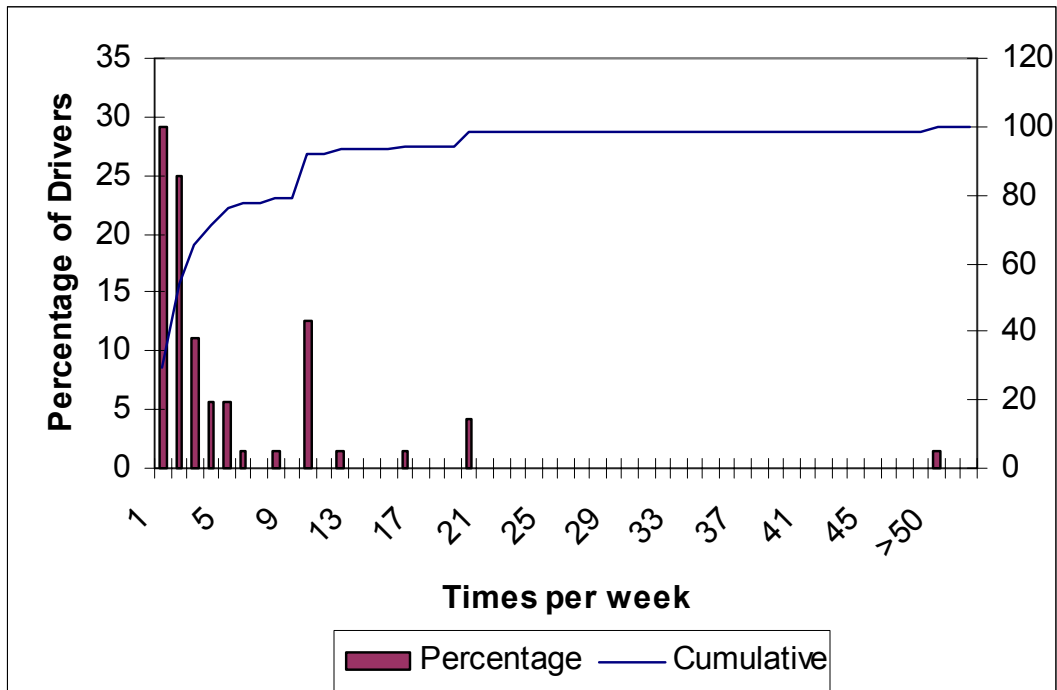


Figure 3: Distribution of number of times the drivers crossed the Chestnut Street crossing.

**Shermer Road in Northbrook:** A total of 111 drivers reported using the Shermer Road crossing, 55 were in the combination and 56 in the visual-plus group. Figure 4 shows the frequency of usage of the crossing by the drivers. On the average, the drivers used this location 9.2 times per week. The average responses obtained from the drivers in the combination and the visual-plus groups were significantly different with a significance level of 0.05. The percentage of the drivers who used this crossing no more than two times

per week totaled 29.1% for the combination and 19.6% for the visual-plus group. We wanted to get an idea on the frequency a great majority of drivers (say 90%) used this crossing. About 92.7% of the drivers using the combination group crossed this location no more than 10 times per week. In contrast, about 91.1% of the drivers in the visual plus group used this location up to 30 times per week. The maximum usage numbers reported for this crossing were 48 times per week for the combination and 100 times per week for the visual-plus.

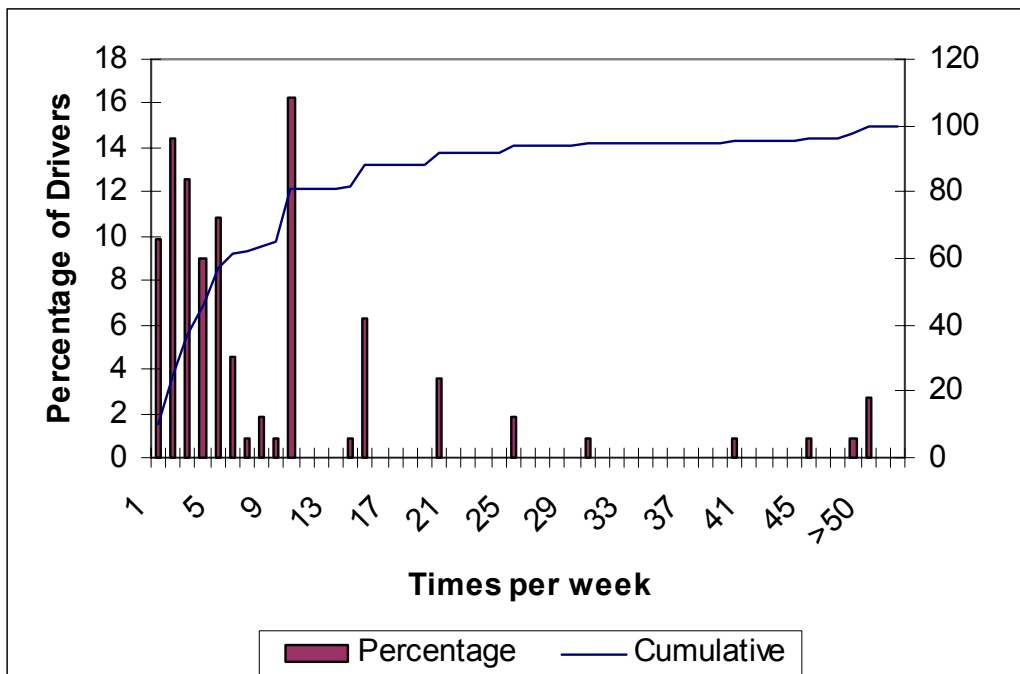


Figure 4: Distribution of number of times the drivers crossed the Shermer Road crossing.

**Dundee Road in Northbrook:** A total of 129 drivers reported using the Dundee Road crossing. Figure 5 shows the frequency of usage of the crossing by the drivers. On the average, the drivers used this location 17.2 times per week. The percentage of the drivers who used this crossing up to two times per week was 17.9%. The average number of times that the participants used this crossing was not significantly different for both modes at a significance level of 0.05. About 92.4% of the drivers used this location no more than 20

times per week. The maximum usage reported for this crossing was 940 times per week, which does not seem reasonable.

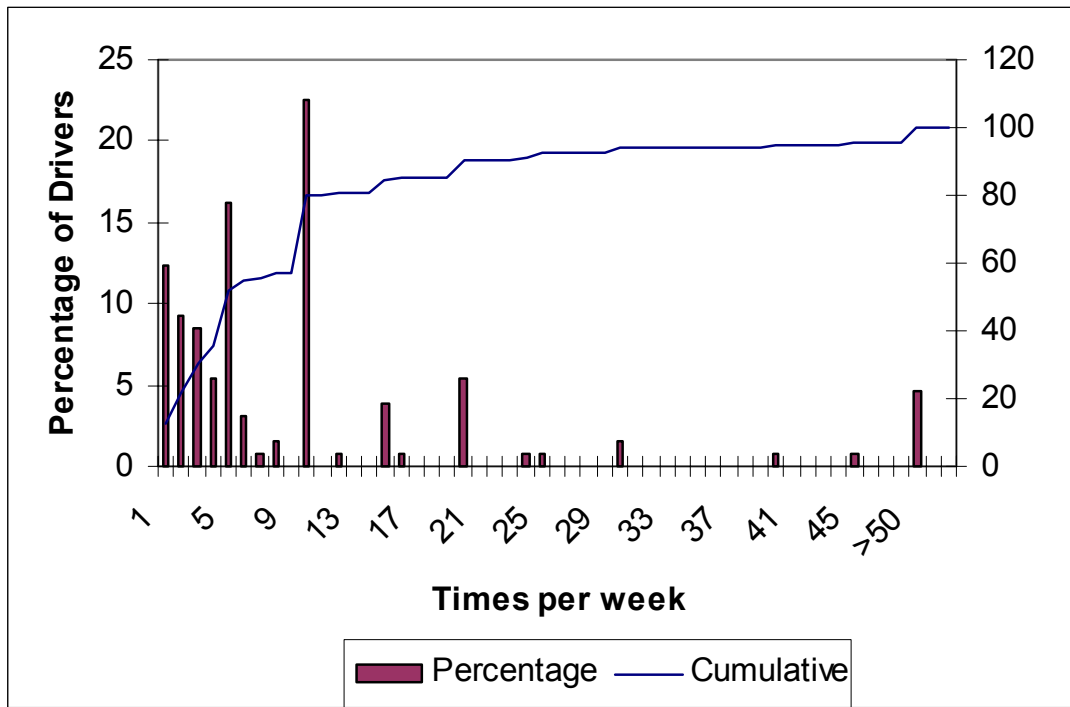


Figure 5: Distribution of number of times the drivers crossed the Dundee Road crossing.

**Greenwood Avenue in Deerfield:** A total of 60 drivers reported using the Greenwood Avenue crossing. Figure 6 shows the frequency of usage of the crossing by the drivers. On the average, the drivers used this location 4.6 times per week. The average number of times that the participants used this crossing was not significantly different for both modes at a significant level of 0.05. The percentage of the drivers who used this crossing no more than two times per week was 30.2%. About 90.8% of the drivers used this location no more than 8 times per week. The maximum usage reported for this crossing was 30 times per week.

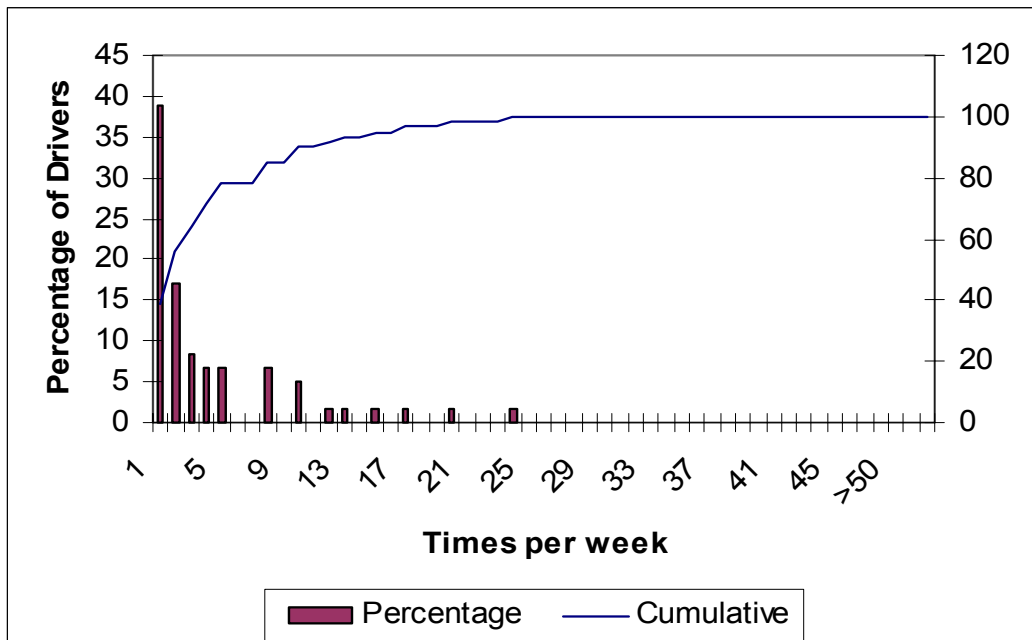


Figure 6: Distribution of number of times the drivers crossed the Greenwood Avenue crossing.

### Q3. Rate the effectiveness of the railroad crossing warning devices (IVR)

The number of drivers who answered this question varied from 222 to 241 depending on the type of 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). The results showed that the crossing gate is perceived as the most effective warning device. As shown in Table 3, about 80.6% of the drivers rated its effectiveness as “very high”. Approximately 41.8% of the drivers said that the effectiveness of the flashing lights was “very high”. The effectiveness of the train horn and clanging bell were rated as “very high” by 33.3% and 32.5%, respectively. Approximately 20.7% of the drivers rated the effectiveness of the IVR “very high”. The effectiveness of the crossbuck sign and the advance warning sign were rated “very high” by 9.3% and 8.0% of the drivers, respectively. The distributions of the effectiveness ratings are given in Figure 7 and in Table 3 for drivers who had either the combination mode or the visual-plus mode of IVR. Tables 3a and 3b show the distribution of the responses for each mode. In

the following section they will be analyzed separately. The data shows that the crossing gate was considered highly effective by a large majority of the drivers.

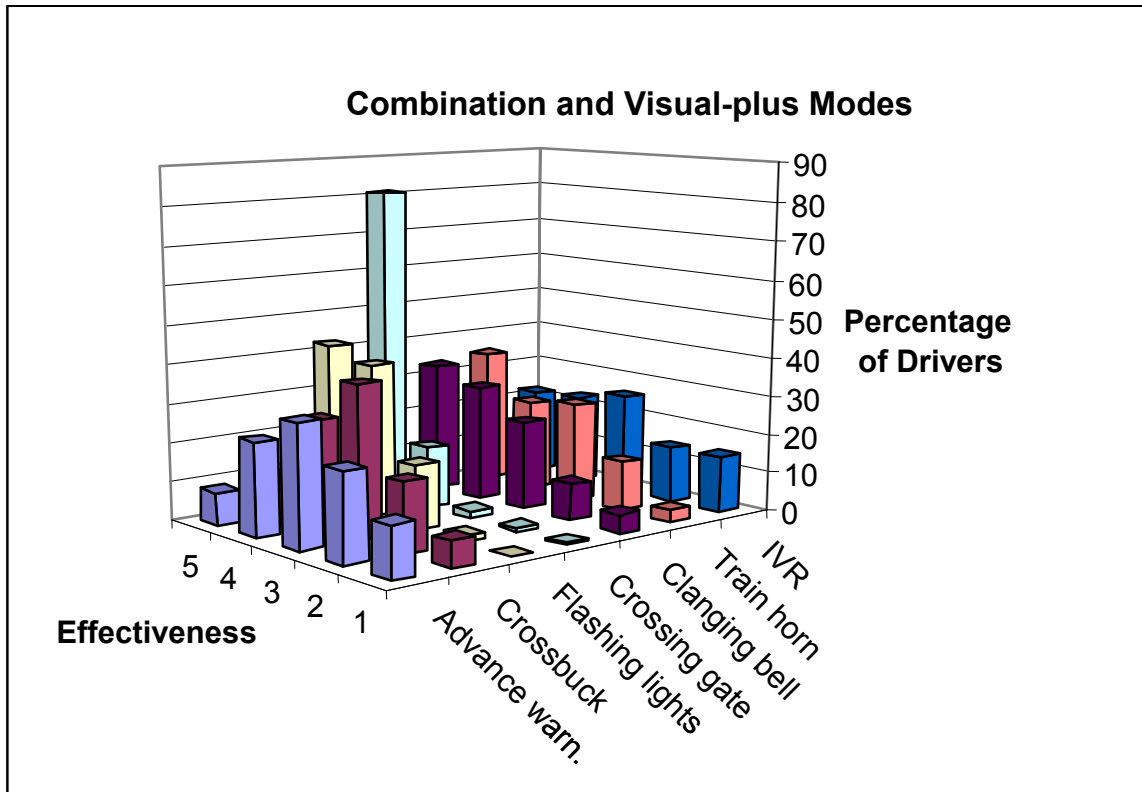


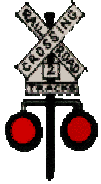
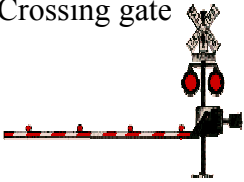





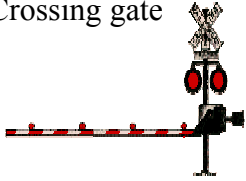
Figure 7: Percentage of all the drivers (combination and visual plus groups combined) who participated in the survey, rating effectiveness of each railroad warning device.

The average effectiveness of each device is given in Table 3. The highest score is 5. The average effectiveness score indicated that the effectiveness of the crossing gate was the highest followed by the flashing lights, the clanging bell, the train horn, the IVR, the crossbuck sign, and lastly, the advance warning sign. The average effectiveness rating for the IVR was “medium”. The effectiveness of the IVR was rated “very high” by 20.7%, “high” by 21.4% and medium by 23.9%. About 13.4% and 13.9% rated its effectiveness “low” and “very low”, respectively, while 6.7% had no opinions on its effectiveness. In Table 3, the no opinion group for the IVR was the largest of all the warning devices. Thus, over 42% of the drivers considered the effectiveness of the IVR high or very high,




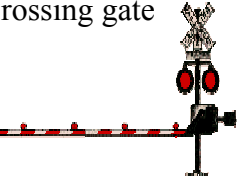
Table 3: Device effectiveness selected by the percentage of participants								
Warning Signs	No opinion	Effectiveness						No. of drivers
		Very Low	Low	Medium	High	Very High	Average	
Advance warning sign 	3.8	12.7	21.9	30.4	23.2	8.0	2.9	228
Crossbuck sign 	3.8	6.4	16.9	37.3	26.3	9.3	3.2	227
Flashing lights 	1.3	0.0	1.7	16.3	38.9	41.8	4.2	236
Crossing gate 	0.4	0.4	0.8	2.1	15.7	80.6	4.8	241
Clanging Bell	2.1	4.6	9.3	22.4	29.1	32.5	3.8	232
Train Horn	4.3	3.0	12.4	24.4	22.6	33.3	3.7	224
IVR	6.7	13.9	13.4	23.9	21.4	20.7	3.2	222



**Table 3a: Percentage of drivers and ratings of effectiveness of warning devices for COMBINATION mode**

Warning Device	No opinion	Effectiveness						No. of drivers
		1	2	3	4	5	Average	
Advance warning sign 	2.5	10.7	17.6	28.9	30.2	10.1	3.1	155
Crossbuck sign 	3.8	6.4	13.5	34.0	29.5	12.8	3.3	150
Flashing lights 	1.3	0.0	2.5	11.3	37.7	47.2	4.3	157
Crossing gate 	0.6	0.0	1.2	1.9	18.5	77.8	4.7	161
Clanging Bell	2.5	5.7	6.4	20.4	31.8	33.2	3.8	153
Train Horn	4.5	3.2	11.7	26.0	19.5	35.1	3.7	147
IVR	5.7	6.3	12.0	22.2	26.6	27.2	3.6	149

**Table 3b: Percentage of drivers and ratings of effectiveness of warning devices for VISUAL-PLUS mode**

Warning Device	No opinion	Effectiveness						No. of drivers
		1	2	3	4	5	Average	
Advance warning sign 	6.4	16.7	30.8	33.3	9.0	3.8	2.5	73
Crossbuck sign 	3.8	6.3	23.8	43.8	20.0	2.5	2.9	77
Flashing lights 	1.3	0.0	0.0	26.3	41.3	31.3	4.1	79
Crossing gate 	0.0	1.3	0.0	2.5	10.0	86.3	4.8	80
Clanging Bell	1.3	2.5	15.0	26.3	23.8	31.3	3.7	79
Train Horn	3.8	2.5	13.8	21.3	28.8	30.0	3.7	77
IVR	8.8	28.8	16.3	27.5	11.3	7.5	2.5	73

while over 27% 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.

A comparison between the effectiveness of the IVR to the other warning devices was conducted using the responses from 198 individuals who provided a rating for all of the warning devices. Some of these drivers belonged to the visual-plus and the others to the combination groups. When the responses from these two groups were combined, with a confidence level of 95%, the devices that were significantly different from the IVR were the advance warning sign, the flashing lights, the crossing gate, the clanging bell, and the train horn. For the two combined groups, the effectiveness ratings for the crossbuck sign and IVR was not significantly different. These results are presented in Table 4 along with the mean differences between the devices, the standard deviations, the t-distribution values and its respective probabilities. The ratings for each mode are analyzed in the next section.

<b>Table 4: T-Test results for a sample of 198 drivers</b>				
<b>Difference</b>	<b>Mean difference</b>	<b>Standard Deviation</b>	<b>T</b>	<b>Prob. T</b>
Advance Warning – IVR	-0.32	1.51	-3.04	0.0025
Crossbuck Sign – IVR	-0.06	1.50	-0.57	0.5695
Flashing Lights – IVR	1.00	1.30	10.81	0.0001
Crossing Gate – IVR	1.56	1.37	15.95	0.0001
Clanging Bell –IVR	0.54	1.58	4.82	0.0001
Train horn – IVR	0.54	1.58	4.83	0.0001

### **IVR Effectiveness Ratings by the Visual-plus and Combination Groups**

In the previous section, we discussed the IVR effectiveness ratings for the combination and visual-plus groups combined. In this section, the responses from the combination and visual-plus groups are 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 combination and visual-plus groups. The average effectiveness ratings are summarized in Table 5.

A comparison between the effectiveness ratings given by combination versus visual-plus drivers is presented in Table 5. There were 132 and 66 drivers in the combination and visual-plus groups, respectively, who provided a rating to all the warning devices. The t-tests show the combination and visual-plus drivers gave significantly different ratings to the advance warning sign, the crossbuck sign, the flashing lights and the IVR.

Table 5 shows that the average effectiveness rating of the IVR from the combination group (3.6) was significantly higher than the rating for the visual-plus group (2.5) with 95% confidence. An explanation for the high rating of the combination group is that the participants had already experienced previous IVR modes, visual or audible alone and showed a preference of the combination mode by rating it with a “medium-high” effectiveness. Visual-plus IVR users gave it a “medium-low” effectiveness.

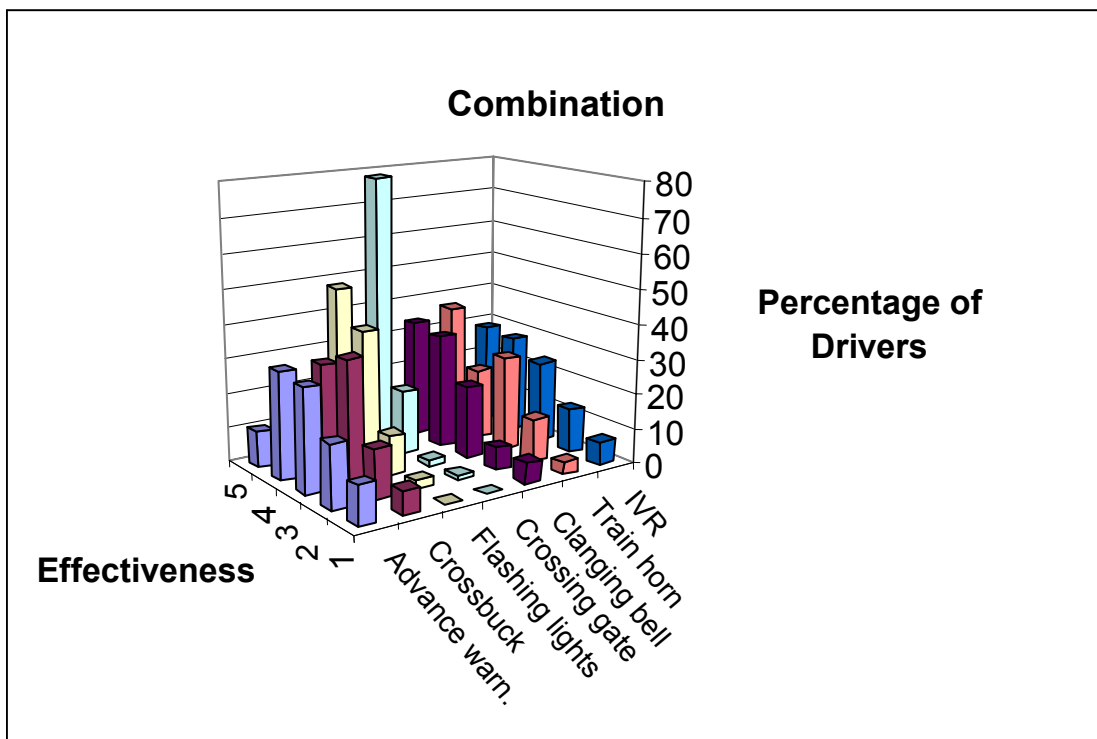


Figure 8: Percentage of drivers using the combination mode, rating effectiveness of each railroad warning device.

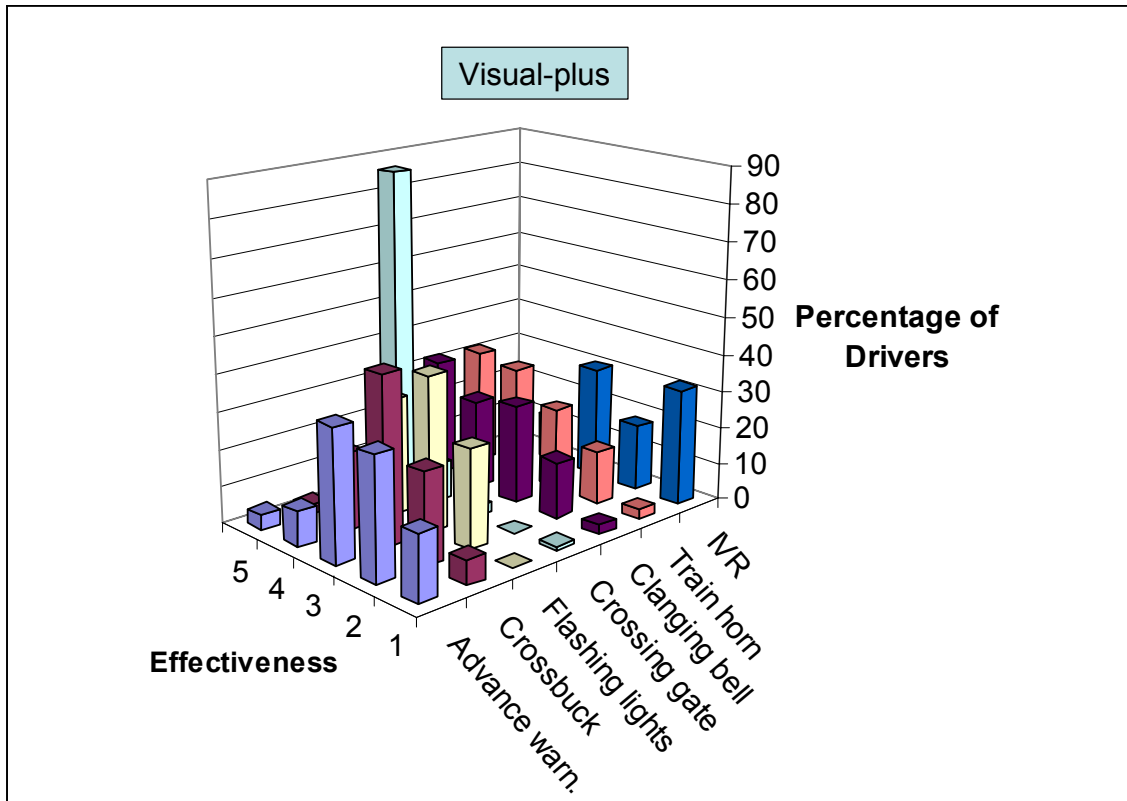


Figure 9: Percentage of drivers using the visual-plus mode, rating effectiveness of each railroad warning device.

**Table 5: T-Test results comparing combination and visual responses for every warning device (132 drivers in Combination and 66 drivers in Visual-Plus = 198 drivers)**

Warning Device	Mean Rating		Standard Deviation		T value	Prob. T	
	C	V+	C	V+			
Advance Warning	3.1	2.5	1.1	1.0	4.13	0.0001	0.0001
Crossbuck Sign	3.3	2.9	1.1	0.8	2.91	0.004	0.0040
Flashing Lights	4.3	4.1	0.8	0.8	2.18	0.0307	0.0294
Crossing Gate	4.8	4.8	0.5	0.4	-1.40	0.1624	0.1848
Clanging Bell	3.8	3.7	1.1	1.2	0.61	0.5447	0.5427
Train Horn	3.8	3.8	1.2	1.1	-1.13	0.8956	0.8957
IVR	3.6	2.5	1.2	1.3	5.78	0.0001	0.0000

Notation: C = Combination mode, V+ = Visual-plus mode. Ratings are based on a 5-unit scale, 1 is low and 5 is very high

<b>Table 6: T-Test results for combination mode (132 drivers)</b>				
<b>Difference</b>	<b>Mean Difference</b>	<b>Standard Deviation</b>	<b>T</b>	<b>Prob. T</b>
Advance Warning – IVR	-0.46	1.56	-3.46	0.0007
Crossbuck Sign – IVR	-0.27	1.51	-2.06	0.0404
Flashing Lights – IVR	0.72	1.16	7.21	0.0001
Crossing Gate – IVR	1.17	1.19	11.24	0.0001
Clanging Bell – IVR	0.22	1.39	1.81	0.0725
Train horn – IVR	0.18	1.40	1.50	0.1372

The comparisons of the effectiveness ratings between the warning devices and IVR are presented in Tables 6 and 7. Table 6 shows that the ratings for the clanging bell and train horn were similar to that of the combination mode of the IVR, with 95% confidence. The rating for the combination IVR was significantly lower than the ratings for the crossing gate and flashing lights, but significantly higher than the ratings for the advance warning and crossbuck signs.

<b>Table 7: T-Test results for visual-plus mode (66 drivers)</b>				
<b>Difference</b>	<b>Mean difference</b>	<b>Standard Deviation</b>	<b>T</b>	<b>Prob. T</b>
Advance Warning – IVR	-0.05	1.36	-0.27	0.7874
Crossbuck Sign – IVR	0.36	1.37	2.14	0.0357
Flashing Lights – IVR	1.54	1.41	8.93	0.0001
Crossing Gate – IVR	2.33	1.38	13.69	0.0001
Clanging Bell – IVR	1.18	1.74	5.53	0.0001
Train Horn – IVR	1.27	1.71	6.06	0.0001

The effectiveness ratings the visual-plus group gave to the IVR and other warning devices are compared and the results are presented in Table 7. For the visual-plus group,

the rating for the IVR was not significantly different than that of the advance warning sign, but was significantly lower than the ratings of the other warning devices, with 95% confidence.

**Q4. Do you trust your IVR to give an accurate warning of a train approaching / occupying the equipped crossings?**

A total of 244 drivers responded to this question. Overall, 13.1% of the drivers indicated that they trusted the IVR very much, 38.9% of the drivers stated that they trusted the IVR to some degree, 42.6% of the drivers did not trust the IVR at all, and 5.4% of the drivers had no opinion or left the question blank. The distribution of the drivers' responses is given in Figure 10.

The Chi-square test comparing the combination and visual-plus groups showed that a much higher percentage of drivers in the combination group (66.0%) trusted the IVR compared to the visual-plus group (33.3%) to give an accurate warning of a train approaching/occupying the equipped crossings. Fifty-two drivers in the visual-plus group said they did not trust the IVR when we were expecting 35 drivers. Similarly, less than the expected number of drivers (3 versus 11) in the visual-plus group said that they trusted the IVR very much. On the other hand, in the combination group, more drivers than expected trusted their IVR. The number of drivers who trusted the IVR "very much" was 29 versus the expected number of 21, and the number of drivers who trusted the IVR "to some degree" was 72 versus the expected number of 63. The Chi-square value (Table 8) was 24.6 with a p-value of 0.001. The chi-square test rejects, with 95% confidence, the hypothesis that the combination and visual-plus groups gave similar responses to this question. The results of the chi-square test are presented in Table 8.

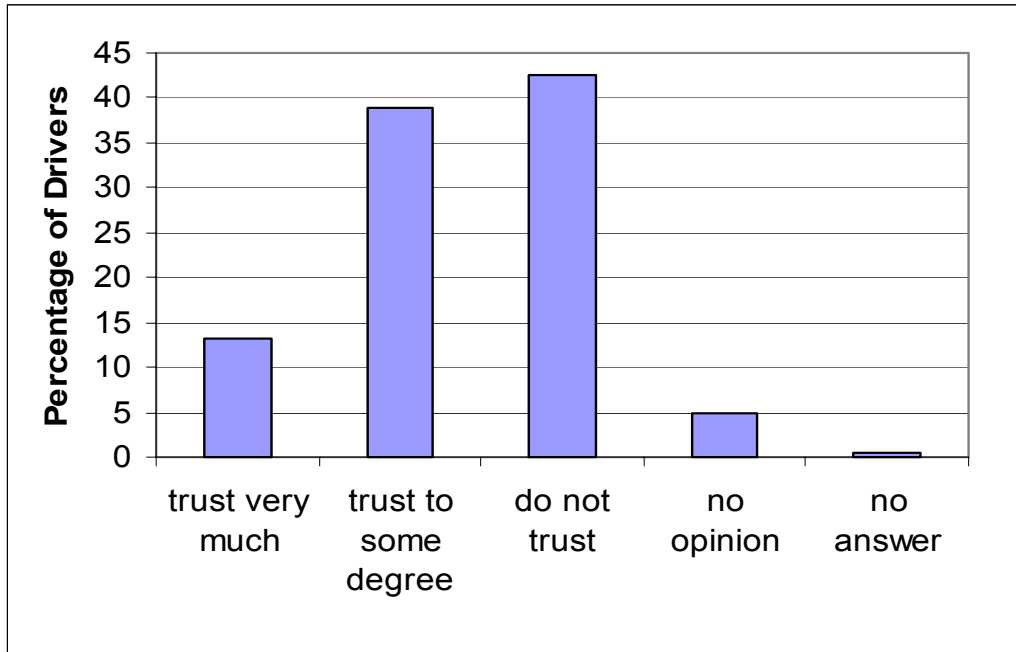


Figure 10: Percentage of drivers that trust the IVR to give an accurate warning of a train approaching or occupying the equipped crossings.

		Trust very much		Trust to some degree		Do not trust	
		C	V+	C	V+	C	V+
Observed	Frequency	29	3	72	23	52	52
	Percent	18.9	3.8	47.1	29.5	34.0	66.7
Expected	Frequency	21.2	10.8	62.9	32.1	68.9	35.1
	Percent	13.9	13.8	41.1	41.2	45.0	45.0

Table 8 shows that approximately 18.9% of the drivers in the combination group trusted the IVR very much and 47.1% trusted it to some degree. In contrast, in the visual-plus group, only 3.8% trusted the IVR very much and 29.5% trusted the IVR to some degree.



**Q5. Have you experienced any problems with the IVR powering-on properly?**

A total of 244 drivers responded to this question. Approximately 49.2% of the drivers did not encounter any problems with the IVR powering on properly, but 19.3% of the drivers experienced problems. Approximately 30.3% of the drivers did not recall or had no opinion, and 1.2% of the drivers did not respond to the question. Figure 11 presents the distribution of the drivers' responses.

The drivers were also requested to write the number of times the power-on problems occurred. A total of 22 drivers provided numeric responses. Nineteen of these drivers had the combination IVR and the remaining three had the visual-plus mode. The visual-plus drivers reported that power-on problems occurred on average 4.0 times, while the combination IVR drivers reported that power-on problems occurred on an average of 8.3 times. This difference is not statistically significant based on a t-test.

A comparison of the responses given by the drivers in the combination and visual-plus groups is presented in Table 9. The chi-square test (chi-square value was 26.644 with a p-value of 0.001) showed that the responses given by the drivers in the combination group were different than the visual-plus group, with 95% confidence. The test indicated that a higher than expected proportion of the combination group (54.9% versus 49.8%) had no power-on problems; while, a higher proportion had problems with the IVR powering-on properly (24.7% versus 19.5%). Thus, the proportion of drivers in the combination group who did not have an opinion or did not recall having a power-on problem was much lower than expected (20.4% versus 30.7%). In contrast, a much higher proportion of the visual-plus drivers (51.9% versus expected 30.8%) did not have an opinion or did not recall having power-on problems and a much lower proportion (8.9% versus expected 19.5%) had power-on problems. For the visual-plus group, a lower proportion of drivers (39.2% versus expected 49.7%) had no power-on problems with the IVR. These numbers indicate that the drivers in the combination group were more aware of whether or not the IVR powers-on than the visual-plus group. This is mainly due to the beeping sound of the IVR heard by the combination group when they started the vehicles.

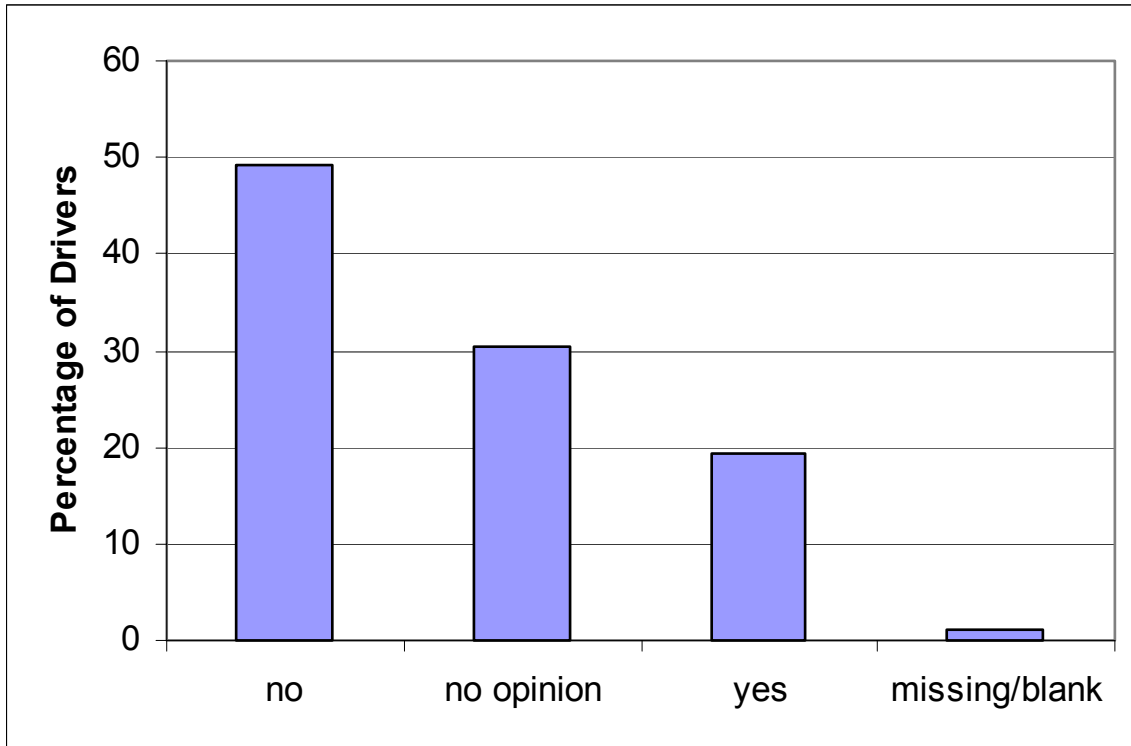


Figure 11: Distribution of drivers that experienced power-up problems.

<b>Table 9: Chi-square test results</b>							
<b>(162 Drivers in Combination and 79 in Visual-plus)</b>							
		<b>No power-on problems</b>		<b>Don't recall/No opinion</b>		<b>Yes, had power-on problems</b>	
		<b>C</b>	<b>V+</b>	<b>C</b>	<b>V+</b>	<b>C</b>	<b>V+</b>
Observed	Frequency	89	31	33	41	40	7
	Percent	54.9	39.2	20.4	51.9	24.7	8.9
Expected	Frequency	80.7	39.3	49.7	24.2	31.6	15.4
	Percent	49.8	49.7	30.7	30.8	19.5	19.5

**Q6. How many times has your IVR given you a warning when a train was not approaching / occupying the equipped crossings?**

This question requested a numeric response. However, a large number of drivers did not give a number, but wrote words like “many” and “numerous”. Only 113 drivers provided numerical responses. On the average, the IVR gave a message when a train was not approaching 9.6 times in a three-month period. Approximately 82 of the drivers that provided an answer were using the combination mode and 31 drivers were using the visual-plus mode. The minimum and maximum values reported by the drivers were 0 and 200. The drivers in the visual plus group reported 5.3 false alerts on the average, while the drivers in the combination group reported 11.2 false alerts in a three-month period. The difference was not 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.

**Q7. How many times has your IVR failed to give you a warning when a train was approaching?**

On the average, the 119 drivers who answered this question stated that the IVR failed to give a warning when a train was approaching/occupying the equipped crossings 1.4 times in a three-month period. Of these, 90 drivers had the IVR in the combination mode, which failed to give a warning an average of 1.4 times. For the remaining 29 drivers that were in the visual-plus group, the average number of times that the IVR failed to give a warning was 1.2 times. The range of the responses was from 0 to 50 times. The highest number reported for an IVR failure to give a warning message when a train was approaching/occupying the crossing was 50 during a three-month period. The latter was reported by one of the drivers in the combination group. The difference in the averages of the responses between the combination and visual-plus groups was not statistically significant at a significance level of 0.05.

**Q8. What percentage of the time has your IVR provided you a warning when a train was approaching / occupying the equipped crossings?**

A total of 143 drivers answered this question. On the average, they stated that the IVR provided a warning 77.7% of the time when a train was approaching/occupying the crossing. The averages for the drivers in the visual-plus and combination groups were 55.4% and 83.8% of the time, respectively. The difference in the responses between the combination and visual-plus groups is statistically significant using a t-test with a significance level of 0.05. Approximately 76.8% of the drivers in the combination group compared to 38.7% in the visual-plus group said that the IVR worked at least 90% of the time. Of these, 53.6% of the drivers in the combination group and only 29.0% in the visual-plus group found that the IVR gave a correct signal 100% of the time. One should note that 45.2% of the visual-plus drivers said that the IVR worked no more than 50% of the time compared to 14.3% in the combination group.

**Q9. Has the IVR given you a signal that you did not understand?**

Out of 235 drivers who responded to this question, only 36 drivers received a signal that they did not understand. The drivers were asked to provide a description of the signal given. Seventeen of these drivers responded that they received a non-understandable signal an average of 19.9 times in three months. The actual statements are given in Table 10. Drivers mostly reported false alerts they received as signals that they did not understand.

<b>Table 10: Driver verbatim statements regarding IVR messages not understood</b>
At Jewel-Osco and Walgreen's all the time
When you went past Walgreen stores
Sometime when a police car was present, it would go off by itself
Signal activated in proximity to hospital magnetic imaging lab
It would always go off on Western about two blocks south of post office

## RESPONSES SPECIFIC TO VISUAL PLUS IVR MODE

The results discussed in the following sections are based upon responses from 80 drivers.

### Q10. Visual distractions during daily driving conditions

A large percentage of the drivers (52.6%) said that passengers distracted them during daily driving. Approximately 67.7% of the drivers were distracted by exterior light sources and 65.2% of the drivers were distracted by interior warning lights. The distribution of the visual distractions is presented in Figure 12. Approximately 18.9% of the drivers complained of other distractions. These additional distractions are presented in Table 11. Ten percent of the drivers did not answer this question. Please note that this is a “circle all that apply” and thus, the percentages do not add up to 100%.

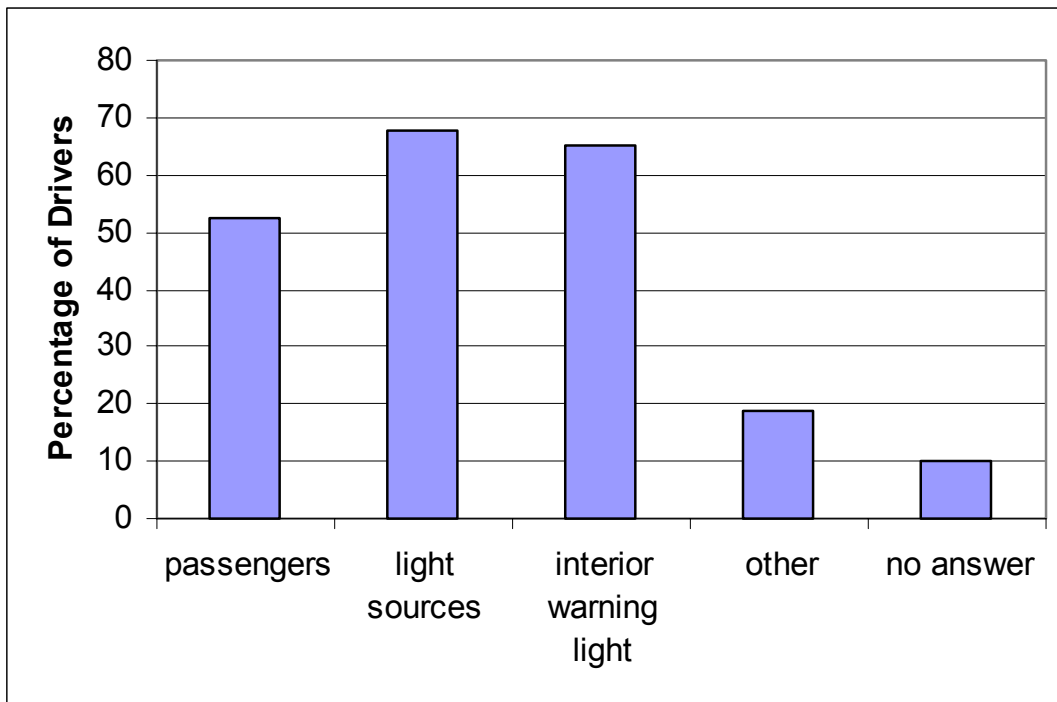


Figure 12: Visual distractions that drivers experienced while driving.

**Table 11: Additional visual distractions reported by the drivers using the visual IVR**

Police patrol activity
Police radio, radar, phone, video camera equip., lights, sirens
Interior radio traffic
Radios, computers

**Q11. During daytime and nighttime, how well can you see the visual display?**

The distribution of the responses is presented in Figure 13. During daytime, 48.8% the drivers stated that the view of the visual display was “just right”, 28.8% said that the display was too dim, 22.4% had no opinion or did not answer the question. None of the drivers said that the display was too bright.

During nighttime, the majority of the drivers (68.8%) said that the visual display was “just right”, 3.8% said that it was too dim, 26.1% of the drivers did not have an opinion or did not answer the question. One of the drivers thought that the display was too bright.

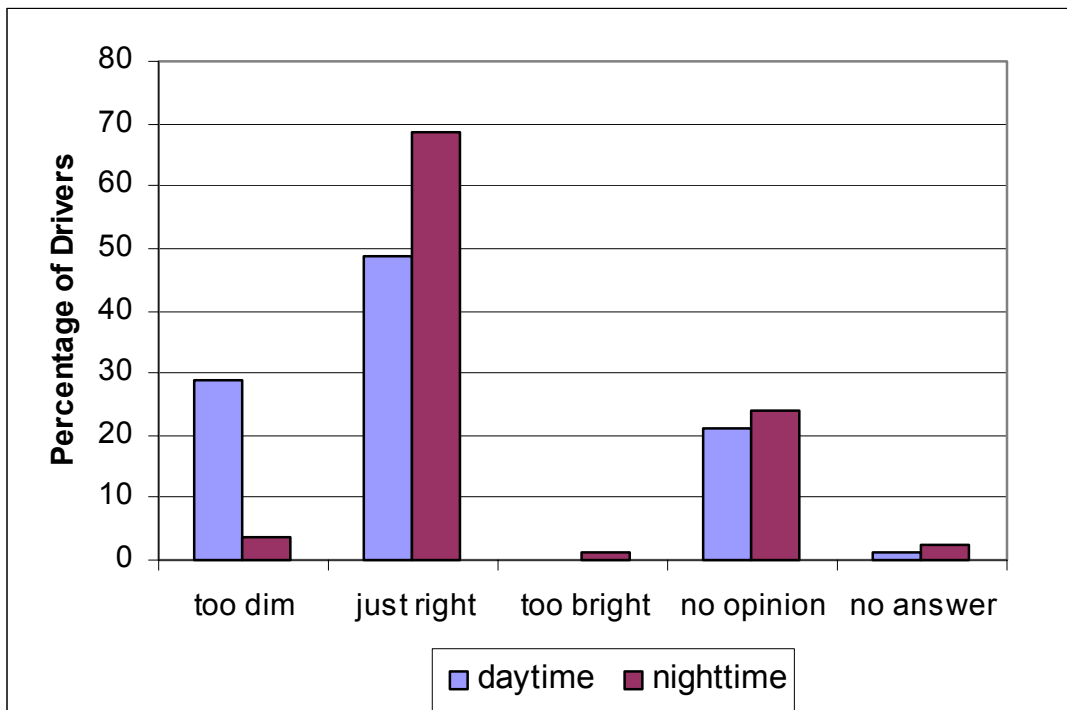


Figure 13: Percentage of how well drivers can see the visual display during daytime and nighttime.

**Q12. Is the size of the lettering on the visual display easy to read?**

The distribution of the drivers' responses is shown in Figure 14. Approximately 70.0% of the drivers considered the lettering on the visual display to be easily readable, 18.8% found the lettering to be too small, and 11.2% of the drivers had no opinion.

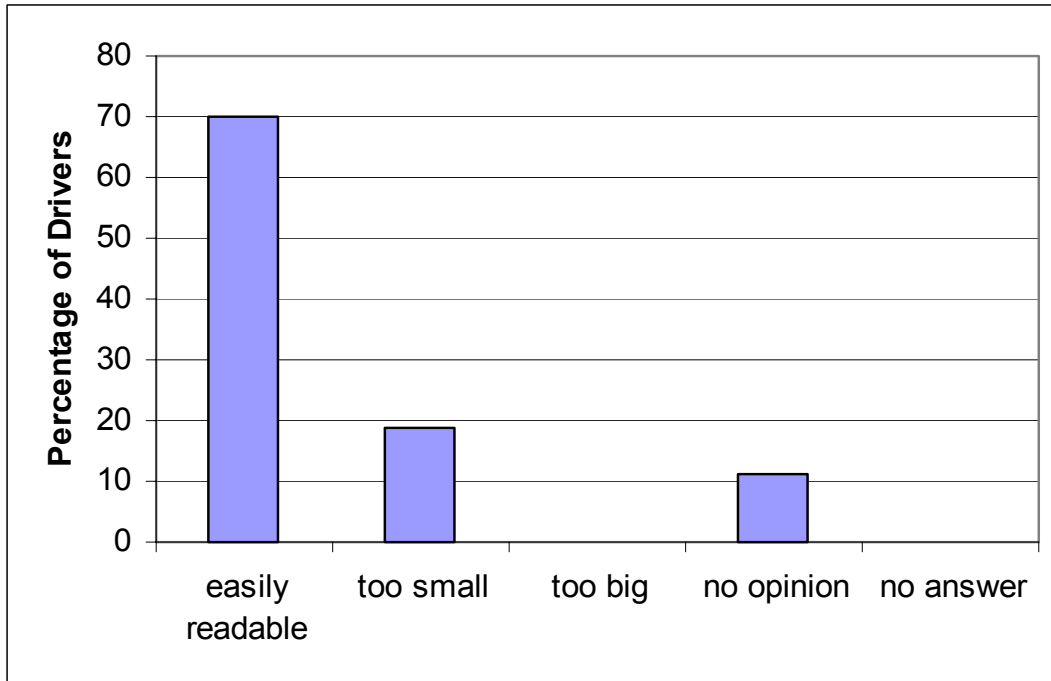


Figure 14: Distribution of drivers' opinions on the size of the lettering on the visual display.

**Q13. How does the blinking rate of the warning message affect readability?**

Figure 15 shows the distribution of the drivers' responses to the blinking rate of the visual message. Approximately 47.5% of the drivers found that the visual message blinked at the right speed, 5.0% of the drivers found the message blinked too fast, while 1.3% thought that it blinked too slowly. Approximately 46.2% of the drivers had no opinion.

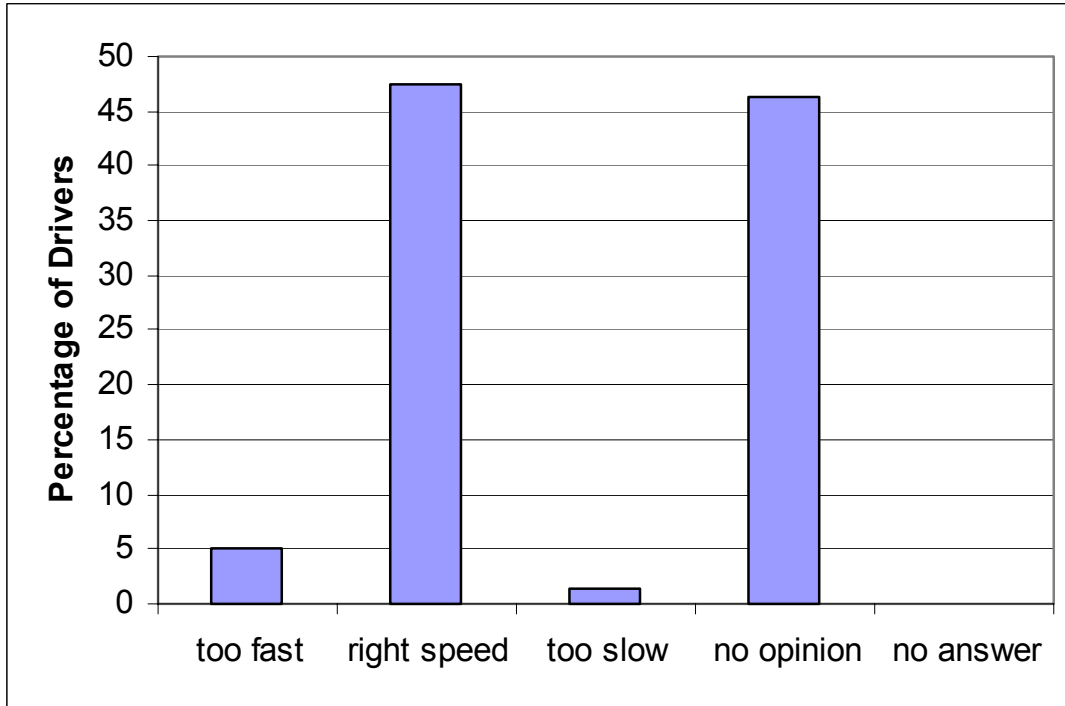


Figure 15: Distribution of the drivers' opinions on the visual message-blinking rate.

**Q14. Is the color of the visual warning message easily noticed?**

Approximately 71.3% of the drivers found the color of the warning message to be noticeable, while 15.0% of the drivers did not. Approximately 13.7% of the drivers had no opinion. The color suggested by some drivers was red. The distribution of the responses is given in Figure 16.

**Q15. Is the visual warning message easily noticed?**

The distribution of the drivers' opinions on the warning message compared to other visual cues is shown in Figure 17. A large percentage of drivers (46.3%) said that the message was noticeable. On the other hand, 36.3% thought that the message was not noticeable enough compared to the other visual cues. Approximately 16.2% of the drivers did not have any opinion, and 1.2% of the drivers did not answer the question.



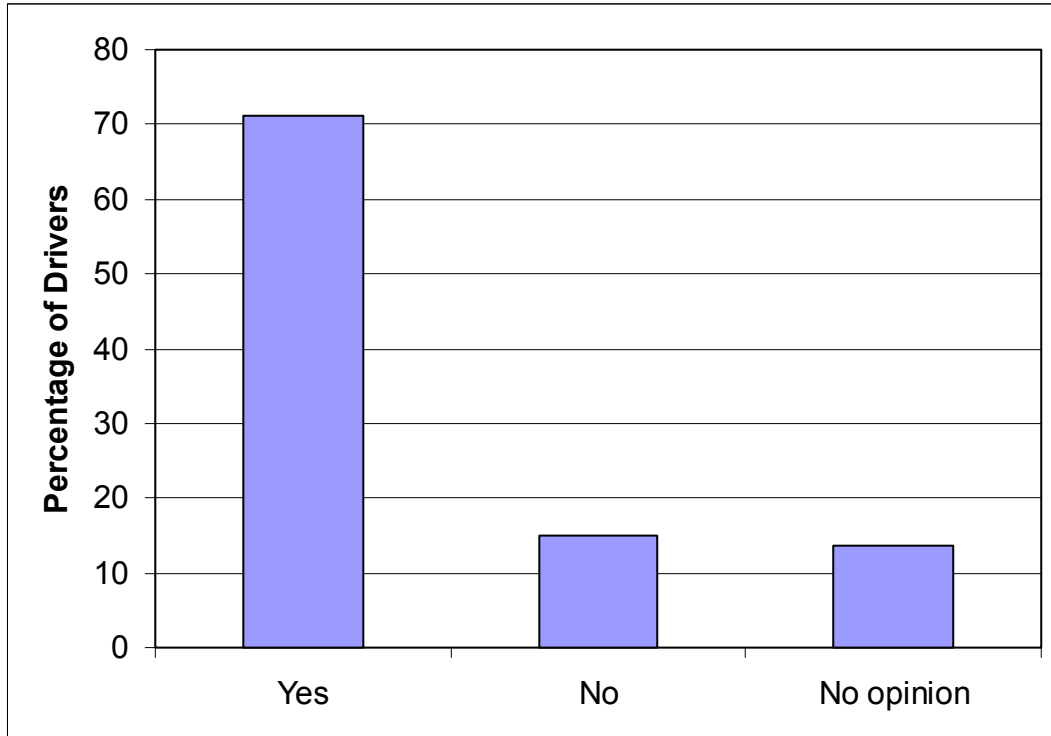


Figure 16. Distribution of drivers' opinion on whether the color of the visual warning message was easily noticed.

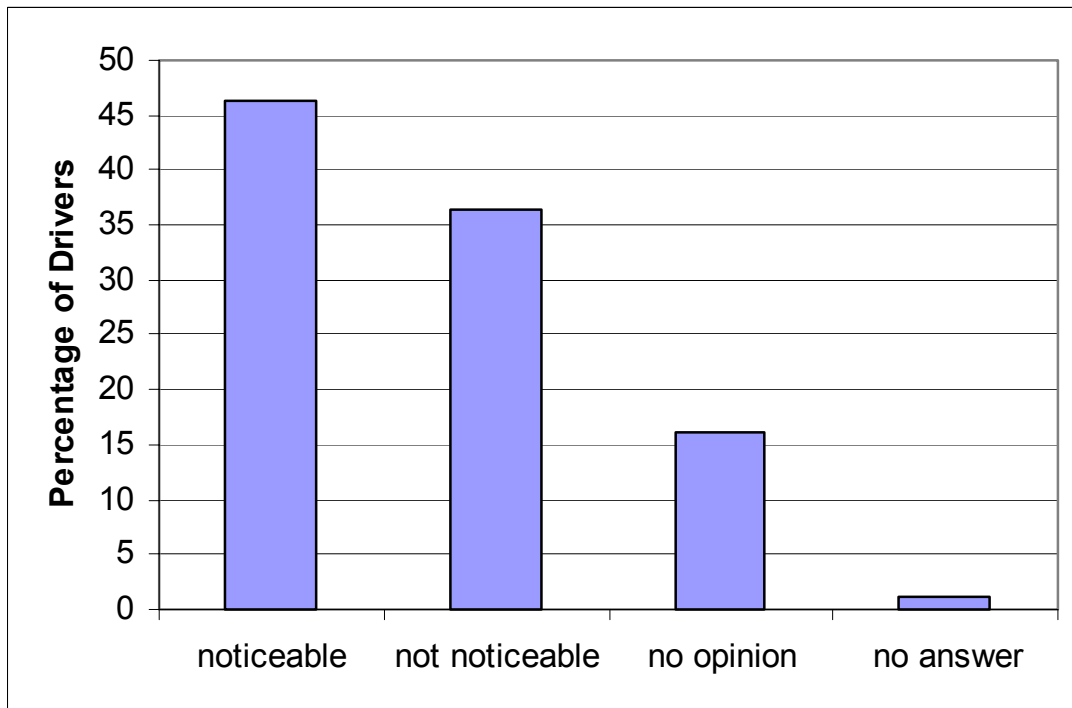


Figure 17: Distribution of the drivers' responses on the visual message.

**Q16. How would you rate the overall quality of the visual message you received from your IVR?**

The distribution of the drivers' responses is presented in Figure 18 (on the following page). A large group of drivers (43.8%) rated the quality of the visual message from the IVR as good or excellent, 18.8% said it was fair and 26.2% rated it poor. The remaining 11.2% of the participants had no opinion.

## RESPONSES SPECIFIC TO COMBINATION IVR MODE

The results discussed in the following sections are based upon responses from 164 drivers.

### Q10. How would you rate the overall quality of the combined audible and visual message you received from your IVR?

Figure 18 presents the driver responses to this question. Approximately 54.2% of the drivers thought that the overall quality of the combined warning message was good or excellent, 28.7% said it was fair, while 7.9% said it was poor. The remaining 9.2% of the drivers did not express any opinions or did not answer this question.

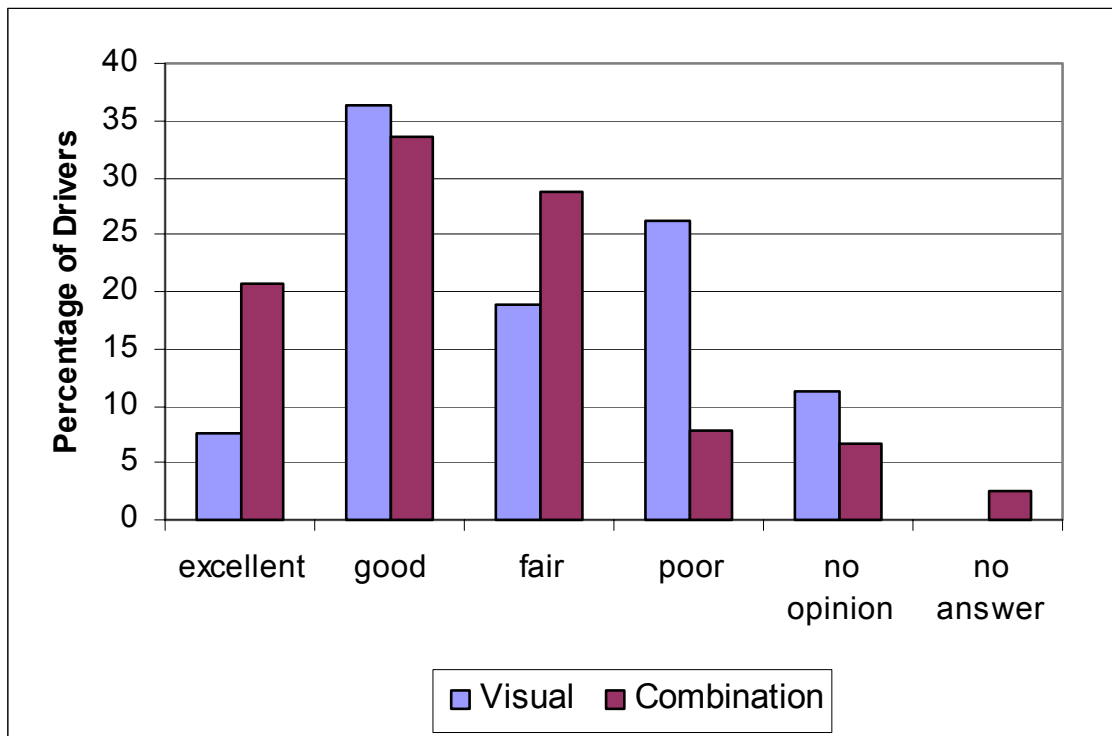


Figure 18: Ratings on the overall quality of the visual and combined messages.

The proportion of drivers who rated the overall quality of the combination mode message as excellent was about three times higher than that of the visual-plus mode. In contrast, the proportion of drivers who rated the overall quality of the combination message as poor was three times less than the proportion for the visual-plus mode. The

responses from the visual-plus mode shifted toward poorer ratings while the responses for the combination mode shifted toward better ratings. Figure 18 clearly shows this shift in ratings.

**Q11. Is the combined audible and visual warning message noticeable from other audible and visual messages you received while driving?**

Figure 19 presents the distribution of the answers given by the participants. The majority of the drivers (54.9%) thought that the message given by the IVR was noticeable over the other messages they received while driving. On the other hand, 23.8% of the drivers did not believe the IVR message was noticeable over the other messages. The remaining 21.3% of the drivers did not have an opinion or did not respond to this question.

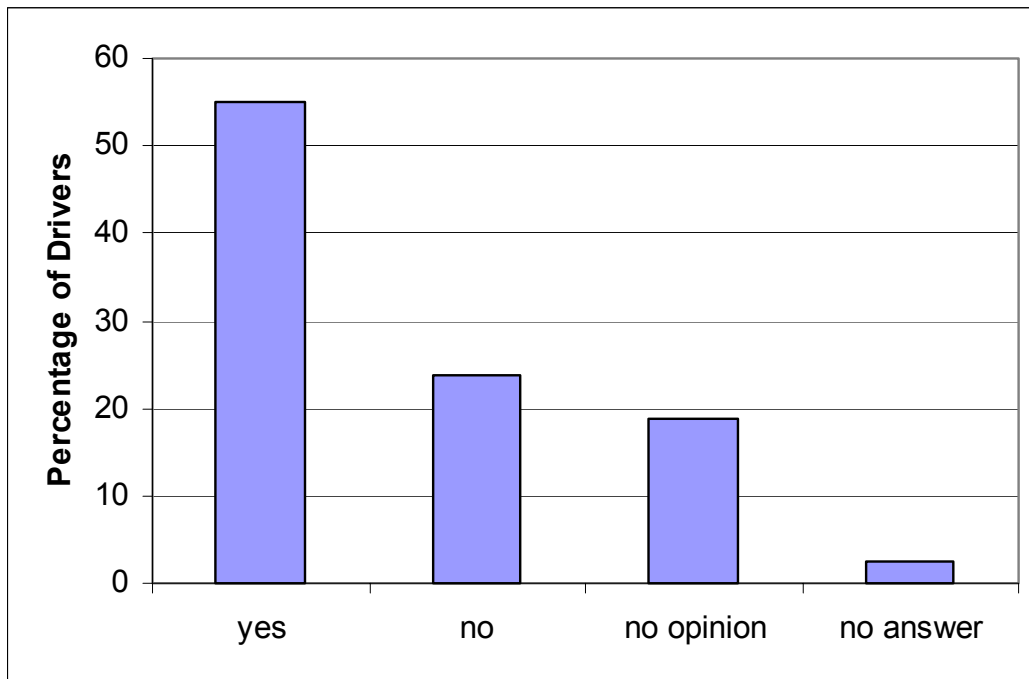


Figure 19: Overall, was the IVR combined audible and visual warning message noticeable from the other visual and audible messages you received while driving?

**Q12. If you had experience with the IVR operating in all three modes, please rate the ability of each mode to attract your attention?**

Table 12 presents each mode’s “ability to attract attention” level, and Figure 20 presents the distribution of answers of the participants. Seventy-one percent (71%) of the drivers in the audible group, 26.7% in the visual group, and 77.2% in the combination group said that the IVR had a high or very high ability to attract their attention. For the audible, visual, and combination modes, 14.2%, 31.7%, and 11% of the drivers, respectively, gave a medium rating for getting their attention. The audible, visual, and combination modes received low and very low ratings for getting attention by 7.0%, 32.4%, and 4.2% of the drivers, respectively. It is very clear that the beeping sound got the attention of the drivers.

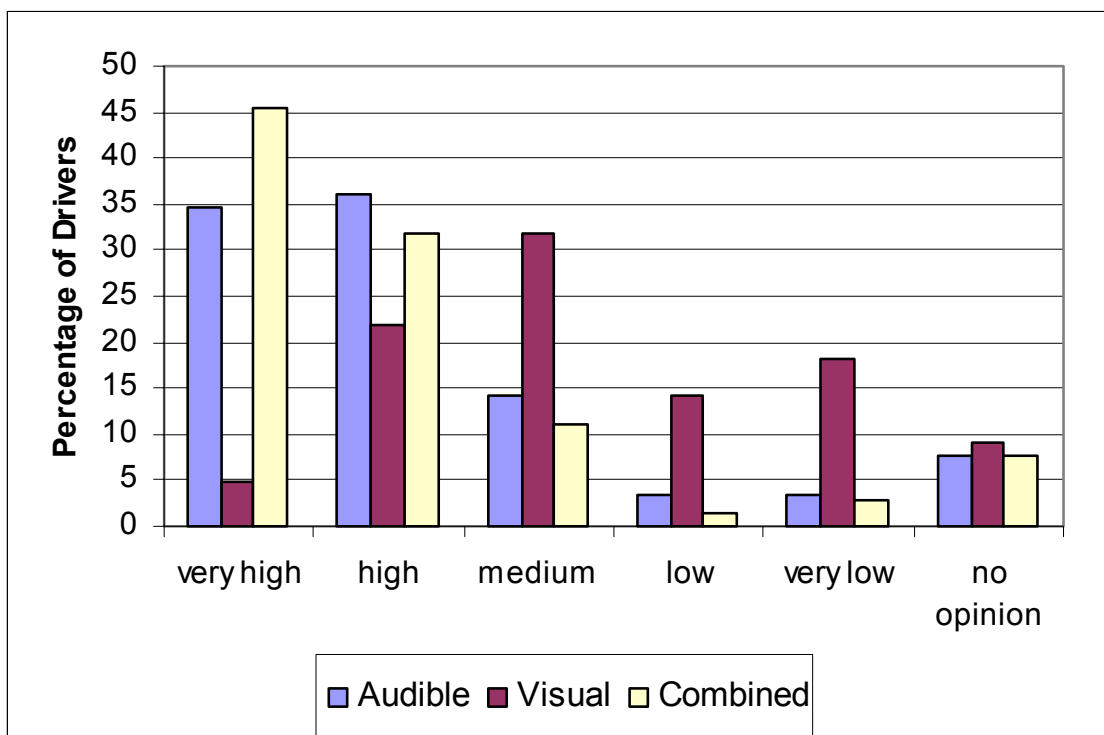


Figure 20: Ability of the IVR to attract attention.

Mode	No. of drivers	Percentage of Drivers					
		Very High	High	Medium	Low	Very Low	No opinion
Audible	141	34.8	36.2	14.2	3.5	3.5	7.8
Visual	142	4.9	21.8	31.7	14.1	18.3	9.2
Combination	145	45.5	31.7	11.0	1.4	2.8	7.6

**Q13. Which IVR Mode did you prefer?**

The distribution of the driver responses is given in Figure 21. Approximately 54.9% of the drivers preferred the combination of audible and visual mode, 20.1% of the drivers preferred the audible, and 3.7% preferred the visual mode. About 6.1% of the drivers preferred to have no IVR, 7.9% did not have any preference, and the remaining 7.3% did not give an answer to this question.

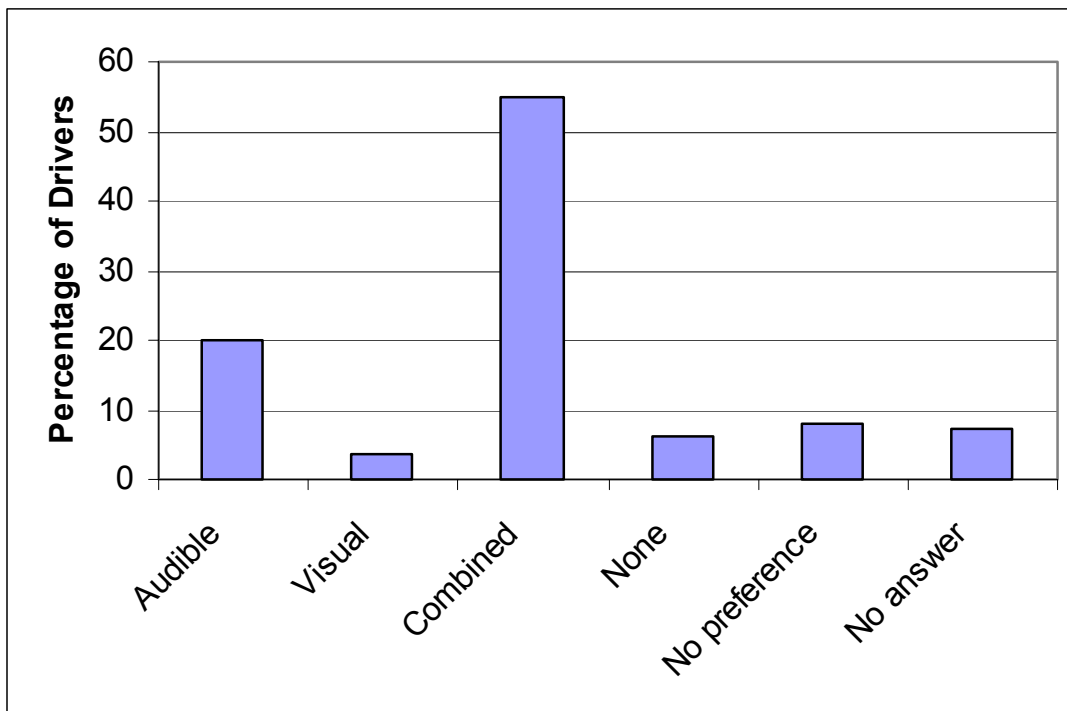


Figure 21: Distribution of which IVR mode the driver preferred.

**Q14. Did any of the warning methods pose a significant driving distraction to you ?**

The distribution of the driver responses is presented in Figure 22. The majority of the drivers, 58.5%, indicated that none of the warning methods was a significant distraction while driving, however, 7.3% of the drivers said that the combination, 4.9% said that the visual, and 15.2% said that the audible IVR mode was distracting. Approximately 9.1% had no opinion and 7.3% did not answer this question. This question was a “circle all that apply” type and the percentages do not add up to 100%.

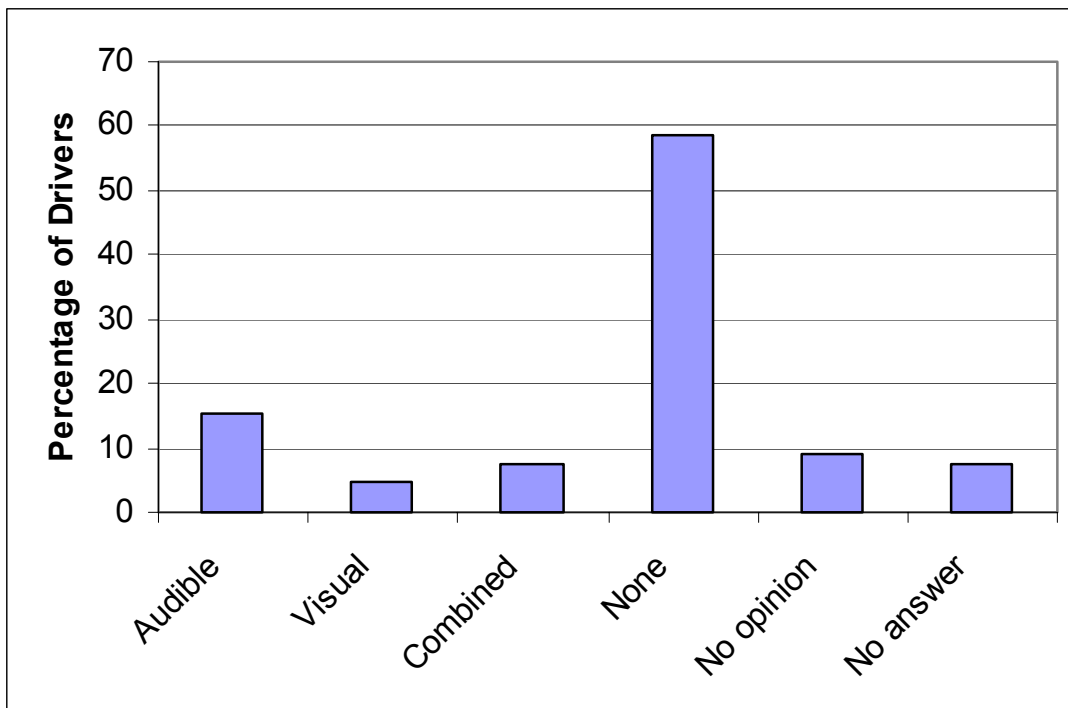


Figure 22: Responses of the drivers on which IVR modes became a significant distraction while driving.

**Q15. Was the IVR mounted in your vehicle in a place where it was easily heard / seen?**

The distribution of the drivers responses is presented in Figure 23. Most drivers, 87.8%, indicated that their IVR was mounted in a place where they could easily hear and/or see the message, and 2.4% of the drivers said that they did not have the IVR in an

appropriate location. Approximately 9.8% did not express any opinion, and 2.5% did not answer this question.

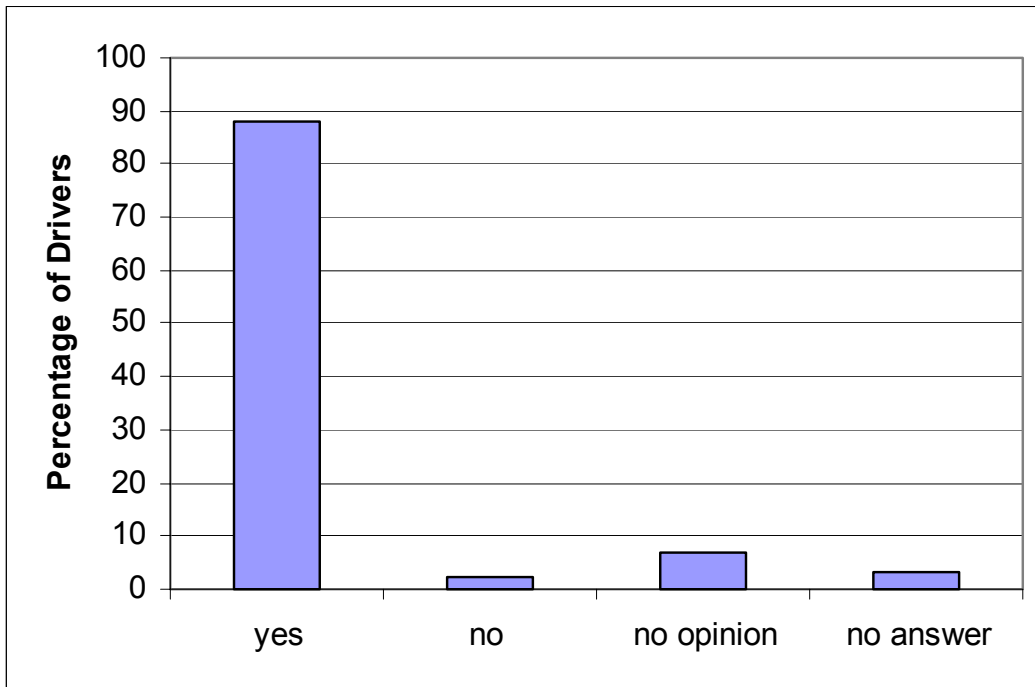


Figure 23: Was the IVR mounted in your vehicle in a place where it was easily heard and/or seen?



## INSTRUCTION AND TRAINING

Both, the combination and visual-plus IVR users answered the following questions.

### **Q16. How useful was the instruction and training program in familiarizing you with the IVR system?**

The drivers were asked to indicate how useful the instruction and training program was in teaching them the IVR system. The program consisted of an instructional videotape, a laminated written information card that was placed in the vehicle, and a question/answer session. The responses are presented in Figure 24. The instructional videotape was perceived “very useful” by 42.1%, “somewhat useful” by 35.2%, and “not useful” by 4.3% of the 233 drivers who responded to this question. About 18.4% of the participants did not express any opinion.

The laminated information card that was placed inside the vehicles was rated as “very useful” by 30.9%, “somewhat useful” by 36.3%, and “not useful” by 12.6% of the 223 drivers that responded to this question. The higher “not useful” percentage might have resulted from the laminated card being removed or misplaced in the vehicle. About 20.2% of the drivers did not express an opinion. The question/answer session was rated as “very useful” by 42.5% of the 226 drivers that responded. Approximately 34.1% thought it was “somewhat useful”, 4.4% of the drivers found the session “not useful” and 19.0% did not have an opinion.

### **Q17. How would you rate the amount of instruction / training you received regarding the IVR system?**

Survey responses from 244 drivers are used and Figure 25 presents the answers given by the participants. About 65.6% of drivers obtained the right amount of instruction/training, 6.1% did not have enough, and 5.7% said they received too much instruction/training. About 20.5% of the drivers did not have an opinion and 2.1% of the drivers did not answer the question.

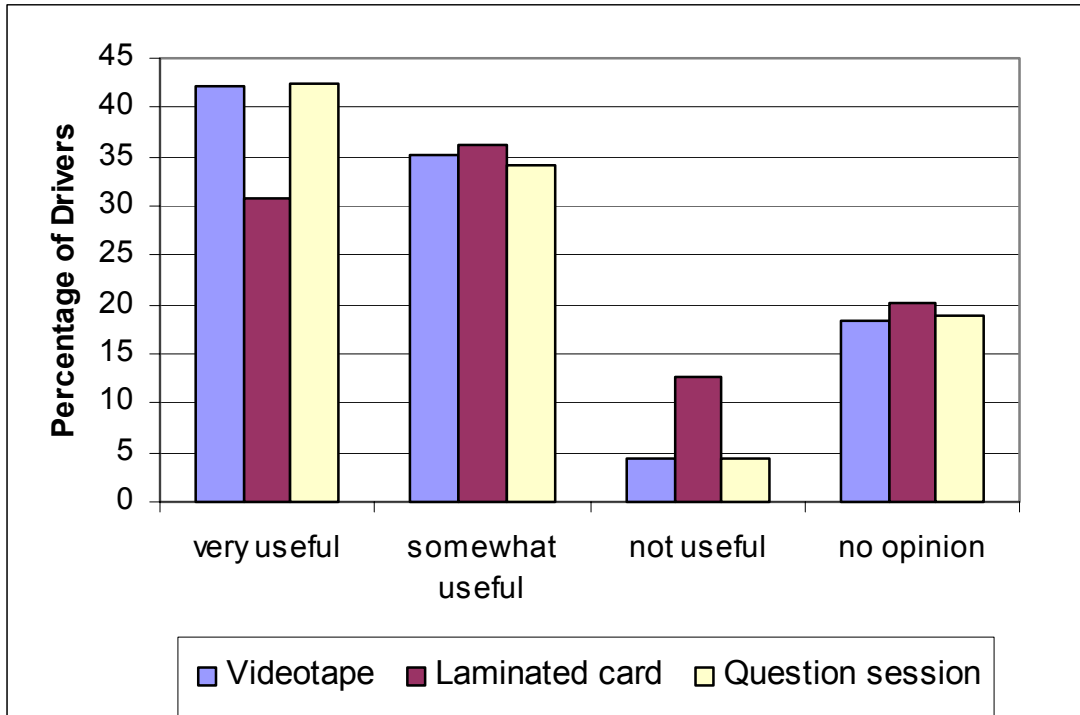


Figure 24: Distribution of the drivers' opinions on how useful they considered the instruction and training program was for explaining the IVR system.

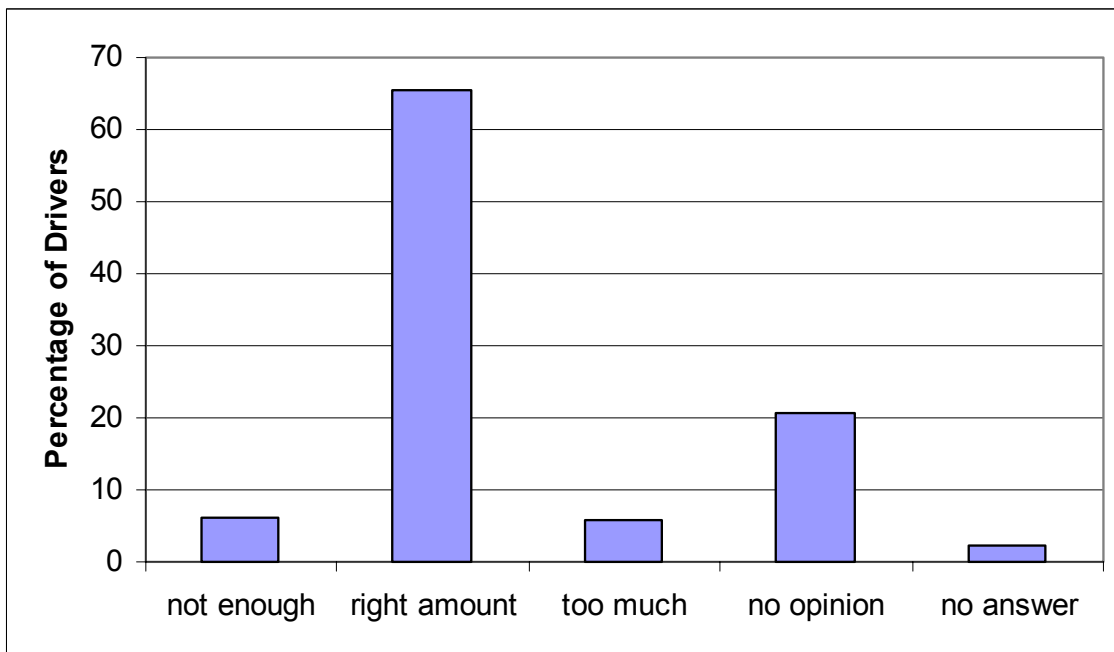


Figure 25: Amount of instruction/training regarding the IVR obtained by the participants.

**Q18. What additional instruction / training would you suggest?**

The drivers were asked to indicate any additional instruction or training they thought should be incorporated into the program. The answers are included in Table 13.

**Table 13: Additional Instruction / Training Suggested by the Participants**

Individual one on one. Walk each test location through step by step. Work on the device itself so that it functions properly and consistently. Look, listen, live. Random check ups to see they are still working. Not involved in training. Should have told us to count (the number of false alerts). Never saw training material. I received no training.
---

**Q19. What instruction / training should be reduced / eliminated?**

The participants were asked to indicate which parts of the instruction/training they thought should be reduced or eliminated. The responses we got to this question were “state tests”, “all”, and “baseline survey”. These responses seemed to be unrelated to the question asked.

## OVERALL COMMENTS ON IVR WARNING SYSTEM

**Q20. During the period, March 2000 - December 2000, how many months did you drive a vehicle equipped with an IVR?**

A total of 232 drivers answered this question. The responses from 21 of these drivers were eliminated because they exceeded the expected range of 1 to 10 months. The average number of months that the remaining 211 drivers possessed a vehicle equipped with an IVR was 6.6 months. Approximately 45% of drivers possessed an IVR-equipped vehicle for 9 or 10 months. Figure 26 presents the response distribution given by the participants.

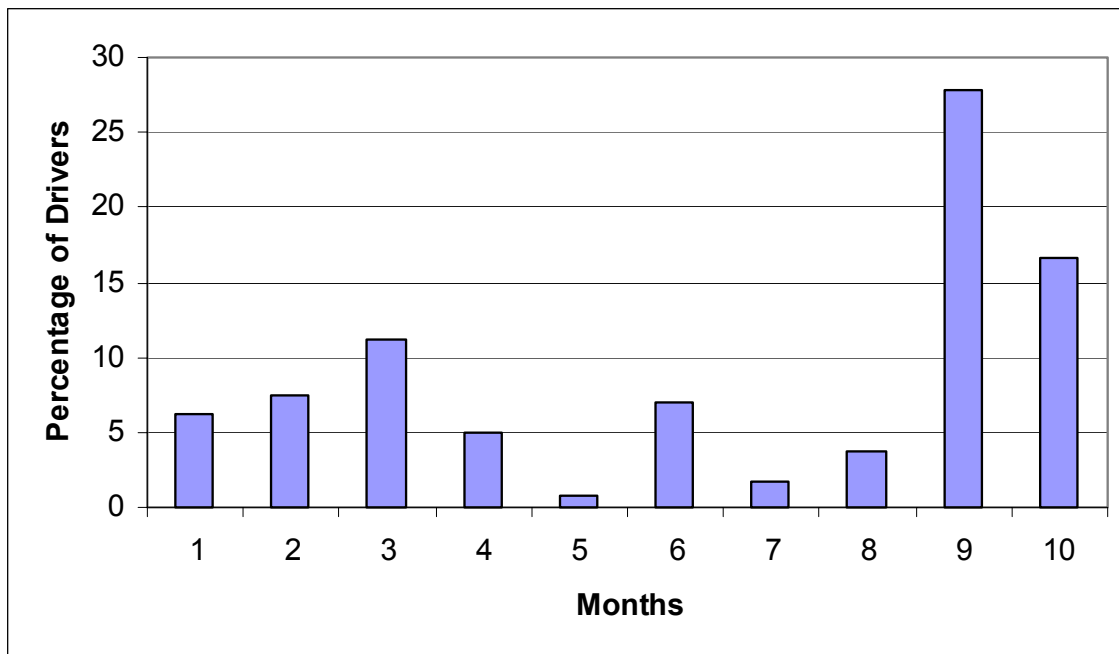


Figure 26: Number of months the drivers had the IVR during the time period between March 2000 to December 2000.

**Q21. During the period, March 2000-December 2000, how many times did your IVR give you a warning message when no train was present?**

A total of 174 drivers responded to this question, and the responses from 155 were analyzed based on the number of months they said that they had the IVR from the previous

question. Figure 27 presents the response distribution given by the participants. The average number of times the IVR gave a warning when no train was present equaled 11.1. The highest number reported was 350 times during the specified time period. Approximately 90% (90.3%) of the drivers received no more than 25 warnings when no train was present. About 33.5% received no false alerts, and 7.7% received only one warning when no train was present.

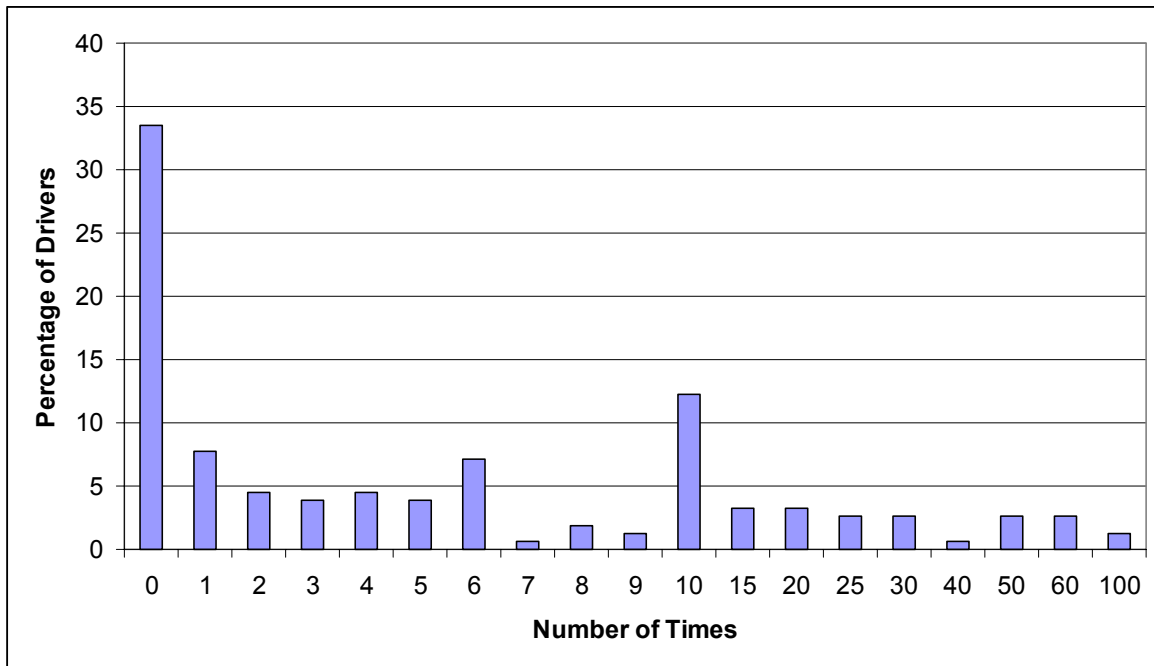


Figure 27: During the period March 2000 – December 2000, how many times did your IVR give you a warning message when a train was not present?

**Q22. In your opinion, did the IVR activation generally occur...?**

A total of 237 drivers responded to this question. Figure 28 presents the distribution of the drivers’ opinions on the amount of warning time provided by the IVR. They were asked if the IVR activated too far away, at the proper distance, or too close to the railroad crossing. About 46.7% of the drivers said that the IVR activated at the proper distance from the railroad crossing thus, giving the driver an adequate warning time. About 8.6% of the participants thought that the IVR activated too far away, 13.9% said it activated too

close to the railroad crossing, and 30.8% did not have an opinion or did not answer this question.

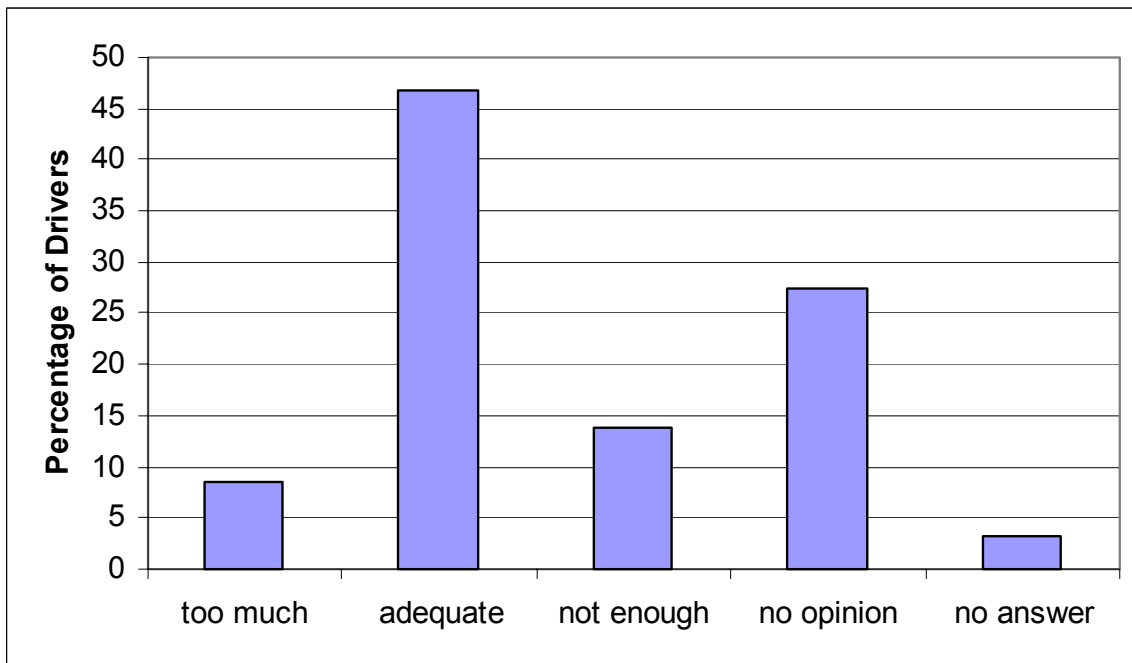


Figure 28: Distribution of the drivers' opinions on the amount of warning time provided by the IVR.

**Q23. Should the State of Illinois install IVR systems at more railroad crossings?**

A total of 240 drivers responded to this question and the frequency of responses is given in Table 14. About 47.1% of the drivers were in favor of the state installing IVR systems at more railroad crossings, while 31.1% were not in favor of installing IVR systems at more crossings. About 21.8% of the participants did not have an opinion on this matter.

Yes	47.1%
No	31.1%
No opinion	21.8%

**Q24. If given a choice, would you continue to use the IVR?**

As shown in Table 15, out of the 244 drivers, 44.7% said if given the choice they would continue to use the IVR while 42.2 % said they would not. About 12.7% of the drivers gave no opinion and 0.4% did not respond to this question.

Table 15. If given the choice, would you continue to use the IVR?	
Yes	44.7%
No	42.2%
No opinion	12.7%
Did not respond	0.4%

## DRIVERS' COMMENTS AND SUGGESTIONS

Additional comments concerning the training, placement and/or operation of the IVR system are presented in Table 16. Suggestions on what can be done to make the IVR system more effective and useful are presented in Table 17.

**Table 16: Q25. Verbatim comments related to installation, training and/or operation of the IVR**

1. The operating tone when approaching a crossing becomes monotone and blends in with on going sounds in surrounding. Just like a radio, it is eventually ignored.
2. Fix the units.
3. Every time there was a train at the Greenwood Avenue crossing, the system worked but the main problem is the false alarms. When there are this many false alarms you don't take the real ones seriously.
4. System was ineffective. Visual confirmation of warning gates/flashing lights was made prior to or at the same time as activation of IVR.
5. Too much interference with other radio transmitting devices to be safe and practical.
6. Too loud.
7. Needs a lot of improvement.
8. Install was good, training was also fine.
9. It is a good idea and I like it if it would work.
10. Just use audible system.
11. They should be place in the vehicle where it does not attract unwanted attention (theft) and should be mandatory in all school buses, emergency vehicles or tractors.
12. I was behind some and a train was coming and the alarm did not go off.
13. The audio stayed on too long and the sound was too piercing.
14. Audible signal could be reduced in volume and frequency after initial warning alert.
15. Should be on all public safety vehicles.
16. Too noisy + distracting safety belt sensor, radio, headlights on sensor, truck rattling, exterior horns and noise-don't need train warning. Hated the damn thing.



17. The system is greatly useful on crossings where visibility is limited or non-existent.
18. Re-check the system. Goes off at any given time when no tracks are present.
19. A demonstration should be done by someone from IDOT while the driver is driving at railroad crossing to get a better idea.
20. The gates never malfunction at these crossings. It is not hard to figure out a train is coming. The IVR works but seems unnecessary.
21. This device worked improperly.
22. It doesn't work properly.
23. The IVR system is very useful to have.
24. I would not trust or become dependent of this device, margin of error?
25. Good system for rural areas.
26. It went off so seldom that often I did not know what was making the noise right away (lots of noises in fire engine).
27. The sound is something not to be desired.
28. The IVR activated only once.
29. The audible mode should be little louder.
30. The unit should be in direct line of sight at head level.
31. In urban settings with protected crossings, the IVR is not effective. Install the transmitters on each engine, not each crossing.
32. There is plenty of warning system available. I would never depend on this device.
33. Too long of a program.
34. System is good for noisy situations police radios, air conditioning on etc.
35. If people fail to notice warning devices already in place at RR crossings then I don't think they would pay attention/notice the IVR system in their cars.
36. I think crossing gates w/flashing lights are adequate warning devices. If people disregard these, they will certainly ignore the IVR.
37. I would continue to use if they work.
38. Spend more money on educating people not to cross tracks when gates are down and operating than on this device.

39. Save the money and get rid of them.
40. Should have been at more locations for testing.
41. On at least one occasion, the system did not activate until the train was very close to the Greenwood crossing.
42. Needs to activate at greater distance.
43. Should include audible signal.

**Table 17: Q26. Verbatim suggestions on how to make the IVR more useful and effective.**

1. Eliminate false signals.
2. Decrease the occurrence of false readings (alerts).
3. Get rid of them. I don't see what the purpose is.
4. The system seemed to be set off by many different frequencies causing many false warnings. This never seemed to work quite right at anytime.
5. Put more crossing gates.
6. Should have audible to be helpful.
7. The system is too cheap to be reliable.
8. The concept is good for safety but its hardware needs work.
9. Reduce false warnings.
10. Place IVR systems at all crossings.
11. New technology.
12. Cancel the program.
13. I can not turn the volume down. It's too noisy.
14. The audible signal for loudness. Resume message should be brighter and bigger.
15. Doesn't go off in supermarket parking lots.
16. Better technology to make sure the IVR system works better and only at train crossings.
17. Get it to work for trains only. You start to disregard because of Jewel Osco.
18. Get the system not to go off anytime you go past neon lights.

19. Make sure the system does not activate when no train is present.
20. Try to perfect it. I believe this is a great idea for school buses and public transportation mainly children and the elderly.
21. Keep it on for a minute and then stop it. Some trains were long and the unit was on all the time.
22. System implementations at all locations.
23. Device is unnecessary and waste of technology. If you are so stupid as to drive around all existing bells and whistles and get hit by a train, then you deserve to have the full force of the law against you, including being fined just for being so stupid.
24. Install it at all crossings and in all buses.
25. Let the public and school board know of its effectiveness.
26. Remove it.
27. An option for a user to be able to shut off the audible portion of the device after it has been activated. Then it could automatically reset itself once the cause is dropped.
28. The intersection where it was installed was not used very often. If it could be placed at a busier crossing, I could give a better opinion of the system.
29. Through continued research.
30. More volume to audible alarm.
31. A private frequency for RR crossings only.
32. More advanced notice-before the already in place warnings of the RR.
33. I don't think the IVR is useful in our setting (fire engine).
34. It should be on all RR crossings. If it is only on a few it might leave the driver with confidence that he will always know when a train is coming even though no warning will be given at crossings that are not equipped. That is more dangerous.
35. Make sure it activates all the time. If it saves one life it is worth it.
36. Do not pick up police cars.
37. Put it in all vehicles.
38. The system seems to go off whenever I drive by a police car. If the IVR system can be adjusted so this doesn't happen, it would be more effective.
39. System needs to be activated by train not linked to existing gates.
40. The amount of times we have to re-start our vehicles, it gets annoying to hear the

unit switch on every time.

41. Reminder training once or twice a year.
42. Just use indicator light when starting the vehicle. Stop audible after train.
43. Wouldn't it be more effective to install it on each engine, instead of the thousands of grade crossings?
44. Combo is best since the visual was not obvious in bright sunshine.
45. Give advance warning or use this device at passive crossings.

## CONCLUSIONS

The combination and visual-plus drivers gave significantly different ratings to the advance warning sign, the crossbuck sign, the flashing lights and the IVR. The combination group gave an average effectiveness rating of 3.6 to the IVR that was significantly higher than the 2.5 rating from the visual-plus group, with 95% confidence. The combination group had already experienced previous IVR modes, visual or audible alone and showed a preference for the combination mode by rating it with “medium-high” effectiveness, but the visual-plus IVR users did not have that experience and gave the IVR system “medium-low” effectiveness.

The effectiveness rating for the combination mode of the IVR was similar to the clanging bell and the train horn, lower than the ratings for the crossing gate and flashing lights, but higher than the ratings for advance warning and the crossbuck signs, with 95% confidence. For the visual-plus group, the rating for the IVR was not significantly different than that of advance warning sign, but was significantly lower than the ratings of the other warning devices, with 95% confidence.

Comparison of the combination and visual-plus group showed that a much higher percentage of drivers in the combination group (61.0%) trusted the IVR compared to the visual-plus group (33.3%) to give an accurate warning of a train approaching/occupying the equipped crossings. The drivers in the combination group were also more aware when the IVR powered-on than the visual-plus group. This is mainly due to the beeping sound of the IVR heard by the combination group when they started the vehicles.

The false alert figures the drivers gave in the survey are generally lower than what they said in the focus group meetings. In the survey, the drivers responded that on the average, the IVR gave a warning message when no train was approaching/occupying the crossing 9.6 times in a three-month period (the range was 0 to 200). Drivers stated that the IVR failed to give a warning when a train was approaching/occupying the equipped crossings an average of 1.4 times in a three-month period (the range was 0 to 50).

In general, the drivers were satisfied with the quality of the message they received and 43.8% rated the quality of the visual message from the IVR as good or excellent,

18.8% said it was fair, but 26.2% said it was poor. Approximately 54.2% of the drivers thought that the overall quality of the combination mode message was good or excellent, 28.7% said it was fair, but 7.9% said it was poor.

Among the drivers who had experience with the audible, visual, and combination modes, 71.0% said the audible mode, 26.7% said the visual mode, and 77.2% said the combination mode had a high or very high ability to attract their attention. The audible, visual, and combination modes received low and very low ratings by 7%, 32.4%, and 4.2% of the drivers, respectively. It is very clear that the beeping sound got the attention of the drivers. Approximately 54.9% of the drivers preferred the combination of the audible and visual mode, 20.1% of the drivers preferred the audible, 3.7% preferred the visual mode, 6.1% preferred to have no system, 7.9% did not have any preference, and 7.3% did not respond. The majority of the drivers, 58.5%, indicated that none of the warning methods was a significant distraction while driving, however, 7.3% of the drivers said that the combination, 4.9% said that the visual, and 15.2% said that the audible IVR mode was distracting.

For a period of 9 months, the average number of times the IVR gave a warning when no train was present was of 11.1. In contrast, for a three-month period, the drivers gave an average false alert rate of 9.6 times. The 11.1 figure is much lower than expected and indicates that drivers forgot these types of problems over time. The highest number of false alerts reported was 350 for the 9 month time period. Of the respondents, 90.3% received no more than 25 false alerts when no train was present. About 33.5% received no false alerts and 7.7% received only one false alert when no train was present.

Overall, the drivers were not frustrated with the system and 47.1% of the drivers were in favor of the Illinois Department of Transportation installing IVR systems at more railroad crossings, while 31.1% disapproved. About 21.8% of the participants did not have an opinion or did not answer this question. Given a choice, 44.7% of the drivers said they would continue to use the IVR, 42.2 % said they would not, and 12.7% gave no opinion.

## REFERENCES

1. 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.
2. Benekohal, R.F. and Rawls, C. G., “Analyses of the Drivers’ Responses (in Survey Number 2) 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.
3. Benekohal, R.F. and Rawls, C. G., “Analyses of the Drivers’ Responses (in Survey Number 3) to the In-Vehicle Receiver (IVR) After Experiencing Two Modes of Operation”, Report No, FHWA-IL/UI-TOL-12, March 2004, University of Illinois at Urbana-Champaign.
4. 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.

## APPENDIX A



## COMBINATION AUDIBLE AND VISUAL MODE

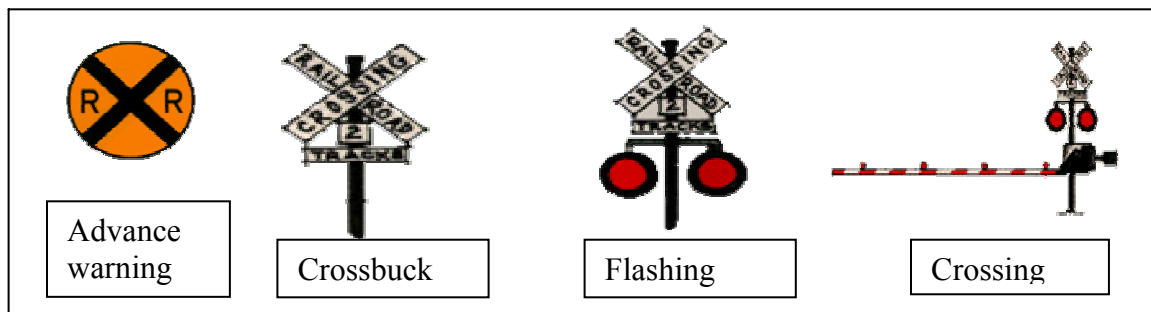
### Survey of Professional Drivers' Opinions for Pilot Study of Advisory On-Board Vehicle Warning Systems at Railroad Grade Crossings

**This is the last survey for this study.** The University of Illinois at Urbana-Champaign is conducting this survey for IDOT. Your responses will be kept confidential. The survey covers the time period your In-Vehicle Receiver (IVR) was giving COMBINED audible and visual messages. Please complete and *RETURN in the enclosed envelope. THANK YOU FOR YOUR HELP.*

- 1) How long have you driven a vehicle with the In-Vehicle Receiver (IVR) in the combination audible and visual mode?
- a) 1 month                      b) 2 months                      c) 3 months                      d) Other (specify)\_\_\_\_\_

- 2) In the past 3 months, have you used any of the following railroad grade crossings? For a "Yes" response please give frequency.

	<u>Community</u>	<u>Crossing</u>	No	Yes	_____ Times/week
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:

	<b>EFFECTIVENESS</b>					
	<u>Very High</u>	<u>High</u>	<u>Medium</u>	<u>Low</u>	<u>Very Low</u>	<u>No Opinion</u>
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 giving combined messages	5	4	3	2	1	0

- 4) Did you trust your IVR to give you an accurate warning of a train approaching or occupying the equipped crossings in Question 2?
- a) Yes, I trusted it very much                      c) No, I did not trust it  
b) Yes, I trusted it to some degree                d) Don't recall/No opinion
- 5) Since your IVR was operating in the combination audible and 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) Since your IVR was operating in the combination audible and visual mode, how many times has your IVR given you a warning when a train WAS NOT approaching or occupying the crossings in Question 2?
- a) \_\_\_\_\_ Times                      b) Don't recall/No opinion
- 7) Since your IVR was operating in the combination audible and 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) Since your IVR was operating in the combination audible and 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) Since your IVR was operating in the combination audible and 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) Overall, was the IVR combined audible and visual warning message noticeable from any other audible and visual messages you received while driving?
- a) Yes                      b) No                      c) No opinion
- 11) How would you rate the overall quality of the combined audible and visual warning message you received from your IVR?

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

12) If you had experience with the IVR operating in ALL THREE modes, please rate the ability of each mode to attract your attention (If not please skip to Question # 15):

**ABILITY TO ATTRACT ATTENTION**

	<u>Very High</u>	<u>High</u>	<u>Medium</u>	<u>Low</u>	<u>Very Low</u>	<u>No Opinion</u>
a) Audible ONLY	5	4	3	2	1	0
b) Visual ONLY	5	4	3	2	1	0
c) Combination of audible and visual	5	4	3	2	1	0

13) Which IVR mode did you prefer?

- a) Audible only mode
- b) Visual only mode
- c) Combination of audible and visual modes
- d) None of them
- e) No preference

14) Did any of the warning methods pose a significant driving distraction to you? (circle all that apply)

- a) Audible ONLY warning was a significant distraction while driving
- b) Visual ONLY warning was a significant distraction while driving
- c) Combined audible and visual warning was a significant distraction while driving
- d) None of the warning methods was a significant distraction while driving
- e) No opinion

15) Was the IVR mounted in your vehicle in a place where it was easily seen and/or heard?

- a) Yes
- b) No
- c) No opinion

**Instruction and Training**

16) How useful was the instruction and training program in familiarizing you with the IVR system?

	<u>Very useful</u>	<u>Somewhat useful</u>	<u>Not useful</u>	<u>No opinion</u>
a) The instructional videotape	3	2	1	0
b) The laminated written information card placed in your vehicle	3	2	1	0
c) The question/answer session during training	3	2	1	0

17) Overall, how would you rate the amount of instruction/training you received regarding the IVR system?

- a) Not enough
- b) Right amount
- c) Too much
- d) No opinion

18) What additional instruction/training would you suggest? \_\_\_\_\_  
\_\_\_\_\_

19) What instruction/training should be reduced/eliminated? \_\_\_\_\_  
\_\_\_\_\_

**Overall Comments on IVR Warning System**

20) During the period March 2000-December 2000, how many months did you drive a vehicle equipped with an IVR? \_\_\_\_\_ months

21) During the period March 2000-December 2000, how many times did your IVR give you a warning message when no train was present? \_\_\_\_\_ times

- 22) In your opinion, did the IVR activation generally occur
- a) Too far from the railroad crossing (too much time)
  - b) At the proper distance (adequate warning time)
  - c) Too close to railroad crossing (not enough time)
  - d) No opinion

23) Should the State of Illinois install IVR systems at more railroad crossings?

- a) Yes                      b) No                      c) No opinion

24) If given the choice, would you continue to use the IVR?

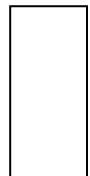
- a) Yes                      b) No                      c) No opinion

25) Do you have any additional comments regarding installation, training, placement or operation of the IVR system? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

26) What can be done to make the IVR system more effective and useful? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Please Return to:**

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



## VISUAL MODE ONLY (VISUAL PLUS)

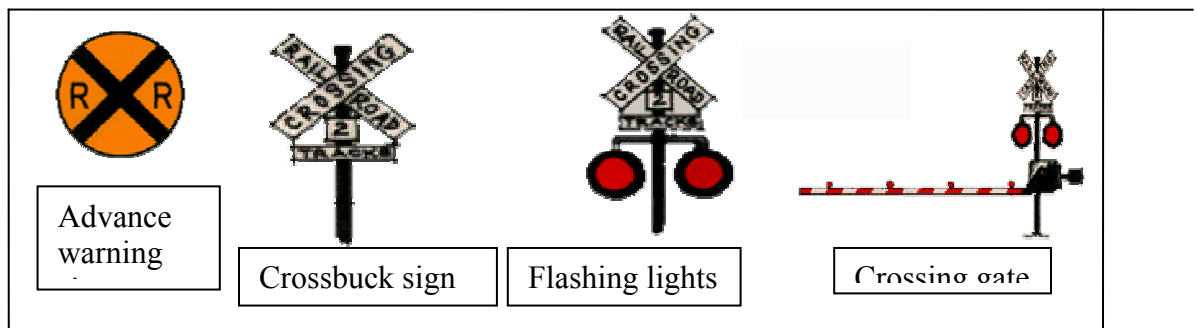
### Survey of Professional Drivers' Opinions for Pilot Study of Advisory On-Board Vehicle Warning Systems at Railroad Grade Crossings

**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                      d) Others (specify)\_\_\_\_\_months

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

	<u>Community</u>	<u>Crossing</u>	No	Yes	_____	Times/week
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:

	<b>EFFECTIVENESS</b>					
	<u>Very High</u>	<u>High</u>	<u>Medium</u>	<u>Low</u>	<u>Very Low</u>	<u>No Opinion</u>
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



**Visual warnings from the In-Vehicle Receiver**

- 11) During daytime and nighttime, how well can you see the **visual** display (the flashing message) on the In-Vehicle Receiver?
- |                |                  |
|----------------|------------------|
| <u>Daytime</u> | <u>Nighttime</u> |
| a) Too dim     | a) Too dim       |
| b) Just right  | b) Just right    |
| c) Too bright  | c) Too bright    |
| d) No opinion  | d) No opinion    |
- 12) Is the size of the lettering for the warning message on the visual display easy to read?
- |                            |                          |
|----------------------------|--------------------------|
| a) Yes, easily readable    | c) No, lettering too big |
| b) No, lettering too small | d) No opinion            |
- 13) How does the blinking rate of the warning message affect readability?
- |                          |                    |
|--------------------------|--------------------|
| a) Blinks too fast       | c) Blinks too slow |
| b) Blinks at right speed | d) No opinion      |
- 14) Is the color of the visual warning message easily noticed?
- a) Yes            b) No, it should use the color \_\_\_\_\_ instead            c) No opinion
- 15) 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
- 16) 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

**Instruction and Training**

- 17) How useful was the instruction and training program in familiarizing you with the IVR system?
- |  | <u>Very useful</u> | <u>Somewhat useful</u> | <u>Not useful</u> | <u>No opinion</u> |
|--|--------------------|------------------------|-------------------|-------------------|
| a) The instructional videotape                                   | 3                  | 2                      | 1                 | 0                 |
| b) The laminated written information card placed in your vehicle | 3                  | 2                      | 1                 | 0                 |
| c) The question/answer session during training                   | 3                  | 2                      | 1                 | 0                 |
- 18) Overall, how would you rate the amount of instruction/training you received regarding the IVR system?
- a) Not enough            b) Right amount            c) Too much            d) No opinion
- 19) What additional instruction/training would you suggest? \_\_\_\_\_
-

20) What instruction/training should be reduced/eliminated? \_\_\_\_\_  
\_\_\_\_\_

**Overall Comments on IVR Warning System**

21) During the period March 2000-December 2000, how many months did you drive a vehicle equipped with an IVR? \_\_\_\_\_ months

22) During the period March 2000-December 2000, how many times did your IVR give you a warning message when no train was present? \_\_\_\_\_ times

- 23) In your opinion, did the IVR activation generally occur
- a) Too far from the railroad crossing (too much time)
  - b) At the proper distance (adequate warning time)
  - c) Too close to railroad crossing (not enough time)
  - d) No opinion

24) Should the State of Illinois install IVR systems at more railroad crossings?

- a) Yes                      b) No                      c) No opinion

25) If given the choice, would you continue to use the IVR?

- a) Yes                      b) No                      c) No opinion

26) Do you have any additional comments regarding installation, training, placement or operation of the IVR system? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

27) What can be done to make the IVR system more effective and useful? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Please Return to:**

**Professor R. F. Benekohal  
University of Illinois at Urbana-Champaign  
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