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Pedestrian/Bicyclist Warning Devices and Signs at CTA Rail-Highway Grade Crossings

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TECHNICAL SUMMARY

Title

Pedestrian/Bicyclist Warning Devices and Signs at CTA Rail-Highway Grade Crossings

Introduction

In the last 10 years, contrary to a decrease in the number of train-vehicle collisions at highway-rail grade crossings, the number of pedestrian and bicycle fatalities at highway-rail grade crossings has increased. The objective of this study was to contribute to the still limited research on pedestrian safety at rail grade crossings by expanding the scope of a previous study (Metaxatos and Sriraj, 2013) to include rail grade crossings operated by the Chicago Transit Authority (CTA),

Approach and Methodology

The study was divided into three components: (a) a literature review; (b) identification of seven survey locations; and (c) survey of non-motorized users and analysis of pedestrian attitudes.

Findings but did not examine CTA standards, efforts and record on grade crossing safety.

The primary findings from the literature review include:

1. There is a wide variety of Manual on Uniform Traffic Control Devices (MUTCD) compliant signs and devices used to warn pedestrians of the presence of a crossing, as well as the approach of a train. There are also a large number of non-compliant MUTCD signs and devices utilized.
2. The warning signs and devices include: pavement markings, detectable warnings (e.g., audible tones, verbal messages, and/or vibrating surfaces), channelization devices (e.g., different types of fencing, swing gates, zigzag/Z-gates, corrals), audible/visual warnings (e.g., low-rise flashing pedestrian signals, multi-use path flashing light signals), automatic pedestrian gates (e.g., short gate arms), and “second train coming” electronic warning signs.
3. The effectiveness to reduce the risk of a collision between a pedestrian and a train of any particular sign or device is unknown.
4. A number of criteria are used to select warning devices for deployment at pedestrian–rail grade crossings, including pedestrian collision experience at the crossing, frequency of inclement weather, pedestrian volumes and peak flows, train speeds, number of trains,

railroad traffic patterns, surrounding land uses, sight distance for pedestrians approaching the crossing, skew angle of the crossing relative to the railroad tracks, existence of multiple tracks, vicinity to a commuter station, and installation/maintenance costs.

5. Few existing methodologies allow for assessing trade-offs among those factors during the selection process, and the potential of newer approaches is not well understood. In particular, there is no commonly accepted method to quantify the risk to pedestrian of being struck by a train at either a highway-rail crossing with pedestrian access.
6. As consistency of engineering standards improves it would be important to monitor the impact on pedestrian safety.
7. It is increasingly important to better track the programming and the expenditure for safety upgrades at grade crossings.
8. There is a need to develop a cost-effectiveness evaluation process to facilitate the activities of a diagnostic team.
9. It is important addressing the needs of users with disabilities at grade crossings to better manage the risk for catastrophic incidents.
10. Continuation of adequate funding for strong local advocacy toward education and enforcement activities is critical to pedestrian safety.

The primary findings from the survey of non-motorized users at seven select CTA grade crossings, and the analysis of pedestrian attitudes, provide additional insight to the literature review of pedestrian safety at railroad grade crossings generally. These findings include:

1. Certain activities, such as talking on a cell phone, or listening to music on earphones, may interfere with environmental awareness while traveling across a grade crossing.
2. Older users, older than 51 years of age, noticed active signs at grade crossings more frequently than passive signs.
3. Overall, female respondents in all age groups appear to be more safety conscious than male respondents when using a crossing. In addition, young males (under 21 years old) appear to be the only group in this sample more likely to cross the tracks against activated signals/warning devices, if in a hurry.
4. Trespassing by crossing the tracks at locations other than a pedestrian crossing is still a habit of a small minority of users that merits attention.
5. Safety improvements at pedestrian grade crossings should always consider the special needs of people with disabilities.
6. Additional educational and enforcement campaigns may be necessary to convince all pedestrian users that (1) it is illegal to cross against activated signals/devices and (2) crossing the tracks at locations other than a pedestrian crossing constitutes trespassing.

7. The propensity of respondents of age 30 years and younger to be in violation of activated devices and signs while crossing the tracks was about three times that of respondents older than 30 years of age.

Conclusions

The focus of this research was on individuals who utilize legally authorized CTA highway-rail crossings with pedestrian access. While trespassing is a major public safety issue, it is not the focus of this research.

An extensive review of the literature concluded that there is a wide variety of warning signs and devices utilized. Some are MUTCD compliant, but many are not. Moreover, none of the warning signs and devices has undergone rigorous testing to develop effectiveness rates. In addition, there is not a standard method to quantify and evaluate pedestrian risk at highway-rail grade crossings.

This study identified seven locations at CTA rail grade crossings suitable to conduct paper/pen manual user surveys. Two hundred and eleven valid surveys were gathered. Within the survey scope limitations and to the extent that observations from the analysis of the users survey can be generalized, several findings below merit attention because they may have implications about the design and placement of signs and warning systems at CTA pedestrian-rail grade crossings, as well as education and enforcement initiatives.

- Certain activities, such as talking on a cell phone, or listening to music on earphones, may interfere with environmental awareness while traveling across a grade crossing.
- Older users, older than 51 years of age, noticed active signs at grade crossings more frequently than passive signs.
- Overall, female respondents in all age groups appear to be more safety conscious than male respondents when using a crossing. In addition, young males (under 21 years old) appear to be the only group in this sample more likely to cross the tracks against activated signals/warning devices, if in a hurry.
- Trespassing by crossing the tracks at locations other than a pedestrian crossing is still a habit of a small minority of users that merits attention.
- Safety improvements at pedestrian grade crossings should always consider the special needs of people with disabilities.
- Additional educational and enforcement campaigns may be necessary to convince all pedestrian users that (1) it is illegal to cross against activated signals/devices and (2) crossing the tracks at locations other than a pedestrian crossing constitutes trespassing.
- The propensity of respondents of age 30 years and younger to be in violation of activated devices and signs while crossing the tracks was about three times that of respondents older than 30 years of age.

Recommendations

The study recommends the following actions to advance safety for non-motorized users at CTA pedestrian-rail grade crossings: (1) Expand MUTCD compliance on all warning signs and devices utilized; (2) Develop methods to determine the effectiveness of warning signs and devices utilized; (3) Develop methods to assess pedestrian risk; (4) Support educational campaigns that promote environmental awareness, especially among younger male users; (5) Promote safety improvements that consider the special needs of people with disabilities.

Publications

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PEDESTRIAN/BICYCLIST WARNING DEVICES AND SIGNS AT CTA RAIL-HIGHWAY GRADE CROSSINGS

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EXECUTIVE SUMMARY

In the last ten years, contrary to a decrease in the number of train–vehicle collisions at highway-rail grade crossings, the number of pedestrian and bicycle fatalities at highway-rail grade crossings has remained relatively constant. The objective of this study was to contribute to the still limited research on pedestrian safety at rail grade crossings by expanding the scope of a previous study (Metaxatos and Sriraj, 2013) to include rail grade crossings operated by the Chicago Transit Authority (CTA), but did not examine CTA standards, efforts and record on grade crossing safety. It should be noted that the findings were not corroborated with observations of CTA safety policies and practices at rail grade crossings. The study was divided into three components: (a) a literature review; (b) identification survey locations; and (c) survey of non-motorized users and analysis of pedestrian attitudes.

A review of the pertinent published literature on pedestrian safety related to highway-rail grade crossings found a distinct lack of any standards to analyze/quantify pedestrian risk and design effective treatments to reduce the risk to non-motorized users from being struck by a train. The primary findings from the literature review include:

1. There is a wide variety of Manual on Uniform Traffic Control Devices (MUTCD) compliant signs and devices used to warn pedestrians of the presence of a crossing, as well as the approach of a train. There are also a large number of non-compliant MUTCD signs and devices utilized.
2. The warning signs and devices include: pavement markings, detectable warnings (e.g., audible tones, verbal messages, and/or vibrating surfaces), channelization devices (e.g., different types of fencing, swing gates, zigzag/Z-gates, corrals), audible/visual warnings (e.g., low-rise flashing pedestrian signals, multi-use path flashing light signals), automatic pedestrian gates (e.g., short gate arms), and “second train coming” electronic warning signs.
3. The effectiveness to reduce the risk of a collision between a pedestrian and a train of any particular sign or device is unknown.
4. A number of criteria are used to select warning devices for deployment at pedestrian–rail grade crossings, including pedestrian collision experience at the crossing, frequency of inclement weather, pedestrian volumes and peak flows, train speeds, number of trains, railroad traffic patterns, surrounding land uses, sight distance for pedestrians approaching the crossing, skew angle of the crossing relative to the railroad tracks, existence of multiple tracks, vicinity to a commuter station, and installation/maintenance costs.
5. Few existing methodologies allow for assessing trade-offs among those factors during the selection process, and the potential of newer approaches is not well understood. In particular, there is no commonly accepted method to quantify the risk to pedestrian of being struck by a train at either a highway-rail crossing with pedestrian access.
6. As consistency of engineering standards improves it would be important to monitor the impact on pedestrian safety.
7. It is increasingly important to better track the programming and the expenditure for safety upgrades at grade crossings.

8. There is a need to develop a cost-effectiveness evaluation process to facilitate the activities of a diagnostic team.
9. It is important addressing the needs of users with disabilities at grade crossings to better manage the risk for catastrophic incidents.
10. Continuation of adequate funding for strong local advocacy toward education and enforcement activities is critical to pedestrian safety.

The second phase of the study consisted of identification of seven locations used to conduct a survey of users. The survey of users permitted an analysis of user perception pertaining to pedestrian safety at those seven grade crossings. A total of 211 usable surveys were obtained. Within the survey scope limitations and to the extent that observations from the analysis of the users survey can be generalized, several findings below merit attention because they may have implications about the design and placement of signs and warning systems at CTA pedestrian-rail grade crossings, as well as education and enforcement initiatives.

- Certain activities, such as talking on a cell phone, or listening to music on earphones, may interfere with environmental awareness while traveling across a grade crossing.
- Older users, older than 51 years of age, noticed active signs at grade crossings more frequently than passive signs.
- Overall, female respondents in all age groups appear to be more safety conscious than male respondents when using a crossing. In addition, young males (under 21 years old) appear to be the only group in this sample more likely to cross the tracks against activated signals/warning devices, if in a hurry.
- Trespassing by crossing the tracks at locations other than a pedestrian crossing is still a habit of a small minority of users that merits attention.
- Safety improvements at pedestrian grade crossings should always consider the special needs of people with disabilities.
- Additional educational and enforcement campaigns may be necessary to convince all pedestrian users that (1) it is illegal to cross against activated signals/devices and (2) crossing the tracks at locations other than a pedestrian crossing constitutes trespassing.
- The propensity of respondents of age 30 years and younger to be in violation of activated devices and signs while crossing the tracks was about three times that of respondents older than 30 years of age.

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LITERATURE REVIEW

1.1 INTRODUCTION

In the United States, despite a 69% reduction in road-rail crossing accidents from 1978 to 1994, hundreds of fatalities still occur every year, resulting in economic losses amounting to more than US$1 billion in medical costs, insurance payments, legal fees, and damages to railroad property (U.S. Department of Transportation (USDOT), 1994). Goldberg et al. (1998) calculated that the annual direct cost to society in the United States exceeded $300 million annually. In addition, indirect costs – medical costs, insurance payments, legal fees, and damages to property – must push such estimates into billions of dollars, not to mention the human tragedy that each accident represents. Recent estimates for such direct and indirect costs are reported to be as high as $7.9 million per crash or almost $600,000 annually per crash at each crossing (Brod et al., 2013).

In contrast to the declining number of fatalities due to train-vehicle collisions at highway-rail grade crossings, the number of non-motorist fatalities at rail grade crossings remains relatively unchanged. Indeed between 1994 and 2007, incidents at highway-rail grade crossings declined 44%. However, between 2003 and 2007 the number of pedestrian incidents remained unchanged (Horton, 2010).

Clearly, pedestrian crossing incidents occur in different settings requiring the coordination of different stakeholders with context sensitive solutions. For example, incidents involving violations at rail grade crossings are different than trespassing incidents away from such crossings. Even more, pedestrian crossing incidents at exclusive pedestrian crossings (including rail stations) are different than those occurring at highway-rail grade crossings. Furthermore, incidents in crossings with commuter rail or light rail would require different countermeasures than those occurring in crossings with freight rail. In addition to pedestrians, pedestrian crossings serve other types of non-motorized users including cyclists and wheelchair users, although cyclists may mostly travel on the main highway as opposed to pedestrians and wheelchair users on the sidewalk. Other types of users include pedestrians on skateboards, rollerblades and equestrians.

A large array of treatments has been applied in different rail grade crossing environments to improve the safety of non-motorized users, but their effectiveness remains difficult to assess (Metaxatos and Sriraj, 2013). This chapter will highlight thematic areas related to pedestrian safety at rail grade crossings that are primed for further research and policy intervention. The presentation will synthesize literature findings and discussions with expert professionals in the public and private sectors. The objective of this chapter is to offer an informed and focused discussion for researchers and practitioners involved with safety at rail grade crossings. It should be noted that the discussion in this chapter has not corroborated with observations of CTA safety policies and practices at rail grade crossings.

1.2 LITERATURE REVIEW

In this report the terms ‘pedestrian’, ‘non-motorists’ and ‘non-motorized users’ will be used interchangeably. The literature findings will discuss issues with warning devices, accessible non-motorist signals, engineering, education and enforcement, engineering standards and guidelines, intelligent grade crossings, and cost considerations. Such issues have received considerable attention and remain central in the discussion of pedestrian safety but, to our knowledge, have never been presented in a comprehensive manner.

1.2.1 Warning Devices

A Federal Railroad Administration (FRA) report (USDOT/FRA, 2008) on existing pedestrian safety devices at grade crossings discusses active and passive devices both in and not included in the Manual on Uniform Traffic Control Devices (MUTCD). Examples of devices illustrated include: audible/visual devices, such as low-rise flashing pedestrian signals and multi-use path flashing light signals; highly reflective passive warning signs; short gate arms; channelizing devices, such as different types of fencing, swing gates, and zigzag or Z-gates; and second-train-coming electronic warning signs. According to the report, various factors that should be examined during device selection include: (a) collision experience, if any, at the crossing, as it involves pedestrians;(b) pedestrian volumes and peak flows, if any; (c) train speeds, numbers of trains, and railroad traffic patterns, if any; (d) sight distance that is available to pedestrians approaching the crossing; and (e) skew angle, if any, of the crossing relative to the railroad tracks.

A study evaluating the effects of the installation of a train-activated signal intended to warn pedestrians when two or more trains are approaching a highway-rail intersection was conducted in Los Angeles by Khawani (2001). The study found that the installation of the signal reduced the incidence of risky pedestrian behavior as measured by the time elapsed between the pedestrian entering the tracks and the arrival/departure of a train.

A “Second Train Coming” warning sign demonstration project was conducted by the Los Angeles County Metropolitan Transportation Authority (TRB, 2001). In that case, the pedestrian sidewalk crossed two light rail transit (LRT) tracks and two freight rail tracks. The study found that the warning sign was effective in reducing risky behavior as measured by an overall 14 percent reduction in the number of pedestrians crossing the LRT tracks at less than 15 seconds in front of an approaching LRT train. Additionally, the number of pedestrians crossing the LRT tracks at 6 seconds or less before an LRT train entered the crossing was reduced by about 32 percent. Finally, the number of pedestrians crossing the tracks at 4 seconds or less in front of an approaching LRT train was reduced by 73 percent.

1.2.2 Accessible Non-Motorist Signals

Accessible pedestrian signals (APS) are devices that communicate information about pedestrian timing in nonvisual formats such as audible tones, verbal messages, and/or vibrating surfaces (MUTCD, Section 4A.01) (USDOT/FHWA, 2009). APS can provide information to pedestrians about the existence and location of the pushbutton; the onset of the walk interval; the direction of the crosswalk and location of the destination curb; the clearance interval; intersection geometry through maps, diagrams, or speech; intersection street names in Braille, raised print, or speech; and intersection signalization (Barlow et al., 2003). Description of such features is given in the published guidelines by the U.S. Architectural and Transportation Barriers Compliance Board (2005).

APS at rail grade crossings may assist disabled pedestrians with making better judgments in regard to safely crossing the tracks at rail grade crossings. However, research about APS use in such environments is limited. Indeed Korve Engineering (2007) found only limited research testing APS under field conditions in LRT environments and no additional research other than Blasch (1999) comparing the effectiveness of different APS in normal traffic conditions. In addition, in the United Kingdom, Delmonte and Tong (2011) conducted a comprehensive analysis to identify solutions for improving safety and accessibility at level crossings for disabled pedestrians.

1.2.3 Engineering, Education and Enforcement

Under the Rail Safety Improvement Act of 2008 (P.L. No. 110-432), the U.S. Department of Transportation has developed model railroad trespassing, vandalism, and highway-rail grade crossing warning device violation prevention strategies to assist State and local governments, and railroads. These strategies fall under three broad categories: 1) expanding educational outreach, 2) energizing enforcement, and 3) fostering engineering and sight improvements. Educational outreach involves public awareness programs helping non-motorists to safely navigate grade crossings. Consistent enforcement of traffic safety laws by State or local police, and a sustained effort by the courts to impose penalties on violators, discourage and deter non-motorists from making poor decisions at grade crossings. A recent report has published the latest compilation of state laws and regulations affecting highway-rail grade crossings (Jennings, 2009). Moreover, engineering improvements greatly reduce or prevent the potential for non-motorist-train collisions (USDOT/FRA, 2010). Finally, Fitzpatrick et al. (2015) presents additional discussion about engineering treatments for light rail, commuter rail, and streetcar rail services.

The Illinois Commerce Commission (ICC), and the FRA initiated the Public Education and Enforcement Research Study (PEERS) to measure the before and after change in the public's adherence to traffic safety laws (Sposato et al., 2006). The study demonstrated a reduction in crossing violations and a dramatic reduction in the most dangerous pedestrian behavior.

1.2.4 Engineering Standards and Guidelines

The Federal Highway Administration's (FHWA's) Railroad-Highway Grade Crossing Handbook (Ogden, 2007) provides guidance about pedestrian crossings. Additional guidance is provided by the MUTCD (USDOT/FHWA, 2009, Part 8), American Railway Engineering and Maintenance of Way Association (AREMA) Communications & Signal Manual (AREMA, 2010), and Code of Federal Regulations 49 (Part 234). In addition, the FHWA's Handbook (Ogden, 2007) identifies pedestrian crossing treatments and provides recommendations for flashing light signals, second train coming signals, dynamic envelope markings, pedestrian automatic gates, swing gates, bedstead (maze) barriers, z-crossing channelization, and combined pedestrian treatments.

Different standards apply to at-grade crossings of light rail transit (LRT). LRT has at least five different categories of operational alignments all of which have criteria for the type of warning systems needed at intersections based on the maximum operating speeds. Usually at speeds under 35 mph, LRTs use the existing street traffic signal controls in conjunction with priority and preemption controls (Korve et al., 1996). At speeds above 35 mph Active Warning Railroad systems are used in conjunction with adjacent traffic signal controls (Korve et al., 2001). Additional guidelines for improving pedestrian and motorist safety along LRT alignments are reported in (Cleghorn et al., 2009).

In California, CalTrain developed their own design criteria regarding grade crossings and began implementing them in 1999 (CalTrain, 2009). These standard practices utilize active warning devices similar to those at vehicular crossings: signal equipment modified from that of vehicular crossing, crossing gate arm, and a crossing configuration which channels pedestrians. Different design criteria apply for pedestrian crossings in general regarding warning time, center fence, warning devices, safety buffer zone, warning assemblies, gate recovery, as well as pedestrian crossings at stations, at stations and roadway, and crossings between roadway crossings.

In addition, also in California, the SCRRA (aka Metrolink) Highway-Rail Grade Crossings Recommended Design Practices and Standards Manual (SCRRA, 2009) is a comprehensive single document that incorporates current and applicable highway-rail and pedestrian-rail grade crossing design standards and recommended design practices. Regarding pedestrian rail grade crossings, the manual finds that pedestrian treatments work well with proper channelization and signs, as well as sidewalks on either side of tracks and/or through the track area. Moreover, pavement striping continued across the track portion of roadway is a good visual and effective. In addition it is important to add extra pedestrian treatments near stations for riders running to catch trains. Finally, the manual provides a decision tree to determine the designs of pedestrian-rail grade crossings and appropriate warning treatments.

The American Public Transportation Association (APTA) provides guidance for rail transit systems for selecting, installing and operating highway rail transit grade crossing warning systems and includes minimum requirements for highway rail grade crossing warning devices, highway traffic signs and other highway traffic control appliances (APTA, 2007). Particular recommendations are made for pedestrians at rail grade crossings.

The California Public Utilities Commission (CPUC) has published extensive design guidelines for pedestrian-rail crossings within the state of California (CPUC, 2008). Their review of design considerations and installations includes recommendations for swing gates, detectable warnings, and pedestrian gates, flashing light signal assemblies, signage, crossing surfaces, channelization design and other treatments. Signage must conform to the state MUTCD. The report makes a particular reference to the Transportation Research Board's Transit Cooperative Research Program (TCRP) Report 69 Section 3.8.3 (Korve et al., 2001) which provides a decision tree as a tool to determine appropriate pedestrian-rail at-grade crossing treatments. The tool has been adopted by TriMet in Portland, Oregon but otherwise has not been validated by research (private communication with Brent Ogden, one of the co-authors of the study, 11/17/2011). In addition, a risk-scoring methodology to evaluate safety factors at station pedestrian crossings is in use in the United Kingdom (U.K. Department for Transport, 2006).

A risk-assessment methodology for pedestrian grade crossings is part of the Australian Level Crossing Assessment Model (ALCAM) still under development (Ford & Heneker, 2004; Spicer, 2007). The model is an assessment tool used to identify key potential risks at level crossings and to assist in the prioritization of railway level crossings according to their comparative safety risk. ALCAM uses a scoring algorithm which considers each level crossing's physical properties (characteristics and controls) including consideration of the related common human behaviors, to provide each level crossing with a "Likelihood Factor" score. This score is then multiplied by the level crossings "Exposure" score (a factor taking into account the volumes of Vehicles / Pedestrians & Trains) & finally multiplied by the Consequence score (which is set to be one for pedestrians) to give the ALCAM Risk Score.

The ALCAM model is designed to apply for both active and passive grade crossings, whereas the Risk Assessment of Accident and Incident at Level crossings (RAAILc) model can be used for predicting accidents at passive level crossings only. A review by Little (2007a) has categorized ALCAM under a simple weighted factor, and RAAILc as a statistically driven approach. Note that the ALCAM model is different than the All Level Crossings Risk Model (ALCRM) that was developed in the United Kingdom and was categorized as a complex weighted factor model in that review. Interestingly, Little, in the same review, found only four operational models that take into account the number of pedestrians using the crossing. Newer approaches based on simulation methods such as Petri nets are still developing (Ishak et al., 2010).

1.2.5 Intelligent Grade Crossings

Interesting new developments in the area of Cooperative Intelligent Transportation Systems (ITS) may bring to bear applications that could dramatically affect safety for non-motorized users in grade crossings in the not so distant future. Vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle to consumer devices (V2D) are being developed to deliver more safety mobility benefits. Pedestrians and non-motorized users, in general, at rail grade crossings will be able to receive personalized advance warning of incoming trains in time to avoid injuries and fatalities.

1.2.6 Cost Considerations

The cost breakdown (2000 U.S. dollars) of the "Second Train Coming" warning sign demonstration (TRB, 2001) included: (a) $15,000 for the "Second Train Coming" sign; (b) $80,000 for the sign installation including track circuit modification and camera equipment; (c) $35,000 for project management and engineering; and (d) $70,000 for project evaluation.

Roop et al. (2005) argue that likely candidate technologies that can reduce active warning costs at highway-rail crossings are those with significantly lower installation costs. In a fully redundant system, installation is one of the largest cost items of systems now in use, ranging from 25 to 35 percent of the total system cost.

Cost figures provided by SafeTran Systems (Petit, 2001) about the cost of active warning systems provide a component breakdown showing, among other things, that for a fully redundant system, installation (labor) is one of the largest cost components, ranging from 25 to 35 percent of the total system cost (for Class I railroads). Train detection, on the other hand, may only comprise 20 to 25 percent of the total cost – and train detection is where most people think the economies are to be achieved.

1.2.7 Conclusions from the Literature Review Synthesis

Communities and railroads have installed various warning devices for non-motorized users at rail grade crossings including signage, pavement markings, detectable warnings, channeling pedestrian traffic, audible/visual warnings, automatic pedestrian gates, and "second train coming" electronic warning signs. A number of criteria are used to select warning devices for deployment at pedestrian-rail grade crossings including: pedestrian collision experience at the crossing, frequency of inclement weather, pedestrian volumes and peak flows, train speeds, numbers of trains, railroad traffic patterns, surrounding land uses, sight distance for pedestrians approaching the crossing, skew angle of the crossing relative to the railroad tracks, existence of multiple tracks, vicinity to a commuter station, and installation/maintenance costs. However, very few existing methodologies allow for assessing trade-offs among those factors during the selection process, and the potential of newer approaches is not well understood.

1.3 INTERVIEWS WITH EXPERT PROFESSIONALS

The previous study (Metaxatos and Sriraj, 2013) conducted telephone interviews of experts in rail crossing safety from both the public and private sectors using structured questionnaires that were based on findings from the literature. The purpose of the interviews was to obtain information about (1) additional relevant literature that could not be located in the literature search discussed in the previous section (e.g., internal studies, consultant reports); (2) agency experiences with planning, implementation, and evaluation of warning devices under study; (3) cost estimates and/or actual costs of such warning systems; and (4) policies for use of warning signs for non-motorized users at grade crossings.

The following questions were asked:

- What types of non-motorist safety treatments have you installed at rail grade crossings?
- What types of Accessible Pedestrian Signals have you installed?
- What information do you have on cost estimates and/or actual costs of the warning systems you have already installed?
- How do you evaluate the cost-effectiveness of such safety treatments?
- What criteria are you using for the selection of warning devices for deployment?
- How do you prioritize/make trade-offs between these factors during the selection process?
- What engineering standards and guidelines do you apply to such crossings?
- What are your educational outreach activities (e.g., public awareness programs, partnerships with other organizations, etc.). How effective are they?
- What are your enforcement initiatives (e.g., police, courts). How effective are they?
- What is your overall budget for safety at grade crossings? For pedestrian safety?
- Can you provide a percentage cost breakdown among engineering, education and enforcement activities?
- What funding sources do you make use of to promote pedestrian safety at rail crossings?
- What are your policies/warrants/standards for using warning signs for non-motorized users at rail grade crossings (e.g., minimum warning times at/near to/far from commuter stations, design/installation/operational guidelines, etc.)?
- What state and local regulations in addition to federal regulations apply to non-motorized users at rail grade crossings in your area?

More details about individual interviews can be found elsewhere (Metaxatos and Sriraj, 2013). Overall, interview participants did not provide additional literature compared to the information discussed in the previous section. Therefore, the cited literature in the next section indicates that a particular argument made by interviewee(s) is in agreement with prior published work.

1.4 FOCUS AREAS FOR IMPROVING PEDESTRIAN SAFETY

The discussion below will focus on several general themes that emerged from these interviews, which in turn, seem to raise a number of issues regarding safety at pedestrian-rail highway grade crossings. Some of the issues have been discussed, mainly, in relation to motorist safety at rail grade crossings (Ogden 2007; Carroll et al., 2010). However, none of these issues has been thoroughly discussed in relation to pedestrian safety at such locations.

1.4.1 Prioritization of Safety Upgrades

All interview participants agreed that safety upgrades are usually prioritized based on a diagnostic review process that examines a number of criteria (e.g., number of tracks, engineering design, number of trains, train speed, etc.), but decisions are usually based on a consensus among relevant stakeholders representative of all groups having responsibility for the safe operation of crossings rather on a formal cost-effectiveness methodology. However, due to funding constraints, safety upgrades at dedicated pedestrian crossings are not prioritized as highly as those at rail-highway grade crossings unless these two types of crossings are adjacent to each other (e.g., adjacent sidewalks on one or either side of a rail-highway crossing extending to the other side of the tracks).

1.4.2 Engineering Standards

Based on the interviews, states with substantial passenger, commuter and freight rail operations are leading the effort to develop guidelines and engineering standards for safety improvements. Moreover, it is likely that pedestrian safety at rail grade crossings will benefit in the longer term by the increasing consistency in standards for warning devices and treatments among organizations responsible for this task. As an example of standards consistency, the definition of advance preemption in MUTCD looks the same as the one in AREMA and Institute of Transportation Engineers (ITE) documents as well as in APTA standards.

The requirement for extra warning time for pedestrians and motorists in grade crossings of high speed rail operations is emerging as an additional issue for safety upgrades at such crossings. Currently, the typical warning time at crossings where pedestrians may be present is between 20 and 30 seconds for conventional speed trains. In an environment with 110 mile an hour trains there would be a need to provide confirmation signals to the train crew and the onboard computer that the crossing is clear likely requiring a warning time of at least 80 seconds. The question about how pedestrians will react to such extended warning times at pedestrian crossings remains to be determined. This is because currently most of the warning time is built into the time that the train occupies the crossing. When high speed trains begin to operate most of the warning time is going to be built into the time for the train approaching the crossing. Therefore, there would be an extended warning time where the crossing remains unoccupied while a high speed train cannot even be seen on the horizon. This situation will require “reeducation” of the public, especially in areas where crossings are very near to each other.

1.4.3 Reliability of Cost Estimates

The interviews revealed that cost estimates and/or actual costs of the warning systems already installed, unless for dedicated pedestrian crossings, are not generally available despite federal requirements, under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) program (formerly known as “Section 130”), to the contrary. This is probably due to the fact that such funds are usually absorbed into much larger projects (e.g., grade separation). Moreover, a cost breakdown for design, installation, component maintenance, and operating costs is rarely finalized considering the actual costs keep changing as they move from the planning stage, to the design stage, to the design & build stage. Additional reasons are presented elsewhere (Roop et al., 2005).

Such difficulties, in addition to lacking dedicated funding for cost-effectiveness studies, result in the general lack of cost-effectiveness information of pedestrian safety treatments. On the other hand, given that the number of fatalities at grade crossings is relatively low it would be very difficult to assign a cost-effectiveness value to a particular treatment. In any case, cost oversight from state departments of transportation may be needed to effectively manage targeted funding for grade crossings safety improvements.

1.4.4 Funding Availability

All interview participants agreed that the vast majority of funding available for safety improvements is programmed for rail-highway crossings, and very rarely exclusively for dedicated pedestrian grade crossings. Some interviewees opined that it would be critical that Section 130 funding remain exclusive to railroad safety and not rolled back with other highway funds. Continuing this source of support would help maintain the level of expertise for rail safety at the FRA as well at state departments of transportation.

1.4.5 Selection Criteria

Based on the interviews, a number of criteria are used for the selection of warning devices for deployment at pedestrian-rail grade crossings including: pedestrians collision experience at the crossing, frequency of inclement weather, pedestrian volumes and peak flows, train speeds, numbers of trains, and railroad traffic patterns, surrounding land-uses, sight distance for pedestrians approaching the crossing, skew angle of the crossing relative to the railroad tracks, multiple tracks, vicinity to a commuter station, and installation/maintenance costs. Furthermore, to discourage trespassers at or in the vicinity of grade crossings, communities apply fencing, landscaping, prohibitive signs, video monitoring, education/outreach, and enforcement.

However, very few existing methodologies allow for assessing trade-offs between these factors during the selection process (e.g., similar in functionality to the FRA's Accident Prediction Formula), and the potential of newer approaches is not well understood. Despite the absence of a formal cost-effectiveness evaluation process, in practice the process is realized as a consensus-building exercise among the diagnostic team members.

A way to formalize this process would be to ask, first, whether the particular crossing under consideration may be closed or consolidated with neighboring crossings. This is an important decision because a crossing closure may be helpful to limiting the number of automobile exposures but is nearly ineffective in limiting pedestrian exposures. Unless additional treatments to prevent pedestrian use are done pedestrians would likely continue to cross where they always have, except now as trespassers. Once such considerations have been resolved then the process would continue by examining the cost of various safety treatment options available versus the expected benefits.

1.4.6 Lack of Accessible Pedestrian Signals

All interview participants agreed that the lack of Accessible Pedestrian Signals at pedestrian-rail grade crossings is mainly due to the shortage of dedicated funding for such crossings. Such signal treatments need not convey the type of messages needed in regular intersection street crossings with more complicated traffic patterns. Occasionally, there are situations in grade crossing improvement projects where certain options are not available. For example, in the absence of adequate right of way, it usually becomes impossible to produce accessible sidewalks of the proper width in compliance with the Americans with Disabilities Act (ADA) standards. Another reason for the infrequent use of accessible signals (other than detectable strips and detectable yellow tiles just ahead of the pedestrian gates) at rail grade crossings is the lack of standardization among manufacturers.

1.4.7 Education and Enforcement Campaigns

Interviewees believe that strong local advocacy is probably the most important factor other than adequate funding availability behind effective education, outreach and enforcement safety campaigns at pedestrian-rail grade crossings. Moreover, such campaigns should continue unmitigated with additional service improvements in different geographic locations. Furthermore, campaigns for light rail grade crossing safety can be relatively more effective with the active participation of a transit agency and a captive local audience exposed to the frequency of transit operations.

1.4.8 Risk Management

The interviews revealed that the states did not have a consistent approach for managing the risk at pedestrian-rail grade crossings that could assure: (a) the uniformity and continuity of data collection programs and administration of related databases on all such crossings; (b) the analysis of risks at such crossings; (c) the prioritization of crossing upgrades; (d) the introduction of suitable risk controls; and (e) the assessment of cost effectiveness of such measures. Perhaps the FRA could promote a national campaign to this end with all states committing to the approach.

Interview experts seem to agree on a five-point program of risk management (affectionately called the five ’Es’ – ‘Engineering’, ‘Education’, ‘Enforcement’, ‘Enabling’ and ‘Evaluation’) to increase safety at pedestrian (and vehicular) rail grade crossings. Note that the first three ‘Es’ have been key underlying principles of Operation Lifesaver in the USA. ‘Enabling’ was added during the formation in Britain of the National Level Crossing Safety Group (NLXSG) in 2002, and is concerned with providing resources, people and systems to facilitate progress with improving level crossing safety (Little, 2007b). ‘Evaluation’ was added more recently, and has become of particular interest in Europe where attention is being paid to developing common reporting methods for level crossings (i.e. types of crossings, numbers and risk measurement), and being able to measure the effectiveness of programs. Little (2007b) defined these five ‘Es’ as follows:

- Enabling: The provision of resources through people, procedures, and systems to allow the other ‘Es’ to be effective.
- Education: Increasing public awareness of the dangers of crossings and educating pedestrians, road vehicle drivers and other users how to use them correctly.
- Engineering: The protection fitted to level crossings through lights, horns, barriers, telephones and signs together with research into innovative means of increasing safety.
- Enforcement: The use of laws to prosecute those who endanger themselves or others by misuse of crossings.
- Evaluation: The idea as envisaged by the NLXSG is to encourage organizations to set a baseline before embarking on new initiatives so that the before and after can be properly compared.

Based on the interviews, it appears that the majority of the research focusing on mitigating the risk for non-motorized users at rail grade crossings has focused on the grade crossing risk as a potential cause of train accidents rather than the individual risk to such users. However, the level of risk to which an individual is exposed is a key consideration in the safety management process, but is not explicitly part of the criteria applied to deciding about whether or not to implement an action to improve safety. This is in agreement with the literature (RSSB, 2010).

1.4.9 Public and Private Stakeholder Responsibilities

Interviewees believe that determining the most suitable mix of safety upgrades at pedestrian crossings is a challenging issue complicated by the fact that regulatory authorities make the selection while the operating railroads are responsible for the installation and life-cycle costs. The public authority is interested to select the most robust technology available to maximize the public investment in the long run. On the other hand, the private railroad is looking to minimize the life-cycle costs of a technology that is likely to become obsolete before the end of its life and thus expensive to maintain.

1.4.10 Quiet Zones

Some interviewees seem to believe that non-motorized users at grade crossings within quite zones may not receive safety benefits comparable to motorists. This is because, and this is only a conjecture at this point, supplemental safety measures (SSMs), such as gates and flashing lights are mostly focusing on motorists, while alternative safety measures (e.g., non-engineering elements such as public awareness campaigns or photo enforcement technology to increase driver and pedestrian awareness at grade crossings) may not be necessary for the establishment of a quiet zones if adequate SSMs have been installed. As a result, distracted non-motorists may not be sufficiently alerted to an incoming train, especially when a second-train is coming from the opposite direction.

1.4.11 Conclusions from Interviews with Experts

The discussion with the experts in this section seems to highlight a number of areas primed for further research and policy intervention. First, as consistency of engineering standards improves it would be important to monitor the impact on pedestrian safety. Second, high speed passenger rail service will require re-education of pedestrian users regarding safety impacts at or in the vicinity of or away from grade crossings. Third, it is increasingly important to better track the programming and the expenditure for safety upgrades at grade crossings. Fourth, there is a need to develop a cost-effectiveness evaluation process to facilitate the activities of a diagnostic team. Fifth, it is important addressing the needs of users with disabilities at grade crossings to better manage the risk for catastrophic incidents. Sixth, continuation of adequate funding for strong local advocacy toward education and enforcement activities is critical to pedestrian safety. Finally, the development of an appropriate risk management approach would better support the planning, programming and implementation of safety upgrades at pedestrian grade crossings.

1.5 CHAPTER CONCLUSIONS

The number of incidents between trains and non-motorist users at rail grade crossings has remained relatively unchanged in recent years despite a noticeable parallel reduction in the number of collisions between vehicles and trains at rail-highway grade crossings. However, the reasons for such an outcome disparity are not well understood.

An extensive review of the literature pertaining to pedestrian safety at highway-rail crossings concluded that there is a wide variety of warning signs and devices used. Some are MUTCD compliant, but many are not. None of the warning signs and devices has undergone rigorous testing to develop effectiveness rates for a variety of reasons. In addition, there is not a standard method to quantify and evaluate pedestrian risk at highway-rail crossings. These finding were confirmed via extensive interviews with a large number of experts.

Addressing each of these areas of concern would require a continuing commitment to education, engineering, enforcement and evaluation efforts. This can be achieved by enabling organizations involved in all aspects of pedestrian safety at rail grade crossings to provide adequate resources through trained personnel, diagnostic procedures, and systems implementation.

CHAPTER 2
SURVEY SITE SELECTION

All 25 grade crossings on the Chicago Transit Authority (CTA) rail system have train-activated warning devices as well as passive signs such as crossbucks or stop signs. Of the 25 grade crossings we selected seven sites on the CTA's Pink Line, Brown Line, and Yellow Line as follows:

<u>CTA Pink Line</u>

- Laramie Avenue (54th & Cermak) – 2134 S. 54th Avenue, Cicero, IL 60804 (see Figures 1a, 1b)
- Cicero Avenue – 2134 S. Cicero Avenue, Cicero, IL 60804 (see Figures 2a, 2b)
- Kostner Avenue – 2019 S. Kostner Avenue, Chicago, IL 60623 (see Figures 3a, 3b)

<u>CTA Yellow Line</u>

- Oakton Street – 4800 Oakton Street, Skokie, IL 60076 (see Figures 4a, 4b)
- Crawford Avenue – Crawford Avenue north of Howard Street (see Figures 5a, 5b)

<u>CTA Brown Line</u>

- Kedzie Avenue – 4648 N. Kedzie Avenue, Chicago, IL 60625 (see Figures 6a, 6b)
- Manor Avenue (Francisco) – 4648 N. Francisco Ave., Chicago, IL 60625 (see Figures 7a, 7b).

All seven selected sites have heavy train daily flows and a fairly busy crossing highway (Table 1). In the absence of variability in safety signs/devices among the crossings, the selection of the seven sites was based on the FRA's accident prediction formula (APF) values for the associated highway-rail grade crossing (Table 1). Note that APF values show the chance, as a percentage, of an accident occurring at that crossing in the next 12 months; high-risk crossings have an APF value ≥ 0.05).

Table 1. Selected Crossings and Operational Characteristics

US DOT Inventory No.	CTA Line	Street Name	Daily Train Total	AADT	Tracks	Track Speed (mph)	2006-10 Pedestrian Crashes	APF
850121T	Pink Line	LARAMIE AVE	198	16,900	2	35	0	0.063709
850123G	Pink Line	CICERO AVE	198	32,400	2	35	0	0.067755
850128R	Pink Line	KOSTNER AVE	198	10,100	2	35	0	0.053673
861284H	Yellow Line	OAKTON ST	139	17,500	2	55	0	0.064752
861286W	Yellow Line	CRAWFORD AVE	139	13,000	2	55	0	0.059647
864002A	Brown Line	KEDZIE AVE	198	13,900	2	35	0	0.05591
864005V	Brown Line	MANOR AVE	198	11,400	2	35	0	0.054525

The APF does not include pedestrian flows as an input into the estimation process; therefore, a crossing cannot be assigned a separate risk index for vehicular and pedestrian incidents.

However, the majority of pedestrian collision incidents occur at highway-rail crossings vis-à-vis at dedicated pedestrian crossings. It is reasonable, therefore, to assume that at least some of the environmental factors that serve as input into the APF process remain relevant for incidents involving non-motorized users.

It should also be noted that the reason for using the APF and not observed frequencies of accidents is that the latter cannot be deemed as being high or low in the absence of a benchmark. The APF provides an estimate of the expected number of collision incidents for each crossing that takes into account vehicular and train flows. This estimate can then be used as a benchmark against observed collision frequencies.

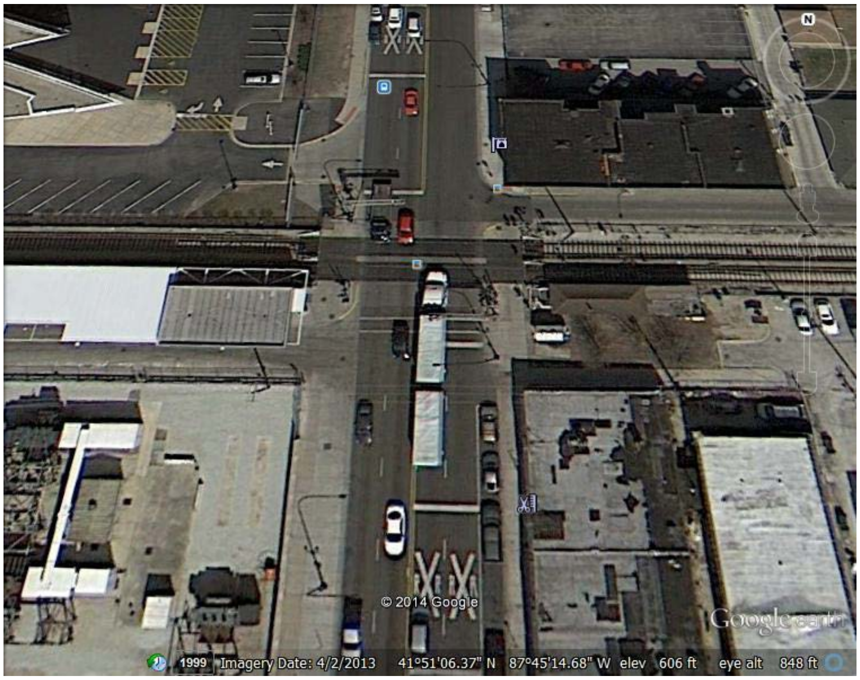

Figure 1 - Laramie Avenue crossing (view from above)

Source: Google Earth (accessed 10/19/15)

Figure 2 - Laramie Avenue crossing (street view)

Source: http://www.icc.illinois.gov/railroad/images/o/850121T/850121T-1.jpg (accessed 10/19/15)

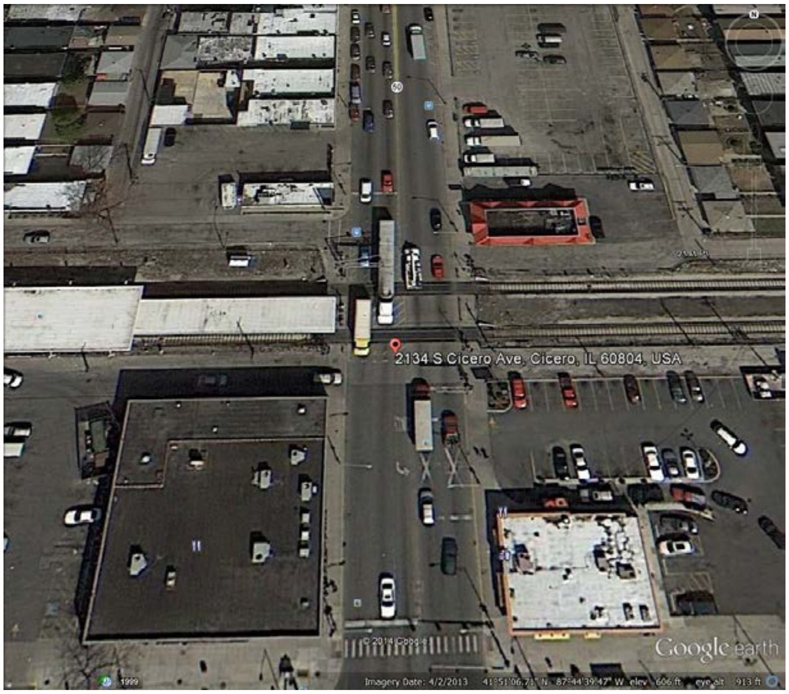

Figure 3 - Cicero Avenue crossing (view from above)

Source: Google Earth (accessed 10/19/15)

Figure 4 - Cicero Avenue crossing (street view)

Source: http://www.icc.illinois.gov/railroad/images/o/850123G/850123G-4.jpg (accessed 10/19/15)

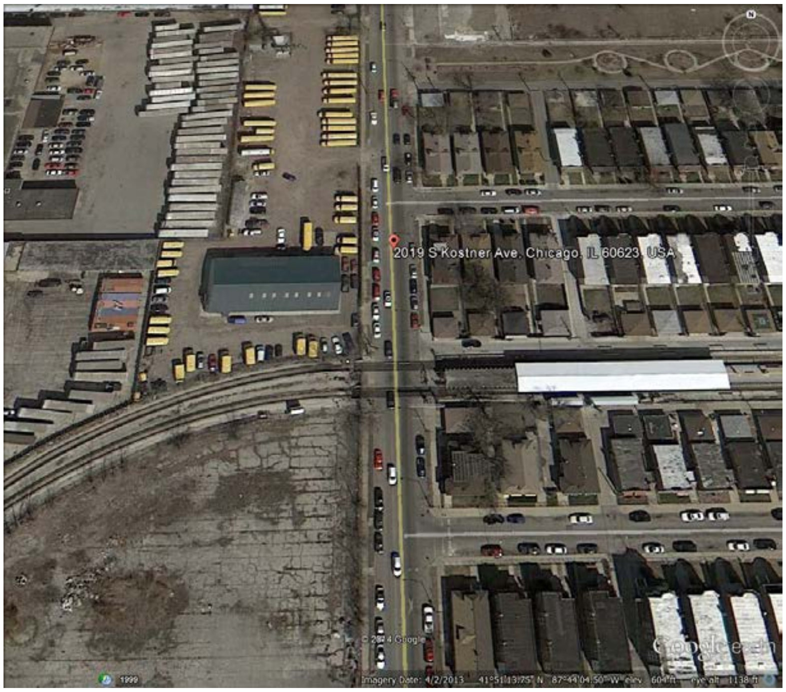

Figure 5 - Kostner Avenue crossing (view from above)

Source: Google Earth (accessed 10/19/15)

Figure 6 - Kostner Avenue crossing (street view)

Source: http://www.icc.illinois.gov/railroad/images/o/850128R/850128R-1.jpg (accessed 10/19/15)

Figure 7 - Oakton Street crossing (view from above)

Source: Google Earth (accessed 10/19/15)

Figure 8 - Oakton Street crossing (street view)

Source: http://www.icc.illinois.gov/railroad/images/o/861284H/861284H-4.jpg (accessed 10/19/15)

Figure 9 - Crawford Avenue crossing (view from above)

Source: Google Earth (accessed 10/19/15)

Figure 10 - Crawford Avenue crossing (street view)

Source: http://www.icc.illinois.gov/railroad/images/o/861286W/861286W-1.jpg (accessed 10/19/15)

Figure 11 - Kedzie Avenue crossing (view from above)

Source: Google Earth (accessed 10/19/15)

Figure 12 - Kedzie Avenue crossing (street view)

Source: http://www.icc.illinois.gov/railroad/images/o/864002A/864002A-4.jpg (accessed 10/19/15)

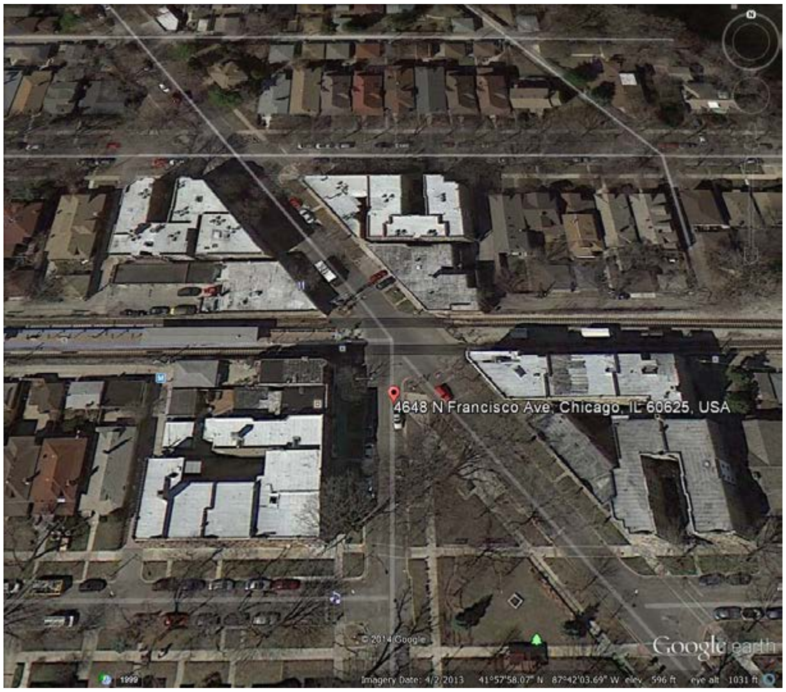

Figure 13 - Manor Avenue crossing (view from above)

Source: Google Earth (accessed 10/19/15)

Figure 14 - Manor Avenue crossing (street view)

Source: http://www.icc.illinois.gov/railroad/images/o/864005V/864005V-4.jpg (accessed 10/19/15)

CHAPTER 3
SURVEY OF NON-MOTORORIZED USERS

3.1 INTRODUCTION

Following the selection of the seven crossing sites as discussed in Chapter 2, we conducted interviews of non-motorized users at each location to provide additional insight to the literature review findings in Chapter 1. The objectives of the survey were to (1) gauge user attitudes about crossing the tracks; (2) assess environmental, demographic, and socioeconomic factors that may impact the crossing behavior; and (3) attempt to quantify the effectiveness of installed signs and devices to improve safety at pedestrian-rail grade crossings. This chapter discusses the organization and implementation of the survey and the analysis of the data.

3.2 SURVEY MANAGEMENT

With assistance from the University of Illinois at Chicago (UIC) Survey Research Laboratory (SRL), we conducted an attitudinal survey of non-motorized users at seven CTA highway-rail and pathway-rail grade crossings. A UIC Institutional Review Board (IRB) exemption was granted on February 26, 2014 (IRB protocol #2011-0785), and questionnaires were completed by 211 pathway-rail and highway-rail grade crossing users between April 11, 2014, and May 12 2014.

The SRL is a research and service unit established in 1964. It is a division of UIC's College of Urban Planning and Public Affairs. The SRL project management team consisted of (1) a project coordinator responsible for the overall coordination of project activities and communication with the UTC research team, (2) a field coordinator who provided training and direct supervision of the interviewing staff, (3) a data reduction manager who oversaw coding staff, (4) a research programmer who removed remaining inconsistencies from the data and produced data files and formats to facilitate statistical analysis, and (5) a sampling and analysis director who provided expertise for sampling procedure planning. Each member of the team participated in methodology discussions during the planning phases of the study and throughout the data collection period.

3.3 SAMPLING PLAN

Data were collected from users of seven CTA rail crossing sites chosen in Chapter 2. To obtain a mix of pedestrian types, each site was visited at least once on a weekday and once on the weekend. Interviewers completed four-hour shifts on these days. On the weekdays, we started shifts early – 6:00 AM – to capture the start of the morning rush hour. On weekends, we began interviewing at approximately 7:00 a.m. It was assumed that we would have lower cooperation from pedestrians in the evening because most would be on their way home.

To avoid temporal clustering of respondents by gaining the desired number of completed interviews in a short amount of time at the sites with many users, only one questionnaire was completed every 15 minutes. To achieve this, interviewers divided the four-hour shift into 15-minute intervals. During each interval, only one questionnaire was completed. Once the interview was complete, interviewers waited until the next interval began to approach crossing users to participate. Through this process, only 15 interviews could be completed per site on an assigned day. However, at the sites with low foot traffic, we attempted interviews with all available pedestrians rather than trying to space them out over a 15-minute interval.

3.4 DATA COLLECTION

3.4.1 Questionnaire Development

The questionnaire was the same one developed by the UTC research team and the SRL project coordinator for an earlier survey of Chicago region non-CTA grade crossings (Metaxatos and Sriraj, 2013). The paper instrument (Appendix 1) was interviewer administered, and respondents were expected to complete the questionnaire in approximately 3 minutes. Topics covered in the instrument include (1) history of pathway-rail and highway-rail use, (2) perceptions of active and passive warning devices, and (3) impairment and other background characteristics.

3.4.2 Pretest

A pretest was conducted on Friday, April 11, 2014, at the Cicero Pink Line stop and on Saturday, April 12, 2014, at the Kedzie Brown Line stop. For the pretest, an interviewer spent approximately three hours at these two crossing locations to test the sampling plan and the questionnaire. No issues arose, and the study team proceeded with main study data collection. All completed pretest questionnaires were included in the data set.

3.4.3 Main Study

Main study data collection took approximately four weeks, beginning on April 17, 2014, and ending on May 12, 2014. All sites achieved the estimated 30 completed interviews, with the exception of the Crawford Avenue crossing site. There were very few pedestrians and bicyclists that used this crossing during our data collection period, so we added additional days for interviewers to revisit that site. The specific challenges of the Crawford site are discussed in more detail below.

3.4.4 Personnel

Experienced SRL interviewers were staffed on this study. Three interviewers received a two-hour study-specific training on April 10, 2014. Training included a general orientation to the background and purpose of the study, a review of the seven crossing locations, discussion of the sampling plan and data collection procedures, and a review of the oral screener and questionnaire. All field staff were supplied an interviewer training manual covering all aspects of the data collection procedures, which was used during the training session and as a reference manual throughout the course of the study.

3.4.5 Field Procedures

Each shift at a crossing location was assigned to one interviewer and one back-up interviewer. Each site was visited at least once on the weekday and once on the weekend. The interviewer reported to each site between 6:00 AM and 10:30 PM on the weekday and 7:00 AM and 11:00 AM on the weekend. As already noted, for most sites the four-hour shift was divided into 15-minute intervals. During each interval, only one interview was completed. Once the interview was complete, interviewers waited until the next interval began to approach crossing users to participate. Through this process, a maximum of 15 interviews could be completed per site on an assigned day.

At each site, interviewers approached prospective respondents, provided a study information sheet if necessary, asked for respondents' oral consent to participate, and completed the questionnaire with respondents. Interviews were conducted only with respondents at least 18 years of age. The questionnaire can be found in Appendix 1; answers to common respondent questions can be found in Appendix 2; the oral consent form script can be found in Appendix 3; and the study information sheet can be found in Appendix 4.

3.4.6 Data Collection Challenges at Crawford Avenue

The Crawford Avenue crossing site is located in a residential neighborhood with no business or commercial property nearby. Unlike the other crossing sites, there was no CTA station in the immediate vicinity. This site was also surrounded by road construction during our data collection period. Therefore, pedestrian and bicycle traffic was limited. Several of the pedestrians we did encounter did not speak English. They spoke Spanish, Arabic, and Polish.

The weekday and weekend shifts at this site yielded far fewer completed interviews than the same number of shifts at the other crossing sites. We added additional data collection days and tried an evening shift from 3:00 PM to 7:00 PM one weekday afternoon to see if more pedestrians or bicyclists would be present later in the day. This afternoon shift resulted in fewer completed interviews than the morning shifts. Ultimately, we were only able to complete 15 interviews total at the Crawford Avenue crossing site.

3.4.7 Data Processing

The SRL Office of Data Reduction entered data from the completed questionnaires. One aspect of data reduction of the pen and pencil instrument (PAPI) questionnaire data was the processing of all text answers to survey items. On items with an "other-specify" response option, interviewers sometimes entered a text response that could be changed later to one of the precoded response options. All the other-specify responses were reviewed by the Project Coordinator after data collection was complete. The changes then were made by the SRL Data Reduction section in a process known as backcoding.

The SRL Office of Data Reduction also was responsible for producing an edited text file of all the "other-specify" and open-ended variables as a deliverable at the end of the survey. The editing consisted of regularizing spelling and capitalization, filling out abbreviations, and eliminating software-related text, such as the interviewer- and time-stamps added to each text answer. Staff from the Office of Survey Systems checked and cleaned the data to ensure that any illegal answers were caught and corrected and any missing data properly coded. The data sets and SPSS and SAS setup files were created at the end of the main study data collection and delivered to the UTC research team.

3.4.8 Final Disposition of Sample

We completed a total of 211 interviews. The final completed questionnaire outcomes per site can be seen in Table 2.

Table 2. Survey Responses Completed at Each Crossing Location

US DOT Inventory Number	City Name	Street Name	2008 - 2012 Crash History	Surveys Completed				Refusals	
				W'kday	W'kend	Total	Percent	W'kday	W'kend
850121T	CICERO	LARAMIE AVE	0	15	15**	30	14.2%	59	54
850123G	CICERO	CICERO AVE	0	26*	15	41	19.4%	4	5
850128R	CHICAGO	KOSTNER AVE	0	14	16**	30	14.2%	No refusals reported	5
861284H	SKOKIE	OAKTON ST	0	15	16	31	14.7%	45	11

US DOT Inventory Number	City Name	Street Name	2008 - 2012 Crash History	Surveys Completed				Refusals	
				W'kday	W'kend	Total	Percent	W'kday	W'kend
861286W	SKOKIE	CRAWFORD AVE	0	7*	8**	15	7.1%	10	4
864002A	CHICAGO	KEDZIE AVE	0	15	16*	31	14.7%	48	53
864005V	CHICAGO	MANOR AVE	0	18	15	33	15.6%	25	11
Totals			0	110	101	211	100.0%	191	143

*surveys completed in multiple weekdays; **surveys completed in multiple weekend days

3.4.9 Survey Limitations

Intercept surveys by definition rely on convenience samples. We did not have a sample frame of all people who use the sampled crosswalks, so we could not calculate the probability of selection of each survey respondent. Varying the day and time of interviewing, as well as spacing the number of interviews collected in a given time period, increased the variability of the respondents sampled, but it did not guarantee that the sample was representative. Thus, one cannot draw inferences about the population from such a sample. Information gathered from these interviews pertains only to the sample included in the survey, not to the larger population of pedestrians who use these crosswalks. In addition, we were unable to reliably verify the activation of warning devices during each of the interviews. As a result, participants were assumed to be giving answers to relevant questions based on previous experience.

3.5 SURVEY RESULTS

3.5.1 Mode of Crossing

Almost 98% (206 of 211) of the respondents walked, while less than 1% (2 of 211) were on bicycle (Table 3). About one in four of walkers (50 of 206) were listening to music on their earphones or were talking and texting on their cell phone. Finally, almost 5% of walkers were with young children or pushing a stroller.

Table 3. Mode of Crossing

Responses	Frequency	Percent of Respondents
Biking	2	0.9%
Walking	206	97.6%
Walking Aid	2	0.9%
Pushing Cart	3	1.4%
Pushing stroller	2	0.9%
With Young Children	8	3.8%
Music on Earphones	44	20.9%
On Cellphone	5	2.4%
Texting	1	0.5%
Total Number of Respondents*	211	

*Respondents checked multiple categories

3.5.2 Day and Time of Interview

Interviews were almost equally distributed between weekdays (52 percent) and weekends (48 percent). Fifteen survey days were required to complete 211 interviews (Table 4). Weekdays, with an average 15.9 completed interviews per weekday, ended up being more productive than weekends (on average, 12.6 completed interviews per weekend day).

Table 4. Day of the Week

Day of the Week	Frequency	Number of Surveys	Percent of Surveys
Monday	1	2	0.9%
Tuesday	3	50	23.7%
Wednesday	0	0	0.0%
Thursday	2	47	22.3%
Friday	1	11	5.2%
Saturday	4	58	27.5%
Sunday	4	43	20.4%
Total	15	211	100.0%

More than two thirds of the interviews were conducted between seven and ten o'clock in the morning (Table 5). Only two interviews were conducted after twelve o'clock in the afternoon.

Table 5. Time of Interview

Responses	Frequency	Percent
6 AM to 7 AM	27	12.8
7 AM to 8 AM	43	20.4

Responses	Frequency	Percent
8 AM to 9 AM	54	25.6
9 AM to 10 AM	56	26.5
10 AM to 11 AM	25	11.8
11 AM to 12 PM	4	1.9
12 PM to 1 PM	2	1.0
Total	211	100.0

3.5.3 Age and Gender of Survey Respondents

Male respondents were clearly overrepresented in the survey sample (Table 6). In five cases the gender information is missing.

Table 6. Gender of Survey Respondents

Gender	Frequency	Percent of Valid Responses
Male	120	58.3%
Female	86	41.7%
REFUSED/MISSING	5	–
Total	211	100.0%

The distribution by age category is shown in Figure 15. More than twice as many male respondents 21 to 30 and 61 to 70 years old compared with their female counterparts participated in the survey. The other age categories are more evenly distributed between genders. No female user over 70 is represented in the sample.

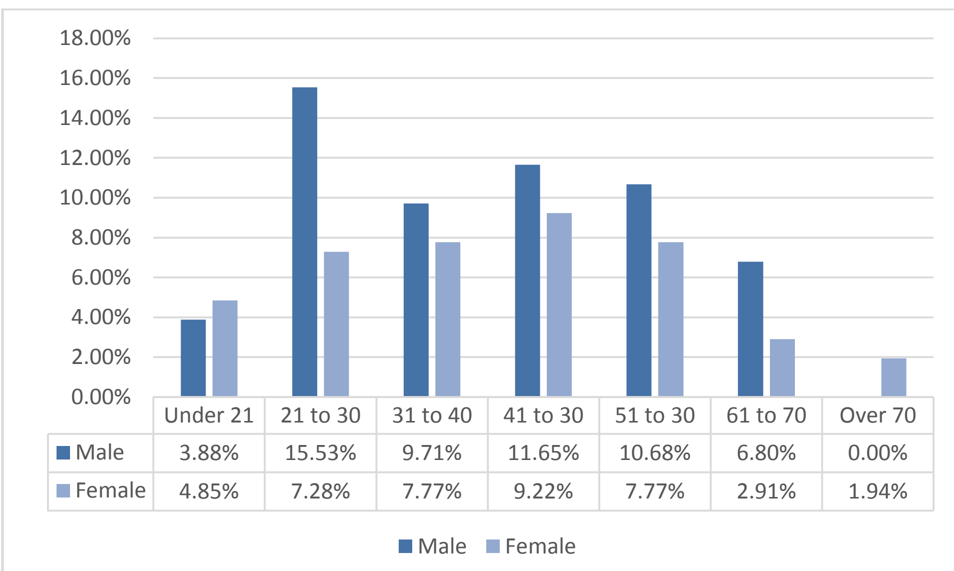

Figure 15. Distribution of survey respondents by gender and age group

3.5.4 Q1. Frequency of Using Crossing

Users who responded using the crossing “for first time/irregularly” were classified as irregular users. Thus almost 93% (196 out of 211) of respondents were regular users of the crossing at which they were interviewed (Table 7). Six out of ten of the regular users used the crossing daily while a third of them on a weekly basis. The mode of the daily distribution of the frequency of crossing use was two times.

Table 7. Frequency of Using Crossing

Number of Times	Time Period				Total	Percent
	Daily	Weekly	Monthly	Yearly		
1	43	6	2	0	51	26.0%
2	56	11	5	0	72	36.7%
3	4	10	0	0	14	7.1%
4	11	5	1	0	17	8.7%
5	1	27	0	0	28	14.3%
6	1	1	0	0	2	1.0%
7	3	2	0	0	5	2.6%
10	2	2	0	0	4	2.0%
12	0	1	0	0	1	0.5%
40	0	0	0	1	1	0.5%
60	0	0	1	0	1	0.5%
Total	121	65	9	1	196	100.0%
Percent	61.7%	33.2%	4.6%	0.5%	100.0%	
First Timers/ Irregular Users					15	
Total					211	

3.5.5 Q2. Warning Signs and Devices Awareness

User awareness of warning signs (always a passive type of warning) and warning devices (always an active type of warning) is discussed in this section. Note that the warning devices may or may not have been actually activated when the survey question was being asked. As a result, we could not distinguish between the activation states of a warning device and its parallel ability to be observed by the survey respondent.

More than one in seven respondents (70% of whom were male) did not notice any warning signs or warning devices (Table 8). Age appeared to be a contributing factor. For example, all of the respondents older than 60 years old noticed such safety signs/devices while 60% of those who did not notice these signs/devices were between 21 and 40 years old. The odds of not noticing these signs/devices increase from one in five for those under 21 years old to one in four for users between 31 and 40 years old. Moreover, more than nine in ten of both regular and irregular users noticed these safety signs/devices, but the odds of not noticing are more than double for regular compared to irregular users (16.1% compared to 7.1%).

Table 8. Q2. Noticed Signs or Warning Devices

at Pedestrian Crossing

Responses	Frequency	Percent Valid Responses
Did notice	182	86.7%
Did not notice	28	13.3%
REFUSED/MISSING	1	–
Total	211	100.0%

Awareness of warning signs and devices varied by the time period of the day. For example, the odds of not noticing safety signs/devices seem to increase from 13% between 6:00 a.m. and 7:00 a.m. to 19% between 9:00 a.m. and 10:00 a.m. These odds fall to more than half (9%) the next time period (10:00 a.m. to 11:00 a.m.) to zero percent after 11:00 a.m. Reduced awareness in the early part of the day can be attributed to other distractions at play.

Indeed, discrepancy in awareness among different types of users is telling (Table 9). Almost one in four respondents listening to music on earphones indicated they had not noticed a warning sign or a device. Moreover, one in four respondents on cellphones exhibited similar behavior. No other activity in Table 9 appears to be a contributing factor.

Table 9. Sign/Warning Device Awareness by Type of User

Responses	Noticed	Percent	Did Not Notice	Percent	Total
Walking	177	86.3%	28	13.7%	205
Music on earphones	36	81.8%	8	18.2%	44
Bicycling	2	100.0%	0	0.0%	2
With young children	2	100.0%	0	0.0%	2
On cell phone	4	80.0%	1	20.0%	5
Pushing stroller	2	100.0%	0	0.0%	2
Pushing cart	3	100.0%	0	0.0%	3
Texting	1	100.0%	0	0.0%	1
Walking aid	2	100.0%	0	0.0%	2

Among the 182 respondents who showed awareness of warning signs or devices (Table 8), flashing lights, fencing and pedestrian crossing gates attracted most of the attention (Table 10).

Table 10. Q2a. Sign or Warning Devices Noticed

Responses	Percent Respondents
Detectable audible or visual warnings for people with disabilities	2.2%
Fencing, swing gates, or zigzag	42.5%
Flashing lights	49.2%
Pedestrian crossing gate	35.2%
Ringing bells	28.5%
Other signs	21.8%

Of the other warning signs noticed (not included in Table 10) the “Danger keep off tracks” signs (4 out 35 mentions), and the “Do not stop on tracks” signs (4 out 35 mentions) appeared to have attracted most of the attention. Other warning signs were even less conspicuous. For example, the sign warning about a $500 fine received only one mention.

The warning signs and devices listed in Table 10 were additionally categorized into two groups, active and passive, to further investigate visibility differences. Forty-two percent of respondents noticed the active warning devices compared with 58%% of the respondents who noticed the passive warning signs. Moreover, respondents 70 years old and older noticed the active signs/devices three times more than passive signs/devices. Respondents between 51 and 60 years old were the only other age group that noticed more the active vis-à-vis the passive signs/devices (51.4% to 48.6%, respectively). All other age groups of respondents noticed the active signs/devices less frequently than the passive signs/devices.

In addition, 35% of the male and 51% of the female respondents were more aware of active vis-à-vis passive warning signs/devices. Finally, only 42% of regular crossing users and 38% of respondents who rarely used a crossing noticed the active warning signs/devices.

3.5.6 Q3. Attitudes about Safety at Crossing

A great majority of the respondents said they would not cross the tracks when the lights are flashing, the bells are ringing, or the gates are down (Table 11). However, up to 25% of the respondents, on occasion, would still cross the tracks against activated signals/warning devices.

Table 11. Q3. Attitudes about Safety at Crossing

Responses	Would Cross	Percent	Would NOT Cross	Percent	Number of Respondents
Cross tracks against signal if felt there was enough time	50	23.8%	160	76.2%	210
Cross tracks against signal if others were crossing	22	10.4%	189	89.6%	211
Cross tracks against signal if in a hurry	48	22.7%	163	77.3%	211
Cross tracks against signal if annoyed about having to wait	22	10.4%	189	89.6%	211
Cross tracks against signal if could not see a train coming	52	24.6%	159	75.4%	211

Overall, female respondents in all age groups appeared to be more safety conscious than male respondents. Among male respondents, the youngest (under 21 years old) appeared to be the only group more likely to cross the tracks against activated signals/warning devices, if in a hurry. Moreover, regular users appeared to be more safety conscious compared with irregular users.

3.5.7 Q4. Frequency of Seeing Others Cross Tracks

The majority of respondents (78%) have seen others crossing the tracks against activated signals/warning devices (Table 12). Regular users appeared to be much more emphatic in their responses. Moreover, female respondents seem more eager to spot such illegal activities.

Table 12. Q4. Frequency of Seeing Others

Cross Tracks Against Signal

Response	Frequency	Percent
Never	46	21.8%
Occasionally	77	36.5%
Sometimes	42	19.9%
Often	36	17.1%
Always	10	4.7%
Total	211	100.0%

3.5.8 Q5. Frequency of Crossing Tracks at Location Other than Pedestrian Crossing

More than 87% of the users responded that they never cross the tracks at locations other than a pedestrian crossing (Table 13). Of those users, 92% were regular and 8% were irregular users. At various frequency levels, about 13% of the users (96% of whom were regular users) would cross the tracks at a location other than a crossing.

Table 13. Q5. Frequency of Crossing Tracks at Location Other

than Pedestrian Crossing

Response	Frequency	Percent Valid Responses
Never	183	87.1%
Occasionally	18	8.6%
Sometimes	7	3.3%
Often	1	0.5%
Always	1	0.5%
REFUSED OR MISSING	1	—
Total	211	100.0%

3.5.9 Q6. Other Crossing Locations

Twenty-seven users who did not respond “Never” in Question 5 (Table 13) were asked to state the alternative locations they use to cross the tracks. Six of those users crossed the tracks through emergency gates and 20 through the road crossing. One user responded that he crossed the tracks at other locations.

3.5.10 Q7 Reasons for Crossing Tracks at Other Location

The 27 users who did not respond "Never" in Question 5 (Table 13) were also asked for some of the reasons behind crossing the tracks at a location other than the official pedestrian crossing. Thirty-nine percent of the time, users claimed they were in a hurry (Table 14).

Table 14. Q7. Reasons Might Cross Tracks at Other Location

Responses	Frequency	Percent
Felt had enough time to get across safely	4	12.9%
The train was stopped	3	9.7%
I could not see a train coming	4	12.9%
I was in a hurry	12	38.7%
Other (see Q7_7 below)	8	25.8%
Total*	31	100.0%

*The total number of mentions may exceed/be less than the total number of respondents.

Some of the users provided more specific information, as shown in Table 15.

Table 15. Q7_7. Other Reasons Might Cross Tracks at Other Location

Frequently Cited Responses	Frequency
I don't know.	1
Not paying attention.	1
Lack of traffic.	1
Lack of traffic.	1
Convenience.	1
None.	1
No traffic.	1
Timing was off.	1
Total	8

3.5.11 Q8. Legality of Crossing Tracks against Activated Signal

The great majority of the respondents recognize that it is illegal to cross the tracks against activated signals (Table 16). There is a difference in the perception of legality between regular (83%) and irregular users (17%).

Table 16. Q8. Legality of Crossing Tracks against Signal

Responses	Frequency	Percent Valid Responses
Legal	6	2.9%
Illegal	202	97.1%
Don't know	2	—
Refused or missing	1	—
Total	211	100.0%

3.5.12 Q9. Perception of Safety Using Pedestrian Crossing

Three in four users felt very safe or extremely safe using a pedestrian crossing (Table 17). Less than six percent of the users felt slightly safe or not at all safe doing so. Such perceptions are evenly shared between male and female respondents, as well as regular and irregular users.

Table 17. Q9. Safety Using Pedestrian Crossing

Responses	Frequency	Percent
Extremely safe	79	37.6%
Very safe	78	37.1%
Moderately safe	41	19.5%
Slightly safe	10	4.8%
Not at all safe	2	1.0%
REFUSED OR MISSING	1	—
Total	211	100.0%

3.5.13 Q10. Difficulty Crossing Tracks

Eighty-two percent of the respondents felt that they had no difficulty crossing the tracks, while the remaining 18% found some level of difficulty in doing so (Table 18). There was little variability in attitudes among age and gender groups, as well as between regular and irregular users.

Table 18. Q10. Difficulty Crossing Tracks

Responses	Frequency	Percent Valid Responses
Extremely difficult	2	1.0%
Very difficult	5	2.4%
Moderately difficult	16	7.6%
Slightly difficult	14	6.7%
Not at all difficult	173	82.4%
REFUSED OR MISSING	1	—
Total	211	100.0%

3.5.14 Q11. Reasons Crossing Tracks Is Difficult

The 37 respondents who found some difficulty crossing the tracks (Table 18) were subsequently asked to explain the reasons for their difficulty (Table 19). More than 90% of the answers were given by respondents with at least a high school education. The difficulty with the surface of the path/sidewalk when in disrepair was mentioned as such a reason 11% of the time. Moreover, the difficulty with with the direction of the path/sidewalk is not clear was mentioned 9% of the time. Other notable mentions include the following: “Audible (safety) devices are not loud enough.” (We were unable to verify the sound level of electronic crossing bells; neither were we able to identify a maximum sound level regulated by the FRA or any other state.)

Table 19. Q11. Reasons Crossing Tracks Is Difficult

Responses	Frequency	Percent
Visual pollution/can't see signs	1	2.9%
Signs are not reflective at night	0	0.0%
Audible devices are not loud enough	1	2.9%
The direction of the path/sidewalk in not clear	3	8.6%
The surface of the path/sidewalk is in disrepair	4	11.4%
The line of sight to view an approaching train is obstructed	0	0.0%
The second-train warning sign has a glare/is difficult to read	0	0.0%
Other (see Q11_8 below)	26	74.3%
Total*	35	100.0%

*The total number of mentions may exceed/be less than the total number of respondents.

Respondents also provided other reasons that make it difficult to safely cross the tracks. These responses are shown in Table 20.

Table 20. Q11_8. Other Reasons Crossing Tracks Is Difficult

Frequently Cited Responses	Frequency
Car traffic.	5
Gate frequency/during rush/wait time too long.	4
Frequency of trains.	3
A little narrow.	2
Amount of people.	2
It's electric.	2
Hard to tell when cars are coming.	1
Weather/snow/ice.	1
Older people cross slower, makes me nervous.	1
There should be a division in pedestrian gates so if a train is coming on one side pedestrians can still get to the station through the other.	1
Trains get backed up, waiting.	1
Not enough time before bell rings.	1
My legs.	1
Guard.	1
Total	26

3.5.15 Q12. Additions to Improve Safety at Crossing

All 211 survey participants were asked to offer suggestions for improving safety at the pedestrian crossing they were using. There were no suggestions made 60% of the time (Table 21). Ninety percent of the suggestions were made by respondents with at least a high school level of education. The rest of the respondents offered a number of suggestions, as shown in Table 21.

Table 21. Q12. Additions to Improve Safety at Crossing

Responses	Frequency	Percent
Detectable audible or visual warnings for people with disabilities	2	0.9%
Fencing, swing gates, or zigzag	3	1.4%

Responses	Frequency	Percent
Flashing lights	4	1.9%
Pedestrian crossing gate(s)	2	0.9%
Pavement markings/change	1	0.5%
Ringing bells	2	0.9%
“Second train coming” electronic warning signs	2	0.9%
Other signs (see Q12_8 below)	11	5.1%
Other (see Q12_9 below)	58	26.9%
Nothing/no improvements needed	131	60.6%
Total*	216	100.0%

*The total number of mentions may exceed the total number of respondents.

Table 22 shows the suggestions made regarding sign additions to improve safety at the crossing. None of these suggestions are specific enough to stand out.

Table 22. Q12_8. Sign Additions to Improve Safety at Crossing

Frequently Cited Responses	Frequency
Stop sign or warning not to cross when gates are down.	1
Stop signs, more signs in general.	1
Don't walk signs/more visual cues.	1
NO NOTE LEFT.	1
Neon.	1
Warning.	1
Bright.	1
Showing where to cross.	1
More signs.	3

Finally, Table 23 shows other suggestions to improve overall safety at the pedestrian crossing used by the respondents. Suggestions such as police enforcement or a crossing guard, as well as making the crossing gates foolproof, clearly stand out.

Table 23. Q12_9. Other Additions to Improve Safety at Crossing

Frequently Cited Responses	Frequency
Security/Police.	3
More stuff to control traffic.	1
Keep it cleaner.	1
Bridge above traffic.	1
More barriers.	1
Camera.	2
Audio device/more/vocal recording.	1
Faster trains crossing.	1
Pedestrian countdown, know how long until gates go down.	1
Something more than a gate/make it difficult to jump it or go around or under / Double bar, longer fence.	7
Better equipment quality.	1
More workers.	1
Walk light / Traffic light.	2
Agents trained / Traffic cops stand with a whistle to direct the people / Crossing guard.	4
Benches.	1

Frequently Cited Responses	Frequency
Something for kids.	1
Smarter people / Educate people.	2
Move stop light pole.	1
Beautiful crosswalk women.	1
Safety gates.	2
Close it.	1
CTA worker / Employee.	2
Wider gates / Wider path.	2
Make more room/reduce congestion - more newspapers inside.	1
Gates are too close to tracks - kids play.	1
Add hands/walk signal to lights.	1
Brighter lights in daytime.	1
Something more for children/park is right here.	2
Warnings on pavement.	1
Gate timing could be better.	1
Gates in middle on side opposite from station.	1
Slower car traffic speeds.	1
Something to improve visibility of the train.	1
Better traffic control so it's easier for pedestrians to cross.	1
Plastic door slide, like at O'Hare.	1
Snowing - need to clear a walkway.	1
An automated voice to give instruction.	1
Not quite sure, pedestrians too close to train.	1
Gates go up sooner after train.	1
Bridge above traffic.	2

3.5.16 Q13. Disability Status

Seven percent of the respondents (79% of who were at least high school graduates) said they had some kind of disability (Table 24). This is close to an average of 8% for the northeastern Illinois region, based on 2008–2010 estimates from the American Community Survey (ACS) (http://www.census.gov/programs-surveys/acs/).

Table 24. Q13. Disability Status

Responses	Frequency	Percent Valid Responses
Yes (see Q13_1 below)	14	6.7%
No	196	93.3%
REFUSED OR MISSING	1	—
Total	211	100.0%

The 14 survey participants who said they had some kind of disability (Table 24) were asked to specifically describe the disability they have. The responses are shown in Table 25, by location. Three crossings (on Laramie Avenue, Cicero Avenue, and Manor Avenue) had three respondents each with a specific disability. The ages of the respondents varied from under 21 (two respondents) to over 70 years old (two respondents).

Table 25. Q13_1. Reporting Any Kind of Disability

US DOT Inventory No.	Location	Specific Disabilities Cited					
		Visual	Hearing Loss	Physical (Back)	Walk with Cane/ Arthritis	Leg Problem (Limp)	Depression
850121T	CICERO (Laramie Ave.)	1	1	1			
850123G	CICERO (Cicero Ave.)	1	2				
850128R	CHICAGO (Kostner Ave.)					1	
861284H	SKOKIE (Oakton St.)						1
861286W	SKOKIE (Crawford Ave.)				1		
864002A	CHICAGO (Kedzie Ave.)	1			1		
864005V	CHICAGO (Manor Ave.)	2	1				

Six out of 14 respondents with a specific type of disability offered suggestions for improvements or specifically identified problems that made crossings seem more difficult or riskier to use:

- Oakton Avenue: A respondent walking with the help of a cane said that additional signs are needed to control the vehicular traffic. Another respondent with depression issues said that the presence of police would improve safety at the crossing.
- Laramie Avenue: A respondent with hearing problems would like to see 'Don't walk' signs and more visual cues.
- Manor Avenue: A respondent with hearing problems would like to see traffic police standing with a whistle to direct the people. Another respondent with visual problems would like to have benches placed by the crossing. Finally, another respondent with visual problems said that it is not comfortable crossing the tracks along with older/slower moving people indicating that a plastic door slide as in the O'Hare airport would make for a safer crossing.

3.5.17 Q14. Respondents Age

The age distribution of the survey participants is shown in Table 26.

Table 26. Q14. Distribution of Respondents Age

Responses	Frequency	Percent
Under 21	18	8.5%
21 to 30	49	23.2%
31 to 40	39	18.5%
41 to 50	43	20.4%
51 to 60	38	18.0%
61 to 70	20	9.5%
Over 70	4	1.9%
Total	211	100.0%

3.5.18 Q15. Highest Grade or Level of Education Completed

The distribution of highest level of education attained by survey participants is shown in Table 27.

Table 27. Q15. Highest Grade or Level of Education Completed

Responses	Frequency	Percent Valid Responses
8th grade or less	3	1.4%
Some high school	7	3.3%
High school graduate/GED	52	24.8%
Some college	55	26.2%
College or other advanced degree	93	44.3%
REFUSED OR MISSING	1	—
Total	211	100.0%

3.6 VIOLATION PROPENSITY

We sought to investigate the association between violation propensity and various user characteristics using categorical data analysis techniques (Agresti 2007) and found that violation propensity diminishes among users in older age groups (n=210, chi-square=14.60, DF=1, p=0.0001). Moreover, the association between violation propensity and other factors based on user individual characteristics or perceptions about crossing the tracks were not found to be statistically significant.

3.7 REGRESSION ANALYSIS

We investigated how the propensity to be in violation of activated devices and signs is related to respondents' age category. It should be noted that the term "violation" refers to a trespassing violation of the Illinois Vehicle Code (P.A. 96-1244, Section 11-1011). The following model was estimated

$$\text{log odds} \equiv logit(p_i) = log\left(\frac{p_i}{1-p_i}\right) = b_o + b_1 x_{i1}$$

where, $p_i$is the probability that individual *i* has the propensity to be in violation conditional on his/her age category, x_{ik} . The dependent variable in this logistic regression (Cox and Snell 1989; Hosmer and Lemeshow 1989; Agresti 1990; Collett 1991) is the *logit* or *log-odds* that individual *i* exhibited a propensity of being in violation against activated warning devices or signs while crossing the tracks. The information was obtained from responses to Question 3 in the survey (Table 11). In particular, pedestrians who stated they would cross the tracks if they felt there was enough time, if others were crossing, if they were in a hurry, if they were annoyed by having to wait, if they could not see a train coming were thought to have displayed the propensity of being in violation. In this regard, of the 211 users surveyed, 84 displayed and 126 did not display such a propensity. The responses from the remaining one user were not used because of missing information.

The explanatory variable was the age category from the user survey. In particular, the variable age takes the value of 1 for respondents 30 years of age and younger and 0 for respondents older than 30 years of age. The data to be modeled are summarized in Table 28.

Table 28. Association between Violation Propensity and Age Category

Age	**Violation Propensity**		**Total (percent)**
	No (percent)	**Yes (percent)**	
Respondents older than 30 years of age	98 (68.06)	46 (31.94)	144 (100.00)
Respondents 30 years of age and younger	28 (42.42)	38 (57.58)	66 (100.00)
Total	126	84	210

In Table 28, the probability of the propensity to be in violation increases from 32% for respondents older than 30 years of age to 58% for respondents 30 years of age and younger. Similarly, the probability of the propensity to not be in violation decreases from 68% to 42% for the respective age categories

The odds of the propensity to be in violation is the ratio of the probability of the propensity to be in violation to the probability of the propensity not to be in violation. For instance, in Table 28 the odds of the propensity to be in violation for respondents 30 years of age and younger are 57.58/42.42 = 1.357 meaning that the propensity to be in violation is 136% more likely than the propensity to not be in violation for respondents 30 years of age and younger. Similarly, the odds for respondents older than 30 years of age are 0.469 (47%). The odds ratio of these two odds is 1.357/.0469 = 2.892 meaning that the odds of the propensity to be in violation for respondents 30 years of age and younger are 289% the odds of the propensity to be in violation for respondents older than 30 years of age. Indeed this is the odds ratio we observe upon estimation of the model above in Table 29.

Table 29. Logistic Regression Estimation Results

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Sq	Odds Ratio (95% Wald Confidence Limits)
Intercept	1	-0.7563	0.1787	17.9060	<0.0001	
Age (30 and younger)	1	1.0616	0.3065	11.9935	0.0005	2.891 (1.585, 5.272)

The coefficient of age is 1.0616, and its standard error is 0.3065. The p-value for the Wald chi-square test is 11.9935, indicating a significant (at the 0.0005 level) association between the propensity to be in violation and age category. The estimated odds ratio (30 and younger vs. older than 30), is 2.891 (95% Wald Confidence Limits (1.58, 5.27)).[1] This means that the predicted odds for violation propensity were about 3 times for respondents of age 30 years old and younger compared to respondents older than 30 years of age. On a probability scale, respondents of age 30 years old and younger were, on average, 58% more likely to be in violation than respondents older than 30 years of age.[2]

[1] Given the previous definition of the log odds and the estimated model parameters, b_o and b_1 in Table 29, the odds = $\exp(b_o + b_1 x_{i1})$. The odds ratio comparing the odds for the two values of the age categories (0, 1), is

$$\text{Odds ratio} = \frac{\exp(b_0 + b_1 \times \mathbf{1})}{\exp(b_0 + b_1 \times \mathbf{0})} = \exp(b_1 \times 1) = \exp(1.0616) = 2.891.$$

That is exactly the value reported in Table 29.

[2] Since $\frac{p}{1-p} = \exp(b_o + b_1 x_1)$ it follows that $p = \frac{\exp(b_o + b_1 x_1)}{1+\exp(b_o + b_1 x_1)} = \frac{\exp(-0.7563 + 1.0616 \times 1)}{1+\exp(-0.7563 + 1.0616 \times 1)} = 0.5757$. This is exactly the probability estimated in Table 28.

CHAPTER 4
CONCLUSION

While the trend in incidents at all rail grade crossings has been a steady decrease in the rate and quantity of incidents, incidents involving pedestrians have remained relatively constant. A previous study identified several issues that would need to be considered regarding pedestrian safety at rail grade crossings, but its scope did not include CTA rail grade crossings (Metaxatos and Sriraj, 2013). This analysis expanded the scope of the previous study to include CTA rail grade crossings and did not examine policies and practices at CTA rail grade crossings.

The focus of this research was on individuals who utilize legally authorized CTA highway-rail crossings with pedestrian access. Such highway-rail crossings can be identified as having a U.S. DOT inventory number assigned to the location (e.g. 372133T). Individuals crossing railroad tracks at locations other than legally designated locations are trespassing upon private property. While trespassing is a major public safety issue, it is not the focus of this research.

An extensive review of the literature pertaining to pedestrian safety at highway-rail grade crossings conducted in the previous study was expanded to include recent relevant studies. The review concluded that there is a wide variety of warning signs and devices utilized. Some are MUTCD compliant, but many are not. Moreover, none of the warning signs and devices has undergone rigorous testing to develop effectiveness rates. In addition, there is not a standard method to quantify and evaluate pedestrian risk at highway-rail grade crossings. In the previous study, these finding were confirmed via extensive interviews with a large number of state agencies, federal and national organizations, and a number of experts from within the community of consulting engineers (Metaxatos and Sriraj, 2013).

This study identified seven locations at CTA rail grade crossings suitable to conduct paper/pen manual user surveys. Two hundred and eleven valid surveys were gathered. Within the survey scope limitations and to the extent that observations from the analysis of the users survey can be generalized, several findings below merit attention because they may have implications about the design and placement of signs and warning systems at CTA pedestrian-rail grade crossings, as well as education and enforcement initiatives.

- Certain activities, such as talking on a cell phone, or listening to music on earphones, may interfere with environmental awareness while traveling across a grade crossing.
- Older users, older than 51 years of age, noticed active signs at grade crossings more frequently than passive signs.
- Overall, female respondents in all age groups appear to be more safety conscious than male respondents when using a crossing. In addition, young males (under 21 years old) appear to be the only group in this sample more likely to cross the tracks against activated signals/warning devices, if in a hurry.
- Trespassing by crossing the tracks at locations other than a pedestrian crossing is still a habit of a small minority of users that merits attention.

- Safety improvements at pedestrian grade crossings should always consider the special needs of people with disabilities.
- Additional educational and enforcement campaigns may be necessary to convince all pedestrian users that (1) it is illegal to cross against activated signals/devices and (2) crossing the tracks at locations other than a pedestrian crossing constitutes trespassing.
- The propensity of respondents of age 30 years and younger to be in violation of activated devices and signs while crossing the tracks was about three times that of respondents older than 30 years of age.

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APPENDIX 1 SURVEY INSTRUMENT

SRL CASEID #__________
DATE ______________
INTERVIEWER #________

Survey of Pedestrian Safety at CTA RR Crossings

1. First we'd like to know how often you use this pedestrian crossing. Please tell us either how many times per DAY you use this crossing, or how many times per WEEK you use it, or how many times per MONTH you use it, or how many times per YEAR you use it. (ENTER ONE NUMBER ONLY)
   - ____per day
   - ____per week
   - ____per month
   - ____per year
   - ☐ First Time/irregularly

2. Did you notice or did you not notice any signs or warning devices at this pedestrian crossing?
   - ☐ Did notice → 2a. What signs and warning devices did you notice at this pedestrian crossing? (DO NOT READ LIST. CHECK ALL THAT APPLY)
     - ☐ Detectable, audible or visual warnings for people with disabilities
     - ☐ Fencing, swing gates, or zigzag
     - ☐ Flashing lights
     - ☐ Pedestrian crossing gate(s)
     - ☐ Pavement markings/Pavement change
     - ☐ Ringing bells
     - ☐ Second-train-coming electronic warning signs
     - ☐ Signs → SPECIFY: ______________________
     - ☐ Other → SPECIFY: ______________________
   - ☐ Did not notice

3. Would you cross these tracks when the lights are flashing, the bells are ringing, or the gates are down if…

	Yes	No
a. You felt that there was enough time to get across safely?	☐	☐
b. Other people were crossing?	☐	☐
c. You were in a hurry?	☐	☐
d. You were annoyed at having to wait for the train to pass?	☐	☐
e. You could not see a train coming?	☐	☐

4. How often have you seen other pedestrians crossing these tracks when the lights are flashing, the bells are ringing, or the gates are down…
   - ☐ Never?
   - ☐ Occasionally?
   - ☐ Sometimes?
   - ☐ Often?
   - ☐ Always?

5. Some pedestrians cross at locations other than the official pedestrian crossing, how often have you crossed these tracks at a location other than the official pedestrian crossing?
   - ☐ Never? → GO TO Q8
   - ☐ Occasionally?
   - ☐ Sometimes?
   - ☐ Often?
   - ☐ Always?

Crossing Location: ____________________

Circle all that apply: Biking Walking Skateboard Rollerblading Wheelchair Walking aid Pushing cart Pushing stroller With young children Music on earphone On cell phone Texting

Time: ____________________

Gender: Male Female

Direction of Travel:
Circle one: North East South West

6. Where else do you cross these tracks? Do you cross…

	Yes	No
a. Through the emergency gates?	1☐	2☐
b. Through the road crossing?	1☐	2☐

c. A location other than the official pedestrian crossing? → SPECIFY: ____________________

7. What are some reasons why you might cross these tracks at a location other than the official pedestrian crossing? (DO NOT READ LIST. CHECK ALL THAT APPLY)
   - 1☐ I felt I had enough time to get across safely.
   - 2☐ The train was stopped.
   - 3☐ Other people were crossing.
   - 4☐ I could not see a train coming.
   - 5☐ I previously crossed when a train was coming and was not hurt.
   - 6☐ I was in a hurry.
   - 7☐ Other (*please specify*)____________________

8. Do you think it is legal or do you think it is illegal for pedestrians to cross the tracks when the lights are flashing, the bells are ringing, or the gates are down, even if the train is not there yet?
   - 1☐ Legal
   - 2☐ Illegal

9. How safe do you feel using this pedestrian crossing? Do you feel…
   - 1☐ Extremely safe?
   - 2☐ Very safe?
   - 3☐ Moderately safe?
   - 4☐ Slightly safe?
   - 5☐ Not at all safe?

10. How difficult is it to cross these tracks? Do you think it is…
    - 1☐ Extremely difficult?
    - 2☐ Very difficult?
    - 3☐ Moderately difficult?
    - 4☐ Slightly difficult?
    - 5☐ Not at all difficult? → GO TO Q12

11. What makes crossing these tracks difficult? (CHECK ALL THAT APPLY)
    - 1☐ Visual pollution/can't see signs
    - 2☐ Signs are not reflective at night
    - 3☐ Audible devices are not loud enough
    - 4☐ The direction of the path/sidewalk is not clear
    - 5☐ The surface of the path/sidewalk is in disrepair, e.g. cracked or broken
    - 6☐ The line of sight to view an approaching train is obstructed by trees, a lamp post, etc.
    - 7☐ The second train warning sign has a glare/ is difficult to read
    - 8☐ **Other → SPECIFY:** ____________________

12. What else could be added to improve safety at this pedestrian crossing? (DO NOT READ LIST. CHECK ALL THAT APPLY)
    - 1☐ Detectable, audible or visual warnings for people with disabilities
    - 2☐ Fencing, swing gates, or zigzag
    - 3☐ Flashing lights
    - 4☐ Pedestrian crossing gate(s)
    - 5☐ Pavement markings/Pavement change
    - 6☐ Ringing bells
    - 7☐ Second-train-coming electronic warning signs
    - 8☐ Signs → SPECIFY: ____________________
    - 9☐ Other → SPECIFY: ____________________
    - 10☐ Nothing/no improvements needed

13. (RECORD AND SPECIY IF OBVIOUS IMPAIRMENT OR IF R HAS ALREADY STATED IMPAIRMENT AND ASK THE FOLLOWING QUESTION) Do you have any physical, visual, auditory, or any other kind of disability?
    - 1☐ Yes → **SPECIFY:** ____________________
    - 2☐ No

14. In what year were you born? __________

15. And can I get the highest grade or level of education you have completed?
    - 1☐ 8th grade or less
    - 2☐ Some high school
    - 3☐ High School graduate/GED
    - 4☐ Some College
    - 5☐ College or other advanced degree

APPENDIX 2 ANSWERS TO COMMON RESPONDENT QUESTIONS

☐ **What is this study about?**
We are looking at the behavior of pedestrians and bicyclists, who use various rail crossings around Northeastern Illinois, to understand their experiences at these crossings.

☐ **Who is doing this study?**
Researchers from the University of Illinois at Chicago's Urban Transportation Center and Survey Research Laboratory are conducting these surveys.

☐ **Who is paying for the research?**
The research is being funded by the Illinois Department of Transportation (IDOT).

☐ **How was I selected for the survey?**
We are asking pedestrians and bicyclists who cross these tracks at specific times during the day.

☐ **What will happen to my answers / Will my answers be kept confidential?**
Your answers will be kept completely confidential and will be looked at in summary form only.

☐ **How long will this take?**
It takes two minutes to complete the questionnaire on average. If you would like, I can walk with you as I ask you questions.

☐ **What are the questions like on the questionnaire?**
The questions ask about the crossing and your experiences at the crossing.

☐ **Who can I call to verify the survey or get more information?**
You may call Jessica Hyink, who is the project coordinator at the University of Illinois Survey Research Laboratory. Her number is (312) 996-5029 and she can be reached during business hours. If you like, you may call collect.

☐ **Why should I participate?**
Your experiences are important to us and we want to hear what you have to say. Your responses may be used to help benefit the future of pedestrian and bicycle safety at rail crossings.

☐ **How do I apply for a job at SRL?**
You can visit the website at www.srl.uic.edu and apply for a job online. If we have positions available, we will contact qualified individuals to come in for interviews.

APPENDIX 3 ORAL INFORMED CONSENT SCRIPT

Hello, my name is ____________________ and I am with the Survey Research Laboratory at the University of Illinois at Chicago. We are conducting a survey about the experiences of pedestrians and bicyclists with active and passive warning signs at highway-rail and pathway-rail grade crossings around Northeastern Illinois. Your responses may be used to help benefit the future of pedestrian and bicycle safety at rail crossings in this country. Would you be interested in completing a quick survey? It should only take a few minutes.

Have you participated before?

☐ Yes → I'm sorry; we can only interview people once. Thank you for participating last time!

☐ No

Are you over 18 years of age?

☐ Yes → Thank you! I'll move through the questions as quickly as possible.

☐ No → I'm sorry, we can only interview people over the age of 18. Thank you for your interest!

APPENDIX 4 INFORMATION SHEET

Project Title: **Pedestrian / Bicyclist Warning Devices & Signs at Highway-CTA Rail Grade Crossings**

Purpose of the Study: We are looking at the behavior of pedestrians, who use various rail grade crossings on the CTA rail system, to understand their experiences at these crossings. The proposed research will evaluate the adequacy and effectiveness of existing signs, markings, and/or flashing lights in use at highway-rail and pathway-rail grade crossings. This research includes designated walkways/bikeways such as city sidewalks, non-designated walkways/bikeways such as roadway shoulders, and passenger/transit station crossings.

We are asking for your participation to understand your experiences with active and passive warning signs at the crossing you are visiting today. The survey should take approximately 2–5 minutes of your time.

Your participation in this study is entirely voluntary, and you can skip any questions you do not want to answer. All the information you provide will be kept completely confidential and will be presented in summary form only.

Although your participation in the research will not directly benefit from you, the research may be of benefit to the future of pedestrian and bicycle safety at rail crossings in this country.

If you have any questions about this study, feel free to ask them now or contact:

Anne Diffenderffer, Project Coordinator
Survey Research Laboratory
College of Urban Planning and Public Affairs
University of Illinois at Chicago
Phone: (312) 413-0492
e-mail: afulle2@uic.edu

OR

Dr. Paul Metaxatos, Research Associate Professor
Urban Transportation Center
College of Urban Planning and Public Affairs
University of Illinois at Chicago
Phone: (312) 996-4713
e-mail: pavlos@uic.edu

If you have any questions about your rights as a research subject, you may write or call OPRS at the following address:

Office for the Protection of Research Subjects (OPRS)
1737, W. Polk Street, M/C 672
203 Administrative Office Building
Chicago, Illinois – 60612.
Phone: (312) 996 1711 or toll free: 866-789-6215
email: uicirb@uic.ed