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DATA COLLECTION AND ANALYSIS FOR LOCAL ROADWAY SAFETY ASSESSMENT

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A report of the findings of
ICT-R27-SP25
Data Analysis for Local Roadway Assessment

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16. Abstract

The project "Data Analysis for Local Roadway Assessment" conducted systematic road-safety assessment and identified major risks that can be eliminated or reduced by practical road-improvement measures. Specifically, the primary task of this project was to collect and code detailed data on key roadway and traffic control characteristics for 100-meter roadway segments from Internet-based photos on Google Street View®. From November 1, 2013, to April 30, 2014, data on more than 50 key safety-related design characteristics were carefully collected and documented for 1,566 100-meter road segments in Boone County, 3,941 in Champaign County, and 2,545 in Vermilion County. Data were collected at an average rate of 4.16 kilometers per hour. This report summarizes the main activities (training, data coding, and communication), management and control (internal and external supervision), and key results of this project.

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This publication is based on the results of a short special ICT research project, **R27-SP25, Data Analysis for Local Roadway Assessment**, as part of an effort in support of the U.S. Road Assessment Program (usRAP). ICT-R27-SP25 was conducted in cooperation with the Illinois Center for Transportation; the Illinois Department of Transportation; and the U.S. Department of Transportation, Federal Highway Administration.

Members of the Technical Review Panel are the following:

Michael Gillette, Illinois Department of Transportation (TRP Chair)
Zach Hans, Iowa State University
Doug Harwood, MRI Global

We thank Michael Gillette (IDOT), Zachary Hans (Iowa State University), and Doug Harwood (MRI Global) for leadership, guidance, and support. Our thanks also go to Kimberly Kolody and Chenchen Liu (CH2M HILL) for their support. The majority of the work was conducted by graduate students Liqun Lu, Yiwei Mao, and Zhuoran Wu at the University of Illinois at Urbana-Champaign.

EXECUTIVE SUMMARY

The project Data Analysis for Local Roadway Assessment conducted systematic road-safety assessment and identified major risks that can be eliminated or reduced by practical road-improvement measures. Specifically, the primary task of this project was to collect and code detailed data on key roadway and traffic control characteristics for 100-meter roadway segments from Internet-based photos on Google Street View®. The data can be used as the basis for usRAP safety assessments and analyses, such as star ratings and road improvement plans.

This project mainly focused on three Illinois counties: Boone, Champaign, and Vermilion. From November 1, 2013, to April 30, 2014, a research team at the University of Illinois at Urbana-Champaign (UIUC) worked jointly with experts at Iowa State University (ISU), MRI Global, and Ch2M HILL to perform the tasks. The UIUC researchers first participated in a two-day, intensive training program to gain the necessary background and knowledge for data collection. During the course of the project, ISU and MRI Global monitored the progress and quality of the data collected.

The project outcome includes carefully documented data on more than 50 key safety-related design characteristics for 1,566 100-meter road segments in Boone County, 3,941 in Champaign County, and 2,545 in Vermilion County. The student researchers collected data at an average rate of 4.16 kilometers per hour. This report summarizes the main activities (training, data coding, and communication), management and control (internal and external supervision), and key results of this project.

CONTENTS

CHAPTER 1 INTRODUCTION

The U.S. Road Assessment Program, sponsored by the AAA Foundation for Traffic Safety (AAAFTS), provides state departments of transportation and local agencies with a new approach to organizing roadway-safety performance more effectively. The U.S. Road Assessment Program developed a systematic road-assessment tool ("usRAP Tools," a web-based software program) that provides information about roadways' level of safety and provides highway agencies with information on highway needs for safety improvement. This tool has been tested successfully in a number of states, including Illinois. Most recently, a pilot study was conducted for Kane County, Illinois; and the effort was funded by AAAFTS.

This ICT project focused on applying similar methods and efforts for three additional Illinois counties: Boone, Champaign, and Vermilion. From November 1, 2013, to April 30, 2014, a research team at the University of Illinois worked jointly with Iowa State University (ISU), MRIGlobal, and CH2M HILL. In the first phase, researchers were trained to use usRAP software tools until they became proficient in applying usRAP protocols. Detailed data for 50+ key roadway and traffic control characteristics were coded into databases that can be employed for developing star ratings and safer roadway investment plans. In the main course of the project, the University of Illinois research team, with assistance of ISU, MRIGlobal, and CH2M HILL, prepared data that were of high quality and appropriately compiled. At last, a revised and combined database was ready for use with the usRAP safety-analysis tool. In the end, the results from this project, together with the usRAP tools, were shared with local agencies such the Champaign County Highway Department to help prioritize safety projects.

Management is critical to this project. Within the UIUC research team, each member was clear about the expectations and responsibilities. Handing in work in a timely manner was required, and weekly checkpoints and expectations were clearly set up. Touch-base meetings in small groups were regularly held to ensure consistency among the data collected and proper progress. MRIGlobal, ISU, and Ch2M HILL facilitated the process and offered valuable experience, support, and guidance during the course of the project.

The methods, processes, and results from this project are summarized in this final report. The organization of this report is as follows: Chapter 2 briefly describes the training process. Chapter 3 presents the summary of outcomes, including the management of this project and database products. Chapter 4 concludes the report.

CHAPTER 2 TRAINING

2.1 OVERVIEW

In preparation for data coding, a two-day training session was held to make UIUC researchers proficient with the usRAP Tools software. The objectives of the training were to gain an overview of the usRAP program and its software; to identify and become skilled at judging each attribute related to road safety; to explore some existing misconceptions; and to set the expectations and goals for the researchers.

The two-day training session was conducted on the UIUC campus from 8:30 a.m. to 6:00 p.m. on Monday, November 4, 2013, and from 8:30 a.m. to 3:30 p.m., the next day. The agenda is shown in Appendix A. The session was led by Zachary Hans from Iowa State University and Doug Harwood from MRI Global. Both instructors had gained tremendous experience from other usRAP pilot projects. Participants of the training sessions were Michael Gillette from Illinois DOT, Chenchen Liu from CH2M HILL, three graduate students (Liqun Lu, Yiwei Mao, and Zhuoran Wu), and Yanfeng Ouyang from UIUC. The students were required to review relevant highway geometric design textbook prior to the training, so as to refresh their memory on basic concepts of roadway design and control.

Table 1 (see next page) provides the outline of the two-day training session. Day 1 focused on an introduction and explanation of the detailed technical tasks. Day 2 continued the discussion but shifted the focus to examples, case studies, and Q&A. The training session was completed on time, and the original objectives were satisfactorily achieved.

2.2 SUMMARY OF THE TRAINING SESSION

2.2.1 Monday Morning

The UIUC team welcomed Michael Gillette, Zachary Hans, Doug Harwood, and Chenchen Liu.

Mr. Hans and Dr. Harwood provided a comprehensive overview of the anticipated activities in the upcoming session. All the resources—including handouts, usRAP software, and projectors—were set in place and ready for use. The training was carried out in an interactive environment, and the UIUC students were encouraged to interrupt speakers whenever questions arose.

Mr. Hans led an introduction about the U.S. Road Assessment Program and its assessment tool, including the history of usRAP in Europe, Australia, and the United States. The vision and mission behind this project was also discussed. The initial reason for this pilot program was the unacceptably high number of traffic crashes in the United States resulting from general under-investment in highway safety. Therefore, the U.S. Road Assessment Program was initiated by AAA Foundation for Traffic Safety (AAAFTS) to cooperate with federal, state, and local highway agencies. The usRAP software was the technical tool used to identify countermeasures based on roadway geometric design and traffic control characteristics data.

Table 1. Main Activities at the Training Session

Task	Key Takeaway	Resources
Monday Morning		
Welcome and introductions Review training objectives and background of usRAP	usRAP: road assessment to reduce the risk of fatal injuries in Europe, Australia, and the United States (1) Star rating: giving values from 1 (worst) to 5 (best), based on 40 features, such as bicycles, pedestrians, motorcycles, vehicle's occupants (2) Safer road investment plan: A quick indication of accident-prone locations.	• Handouts: *usRAP Star Rating and Investment Plan Coding Manual* • Software: iRAP rating preprocessor software and Excel. • Hardware: Personal computer, projector, and connecting cable.
Monday Afternoon		
In-depth explanation of 50 key roadway and traffic control characteristics	Stick to the definition stated in the *usRAP Star Rating and Investment Plan Coding Manual*	
Tuesday Morning		
Case study of some typical segments in Champaign and Vermilion counties Lessons from and experiences in past projects	1. Rotation of Google Street View 2. Data-consistency requirements and evaluation 3. Resources	
Tuesday Afternoon		
Practice on self-chosen sections, peer learning, and Q&A Setting goals and expectations	Exercises: Individual practice on three road segments for 30 minutes; then students took turns explaining the judgments and reasoning behind the data input.	

2.2.2 Monday Afternoon

On Monday afternoon, discussion focused on definitions for specific roadway attributes and effective data-input methods. The basic idea of the data collection was to look at city street images from Google Street View and then extract useful information on roadway design and traffic, as well as control devices, into a database. A sample image is given in Figure 1, and a user interface for data entry is given in Figure 2.

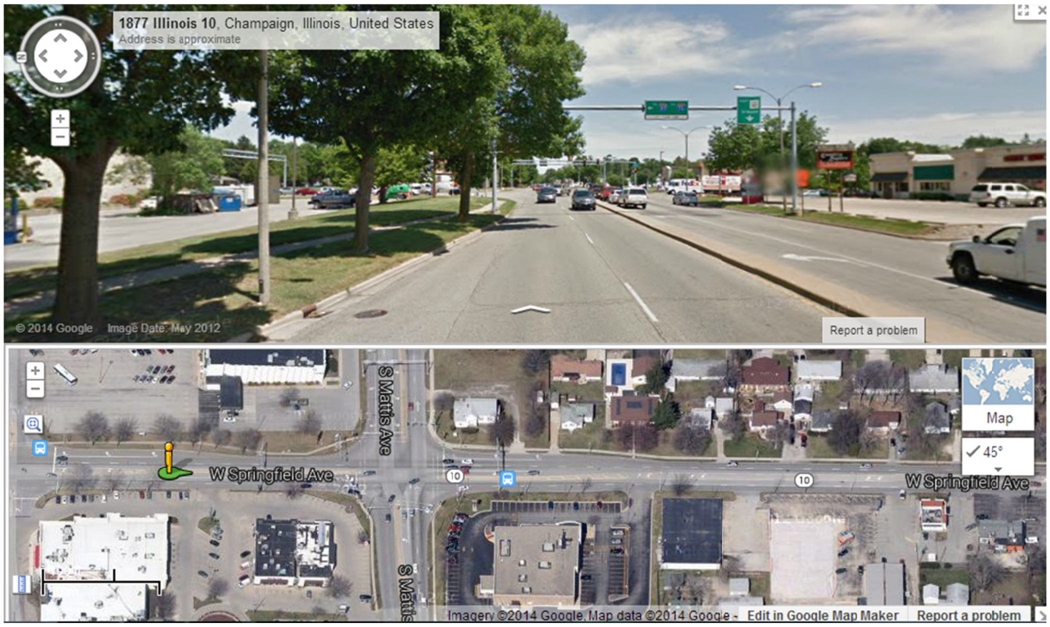

Figure 1. Sample roadway image from Google Street View.

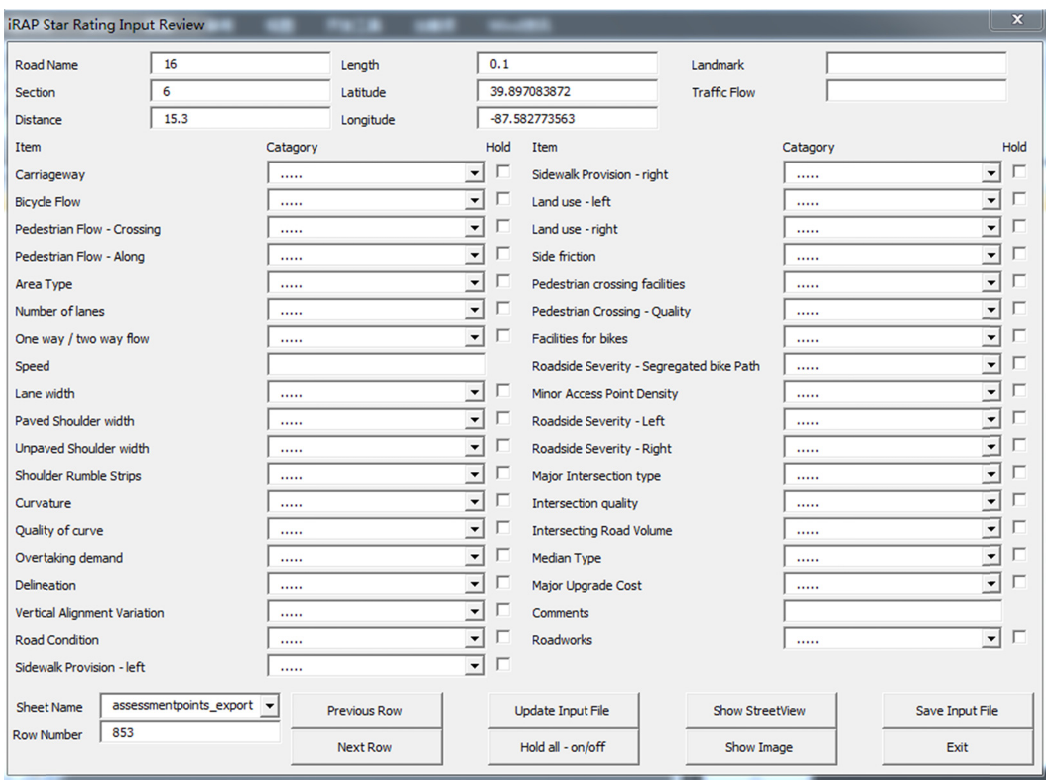

Figure 2. User interface for input about safety-related roadway attributes.

The coding identifiers are important for recording and anticipating completion time. Information in the text fields—including coder name, road survey date, and image reference (to be added)—had no length limit and did not allow commas, semicolons, or slashes but did allow apostrophes, parentheses, and periods. Each entry required some subjective judgment. Detailed explanations of the data rules can be found in usRAP's unreleased guide[1].

2.2.3 Tuesday Morning

Once the students understood the basic rules, the training focused on applying the rules in various cases. In some cases, data encoding was found to be tricky because the perspective/angle of the street picture was incomplete or less than ideal (e.g., for roadside features). Therefore, some typical segments from Champaign and Vermilion were used as training examples for the students. This practice helped them learn lessons from past projects and to improve their consistency in data coding.

Altogether, four cases were illustrated briefly, and six additional cases were discussed and explained in detail. The main issues covered include the following.

- How to judge the left and right traffic direction
- That the intersection should be public way although sometimes a private driveway shows confusingly similar features
- That it is important to verify that the coding direction is from south to north and west to east
- That the existence of a curb is worthy of being recorded in comments
- That it helps to move forward with an image to decide whether to include or exclude certain features
- That it is important to verify consistency of camera direction from record to record.

Training with specific examples helped the students learn how to extract image information into consistent data. For example, data from the street picture in Figure 1 are shown in Figure 3 on the following page.

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[1] AAA Foundation for Traffic Safety, 2013. "usRAP Coding Manual for Start Ratings and Safer Roads Investment Plans."

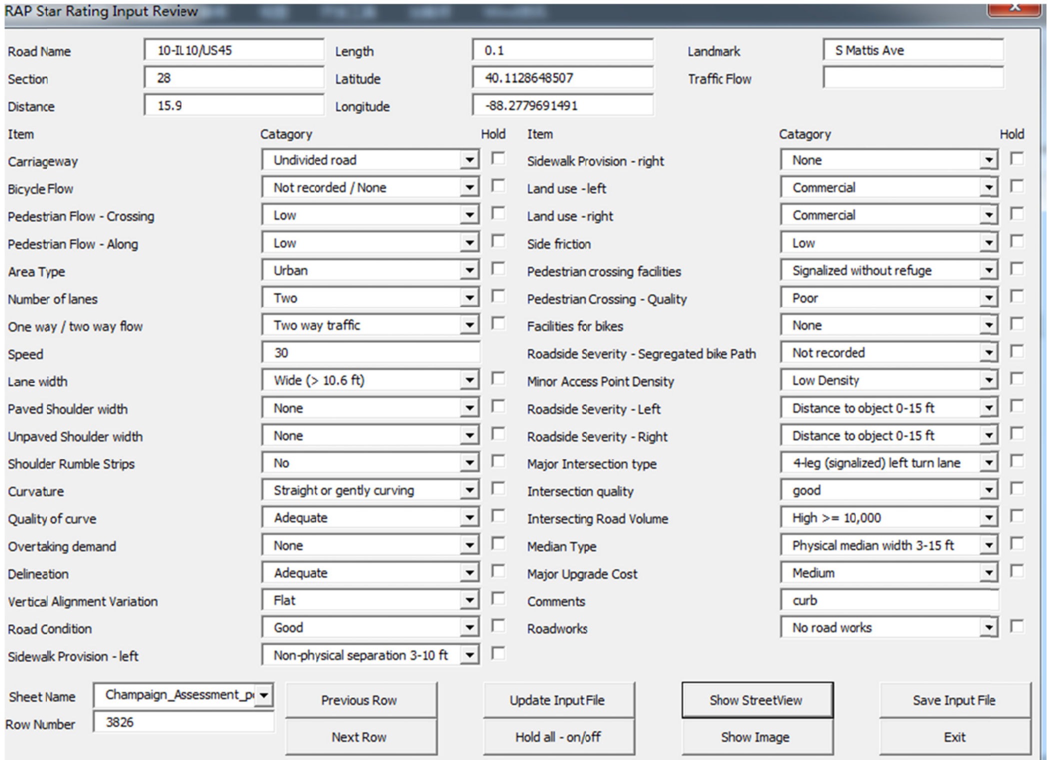

Figure 3. Data coding for the sample roadway image in Figure 1.

Some of the confusing issues identified for this segment are noted in Table 2.

Table 2. Data-Coding Issues for the Sample Roadway in Figure 1
(City: Champaign; Row number: 3826)

Misleading attributes	**Correct input**	**Issue**
Carriageway	Undivided road	Physical median here is not critical to judge carriageway because the median appears for only a certain length.
Intersection type	4 legs signalized with left-turn lane	Make sure which segment the intersection belongs to.
Other issues	1. Need to verify the consistency of camera direction from record to record. Sometimes, it can be confusing when camera direction has been rotated 180 degrees. 2. All the left and right directions should follow the orientation of camera direction.	

2.2.4 Tuesday Afternoon

Students practiced on several self-chosen roadway sections for half an hour and then asked questions about problems encountered in the process. After completing the previous training session, all of the students had gained some experience and could obtain consistent data needed as input to usRAP Tools. The average speed of data entry was about 1 mile per hour.
In closing, Mr. Hans and Dr. Harwood set goals and expectations. Despite the initial learning curve, experienced students were expected to conduct data entry at a rate of no less than 2 to 3 miles per hour. Mr. Hans also suggested that the total duration of nonstop work at one time should be no less than 1 hour but no more than 4 hours (for maximum efficiency).

2.3 Follow-Up Meetings After Training

After the two-day intensive training, the UIUC team met and came up with a work plan. The UIUC group meetings served the following purposes:

- To review the purpose and content of the training and to reflect on the lessons and skills developed during the training.
- To ensure data-coding consistency by working together as a team on several Champaign urban and rural segments. Such meetings successfully cleared up remaining misunderstandings and confusion.

CHAPTER 3 PROJECT OUTCOME SUMMARY

3.1 PROJECT MANAGEMENT

Every member of the UIUC research team was assigned a specific workload. Weekly process reports were required for schedule and quality-control purposes. MRIGlobal and ISU worked as an external support group that offered both supervision for the progress and valuable resources.

The data were periodically backed-up and reviewed for accuracy and consistency. To estimate the completion time, every student was required to hand in personal targets, for example, projections of how many hours he or she could possibly input data in an average week. The average working time was 12 hours per week.
The total workload, for all roadway segments with Street View in these three counties, was divided into three parts, as shown in Table 3. The rule was the entire length of a road should be the responsibility of primarily one student, so as to achieve maximum consistency.

Table 3. Initial Division of Workload Among the UIUC Students

Student	County	Range of rows	Total # of records
Zhuoran Wu	Champaign Boone	1st record to middle 1,001 to 1,566	1,206 566
Liqun Lu	Champaign Boone	Middle to last record 1 to 500	1,206 500
Yiwei Mao	Vermilion Boone	All points 501 to1000	1,959 500

As shown in Table 3, the 3,941 total segments in Champaign County were assigned in equal portions to Liqun Lu and Zhuoran Wu. The 2,545 segments in Vermilion County were assigned to Yiwei Mao. The 1,566 segments in Boone County were completed in approximately equal portions by the three students. Every team member was responsible for the following tasks:

- Input 50+ key roadway and traffic control characteristics from Google Street View. To improve speed, some characteristics like “Carriageway” that are usually consistent in an entire road could be held by clicking “hold” box in the software.
- Among the characteristics, traffic flow would be input at a later stage. A constant speed limit would apply unless there was a clear sign on the Street View picture.
- Go through so-claimed “No Street View” segments to check any updates from Google
- Hand in weekly progress report and calculate cumulative data collection speed.
- Ask questions and seek help promptly in case of any issues.

Per Mr. Hans' suggestion, a single nonstop work session should be no less than 1 hour and no more than 4 hours.

Every time a student finished data input, he or she needed to fill out a Tracking and Rating File (see Figure 4). Starting and ending segments, as well as working hours, were entered to compute progress and efficiency. In the file, the cumulative records, remaining distance, current speed, and total input rate served as gauges to judge the student's performance.

Beg Row	End Row	Rows				
500	1000	500	50	tot. km	tot. hrs	10.5
					ave. kph	4.9

County: Vermilion

Day of Week	Date	Begin Row	End Row	Hours	Cumulative Records	Completed Cumulative Distance (km)	Remaining Distance (km)	Incremental Records	Incremental Distance (km)	KMPH
Mon.	20-Jan	500	581	2	81	8.1	41.9	81	8.1	4.1
Wed	22-Jan	581	721	3	140	14	36	140	14	4.7
Thu	23-Jan	721	911	4	190	19	31	190	19	4.8
Sat	25-Jan	911	1000	1.5	89	8.9	41.1	89	8.9	5.9

Figure 4. Sample tracking and rating records.

The team used several communication channels to facilitate collaboration with each other, including email, i-message, voice calls, and voicemail. Communication was focused on the project deliverables and submitted data records.

During the meetings and through email, the team members shared problems they encountered. IDOT, Iowa State University, MRIGlobal and Ch2M HILL offered great help in this regard. These questions enhanced the synthesis and understanding of the data-coding rules. The weekly report and data review also provided an opportunity for the students to get appropriate feedback from MRIGlobal and ISU. Figure 5 shows some examples of inaccurate data coding that MRIGlobal helped identify at the beginning of the project.

Original Name	Original Section	Distance	X	Y	Correct Name	Correct Section
180 1-DEWEY-FISHER RD	1	0.0000	40.2230	-88.2796	11-FLATVILLE/CENTRAL AV	2
181 1-DEWEY-FISHER RD	1	0.0000	40.1858	-88.2774	13-COUNTY HIGHWAY 13	5
418 11-FLATVILLE/CENTRAL AV	2	6.7020	40.2395	-88.0592	12-2-COUNTY RD 2100E/2200	4
419 11-FLATVILLE/CENTRAL AV	2	0.0000	40.2411	-88.0209	32-COUNTY RD 32	20
1497 17-IVESDALE/SADORUS RD	9	0.0000	39.9660	-88.3492	19-MARKET ST	12
1498 17-IVESDALE/SADORUS RD	9	0.0000	39.9513	-88.4256	6-COUNTY ROAD 6	24
1761 18-2-MONTICELLO RD	11	6.6386	40.0258	-88.3498	19-MARKET ST	12
1762 18-2-MONTICELLO RD	11	0.0000	40.0255	-88.3135	25-STALEY RD	27
1888 20-1-COUNTY RD 20	13	0.0000	40.1782	-88.2416	20-2-COUNTY RD 20	14
2142 20-2-COUNTY RD 20	14	8.0820	40.1861	-88.1049	24-COUNTY ROAD 24	18
2464 22-2-PENFIELD RD	16	27.4623	40.3850	-87.9509	9-COUNTY ROAD 9	26
2571 23-ELLIOT RD	17	0.0000	40.3844	-88.2716	9-COUNTY ROAD 9	26
2705 30-COUNTY RD 30	19	7.3474	40.3547	-88.3480	8-FOOSLAND	25
2929 50-LAKE OF THE WOODS RD	21	0.0000	40.1980	-88.3779	54-TIN CUP RD	22
2930 50-LAKE OF THE WOODS RD	21	1.1282	40.1966	-88.3653	54-TIN CUP RD	22

Figure 5. Examples of inaccurate data coding.

3.2 SUMMARY OF RESULTS

All members of the team contributed and interacted with each other throughout the usRAP project. In all, 3,941segments in Champaign County, 2,545 segments in Vermilion County, and 1,566 segments in Boone County were completed by the end of January 2014.

3.2.1 Data Records

By late December 2013, Liqun Lu and Zhuoran Wu had completed 3,941 segments in Champaign County, and Yiwei Mao had coded data for 2,545 segments in Vermilion County. Then, 1,566 segments in Boone County were evenly assigned to the three students. By the end of January 2014, primary data collection for the star ratings and safe road investment plans was accomplished.

The University of Illinois, with assistance of MRIGlobal, embarked on reviewing data immediately, updated data when necessary, and then combined those data into an input file for the usRAP safety analysis tool for each county. MRIGlobal also assisted the students in estimating mean traffic speeds, pedestrian volumes, and bicycle volumes on the country networks. By February 2014, the final databases were transferred to IDOT, MRI Global, ISU, and CH2M HILL.

3.2.2 Input Rate

Across three students, the overall average rate of data input during the project was 4.16 kilometers per hour. There was definitely a learning curve for the students. In the later stage, during data coding for Boone County, all student improved their pace, with the average speed increasing to 5.96 kilometers per hour. The progress curves of the three students are as shown in Figure 6.

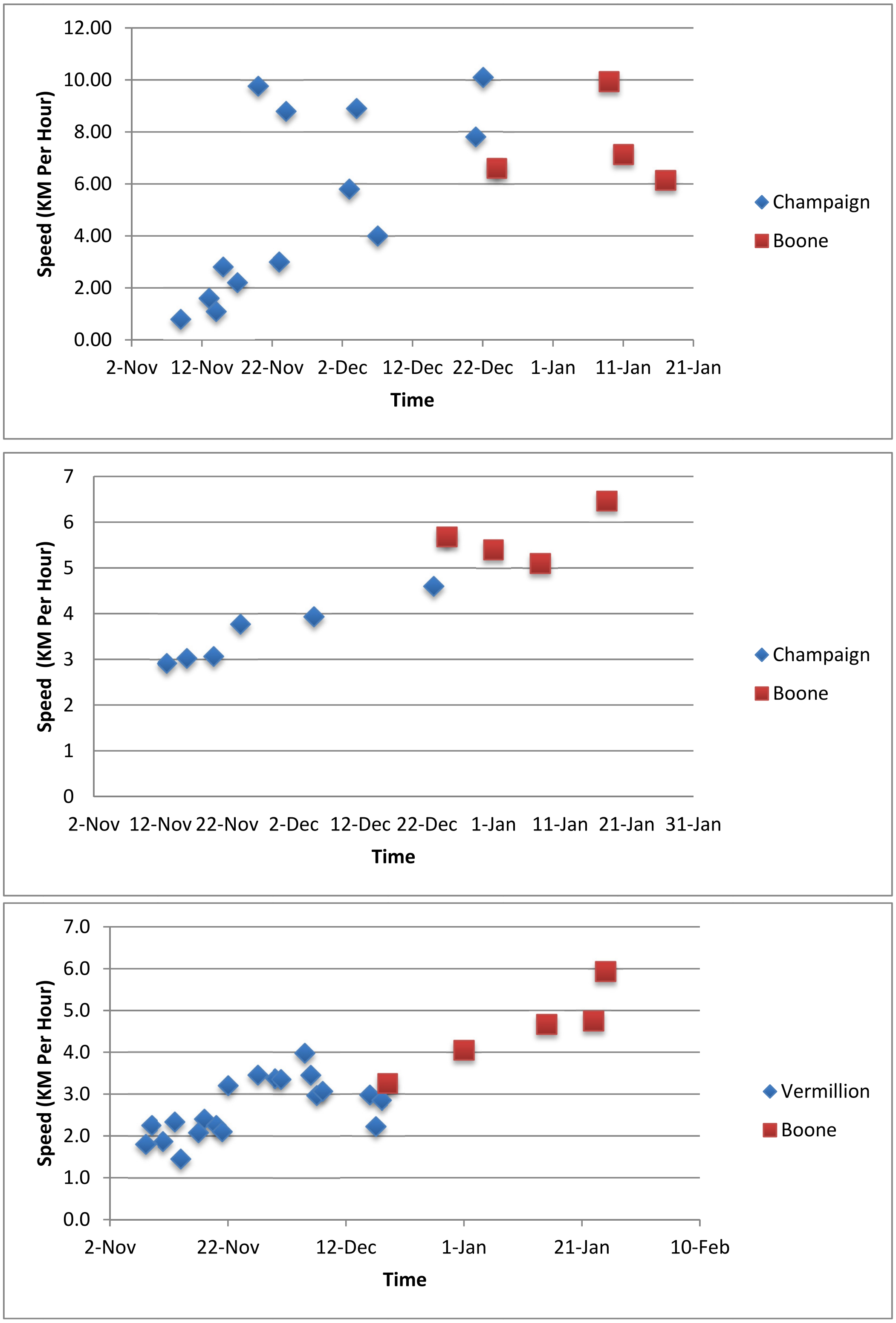

Figure 6. The data collection speed of the three students throughout the project.

3.3 DISSEMINATION OF RESULTS

Upon completion of the project, the results were shared with local officials from Champaign, Vermilion, and Boone Counties. A half-day session was held at the Champaign County Highway Department on May 21, 2014. The participants included Rita Morocoima-Black from the Champaign County Regional Planning Commission, Jeff Blue from Champaign County, Doug Staske from Vermilion County, Alan Ho from FHWA, Priscilla Tobias and Tim Sheehan from IDOT, Yanfeng Ouyang from UIUC, Doug Harwood from MRIGlobal, Kim Kolody from CH2M HILL, Dante Perez-Bravo from CH2M HILL, and Chenchen Liu from CH2M HILL. As part of the process of wrapping up the usRAP initiative, discussion also was carried out to demonstrate the usRAP Tools software, as well as the prepared databases that can be used to help prioritize projects within the counties. The feedback was unanimously positive.

CHAPTER 4 CONCLUSION

The objective of this project was to prepare primary data for star ratings and road improvement plans for three Illinois counties: Boone, Champaign, and Vermilion. The method involved judgment and manual coding of 50 key safety-related characteristics into usRAP software tool based on street photos available in Google Street View. The main tasks completed included training, data coding, and data review. A number of management strategies and quality-assurance actions were taken to facilitate the execution of this project.

The project was completed on time and within budget, running from November 1, 2013, to April 30, 2014. Data-preparation quality and speed were satisfactory. Accurate data were coded for 1,566 road segments in Boone County, 3,941 in Champaign County, and 2,545 in Vermilion County. The overall average input rate was 4.16 kilometers per hour, which was very satisfactory considering, the learning curves for beginners.

The research team and the supervising parties performed the tasks in a highly efficient and coordinated manner. They adhered strictly to rules that were provided and worked diligently toward the goals. MRI Global, ISU, and Ch2M HILL facilitated support and guidance in training, troubleshooting, and review.

As part of the Illinois Safety Program, this project prepared high-quality data that will serve as the basis for various types of quantitative safety analyses. Highway agencies such as IDOT and local agencies will significantly benefit from these databases in making strategic decisions on route improvements, crash protection, and standards of safety management.

APPENDIX A TRAINING AGENDA FOR ICT R27-SP25

NOVEMBER 4–5, 2013

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Monday, November 4, 2013

8:30 a.m.	Greetings at north side of Newmark, 205 N. Mathews Ave., Urbana, IL 61801	Parking at lot N1 and meters (permits provided)
8:40 a.m.–12:00 noon	Training	B226 Newmark
12 noon–1:30 p.m.	Group lunch	
1:30–5:30 p.m.	Training	B226 Newmark
6:00 p.m.	Group dinner	

Tuesday, November 5, 2013

8:30 a.m.–12:00 noon	Training	B226 Newmark
12 noon–1:30 p.m.	Group lunch	
1:30–3:20 p.m.	Training	B226 Newmark
3:30 p.m.	Adjourn	