Program Progress Performance Report
for University Transportation Center

Submitted to: U.S. Department of Transportation
Office of the Assistant Secretary for Research
and Technology (OST-R)

Grant Number: DTRT13-G-UTC60

Project Title: University Transportation Centers
Transportation Research Center for Livable
Communities (TRCLC)

Program Director: Jun-Seok Oh, Ph.D.
Professor and Director
Transportation Research Center for Livable
Communities at Western Michigan University
1903 West Michigan Avenue
Kalamazoo, MI 49008-5316
jun.oh@wmich.edu / (269) 276-3216

Submitting Official: Same as Program Director

Submission Date: April 30, 2017

DUNS and EIN: 622364479 / 386007327

Recipient Account Number: 25-7020240

Recipient Organization: Western Michigan University
1903 West Michigan Avenue
Kalamazoo, MI 49008

Project/Grant Period: September 30, 2013 – September 30, 2018

Reporting Period End Date: March 31, 2017

Report Term or Frequency: Semiannual

Signature of Submitting Official: [Signature]
1 ACCOMPLISHMENTS

1.1 What are the major goals and objectives of the program?

The TRCLC addresses five USDOT strategic goals through the prism of Livable Communities. The Center’s primary focus is to help developing communities that provide people with access to affordable and environmentally sustainable transportation through coordination between transportation, housing, and commercial development. In particular, the Center will concentrate on bringing technological advances to aid the development of livable communities by coordinating efforts among faculty in associated fields at five universities to collectively enable livable communities through transportation research.

Research
Livable communities are where people can enjoy their daily lives without having to drive their car. Toward this end, the TRCLC focuses on three research objectives:

• improving public transit systems and alternative transportation modes,
• providing better and safer pedestrian and bicycle networks, and
• enhancing transportation accessibility for children, people with disabilities, older adults, and lower income populations.

Education and Workforce Development
The TRCLC consortium will create opportunities for learning and knowledge sharing through a comprehensive education and workforce development program based on a lifecycle of occupational development approach that emphasizes K-12 outreach, career-oriented higher education and professional development. Our program goals are to:

1) Develop activities for teachers, counselors, administrators and students in K-12 schools to enhance awareness of the forms and functions of transportation systems.
2) Develop career-oriented higher educational programs that combine multidisciplinary course work, experiential education, participative research and industry-university partnerships
3) Create programs for professional development on a broad range of transportation topics geared to the needs of decision-makers, transportation officials, community members and professional staff.

Technology Transfer
The Center’s technology transfer program will leverage and extend our existing activities as well as build new capacity to achieve the following inter-related goals:

1) to formalize a widely distributed and multi-format knowledge-sharing infrastructure, and
2) to create opportunities for context-sensitive problem identification and participatory research.
**Collaboration**

Our primary collaborative goal is: to develop capacities to identify, cultivate and sustain inter-disciplinary and inter-sectoral partnerships in order to meaningfully frame and address transportation problems that stifle the development of livable communities.

**Diversity**

Our goal for diversity is to outreach to underrepresented groups, low income communities, and diverse disciplines and partners.

### 1.1 What was accomplished under these goals?

**Research**

Research Efforts at WMU

- Final report was submitted for review. (TRCLC 15-6)
- Bicycle simulator was set for experiments and plan to complete the experiment in April. (TRCLC 15-3)
- Point cloud data were analyzed for processing and the data collection system has been designed. (TRCLC 16-1)
- Preliminary analysis was done on non-motorized mobility within construction zones (TRCLC 16-2)
- Data collection sites for yielding culture were determined in cooperation with the City of Ann Arbor. (TRCLC 16-3)
- Field study sites were determined in cooperation with the City of Grand Rapids and survey questionnaire was developed. (TRCLC 16-4)
- Data collection for the travel behavior of blind individuals study is currently in progress (TRCLC 16-5)
- Device-to-vehicle communications for work zone application and intersection crossing have been designed (TRCLC 16-6)

Research Efforts at UTA

- Android App, “Safe Activity,” was finalized and placed in the Google Play store and the project completed (TRCLC 15-7)
- Documentation of advocacy groups and safety experts completed; Localities selected for the analysis; Gathering of FARS data for the selected localities has begun (TRCLC 16-7)
- Reviewed HUD programs identified 16 major national housing programs for low income families started with finding all programs in HUD; Measured D variables for 1/4, 1/2, and 1-mile radius buffers around each property; Developed a road network for DFW using Network Analyst tool in Arc GIS (TRCLC 16-8)
- Categories of impacts identified; Preliminary questions developed; Recruitment partner identified; App story boarding complete and flow chart drafted for tablet app; IRB application is drafted including obtaining letter of support from Meals on Wheels director in Tarrant County; NCTCOG project initiated (TRCLC 16-9)

Research Efforts at USU
- The space syntax model of regional-scale bicycle demand has been developed to establish transportation network demand (TRCLC 15-10)
- Integrated both mode choice and route choice into a combined modal split and traffic assignment (CMSTA) model; Developed solution algorithm for solving the CMSTA model. (TRCLC 15-11)
- Conducted a literature review on O-D estimation technique; Explored and evaluated bicycle data from multiple sources; Developed a constraint-based bicycle O-D estimation procedure. (TRCLC 16-10)

Research Efforts at TSU
- Final report was submitted and the project completed (TRCLC 15-9)
- VISSIM simulation Setup and run for two corridors; Initial VISSIM simulation findings generated on one corridor (TRCLC 16-11)

Status of Research Projects
- Three research project was completed during the period.

<table>
<thead>
<tr>
<th>Project ID</th>
<th>Title</th>
<th>Institution</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-6</td>
<td>Integrated Crowdsourcing Platform to Investigate Non-Motorized Behavior and Risk Factors on Walking, Running and Cycling Routes</td>
<td>WMU</td>
<td>Al-Fuqaha</td>
</tr>
<tr>
<td>15-7</td>
<td>App-Based Crowd Sourcing of Bicycle and Pedestrian Conflict Data</td>
<td>UTA</td>
<td>Mattingly</td>
</tr>
<tr>
<td>15-9</td>
<td>Impact of Access Management Practices to Pedestrian and Bicycle Operations and Safety</td>
<td>TSU</td>
<td>Chimba</td>
</tr>
</tbody>
</table>

- There are three on-going research projects funded during the 2nd funding cycle.

<table>
<thead>
<tr>
<th>Project ID</th>
<th>Title</th>
<th>Institution</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-3</td>
<td>Real Time Bicycle Simulation Study of Bicyclists’ Behaviors and Their Implication on Safety</td>
<td>WMU</td>
<td>Kwigizile</td>
</tr>
<tr>
<td>15-10</td>
<td>Development of Multi-Class, Multi-Criteria Bicycle Traffic Assignment Models and Solution Algorithms</td>
<td>USU</td>
<td>Christensen</td>
</tr>
<tr>
<td>15-11</td>
<td>Development of a New Combined Modal Split and Traffic Assignment Model for Evaluating Transit Oriented Development Strategies</td>
<td>USU</td>
<td>Song</td>
</tr>
</tbody>
</table>
There are eleven on-going research projects funded during the 2nd funding cycle.

<table>
<thead>
<tr>
<th>Project ID</th>
<th>Title</th>
<th>Institution</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-01</td>
<td>Paths to ADA-Compliance: The Performance and Cost Efficiency of measurement Technologies that Support ADA-Mandated, Self-Evaluations of Pedestrian Rights of Way</td>
<td>WMU</td>
<td>Oh</td>
</tr>
<tr>
<td>16-02</td>
<td>Enhancing Non-motorized Mobility within Construction Zones</td>
<td>WMU</td>
<td>Attanayake</td>
</tr>
<tr>
<td>16-03</td>
<td>The Effects of High Visibility Enforcement on Driver compliance to the Drivers yielding to Pedestrians in Crosswalks: Changing the Driving culture on a Citywide Basis</td>
<td>WMU</td>
<td>VanHouten</td>
</tr>
<tr>
<td>16-04</td>
<td>Effectiveness of Bicycle Signals for Improving Safety and Multimodal Mobility at Urban Intersections</td>
<td>WMU</td>
<td>Oh</td>
</tr>
<tr>
<td>16-05</td>
<td>Travel Behavior of Blind Individuals before and after receiving Orientation and Mobility Training (Phase 2: Full-scal Study)</td>
<td>WMU</td>
<td>Kim</td>
</tr>
<tr>
<td>16-06</td>
<td>Vehicle-to-Device (V2D) Communications: Readiness of the Technology and Potential Applications for People with Disability</td>
<td>WMU</td>
<td>Al-Fuqaha</td>
</tr>
<tr>
<td>16-07</td>
<td>Blame-the-Victim Policy Narratives and Local-Level Transportation Policy Decisions</td>
<td>UTA</td>
<td>Casey</td>
</tr>
<tr>
<td>16-08</td>
<td>Does Location Matter? Performance Analysis of the Affordable Housing Programs in Dallas Fort Worth Metropolis</td>
<td>UTA</td>
<td>Hamidi</td>
</tr>
<tr>
<td>16-09</td>
<td>Transportation Mobility Among Low-Income, Transportation Disadvantaged Older Adults Living in a Low Density Urban Environment using Innovative Data Collection Methods</td>
<td>UTA</td>
<td>Fields</td>
</tr>
<tr>
<td>16-10</td>
<td>A Constraint-Based Bicycle Origin-Destination Estimation Procedure</td>
<td>USU</td>
<td>Song</td>
</tr>
</tbody>
</table>

Research proposals are being accepted for the 4th funding cycle, and the funding decision will be made in June after completing external reviews.

**Education and Workforce Development**

- TRCLC invited 200 high school students and provided a chance to watch a new 3-D iMAX film, “Dream Big” produced by the MacGillivray Freeman Film in partnership with the American Society of Civil Engineers, Bechtel and a coalition of engineering organizations. High school students also had an opportunity to answer questions to TRCLC graduate students about civil and transportation engineering for their future career.
- Three graduate student were chosen for their research in the area of transportation. These students will be supported by TRCLC for their education.
• The Effects of Distance from Crosswalk and Offset Placement of a Gateway In-
Street Sign Configuration on Yielding to Pedestrians on Multilane Roads at an
Uncontrolled Crosswalk, Jonathan Hochmuth, Psychology, WMU
• Drive-time versus Bike-time based Geospatial Model for Optimizing Healthcare
Center Locations, Bandhan Dutta, Geography, WMU
• Wayfinding for Visually Impaired People using Semi-supervised Deep
Reinforcement Learning, Mehdi Mohammadi, Computer Science, WMU
• TRCLC hosted guest speaker series:
  • Dr. Denise Smith, Michigan Department of Transportation, “Are Today’s
Tools Sufficient for Tomorrow’s Technology? – Modeling Autonomous
Truck Platoons,” October 11, 2016
  • Dr. Yifenf Chen, AECOM, “Integrated Corridor Management (ICM),”
November 4, 2016
  • Dr. Tim Gates, Michigan State University, “Raising Speed Limits on Rural
Highways: A Process for Identification of Candidate Highway Segments in
Michigan,” March 17, 2017
  • Dr. Duk-Geun Yun and Dr. Youngrok Kim, Korea Institute of Civil Engineering
and Building Technology, “Highway Sensing Technology and Testing
Environment under Diverse Weather Conditions,” March 27, 2017
  • Dr. Henry Liu, University of Michigan, “Future Traffic Control with Connected and
Automated Vehicles,” March 30, 2017
• WMU conducts training sessions to prepare students to take the American
Concrete Institute (ACI) – Field Technician Grade I Certification. So far, 74
students have been trained through this program. This is relevant to the
research center theme since these students will work in the local communities to
ensure quality of concrete walkways and trails built for non-motorized traffic.
• WMU faculty and graduate students took part in a seven-mile ride highlighting
bicycle infrastructure in Chicago.
• Coordinated and funded student travel to TRB 2017 annual meeting
• UTA included 48 undergraduate students in App Field Test.

Technology Transfer
• TRCLC researchers participated in the TRB annual meeting and other
conferences and presented research outcomes.
• Research reports and outcomes were disseminated through e-mail, homepage,
and social network media (Facebook).

Collaboration
• Collaborated with the City of Grand Rapids for a bicycle-related research. The
city will install bike signals and bike boxes at two intersections for the research
project.
• Collaborated with the City of Ann Arbor to study on pedestrian education and
safety.
• Collaborated with the Reginal UTC at the University of Michigan on Automated
Vehicle Technologies.
• Collaborated with the Regional UTC at the University of Minnesota on providing workshops in each region on pedestrian safety.
• Collaborated with the ATLAS at University of Michigan in sharing research outcomes on elderly mobility.
• Collaborations between WMU and Purdue University, University of Nebraska Lincoln the City University of New York on transportation-related data science research
• UTA members developed a collaborative research proposal between the UTA School of Social Work and Civil Engineering.
• Collaborated with DePaul University’s Chaddick Institute for Metropolitan Development to create an ideal route for highlighting Chicago’s innovative bicycle infrastructure.

Diversity
• Two African American faculty participated in a WMU research project.
• A female faculty participated in a WMU research project.
• Five female graduate students participated in WMU research projects; one of the students is Hispanic, and one of them is African American.
• Female faculty members are PIs of two TRCLC research projects from UTA, and five female graduate researchers are on these projects.
• UTA is still a Hispanic-serving Institution, and TSU is one of Historically Black Colleges and Universities.

1.2 What opportunities for training and professional development has the program provided?
• TRCLC provided latest technologies and knowledge to the students and local practitioners through guest speaker series. During the period, six presentations were offered.

1.3 How have the results been disseminated?
• TRCLC news and information continue to be disseminated though e-mails, center website, and Facebook.
• TRCLC reports and newsletters were electronically disseminated to related agencies.

1.4 What do you plan to do during the next period to accomplish the goals and objectives?
Research
• Select projects to fund for the 4th cycle through external evaluation and research advisory committee’s review
• Develop signature research projects to present best theme of the center.
• Begin a new line of research validating a training protocol for blind travelers
• Plan to carry out research aimed at changing the driving culture in the city of Ann Arbor to increase driver yielding to pedestrians in crosswalks
• Begin examining lake-effect snow and traffic crashes in southwest Michigan in order to inform transportation planning and transportation safety measures in Michigan’s small communities
• Develop virtual reality-based transportation accessibility evaluation method for the elderly and people with disabilities
• Conduct an experiment using bicycle simulator developed to analyze bicyclist behavior.
• Develop a service system to help transportation professionals efficiently track the status of transportation infrastructure conditions, using advanced sensing technologies (e.g., laser scanning, image sensing) together with information modeling, GIS, and knowledge modeling.
• Develop a system that can measure ADA compliance using various sensors and develop methods and algorithms to automate the assessment of roadway accessibility based on sensing data (i.e., point cloud data and depth sensor data).
• Developing a research proposal that examines the contribution of ridesourcing modes such as Uber and Lyft in helping workers make first-mile connections to commuter rail transit in the Chicago region.
• An article will be written regarding the Travel Behavior of Blind Individuals Before and After Receiving Orientation and Mobility Training and submitted to an appropriate academic journal
• Data before and after receiving orientation and mobility training is being collected. Upon completing the analyses of the data, the findings of the project will be published in a journal and presented at a professional conference.
• Developing a Bicycle Level of Service (BLOS) model of regional-scale bicycle demand.
• Develop a set of transit-oriented-development (TOD) strategies for testing the CMSTA model.
• Locate data on Self-Help Homeownership Opportunity Program (SHOP) using XY coordinates, geocode the Vouchers.
• Estimate household transportation costs and calculate the percentage of household’s income spent on transportation for a household with a household size of 3 (Average household size for a typical low income household is 2.39) who qualifies for renting an LIHTC designated property.
• Complete app development for older adults, and conduct a field study.
• Survey advocacy groups on what strategies they currently use to inform decision makers and counter ‘negative’ blaming narratives
• Conduct various simulation scenarios to analyze the impact of access management practices.
**Education and Workforce Development**

- Continue offering guest speaker series to provide education opportunities for graduate students and to provide skills and knowledge for local professionals.
- The 4th Annual Summer Conference scheduled on June 1 – 2 will provide an opportunity for students to present their research through poster presentations and to meet other professionals.
- Provide field trip and field training opportunities to undergraduate and graduate students in CCE Department and other departments at Western Michigan University.
- Try to explore mentorship programs which allow external professionals and experts take selected student mentees to have conversation on a regular basis.
- Incorporate the research results into educational resources for courses at WMU.
- Integrate Social Work students into ITE student chapter.
- Begin development of course materials for introducing transportation concepts into social work curriculum.
- Conduct a training session to prepare students to take the American Concrete Institute (ACI) – Field Technician Grade I Certification.

**Technology Transfer**

- Center research partners will present findings at its 4th Annual Summer Conference in June in Kalamazoo.
- Disseminate newsletters through e-mails, social network media and the center website.
- Organize technological expos during the summer conferences to showcase the different technologies developed and seek collaborations in applying them.
- Organize meetings with Kalamazoo and Portage City engineers and planners to educate them about the research being conducted as well as to understand their needs.
- Develop a workshop for using the new Public Health Performance Measures to make infrastructure funding decisions.
- Continue to provide news and information through the Utah Transportation Center website (http://transportation.usu.edu).

**Collaboration**

- Collaborate with DePaul University’s Sustainable Urban Development program and the Chaddick Institute for Metropolitan Development to design and lead a study trip to Grand Rapids Michigan to see urban planning initiatives underway that foster livability. The event will take place Friday, May 19th 2017 and will be open to current students and recent alumni. The full agenda is under development but will likely include: Downtown Market, City Hall (meeting with city officials including Economic Development Director, Kara Wood), Silverline Bus Rapid Transit (the only BRT in Michigan), and Downtown Grand Rapids (meeting with the downtown development authority).
- Develop a strategy with the Michigan Fitness Foundation to use the Public Health Performance Measures Project to Evaluate SRTS Proposals.
Diversity

- Recruit more female and minority faculty and students to work on TRCLC projects
- Encourage students affiliated with the center to apply to the Dwight David Eisenhower Transportation Fellowship Program (DDETFP) for the Hispanic Serving Institutions Fellowship

2 PRODUCTS

2.1 Publications, conference papers, and presentations

Publications.


Conference Papers


2.2 Website or other Internet sites
• TRCLC disseminates information and relevant news via TRCLC website and the TRCLC Facebook page
  o Website – www.wmich.edu/transportationcenter
  o Facebook – www.facebook.com/TRCLC
• Developed BikeableRoute website (http://www.bikeableroute.com)

2.3 Technologies and techniques
• Developed an assess to HERE data for mobile application through API
• Developed mobile application for collecting bicycle and pedestrian conflict data
• Developed method for pedestrian data extraction
• Developed data system to process Michigan traffic sensor data
• TRCLC researchers are carrying out research via a range of novel technologies and techniques including mobile applications, cloud computing and IEEE 802.11p (WAVE)

2.4 Inventions, patent applications, and/or licenses
• Nothing to report.

2.5 Other products
• Nothing to report.

3 PARTICIPANT & COLLABORATING ORGANIZATIONS
3.1 What organizations have been involved as partners?

<table>
<thead>
<tr>
<th>Organization Name</th>
<th>Type / Location</th>
<th>Partner's contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Financial support</td>
</tr>
<tr>
<td>Michigan State Police</td>
<td>Government / MI</td>
<td>X</td>
</tr>
<tr>
<td>City of Ann Arbor</td>
<td>Government / MI</td>
<td>X</td>
</tr>
<tr>
<td>City of Kalamazoo</td>
<td>Government / MI</td>
<td>X</td>
</tr>
<tr>
<td>City of Portage</td>
<td>Government / MI</td>
<td>X</td>
</tr>
<tr>
<td>City of Grand Rapids</td>
<td>Government / MI</td>
<td></td>
</tr>
<tr>
<td>Organization Name</td>
<td>Type / Location</td>
<td>Partner’s contribution</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>-----------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Mattawan Consolidated Schools</td>
<td>Government / MI</td>
<td>X</td>
</tr>
<tr>
<td>North Texas Council of Governments</td>
<td>Nonprofit / TX</td>
<td>X</td>
</tr>
<tr>
<td>United Way of Tarrant County-Meals On Wheels</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Tarrant County</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Williamson County</td>
<td>Government / TN</td>
<td>X</td>
</tr>
<tr>
<td>Bentley Systems</td>
<td>Private / PA</td>
<td>X</td>
</tr>
<tr>
<td>HERE</td>
<td>Private Chicago/ IL</td>
<td>X</td>
</tr>
<tr>
<td>Accessible Design for the Blind</td>
<td>Private/NC</td>
<td>X</td>
</tr>
<tr>
<td>Center for Persons with Disabilities</td>
<td>Nonprofit / UT</td>
<td>X</td>
</tr>
<tr>
<td>Disability Network Southwest Michigan</td>
<td>Agency / MI</td>
<td>X</td>
</tr>
<tr>
<td>Kalamazoo Area Transportation Study</td>
<td>MPO / MI</td>
<td>X</td>
</tr>
<tr>
<td>Kalamazoo Metro Transit Transit</td>
<td>Transit Agency / MI</td>
<td>X</td>
</tr>
<tr>
<td>Rocky Mountain ADA Center</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>South East Michigan Council of Governments</td>
<td>MPO / MI</td>
<td>X</td>
</tr>
<tr>
<td>City Univ. of New York</td>
<td>University / NY</td>
<td>X</td>
</tr>
<tr>
<td>Purdue University</td>
<td>Government / IN</td>
<td>X</td>
</tr>
<tr>
<td>DePaul University</td>
<td>Government / IN</td>
<td>X</td>
</tr>
<tr>
<td>Univ. of Nebraska Lincoln</td>
<td>University / NE</td>
<td>X</td>
</tr>
<tr>
<td>Michigan DOT</td>
<td>Government / MI</td>
<td>X</td>
</tr>
<tr>
<td>Utah DOT</td>
<td>Government / UT</td>
<td>X</td>
</tr>
<tr>
<td>Tennessee DOT</td>
<td>Government / TN</td>
<td>X</td>
</tr>
</tbody>
</table>
List of Research Projects from Other Partners

- [WMU] QNRF NPRP, “Engineering Security and Performance Aware Vehicular Applications for Safer and Smarter Roads,” Project PI with Elyes Ben Hamida (QMIC, Lead-PI) and Bharat Bhargava (Purdue University, PI), 2014. (Amount: $900,000)
- [WMU] “Reflective Cracking between Precast Prestressed Box Girders”, Wisconsin Department of Transportation (WisDOT), $85,000, August 2013 – June 2017.
- [WMU] “Bridge Structural Analyses for Staged Construction and Constructability Reviews”, Michigan Department of Transportation (MDOT), $271,683, October 2016– June 2018
• [UTA] “Dallas-Fort Worth Regional Assessment of Fair Housing,” City of Dallas, $734,430, January 2017- present [January 2018]
• [USU] A Data Fusion Approach for Extracting Highway Maintenance Features, Utah Department of Transportation (UDOT), $50,000, May 2017 – April 2018.

3.2 Have other collaborators or contacts been involved?
• Collaborated with DePaul University’s Chaddick Institute for Metropolitan Development to create an ideal route for highlighting Chicago’s innovative bicycle infrastructure.
• UTA researchers have been collaborating with bicycling and pedestrian groups and local governments to develop a crowdsourcing app for safety data.

4 IMPACT

4.1 What is the impact on the development of the principal discipline of the program?
• A better understanding of bicyclists’ safety behavior associated with bicycle environment and traffic operations
• A better knowledge of the abilities of blind pedestrians to positively influence their travel environment.
• By jointly modeling the number of crash and the presence of severity and accommodating the nature of correlated data, TRCLC researchers expect to develop a more accurate prediction model.
• Sidewalks, curbs, ramps and other facilities may create significant accessibility challenges for individuals with disability. Improvement of the measurement’s efficiency and accuracy on the public facility’s accessibility using laser scanner and other technologies can save time and effort for local authorities in assessing their facility in terms of its compliance with ADA requirements, therefore providing important information for their facility maintenance decisions.
• Gateway sign treatment is being employed in a number of jurisdiction in MI and in other areas of the US. The Regulatory and Warning Committee of the
NCUTCD is approved changes for the use of the in-street sign based on research findings.

- Bring in knowledge and expertise about various computing technologies to help with transportation related issues, example technologies are natural language processing and machine learning
- Linkage between driver behavior when approaching pedestrians and crash occurrence
- Transportation research presentation and results have been shared with Kalamazoo Metro public transit agency and the City of Kalamazoo to inform the prioritization of infrastructure development in ways that maximize social value/welfare.
- The findings of the study will add to the knowledge base in the discipline of Orientation and Mobility and transportation engineering. In particular, the findings of the study may provide shed some light on the actual travel behaviors of blind pedestrians in their communities.
- Innovative and easy to apply strategies for assessing pedestrian and bicycling infrastructure.

4.2 What is the impact on other disciplines?

- Greater understanding on the part of city planners and transportation engineers regarding the needs and abilities of blind pedestrians
- Facilitate the collaboration of scholars between different disciplines on projects targeting at the common good, including engineering disciplines such as construction engineering and other disciplines such as psychology and education
- Provide test ground for scientific and technological development in other disciplines by adapting/adopting those developments to solve transportation problems
- The multidisciplinary nature of the project brings together faculty and students from the disciplines of Transportation, Construction, Mechanical Engineering, and Geography together to achieve common goals in infrastructure accessibility assessment, which in turn advances each of the discipline as well.
- Social Work is able to collaborate with civil engineering and assess the impact that transportation gaps may have on their client populations.

4.3 What is the impact on the development of transportation workforce development

- High school students who participated in the Dream Big event had an opportunity to understand importance of transportation area and to consider transportation as their future career
- Numerous undergraduate and graduate students are exposed to transportation-related project objectives and research methods.
- Many graduate students are being trained on the use of technology to develop transportation solutions.
• Provide technical training opportunities for transportation engineers and future transportation engineers
• Provide access to state-of-the-art technologies for transportation engineers and future transportation engineers
• Many graduate students are being trained on the use of technology to develop transportation solutions.
• 48 undergraduate students are introduced to active transportation modes through project-based learning. Previously, another 78 students participated in the same project-based learning activity.
• 5 graduate students have received notice to proceed on their mini-grants.
• The first successful mini-grant has been completed and resulted in a paper for the Transportation Research Board 96th Annual Meeting
• In both cases, students are receiving an opportunity to experience transportation research, which may increase their interest in pursuing additional education.

4.4 What is the impact on physical, institutional, and information resources at the university or other partner institutions?
• Through developing applications of advanced technologies in transportation engineering, it not only contributes to the domain of transportation engineering, but also provides opportunities to further develop, adapt, or customize the state-of-the-art technologies to better satisfy the need for real world engineering applications in the transportation sector
• It provides equipment, facilities, and financial resources to Western Michigan University and all partner institutions to allow the faculty there to conduct research using state-of-the-art knowledge and techniques, while at the same time allow students in these institutions to learn about state-of-the-art research and development first-hand
• TRCLC funds have improved recruitment of graduate students interested in transportation engineering and planning field and given participating faculties and students opportunities to pursue and publish transportation research

4.5 What is the impact on technology transfer?
• Research findings may influence a national standard, such as MUTCD
• Clear the barriers between state-of-the-art technologies and transportation workforce to make the technology transfer feasible and smoother
• Provide a platform for industry, government, and academia to communicate and transfer state-of-the-art technologies in transportation domain with each other
• Provide guidelines to drafting DOT policies to better support the development and transfer of state-of-the-art technologies in transportation domain
• Charging station model/tool can be integrated into existing toolkits at one or more transportation planning agencies. The modular designs of the tools developed so can be seamlessly integrated within an organization’ s existing technology infrastructure
The applications and hardware that we are currently working on can potentially lead to the generation of new IP (patent) and commercialization potential.

Applied D2D technologies in developing applications for highway work zone traffic management and mobility for people with disabilities.

4.6 What is the impact on society beyond science and technology?

- Research results are likely to make walking safer which will have a positive impact on the likelihood that people choose walking as a mode choice.
- Increase people’s awareness of transportation issues
- Promote a more sustainable transportation mode consisted of more frequent use of walking and cycling
- Findings from current TRC study may help make walking safer which will have a positive impact on the likelihood that people choose walking as a mode choice.
- A smart construction cone that integrates with D2D technology is expected to improve traffic conditions at highway work zones.
- An RFID based solution is expected to help the blind and visually impaired when crossing intersections without veering.

5 CHANGES/PROBLEMS

5.1 Changes in approach and reasons for change

- Nothing to report.

5.2 Actual or anticipated problems or delays and actions or plans to resolve them

- Nothing to report

5.3 Changes that have a significant impact on expenditures

- Nothing to report

5.4 Significant changes in use or care of animals, human subjects, and/or biohazards

- Nothing to report.

6 SPECIAL REPORTING REQUIREMENTS

- Nothing to report.