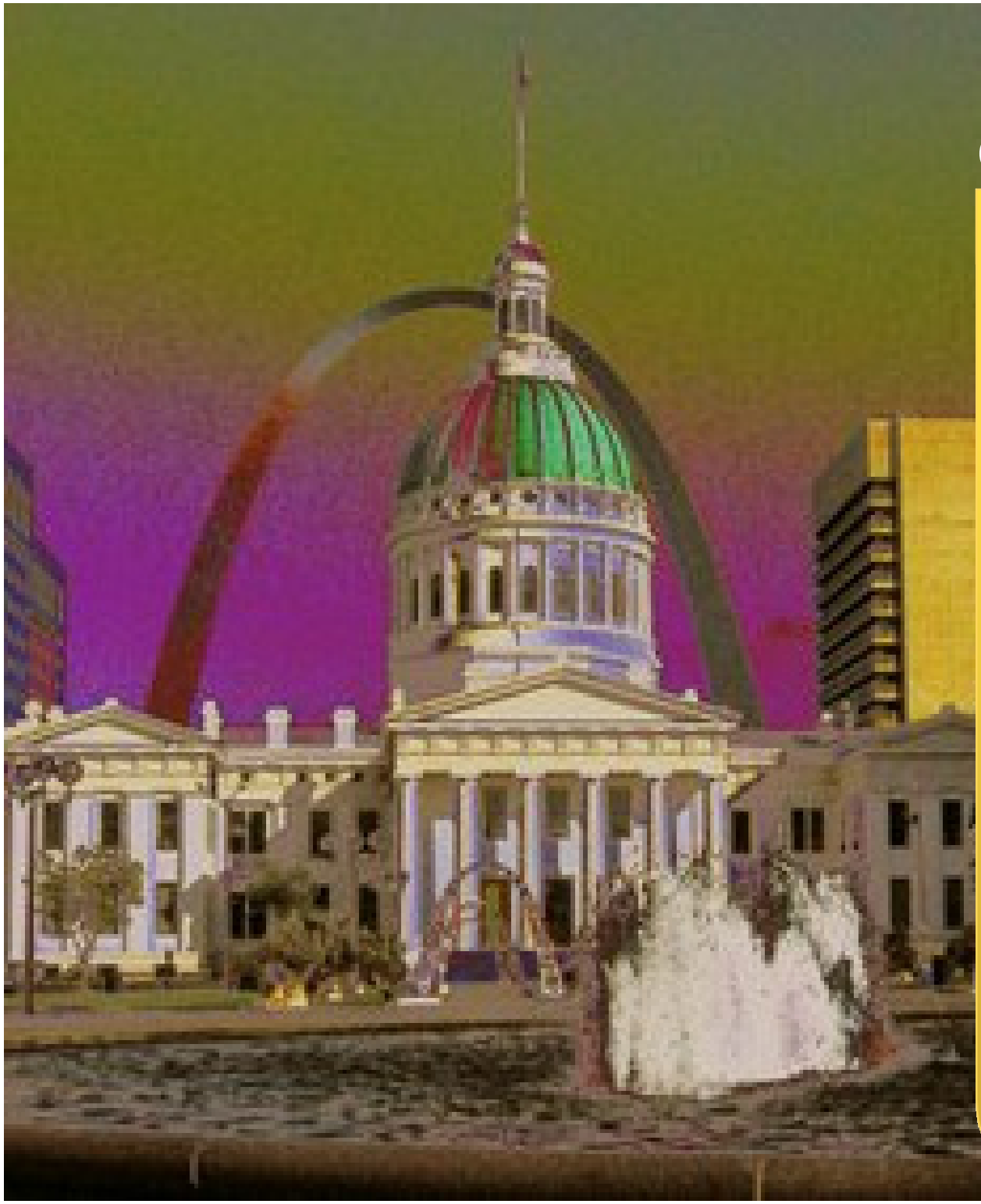

City of St. Louis

Final Pedestrian Safety Action Plan

August 2013

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01

Introduction

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Introduction

In support of the City of St. Louis's Complete Streets ordinance[1] and Sustainability Plan[2] and the Missouri Strategic Highway Safety Plan (Missouri's Blueprint to Save More Lives),[3] and to further address pedestrian safety issues, the City of St. Louis and the Missouri Department of Transportation, in conjunction with the East-West Gateway Council of Governments, are developing and implementing the City of St. Louis Pedestrian Safety Action Plan (PSAP). The purpose of the PSAP is to clarify the nature of pedestrian crash needs in St. Louis and to identify an action plan to reduce pedestrian crashes, with an emphasis on reducing fatal and severe injury crashes through the following means:

- Define the characteristics of the pedestrian safety needs in the City of St. Louis.
- Identify educational, enforcement, engineering, and EMS strategies to enhance pedestrian safety, mobility, and accessibility.
- Identify opportunities for interagency and intra-agency coordination.
- Identify opportunities and funding source for pedestrian safety investments that will enhance economic development
- Provide an opportunity for elected leaders to support agencies staff in implementing these strategies.
- Apply, where appropriate, a multidisciplinary "4E" (engineering, enforcement, education, and emergency medical services) approach to improve pedestrian safety.
- Serve as the Gateway to enhancing pedestrian safety.

The PSAP process consisted of the following steps:

1. Build a consensus among local and statewide stakeholders about the pedestrian safety needs in the city.
2. Use the Vision and Goal to formulate clear objectives that will best address the pedestrian safety needs in the city.
3. Identify a list of strategies based on objectives, while considering current and future planned efforts by stakeholder agencies.
4. Use stakeholder feedback to consolidate strategies.
5. Implement and evaluate PSAP strategies.

[1] http://www.slpl.lib.mo.us/cco/ords/data/ord8663.htm.
[2] http://www.stlouis-mo.gov/government/departments/mayor/initiatives/sustainability/plan/.
[3] http://savemolives.com/the-situation.html.

Background

Within the City of St. Louis between 2006 and 2010, more than 1,800 pedestrian-related motor vehicle crashes were reported. While these pedestrian-related crashes represent only 2.4 percent of all crashes in the city, pedestrian-related crashes comprise 36 percent of all fatalities and 9.4 percent of all injuries. (See Appendix A, Baseline Pedestrian Safety Assessment.)

Since 2004, the Federal Highway Administration (FHWA) has been aggressively working to reduce pedestrian deaths and serious injuries by providing resources to cities and states with the highest pedestrian fatalities and/or fatality rates. The Pedestrian Focus Cities and Focus States were revised in late 2011 as shown on the map below. Pedestrian Focus Cities were selected based on the number of pedestrian fatalities or the pedestrian fatality rate per population. Cities were identified as pedestrian Focus Cities if they had more than 20 average annual pedestrian fatalities or a pedestrian fatality rate greater than 2.33 per 100,000 population. (The annual national average number of pedestrian fatalities is 20, and the average national rate of pedestrian fatalities is 2.33 per 100,00 population.) States with a focus city were automatically identified as Focus States. Because its pedestrian fatality rate is greater than 2.33 per 100,000 population, St. Louis was selected as an FHWA Focus City and Missouri as a Focus State for pedestrian safety.

Total Crashes	2006		2007		2008		2009		2010	
	Pedestrian	***All***	***Pedestrian***	***All***	***Pedestrian***	***All***	***Pedestrian***	***All***	***Pedestrian***	***All***
Killed (K)	9	34	15	36	9	29	13	25	11	31
Injured (A)	336	3,458	303	3,228	316	3,129	310	3,361	296	3,393
Not Injured/Unk (O)	32	12,881	37	12,203	35	11,769	54	12,076	42	11,018
Missing Info	1	0	3	0	0	0	0	0	0	0
Total	378	16,373	358	15,467	360	14,927	377	15,462	349	14,442

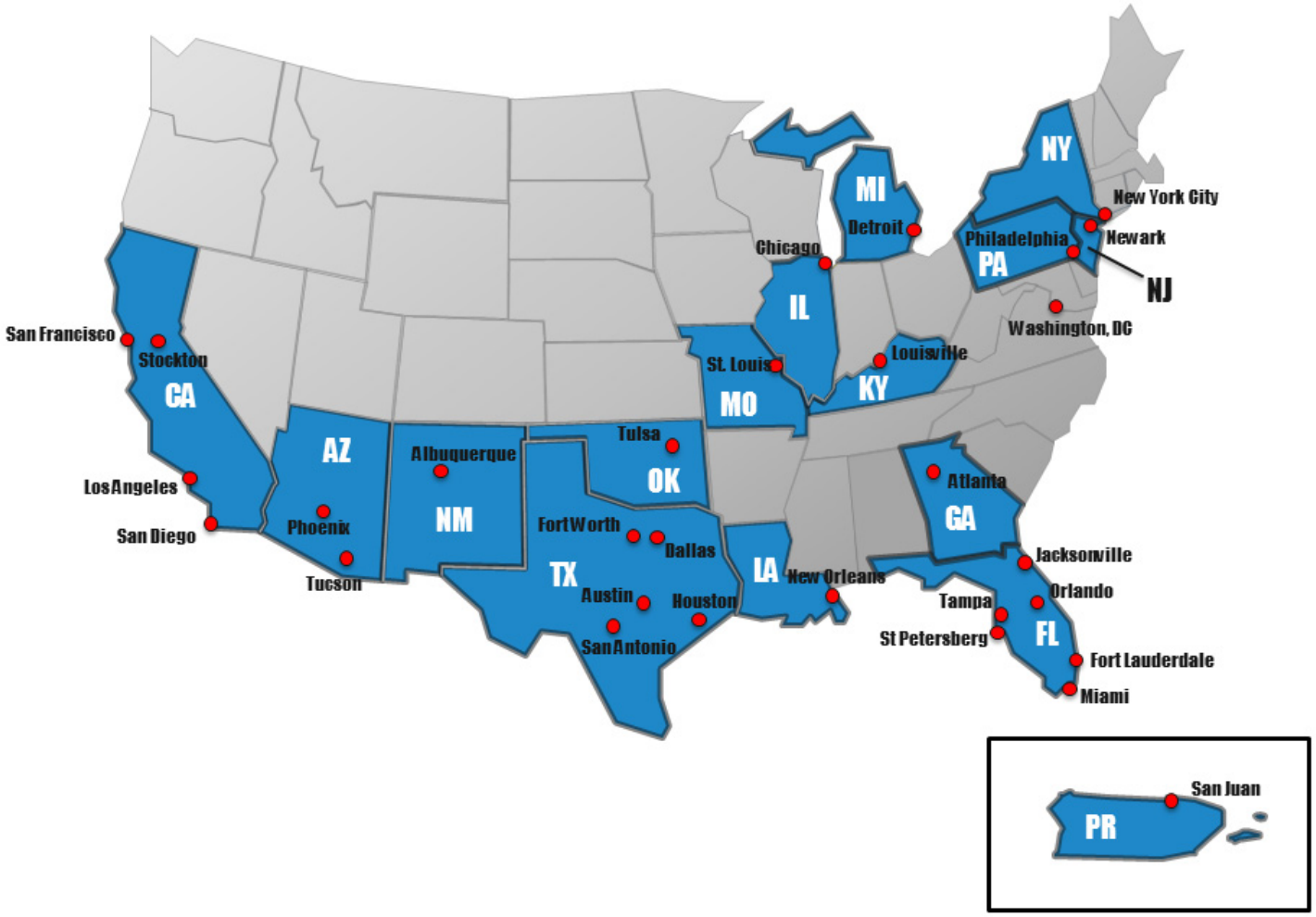
Upon being selected as a Focus City and Focus State, the City of St. Louis and the State of Missouri became eligible to receive specific program benefits, including:

- Free expert assistance in the development of a Pedestrian Safety Action Plan (PSAP).
- Free additional training and technical assistance, individualized to meet State/City needs, to support deployment of effective safety countermeasures.

This City of St. Louis Pedestrian Safety Action Plan was developed as part of this Pedestrian Safety Focus City Program.

Focus Approach to Pedestrian Safety

Pedestrian Focus Cities and Focus States



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02

Pedestrian Safety Action Plan

Pedestrian Safety Action Plan

The purpose of the City of St. Louis Pedestrian Safety Action Plan is simple—to identify and guide the implementation of actions to reduce pedestrian fatalities and serious injuries in the city of St. Louis. This section outlines the most important parts of the Plan:

- **Vision**—The Big Picture of what we want to achieve.
- **Goal**—What we plan to accomplish and the specific milestones we plan to reach along the way.
- **Objectives**—Focus areas where we agree that the improvements should be made.
- **Strategies** —Specific, time-sensitive actions that will be undertaken as a result of this plan. Time frames, responsible parties, and potential funding source(s) should be considered when implementing these items.

This PSAP does not claim to include all of the possible solutions to the city's pedestrian safety needs, but it does identify the key opportunities specific to the St. Louis and proposes possible solutions that agencies can use to make a difference.

Vision
A safe, delightful, efficient, environment
for pedestrians throughout the
city of St. Louis.

Goal of the City of St. Louis PSAP

This goal of this plan is to ***move toward zero roadway deaths,*** which is consistent with the Missouri's Blueprint to Save Move Lives (SHSP) Vision.

Crash type	2008–12	By 2016	By 2020
Combined Fatalities & Serious Injuries	289 (average 58 per year)	Reduce the number of fatalities and serious injuries by 10% (to less than 52 serious injuries and fatalities annually)	Reduce the number of fatalities and serious injuries by 25% (to less than 43 serious injuries and fatalities annually)

Performance Measures

1. Number of pedestrian fatalities and serious injuries
2. Number of pedestrian involved fatal and serious injury crashes
3. Number of pedestrian fatalities and serious injuries occurring at signalized and unsignalized intersections
4. Number of pedestrian fatalities and serious injuries occurring midblock
5. Number of pedestrian fatalities and serious injuries occurring in parking lots
6. Number of secondary pedestrian crashes

Objectives

Objective #1: Infrastructure

Reduce the frequency and severity of pedestrian crashes by improving the transportation infrastructure through implementation of strategic safety countermeasures, construction of new pedestrian facilities, and maintenance of existing facilities.

Objective #2: Education/Enforcement

Reduce the frequency and severity of pedestrian crashes by changing the behavior of all road users to increase compliance with existing laws through coordinated education and law enforcement efforts.

Objective #3: Livability

Support sustainability and livability in our community by addressing pedestrian safety, mobility, and accessibility through transportation infrastructure improvements, facilities, and amenities.

Objective #4: Accountability

Monitor the progress in reducing the frequency and severity of pedestrian crashes annually using the Vision, Goal, and Performance Measures to guide policy and program decisions.

Potential Stakeholders

The following are potential stakeholders in the Pedestrian Safety Action Plan:

- Mayor's Office
- Board of Alderman
- City of St. Louis Board of Public Service
- City of St. Louis Streets Department
- City of St. Louis Police Department
- Missouri Department of Transportation (MoDOT)
- East-West Gateway Council of Governments (EWG)
- Public transit agencies
- Trailnet
- Great Rivers Greenway (GRG)
- National Highway Traffic Safety Administration (NHTSA)
- Federal Highway Administration (FHWA)
- Human service agencies serving persons with disabilities
- Business associations
- Schools and universities (both public and private)
- Economic development agencies
- Major pedestrian generators

Strategies

The following Ongoing and Potential Strategies were identified and discussed by the participants during an August 13–15, 2013 workshop.

Overall Strategy

Focus proactive education, enforcement, and engineering efforts on improving pedestrian safety, with emphasis on high priority corridors and intersections. Use crash data or conduct additional pedestrian activity studies to identify appropriate locations for these efforts.

Education Strategies

Ongoing Education Strategies

- Safety training and pamphlets
- Driver training for older adults
- School safety
  - School Safety Taskforce
  - Safe Routes to School
  - Walk to School Day

Community Outreach

- Safe walking routes
- Community center safety fairs and other community events
- Pedestrian safety Brochures
- Pedestrian safety-themed recognition days
- Efforts of the Bicycle Pedestrian Advisory Committee

Potential Education Strategies

1. Assess ongoing educational programs and materials of the governmental agencies and other private and public organizations.
2. Conduct public outreach campaigns such as PSAs, safety fairs, and partnering with transit agencies.
3. Educate the public about the dangers of walking and driving while impaired.
4. Educate the public about the dangers of distracted walking and driving.
5. Expand/enhance alcohol server training to address impaired individuals.
6. Develop and provide targeted pedestrian safety training for stakeholders.
7. Provide an executive overview of this plan for elected officials, policy-makers, judges, educators, etc.
8. Identify at-risk pedestrians at high-crash locations and segments and develop targeted educational safety outreach efforts focused on reaching those populations.
9. Use social media and new technologies to provide information and promote pedestrian safety.
10. Provide pedestrian safety media press kit.
11. Increase school programs that address pedestrian safety.
12. Implement a pedestrian safety education program for older adults (65 or older).
13. Educate the public about the dangers of exiting or walking around a disabled vehicle or one involved in an incident.
14. Educate and encourage pedestrians to increase their visibility by wearing bright and reflective clothing.

15. Develop a balanced public safety education program that educates drivers and pedestrians on how to safely share the road.
16. Educate and encourage safe walking practices.
17. Achieve a Walk Friendly Community designation.
18. Identify funding sources, opportunities, and partnerships to implement Education Strategies.

Enforcement Strategies

1. Ongoing enforcement strategies.
2. St. Louis Police Department programs, including school Resource Officers.
3. Security program/enforcement of pedestrians using public transit.

Potential Enforcement Strategies

1. Assess current law enforcement programs in St. Louis Police Department.
2. Increase enforcement of speed limits in school zones, areas close to retirement communities, and areas frequented by pedestrians, such as downtown areas.
3. Enforce laws requiring drivers to yield to pedestrians.
4. Enforce laws on pedestrians failing to yield to vehicles.
5. Encourage the St. Louis Police Department to use an electronic crash reporting system.
6. Increase the availability of crash reports to City agencies.
7. Encourage local law enforcement agencies to report DWI arrest information to the Driving While Intoxicated Tracking System (DWITS) database.
8. Use existing and potential funding sources for pedestrian enforcement activities.
9. Support enforcement of excessive speed.
10. Encourage law enforcement training on pedestrian-related safety issues.
11. Identify funding sources, opportunities, and partnerships to implement Enforcement Strategies.
12. Encourage law enforcement to write more Public Intoxication citations (many pedestrian fatalities involve impairment of the pedestrian) if such ordinances exist.
13. Increase the enforcement of the “Move Over” law.

Engineering Strategies

Ongoing Engineering Strategies

1. Install countdown signals and LED signals.
2. Restrict parking near intersections – corner clearances, road diets.
3. Curb extensions and bulb outs.
4. Coordinate and integrate signal.
5. Consider/pursue joint funding (co-mingling of funds).
6. Hold project coordination, Core Team, and partnering meetings.
7. Require appropriate apparel and traffic control devices for school crossing guards.
8. Support Complete Streets ordinance and Implementation and Livable Communities Initiatives.
9. Continue to develop and implement Safe Routes to School Program.
10. Implement ADA improvements and accessible signals.
11. Make ongoing improvements for accessibility and pedestrian accommodation for transit facilities.

Potential Engineering Strategies

1. Update inventory of sidewalk gaps and non-compliant ADA locations.
2. Prioritize improvements based on various factors, including but not limited to, crash data, activity, and cost.
3. Use high-visibility crosswalk markings as appropriate locations.
4. Remove unwarranted traffic control devices.
5. Install dedicated bike lanes on wide roadways.
6. Install flashing yellow arrows.
7. Go above and beyond ADA requirements.
8. Improve pedestrian accommodations in work zones.
9. Develop Pedestrian Safety Prompt List for planners and designers.
10. Develop Work Zone Pedestrian Safety Prompt List for construction and maintenance personnel.
11. Improve lighting in selected locations.
12. Enhance pedestrian signs and pavement markings.
13. Enhance intersection and roadway design to be more pedestrian-friendly.
14. Install proven safety countermeasures (e.g., medians and pedestrian refuge islands) to reduce pedestrian risks at street crossings.
15. Provide sidewalks and walkways separate from motor vehicle traffic.
16. Consider emerging technologies such as rectangular rapid-flashing beacons, pedestrian hybrid beacons, dynamic pedestrian detectors, passive detection devices, school zone speed time-of-day signs, and speed feedback signs.
17. Increase visibility of traffic control devices.
18. Identify visibility sources, opportunities, and partnership to implement Engineering Strategies.

Funding

The successful implementation of the identified pedestrian safety strategies will require additional funding resources. This section identifies funding sources and strategies to enhance pedestrian safety within the city of St. Louis.

1. Continue to incorporate pedestrian safety and accessibility improvements into existing transportation projects. The most efficient method to implement these improvements across the city will be to incorporate them into future projects. Any project being designed in the public right-of-way, from a street resurfacing project to a major street reconstruction project, should be reviewed to ensure that pedestrian safety and accessibility improvements are included.
2. Establish a reliable and sustainable funding source for the maintenance of pedestrian facilities. A sustainable funding source should be based on the life cycle of the facilities to keep pedestrian infrastructure in a state of good repair.
3. Identify and fund pedestrian infrastructure projects. A list of potential pedestrian infrastructure projects should be identified on an annual basis.
4. Identify partnering opportunities to enhance funding for pedestrian safety education strategies and initiatives.

Primary funding sources include:

- City of St. Louis ½ Cent Ward Capital Improvement Funds (½ Cent Sales Tax)
- MoDOT funds
- Federal-aid funding source (annual funding Level)
  - Surface Transportation Program ($262M statewide)
    - Broadly eligible for funding from almost all major federal-aid highway, transit, and safety programs
    - Pedestrian walkways
    - Non-construction projects (maps, brochures, training, PSAs) related to safe walking
    - Modification of sidewalks to meet ADA requirements
    - Studies, including RSAs
  - Highway Safety Improvement Program ($57M statewide)
    - Survey of hazardous locations
    - Safety infrastructure projects
    - Enforcement
    - Education
    - Traffic calming measures
    - SHSP including Action Plans
    - Training
    - Evaluation
  - Section 402 Program ($4.9M statewide)
    - Funds the Missouri Highway Safety Plan and may be used for countermeasures that address wide array of highway safety problems related to human factors and non-construction *countermeasures such as training, identification. and evaluation.*

- Congestion Mitigation and Air Quality (CMAQ) Improvement Program ($23.8M statewide)
  - Must be non-attainment area such as the City of St. Louis for eligibility
  - Construction: walkways and bicycle transportation
  - Non-construction: maps, brochures
- Transportation alternatives
  - Construction, planning, and design of facilities for pedestrians, bicyclists, compliance with ADA, safe routes for non-drivers to access daily needs.
  - Conversion and use of abandoned railroad corridors for trails.
  - Construction of turnouts, overlooks, and viewing areas.
  - Recreational Trails Program
  - Safe Routes to School
- Federal Lands Highway Program
  - May be used for stand-alone ped/bike projects on Federal or Tribal Lands, or in conjunction with roads, highways, and parkways on Federal or Tribal Lands

Potential Secondary Funding sources include:

- City Earnings Tax
- City Property Tax
- City Sales Tax, Payroll Tax
- City Franchise Tax
- Local Use Tax
- License fees
- Grants and intergovernmental revenues
- Department user fees and fines

The City's Street Department allocates approximately $1.5–$2 million annually on various sidewalk infrastructure projects, including sidewalk reconstruction, curb ramps, pedestrian signals, and pedestrian lighting.

The City's Board of Public Service programs approximately $5–$10 million on Transportation Improvement Program (TIP) Projects annually, of which pedestrian infrastructure components comprise an estimated $1–$2 million annually. Improvements could include sidewalk reconstruction, ADA upgrades, pedestrian lighting, enhanced pedestrian crosswalks, pedestrian heads, and curb bulbouts.

In summary, based on this **preliminary** estimate, the City of St. Louis expends approximately $3-$4 million per year on pedestrian safety improvements.

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03

Current Trends & Issues

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Current Trends & Issues

Crash statistics in this section were compiled specifically for the St. Louis Pedestrian Safety Action Plan from crash data from the MoDOT.

St. Louis City Pedestrian Data 2009 - 2011

Gender	Fatalities	Serious Injuries
Male	20	76
Female	16	32
Total	36	108

Age	Fatalities	Serious Injuries
4 or younger	1	2
5 - 10 years	0	11
11 - 20 years	3	17
21 - 30 years	8	15
31 - 40 years	7	14
41 - 50 years	6	16
51 - 60 years	6	20
61 - 70 years	3	10
7 1 - 80 years	0	2
over 80	2	0
Unknown	0	1
Total	36	108

Light Condition	Fatalities	Serious Injuries
Light	13	53
Dark	23	55
Total	36	108

Day of Week	Fatalities	Serious Injuries
Monday	5	18
Tuesday	1	12
Wednesday	7	8
Thursday	10	13
Friday	3	16
Saturday	8	25
Sunday	2	16
Total	36	108

Pedestrian's Contributing Circumstance	Fatalities	Serious Injuries
Failed to Yield	6	23
Alcohol	1	10
Inattention	7	34
None	18	32
Unknown	4	17
Physical Impairment	0	2
Total	36	118

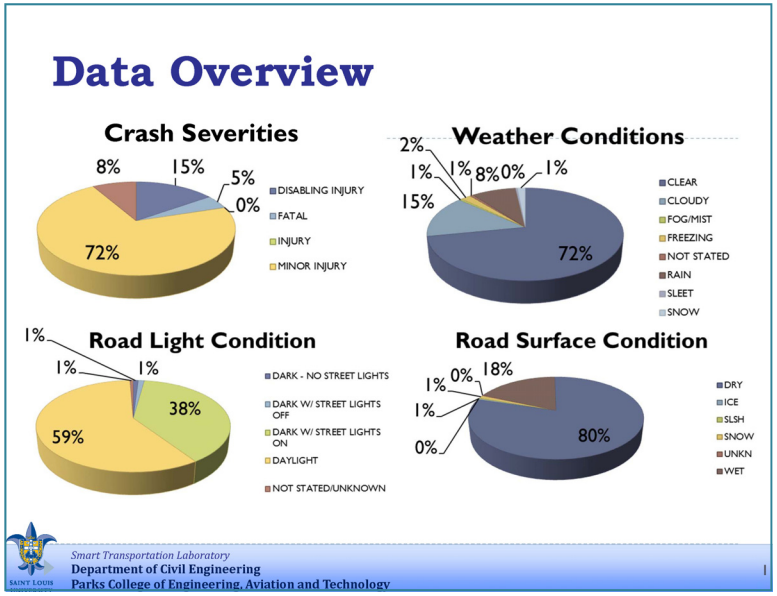
Pedestrian's Action	Fatalities	Serious Injuries
Behind a parked car	2	12
Off the roadway (sidewalk, etlc)	4	4
Pushing/working on a vehicle	1	1
At a Signal Movement	13	48
Standing in the roadway	6	9
Walking against traffic	7	9
Getting On/Off Vehicle	0	1
Other Working	0	2
Playing in Road	0	4
Walking with Traffic	0	3
Within a crosswalk	1	6
Not Listed	2	9
Total	36	108

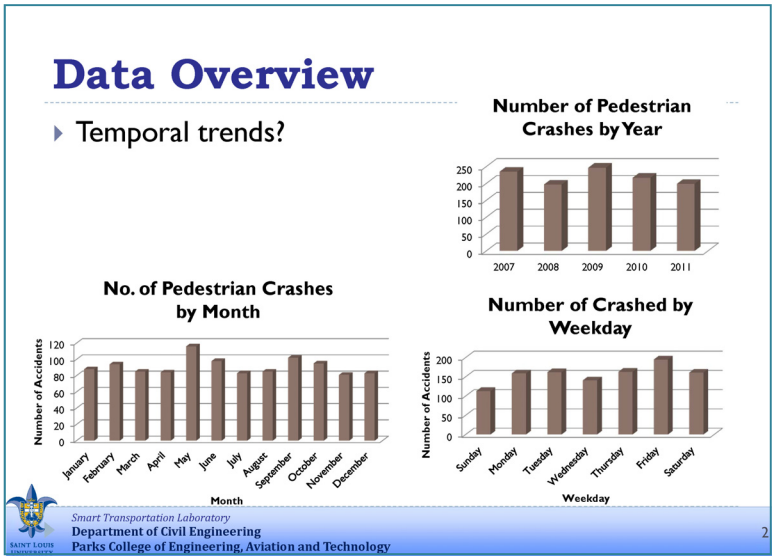
Route Designation	Fatalities	Serious Injuries
Interstates	7	2
MO Routes	5	19
Lettered Routes	0	3
City Streets	24	84
Total	36	108

Based on the Preliminary GIS analysis for pedestrian crashes in St. Louis (Appendix B) by Saber Abdoli and Dr. Yao-Jan Wu, six road segments with 20 or more pedestrian-related crashes per mile and seven or more intersection pedestrian-related crashes were identified. (See Appendix B.) The data account for a five-year history from January 1, 2008, to December 31, 2012. Crash data were obtained from the MoDOT.

Summaries of the following crash attributes are presented in this section:

- Crash Severities
- Weather Conditions
- Lighting Condition
- Road Surface
- Pedestrian Crashes by Year
- Pedestrian Crashes by Month
- Pedestrian Crashes by Weekday





04

Technical Stakeholder Workshop

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Technical Stakeholder Workshop

The first Technical Stakeholder Workshop of the City of St. Louis Safety Action Plan occurred on August 13 –14, 2013. Stakeholders were presented with pedestrian crash statistics and then asked to discuss the most important pedestrian safety issues and formulate strategies to improve pedestrian safety within the county. Strategies focused on four themes: engineering, infrastructure, education, and enforcement.

The following issues were discussed:

- Developing a Pedestrian Safety Action Plan
- Addressing these issues can result in effective and commonly-used elements of a Pedestrian safety Action Plan.

Issue # 1: Planning for Pedestrian Safety: The "Big Picture" Vision, Goals, and Objectives

Commitment to safety for all modes should be the overarching priority of state and local transportation agencies. In support of this commitment, local and state transportation agencies should develop and document a clear **Vision** and **Goals** and practical, achievable, and measurable **Objectives** for reducing crashes.

- List three policies and/or actions that could be adopted to achieve the Vision, Goals, and Objectives.

Issue # 2: Stakeholders

Individual stakeholder involvement is an excellent way to get a better product. Public stakeholders should be viewed as partners who are on-the-ground scouts who can identify problems, needs and opportunities. To be effective, stakeholders must be involved in a regular, ongoing and systematic way.

- Who are your current stakeholders?
- How does your agency currently involve stakeholders?
- What additional stakeholders should be added?

Issue # 3: Data Collection

The purpose of data collection is to be able to identify pedestrian safety problems that can then be addressed through appropriate countermeasures. Typically, agencies code crash data to varying degrees. Others may have pedestrian counts, asset inventories such as sidewalks and marked crosswalks, and traffic characteristics such as ADT, road widths and speeds.

- What kinds of data does your agency currently collect, and how is it used to effect policy and program decision?
- List the five most important types of data for your agency to collect (existing and proposed).

Issue #4: Analyzing Information and Prioritizing Concerns

Categorization of pedestrian crash data should be done to determine whether they are occurring at:

- spot locations
- along corridors
- in a neighborhood area, or
- throughout an entire jurisdiction (poor standard practice such as failing to install pedestrian indicators at signals).

Once categorized, conducting field reviews can provide additional information about how each crash may have occurred.

- How does your agency currently analyze and categorize pedestrian crash data and other data including field reviews findings? By spot locations, along corridors, by neighborhood areas, and throughout an entire jurisdiction.
- What other type of analyses could be done?
- Based on the analyses, how does your agency prioritize and select the identified sites, corridors, and areas for potential improvements and activities?
- How else could the prioritization be done?

Issue #5: Education Strategies

Education is an important way to improve motorist and pedestrian behavior. Motorists and pedestrians must know the types of behavior that lead to motor vehicle/pedestrian crashes.

- What education programs and strategies are currently being conducted in your community?
- List additional three education programs and strategies could be implemented.

Issue #6: Enforcement Strategies

Enforcement is an important way to improve motorist and pedestrian behavior. Enforcement officers must know what types of enforcement are most likely to lead to a reduction in motor vehicle/pedestrian crashes.

- What enforcement programs are currently being conducted in your community?
- List three additional enforcement programs and strategies that could be implemented

Issue # 7: Engineering Programs and Strategies

Engineering is an important way to improve motorist and pedestrian behavior.

- "Right design encourages right behavior."
  - Engineers must know what types of infrastructure improvements are most effective based on the data and situation.
- "Apply the right countermeasure at the right location."
  - What engineering programs and strategies are currently being conducted in your community?
  - List three additional engineering programs and strategies that could be implemented.

Issue # 8: Integrated Approach

A comprehensive, communicative, coordinated program building on a multi-agency, multi-disciplinary approach can result in a synergetic results.

- Work together toward a Common Vision and Goal.
  - Does your agency have an integrated, multi-disciplinary, and multi-agency approach to improving pedestrian safety?
  - How could the pedestrian safety activities be more integrated, multi-disciplinary, and multi-agency?

Issue # 9: Providing Funding

Routine accommodation for pedestrians in all projects, programs, and maintenance activities is the most cost-effective funding strategy for reducing pedestrian crashes and encouraging more walking. The majority of pedestrian infrastructure is built in conjunction with other projects. However, dedicated funding sources and set-asides for pedestrian projects allow for immediate

action in addressing high crash locations, corridors, and other targeted areas.

- How are pedestrian safety improvements and activities funded? Are set aside funds dedicated to pedestrian safety programs and projects?
- List three possible funding sources that could be dedicated to making pedestrian safety improvements.
- How does your agency routinely include pedestrian safety activities in all infrastructure projects, enforcement programs, education programs, and maintenance activities?
- List three ways pedestrian safety improvements could be included in all projects, programs and activities

Issue # 10: Your Next Steps

- What's your Vision for Pedestrian Safety in 2020?
- What are you going to do to improve pedestrian safety in your community?
  - Next week
  - By December 24, 2013
  - By August 1, 2014

Appendix

A

Baseline Pedestrian Safety Assessment

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Baseline Pedestrian Safety Assessment

State of Missouri and City of St. Louis

www.pedbikeimages.org / Dan Burden

August 2013

Prepared by:

Max Bushell

Marissa Miano

Dan Gelinne

Charlie Zegeer

University of North Carolina Highway Safety Research Center

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INTRODUCTION

The purpose of this report is to provide an assessment of pedestrian safety in Missouri as a whole and St. Louis specifically to serve as a baseline for improving safety through engineering, education, and enforcement measures. In 2011, the Federal Highway Administration (FHWA) Office of Safety identified St. Louis as a Pedestrian Safety Focus City and Missouri was therefore identified as a Focus State. Focus Cities were identified as such if they had more than 20 average annual pedestrian fatalities or a pedestrian fatality rate greater than 2.33 per 100,000 population (both national averages). This report presents crash trends and will allow the City, State and FHWA to monitor progress made toward improving pedestrian safety.

Missouri – Summary of Pedestrian Crashes and Initiatives

I. OVERVIEW

According to the 2010 Census, Missouri has a population of 5,988,927 people, an increase of 7.03% from the 2000 Census. The population of the state, in terms of age distribution, is relatively constant across age groups. Children under the age of 5 and between the ages of 5 and 9 each account for 6.5% of the State's population, while children between 10 and 14 account for 6.6%. Teens between 15 and 19 account for 7.1%, and adults between the ages of 20 and 29 comprise 13.6% of the total population. The highest population percentages occur in adults between the ages of 40 and 49 and 50 and 59, which respectively make up 13.8% and 13.9% of the population (United States Census Bureau 2000, United States Census Bureau 2010a).

The majority of people over the age of 16 in Missouri commute to work by driving alone (80.7%), and 10.3% of people carpool. An estimated 1.5% of people commute to work via public transit and 2% of people walk to work. Very few people (0.2%) commute to work via bicycle according to the 5 year estimates of the American Community Survey. Of those workers age 16 and older, 2.6% do not have access to a vehicle (United States Census Bureau 2010b). The following table indicates those cities in Missouri with the highest populations in 2010. Overall, cities in Missouri have experienced increases in population over the past decade, many with double digit percentage increases, including Columbia, Lee's Summit, O'Fallon, and Joplin. St. Louis is the notable exception; it lost 28,895 people, or 8.3% of its population, between 2000 and 2010.

Table 1: Missouri Cities and Towns by 2010 Population

Missouri City or Town	2000 Total Population	2010 Total Population	Population Percent Change between 2000 and 2010	2010 Percent of Total Population
Kansas City city, Missouri	441,545	459,787	4.13%	7.68%
St. Louis city, Missouri	348,189	319,294	-8.30%	5.33%
Springfield city, Missouri	151,580	159,498	5.22%	2.66%
Independence city, Missouri	113,288	116,830	3.13%	1.95%
Columbia city, Missouri	84,531	108,500	28.36%	1.81%
Lee's Summit city, Missouri	70,700	91,364	29.23%	1.53%
O'Fallon city, Missouri	46,169	79,329	71.82%	1.32%

Missouri City or Town	2000 Total Population	2010 Total Population	Population Percent Change between 2000 and 2010	2010 Percent of Total Population
St. Joseph city, Missouri	73,990	76,780	3.77%	1.28%
St. Charles city, Missouri	60,321	65,794	9.07%	1.10%
Blue Springs city, Missouri	48,080	52,575	9.35%	0.88%
St. Peters city, Missouri	51,381	52,575	2.32%	0.88%
Florissant city, Missouri	50,497	52,158	3.29%	0.87%
Joplin city, Missouri	45,504	50,150	10.21%	0.84%
Chesterfield city, Missouri	46,802	47,484	1.46%	0.79%
Jefferson City city, Missouri	39,636	43,079	8.69%	0.72%
Cape Girardeau city, Missouri	35,349	37,941	7.33%	0.63%
Oakville CDP, Missouri	35,309	36,143	2.36%	0.60%
Wildwood city, Missouri	32,884	35,517	8.01%	0.59%
University City city, Missouri	37,428	35,371	-5.50%	0.59%
Ballwin city, Missouri	31,283	30,404	-2.81%	0.51%

II. PEDESTRIAN CRASHES AND TRENDS

There were 7,245 pedestrian-motor vehicle crashes in Missouri between 2006 and 2010, representing 0.9% of all crashes that occurred in Missouri over that time period. 24% of these crashes occurred in St. Louis city. St. Louis also accounted for 9.8% of all crashes occurring across the state. Table 2 provides more detail.

Table 2: Pedestrian and Total Crashes by Municipality by Year

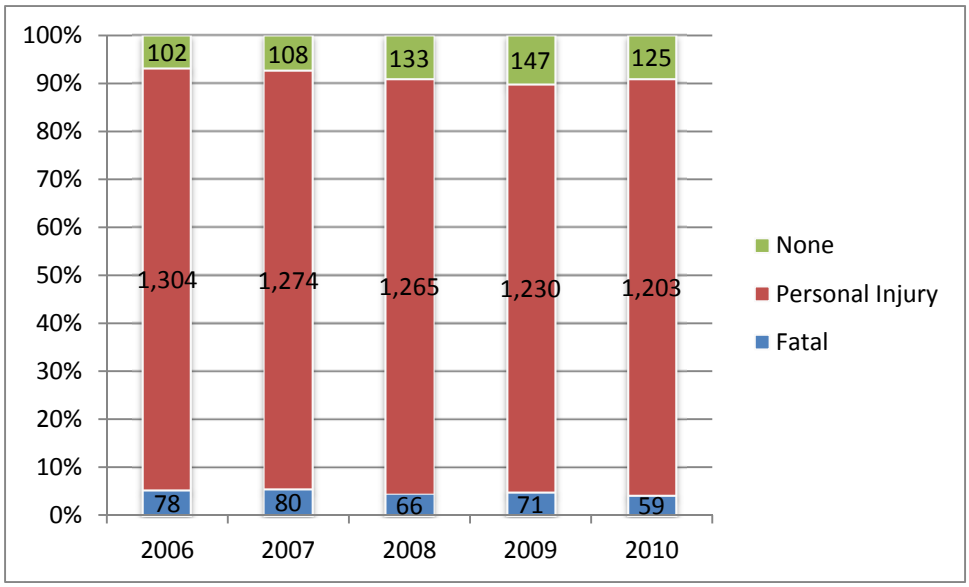
	2006		2007		2008		2009		2010	
	Ped	All	Ped	All	Ped	All	Ped	All	Ped	All
Entire State	1,484	167,143	1,462	166,052	1,464	155,849	1,448	152,995	1,387	151,352
St. Louis	367	16,739	343	15,864	343	15,269	361	15,822	322	14,762
Kansas City	222	19,412	205	19,138	209	17,348	224	16,801	185	17,298
Springfield	56	7,566	47	7,056	49	6,102	63	6,955	55	6,960
Columbia	33	3,462	34	3,158	36	2,906	26	2,780	38	1,847
Independence	33	3,612	25	3,698	42	3,302	30	3,122	26	3,059
Florissant	22	1,639	29	1,636	16	1,596	28	1,522	14	1,691
St. Joseph	19	2,488	25	2,881	21	2,566	19	2,386	22	2,430
Joplin	17	2,251	19	2,188	24	2,148	19	2,060	21	2,166
Jefferson City	15	1,474	14	1,469	22	1,344	14	1,366	12	1,571
St. Charles	15	2,024	11	1,893	11	1,825	15	1,898	16	1,896

Between 2006 and 2010, pedestrian-motor vehicle crashes resulted in 354 fatalities and 6,276 injuries across Missouri. There has been a small decline over the five-year period. Table 3 and Figure 1 provide more information.

Table 3: Pedestrian Crash Severity by Year, 2006-2010

	2006	2007	2008	2009	2010	TOTAL
Fatal	78	80	66	71	59	354
Personal Injury	1,304	1,274	1,265	1,230	1,203	6,276
None	102	108	133	147	125	615
TOTAL	1,484	1,462	1,464	1,448	1,387	7,245

Figure 1: Pedestrian Crash Severity by Year, 2006-2010



Different age groups tend to represent disproportionate percentages of pedestrian crashes. Children under the age of 10, who account for 13% of the total population, represent just 10.5% of pedestrian crashes, while teenagers, who comprise 13.7% of the population, account for 21.1% of all crashes. Similarly, people between the ages of 20 and 29 make up 13.6 percent of the population, but account for 17.6% of all crashes. For older adults aged 40 to 49 and 50 to 59, who make up 13.8 and 13.9% of the population, the trend is reversed. These age groups constitute 13.5% and 11.5% of all pedestrian crashes, respectively. More detail about pedestrian crash numbers by age group are provided in Table 4.

Table 4: Pedestrian Crashes by Age (or Age Group) by Year

Age	2006	2007	2008	2009	2010
4 Years & Under	33	57	56	46	57
5 - 9 Years	105	83	118	120	99
10 - 14 Years	145	172	121	110	96
15 - 19 Years	180	201	199	200	203
20 - 24 Years	148	144	170	131	164
25 - 29 Years	111	120	110	123	137
30 - 34 Years	94	81	105	90	88
35 - 39 Years	93	103	108	105	73
40 - 44 Years	129	102	96	104	88
45 - 49 Years	95	114	109	104	105
50 - 54 Years	115	108	119	92	100
55 - 59 Years	61	59	79	78	77

Age	2006	2007	2008	2009	2010
60 - 64 Years	52	45	49	66	59
65 Years & Over	121	105	92	98	95
Unknown	67	64	53	57	43
TOTAL	1,549	1,558	1,584	1,524	1,484

Light condition information is unavailable for the State of Missouri, and will therefore not be included in this report. Table 5 provides related information about pedestrian crashes by time of day.

As in many other states across the country, pedestrian crashes in Missouri occur most frequently between the hours of 3:00 and 6:00 PM. Specifically, 24.3% of pedestrian-motor vehicle crashes occur during this three hour period, while the evening hours (6:00 to 9:00 PM) contain 19.3% of crashes. Few pedestrian crashes (8.7%) occurred between the hours of 12:00 and 6:00 AM.

Table 5: Pedestrian Crashes by Time of Day

Time	2006	2007	2008	2009	2010
12-3AM	88	73	94	92	92
3-6AM	43	33	38	42	37
6-9AM	148	160	168	135	135
9AM-12PM	146	144	123	140	118
12-3PM	236	212	217	213	210
3-6PM	345	361	379	329	344
6-9PM	285	298	266	293	255
9-12PM	185	178	178	194	191
Unknown	*	*	1	10	5
TOTAL	1476	1459	1464	1448	1387

Table 6 presents the crash frequencies by month for Missouri between 2006 and 2010. Pedestrian crashes typically follow seasonal trends; mild Spring and Autumn months usually account for higher rates of walking and higher numbers of pedestrian crashes. This holds true in Missouri: May, September, and October account for the highest pedestrian crash percentages at 8.7, 9.5, and 10.2 percent, respectively.

Table 6: Pedestrian Crashes by Month

Month	2006	2007	2008	2009	2010
January	144	131	124	117	112
February	106	121	76	99	95
March	118	106	105	100	108
April	128	102	104	96	129
May	130	122	116	142	120
June	108	119	124	125	114
July	97	121	137	108	106
August	110	121	136	118	109
September	136	129	145	138	138
October	153	135	149	148	153
November	121	127	124	124	105
December	133	128	124	133	98

Month	2006	2007	2008	2009	2010
Total	1484	1462	1464	1448	1387

Pedestrian crashes in Missouri are most likely to occur on weekdays, judging by the data presented n Table 7. Friday has the highest frequency of pedestrian crashes, representing 14.1% of all pedestrian crashes, while Sunday has the lowest at 10.6%. The other days of the week comprise an average of 14.3 percent of all pedestrian-motor vehicle crashes in Missouri between 2006 and 2010.

Table 7: Pedestrian Crashes by Day of Week

Day	2006	2007	2008	2009	2010
Sunday	153	163	155	162	137
Monday	199	200	220	198	182
Tuesday	218	215	219	189	191
Wednesday	251	207	204	188	223
Thursday	197	227	222	230	187
Friday	241	266	259	261	257
Saturday	225	182	185	219	210
Unknown	*	*	0	1	0
TOTAL	1484	1460	1464	1448	1387

III. RELEVANT PLANS AND POLICIES

The following plans, policies, and other documents have been developed to address pedestrian safety at the State level:

Engineering Policy Guide (EPG):
http://epg.modot.mo.gov/index.php?title=Category:642_Pedestrian_Facilities All pedestrian related information is in the Engineering Policy Guide (EPG) located in Category 642.

Strategic Highway Safety Plan:
http://www.savemolives.com/documents/FINALBlueprintdocument.pdf There are a number of strategies to improve the safety situation of pedestrians. Missouri has implemented lighting projects, used signs and pavement markings, changed design to improve pedestrian refuge areas, installed the pedestrian count-downs, and other projects that would hopefully improve the pedestrian awareness for drivers. Strategies that can enhance the safety for pedestrians are outlined in the Strategic Highway Safety Plan (Blueprint).

Missouri Long Range Transportation Plan: http://www.modot.mo.gov/plansandprojects/long-range_plan/longrangebicycle.htm

Missouri Livable Streets Design Guidelines:
http://livablestreets.missouri.edu/docs/Missouri_Livable_Streets_Des_FINAL-sm.pdf
The guidelines were created to provide guidance and references for Missouri communities to create Livable Streets. The document includes noteworthy sections on pedestrian safety.

IV. ONGOING PEDESTRIAN CAMPAIGNS AND INITIATIVES

The following campaigns and initiatives help support and promote pedestrian safety at the State level:

MoDOT does have a SRTS program as well as a “Non-Motorized Transportation Engineer” position that focuses on pedestrians.

Additionally, pedestrian safety is a focus of our SHSP and many education campaigns have launched over the last few years. We have tried to better inform the dangers of being near the roadway as a pedestrian not only for urban areas where many can be intersection related but also in the rural environment. For instance, many of the fatalities have involved pedestrians that are near or on the roadway due to a prior crash or disabled vehicle.

Missouri Bicycle and Pedestrian Program:
http://www.modot.org/othertransportation/bike_ped/Bikepedintro.htm The Missouri program that encourages walking and biking, works with planners to create pedestrian and bicycle facilities, and promotes safety among all transportation modes.

St. Louis – Summary of Pedestrian Crashes and Initiatives

I. OVERVIEW

With a population of 319,294, St. Louis is the second largest city in Missouri after Kansas City. Between 2000 and 2010, St. Louis's population decreased by 28,895 people, or 8.3%. The city has a large population of young adults with people aged 20 to 29 representing 19% of the population. Adults aged 30 to 39, 40 to 49, and 50 to 59 comprised 14.5%, 12.9%, and 13.5%, respectively. People over the age of 65 represented 11% of the total. People under the age of 18 make up 21.2% of the total population in St. Louis.

80.8% of workers over the age of 16 in St. Louis commute to work by car, with 70.1% of people driving alone and 10.9% carpooling. These figures are roughly equivalent to the figures for Missouri as a whole. However, the picture is drastically different with respect to transit use, walking, and bicycling. In St. Louis, 10.6% of people use public transit to commute to work, while walking and bicycling account for 4% and 0.7% of the mode share, respectively. These mode shares are at least double the figures for Missouri as a whole. This is partially explained by the fact that nearly 10% of workers over the age of 16 do not have access to a motor vehicle.

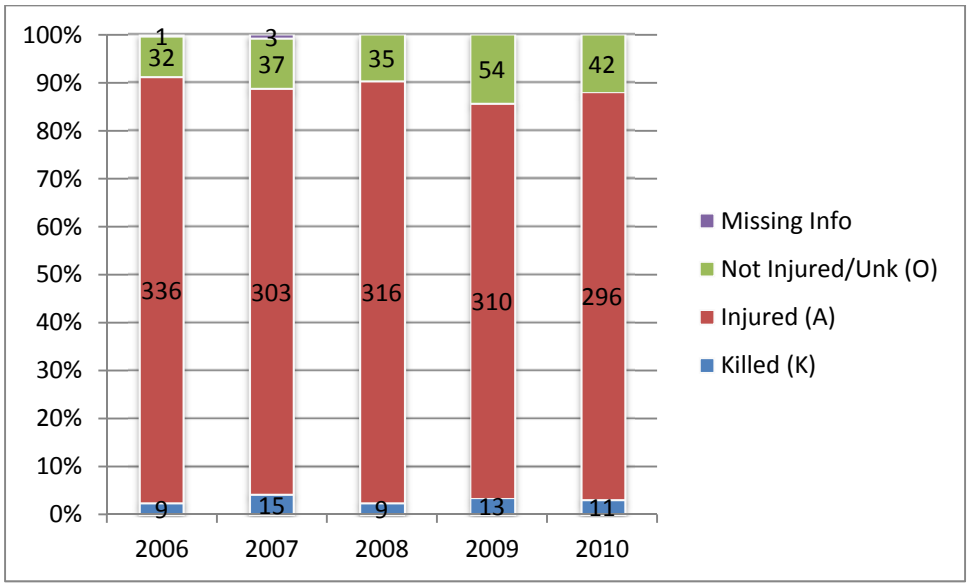
II. PEDESTRIAN CRASHES AND TRENDS

There were 1,822 pedestrian-motor vehicle crashes in the City of St. Louis between 2006 and 2010, which represent 2.4 percent of all crashes during that period. Pedestrian-motor vehicle crashes tend to be more severe than other crashes – despite representing only 2% of all crashes, they comprise 36% of all fatalities and 9.4% of all injuries in the city. Table 8 and Figure 2 provide more information.

Table 8: Pedestrian and Total Crashes by Injury Severity and Year

Total Crashes	2006		2007		2008		2009		2010	
	Ped	All	Ped	All	Ped	All	Ped	All	Ped	All
Killed (K)	9	34	15	36	9	29	13	25	11	31
Injured (A)	336	3458	303	3228	316	3129	310	3361	296	3393
Not Injured/Unk (O)	32	12881	37	12203	35	11769	54	12076	42	11018
Missing Info	1	0	3	0	0	0	0	0	0	0
TOTAL	378	16373	358	15467	360	14927	377	15462	349	14442

Figure 2: Pedestrian and Total Crashes by Injury Severity and Year



In many cities, crash frequencies by age group follow the population demographics. As indicated in Table 9, this holds true for St. Louis in most cases with people aged 20 to 29, 30 to 39, and 40 to 49 accounting for 14.%, 12.9%, and 13.5% of the total population and 18%, 13.2%, and 15.2% of all pedestrian crashes. While these numbers are roughly proportional, other age groups are over- or underrepresented. Notably, those under the age of 18 and over the age of 64 comprise 21.2 percent and 11 percent of the population, respectively, but amount to 29.1 percent and 5.3 percent of all pedestrian-motor vehicle crashes in St. Louis.

Table 9: Pedestrian Crashes by Age (or Age Group) by Year

Age	2006	2007	2008	2009	2010	TOTAL
Under 5	11	13	18	15	15	72
5-9	35	23	32	43	31	164
10-14	32	29	21	19	21	122
15-19	35	34	33	32	39	173
20-24	40	40	32	24	35	171
25-29	25	37	30	34	31	157
30-34	21	17	22	24	30	114
35-39	23	20	30	39	14	126
40-44	33	26	24	24	20	127
45-49	23	33	35	31	28	150
50-54	35	22	32	26	28	143
55-59	22	22	16	23	17	100
60-64	7	13	14	18	12	64
65+	26	19	14	15	22	96
Missing Info	10	10	7	10	6	43
TOTAL	378	358	360	377	349	1822

Light condition data for St. Louis is unavailable, and therefore is not included in this report.

Typical commute hours (3:00 to 6:00 PM) accounted for the most pedestrian-motor vehicle crashes in St. Louis between 2006 and 2010 with a total of 440, or slightly more than 25% of all crashes during this time period. The evening hours (6:00 to 9:00 PM) had the second highest crash frequency with 320 crashes, or slightly more than 18% of all pedestrian crashes. The data, provided in Table 10, indicates that crashes are substantially fewer between 12:00 and 6:00 AM.

Table 10: Pedestrian Crashes by Time of Day

Time of Day	2006	2007	2008	2009	2010
12-3AM	21	20	20	28	27
3-6AM	8	13	9	14	7
6-9AM	44	39	34	33	25
9AM-12PM	28	31	21	35	24
12-3PM	66	48	47	53	53
3-6PM	87	84	102	88	79
6-9PM	65	63	59	68	65
9-12PM	47	42	51	40	42
Unknown	1	3	0	2	0
TOTAL	367	343	343	361	322

Crash trends by month are presented in Table 11 below. As seen in many other cities, crashes typically follow seasonal patterns and are more likely to occur during milder months when more people are walking. In St. Louis, crashes peak in May, September, and October, while November has the fewest crashes. Overall, fewer crashes occurred during the winter and summer months, though seasonal differences are less pronounced in St. Louis than in other cities.

Table 11: Pedestrian Crashes by Month

Month	2006	2007	2008	2009	2010
January	36	30	32	24	29
February	34	39	23	33	21
March	27	31	28	23	23
April	36	24	19	28	18
May	38	25	26	44	34
June	21	28	37	28	30
July	32	26	37	27	26
August	23	28	23	28	31
September	30	31	42	33	33
October	32	25	29	36	34
November	28	22	18	27	22
December	30	34	29	30	21
Total	367	343	343	361	322

Pedestrian crashes in St. Louis occur most frequently on weekdays. Friday has the highest percentage of crashes at 17.3 percent. Saturday also has a substantial percentage of pedestrian crashes at 15.2 percent, while Sunday has the lowest percentage at only 11.1 percent of all pedestrian-motor vehicle crashes in St. Louis between 2006 and 2010.

Table 12: Pedestrian Crashes by Day of Week

Day of Week	2006	2007	2008	2009	2010
Sunday	35	34	41	53	30
Monday	56	52	43	58	41
Tuesday	51	58	46	41	47
Wednesday	62	37	45	42	43
Thursday	50	51	42	54	55
Friday	55	69	68	56	53
Saturday	58	40	58	56	53
Unknown	0	2	0	1	0
TOTAL	367	343	343	361	322

III. RELEVANT PLANS, POLICIES, AND COUNTERMEASURES

The following plans, policies, and other documents have been developed to address pedestrian safety at the City level:

St. Louis Regional Bicycling and Walking Transportation Plan:
http://www.ewgateway.org/pdffiles/library/trans/bike-ped/bikeplan-05/BikePlan-CompleteDoc.pdf
The area MPO, East West Gateway Council of Governments, developed this transportation plan in 2005 which looks at bicycling and walking issues in the greater St. Louis area. The Biking/Walking Transportation Plan, developed as a guide to assist local governments in developing bike and pedestrian facilities, promotes pedestrian safety and access to ensure that the region is a safe, convenient, and attractive place to walk and bike.

We have implemented complete streets projects in our region in an effort to accommodate all users on roadways. Currently, we have four complete street projects. These projects allow pedestrians, bicyclists, transit users and those with disabilities to easily and safely use roads in their communities.

Engineering Policy Guide (EPG):
http://epg.modot.mo.gov/index.php?title=Category:642_Pedestrian_Facilities All pedestrian related information is in the Engineering Policy Guide (EPG) located in Category 642.

Strategic Highway Safety Plan:
http://www.savemolives.com/documents/FINALBlueprintdocument.pdf There are a number of strategies to improve the safety situation of pedestrians. Missouri has implemented lighting projects, used signs and pavement markings, changed design to improve pedestrian refuge areas, installed the pedestrian count-downs, and other projects that would hopefully improve the pedestrian awareness for drivers. Strategies that can enhance the safety for pedestrians are outlined in the Strategic Highway Safety Plan (Blueprint).

Downtown Development Action Plan: http://stlouis-mo.gov/government/departments/planning/documents/downtown-development-action-plan-a.cfm
The Downtown Development Action Plan was created to provide St. Louis with an investment plan combining economic, market, physical, and political actions in shaping the future of downtown. The Plan was a $1.12 billion program with an emphasis on pedestrians. (Developed in 1999)

Strategic Land Use Plan of the St. Louis Comprehensive Plan: http://stlouis-mo.gov/government/departments/planning/planning/adopted-plans/Strategic-Land-Use-Plan.cfm The Strategic Land Use Plan of the St. Louis Comprehensive Plan was adopted in 2005 and has since been amended 8 times with annual updates since 2007. The plan assigns land use designations to every block within St. Louis indicating what future development focus is intended for each block.

Sustainability Plan: http://stlouis-mo.gov/government/departments/mayor/initiatives/sustainability/sustainability-plan.cfm A St. Louis Mayor's Initiative that has included greenhouse gas emissions inventories, public engagement, a Sustainability Summit, and a draft Sustainability Plan.

St. Louis Complete Streets Ordinance: http://www.slpl.lib.mo.us/cco/ords/data/ord8663.htm The ordinance was passed in June 2010 and sets guiding principles and practices to be considered in public transportation projects to encourage walking, bicycling, and transit use while promoting safe operations for all users.

IV. ONGOING PEDESTRIAN CAMPAIGNS AND INITIATIVES

The following campaigns and initiatives help support and promote pedestrian safety at the City level:

Road/Pedestrian Safety Audits: East-West Gateway has recently implemented Road/Pedestrian Safety Audits targeting various road segments in transportation improvement projects. Low-cost physical improvements will be made to infrastructures as a result of the audits. Examples include sidewalk improvements, lighting, ADA accessibility curbs, increased pedestrian signage, and pedestrian buffers. The audits are based on the Federal Highway Administration Pedestrian and Road Safety guidelines.

Bike and Pedestrian Advisory Committee: The goal of the Bike and Pedestrian Advisory Committee is to encourage and enhance walking and biking as a means of transportation, recreation, wellness and environmental enhancement. The BPAC represents a cross-section of individuals, including walking and mobility advocates, neighborhood activists, environmental design professionals and citizens-at-large. MoDOT does have a SRTS program as well as a "Non-Motorized Transportation Engineer" position that focuses on pedestrians.

Additionally, pedestrian safety is a focus of our SHSP and many education campaigns have launched over the last few years. We have tried to better inform the dangers of being near the roadway as a pedestrian not only for urban areas where many can be intersection related but also in the rural environment. For instance, many of the fatalities have involved pedestrians that are near or on the roadway due to a prior crash or disabled vehicle.

The East West Gateway Council of Governments: http://www.ewgateway.org/ The MPO for the St. Louis region (East West Gateway Council of Governments) also plays a major road in pedestrian safety for St. Louis City.

Open Streets: http://stlouis-mo.gov/government/departments/mayor/initiatives/open-streets/ The City of St. Louis holds an annual event that closes several miles of roads to automobiles to promote walking and biking.

CITATION LIST

United States Census Bureau. (2000). *Census 2000 Summary File 1* [Data File]. Retrieved from http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml.

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Technical Stakeholder Workshop

Appendix B

Preliminary GIS Analysis for Pedestrian Crashes in St. Louis

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Geospatial Statistical Analysis for Pedestrian Accidents in the City of St. Louis

Saber Abdoli
Ph.D. Student
abdolis@slu.edu

Smart Transportation Lab
Department of Civil Engineering
SAINT LOUIS UNIVERSITY
Parks College of Engineering, Aviation and Technology

Yao-Jan Wu, Ph.D.
Assistant Professor
yaojan@slu.edu

Director, *Smart Transportation Lab*
Department of Civil Engineering
SAINT LOUIS UNIVERSITY
Parks College of Engineering, Aviation and Technology

Abstract

It is critical for transportation engineers to understand how, where and when traffic accidents occurred in order to develop proper countermeasures to improve road safety. A better understanding of spatial patterns of traffic accidents can facilitate accident reduction efforts. Spatial analysis of point events, known as point pattern analysis, has been widely examined by spatial scientists and a variety of methods have been developed for detecting hazardous network segments. In this research, GIS-based pedestrian accident data from 2007 to 2011 for the City of St. Louis was analyzed. The hazardous locations were identified by using one of the most recent techniques, "Network Kernel Density". Next, the road segments and intersections with potential safety concerns were ranked to help stakeholders prioritize site improvement strategies. Additionally, the statistical and temporal aspect of accident data was also represented.

Introduction

The St. Louis is an old design urban area, which according to the transportation for America website ranked among top 25 metro areas over 1 million for dangerous by design for pedestrians. During 1997~2006, only the City of St. Louis had 127 pedestrian crash deaths as indicated in the previous national reports by (NHTSA 2008). Next figures represent some statistical and temporal aspect of pedestrian accidents based-on 2007 to 2011 data.

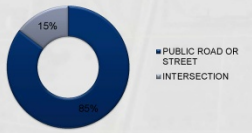

Figure 1: Percent of pedestrian accidents based on location

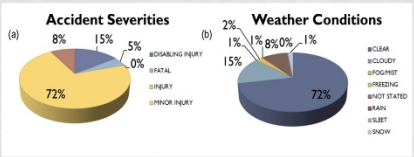

Figure 2: Percent of various (a) accident severities, and (b) weather conditions among pedestrian accident data in the city of St. Louis

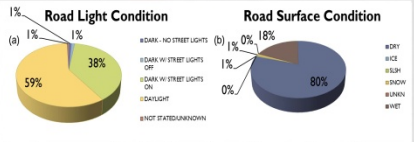

Figure 3: Percent of various (a) light conditions, and (b) road surface conditions among pedestrian accidents data in the city of St. Louis

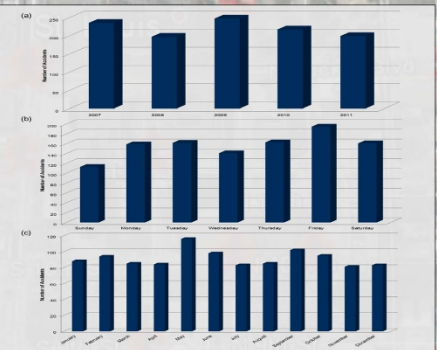

Figure 4: Pedestrian accident frequency (a) from 2007 to 2011, (b) during weekdays, and (c) during months in the city of St. Louis

Network Kernel Density Estimation

Traditionally, planar Kernel Density Estimation (KDE) has been developed and utilized to find spatial point event patterns over a 2-D geographic space. However, point events such as pedestrian accidents cannot be analyzed in a planar surface. Recently spatial scientists developed Network KDE to examine the network's events in the proper 1-D space, which instead of calculating the density over area unit estimate the density over a linear unit. Below is the Network KDE formula:

– — (1)

Where is the density at the location is the search radius of the KDE, and is the weight of the point at distance to location .

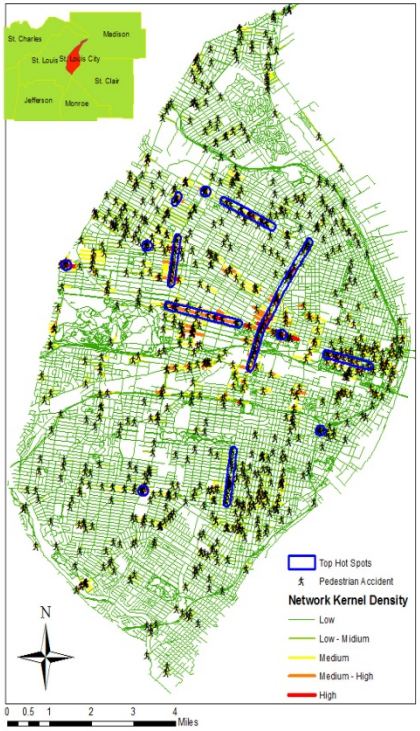

Figure 6: Network Kernel Density of pedestrian accidents in St. Louis City

Visual Analysis

Figure 5: Visual scrutinizing of pedestrian accident data by using ESRI ArcGIS, Google Earth and Google Street View

For implementing Network KDE, GeoDa Net software developed by the GeoDa Center at Arizona State University has been utilized. The results are used to identify the most dangerous road segments as well as intersections along the Saint Louis City network.

Network KDE result map besides count function available in ArcGIS utilized to rank top road segments which need special attention in terms of improving pedestrian safety.

Table 1: Top hot road segments for pedestrians safety improvement in the city of St. Louis

Street Name	From	To	Length (mile)	No of Acc.
Grand Blvd	Chouteau Ave	Harper Street	2.7	56
North Kingshighway	Martin Luther King Drive	Washington Place	0.9	32
Missouri 115	Harris Ave	Shreve Ave	1	30
South Grand Blvd	Arsenal Street	Dunnica Ave	1.1	26
Lindell Blvd	North Vandeventer Ave	Kingshighway Blvd	1.3	25
Market Street	10th Street	20th Street	0.9	20

Table 2: Top hot road intersections for pedestrians safety improvement in the city of St. Louis

Intersect ID	On the Street	At Crossing with	No of Acc.
263533	Missouri 115	Newstead Ave	12
262069	Union Blvd	Saint Louis Ave	10
289913	South Kingshighway Blvd	Lindenwood Ave	10
267045	North Kingshighway Blvd	Page Boulevard	9
261368	Missouri 115	North Kingshighway Blvd	8
268627	North Skinker Blvd	Delmar Blvd	8
268829	North Grand Blvd	Montgomery Street	7

Conclusions and Future Work

The results of this research can not only assist traffic engineers in developing appropriate countermeasures but also help the City of St.Louis determine the priority of allocatingresources andimplementing various crash reduction programs to improve pedestrian safety. Developing cost effective countermeasures is key to reducing the number of pedestrian fatalities and injuries. In this regard, examining different options among pedestrian safety countermeasures as well as assigning a more appropriate type to each hazardous segment and intersection should be studied in the continuation of this research.

Acknowledgement

The authors greatly appreciate Mr. John Miller from MoDOT for providing pedestrian accident data and Mr. Len Efthim from the City of St. Louis for their professional comments.

Geospatial Statistical Analysis for Pedestrian Crashes in the City of St. Louis

Saber Abdoli
Ph.D. Student
abdolis@slu.edu

Yao-Jan Wu, Ph.D.
Assistant Professor
yaojan@slu.edu

Smart Transportation Lab
Department of Civil Engineering
SAINT LOUIS UNIVERSITY
Parks College of Engineering, Aviation and Technology

Abstract

It is critical for transportation engineers to understand how, where and when traffic crashes occurred in order to develop proper countermeasures to improve road safety. A better understanding of spatial patterns of traffic crashes can facilitate crash reduction efforts. Spatial analysis of point events, known as point pattern analysis, has been widely examined by spatial scientists and a variety of methods have been developed for detecting hazardous network segments. In this research, GIS-based pedestrian crash data from 2007 to 2011 for the City of St. Louis was analyzed. The hazardous locations were identified by using one of the most recent techniques, "Network Kernel Density". Next, the road segments and intersections with potential safety concerns were ranked to help stakeholders prioritize site improvement strategies. Additionally, the statistical and temporal aspect of crash data was also represented.

Introduction

St. Louis City is an old design urban area, which according to the transportation for America website ranked among top 25 metro areas over 1 million for dangerous by design for pedestrians.

During 1997~2006, only the City of St. Louis had 127 pedestrian crash deaths as indicated in the previous national reports by (NHTSA 2008). Next figures represent some statistical and temporal aspect of pedestrian crashes based-on 2007 to 2011 data.

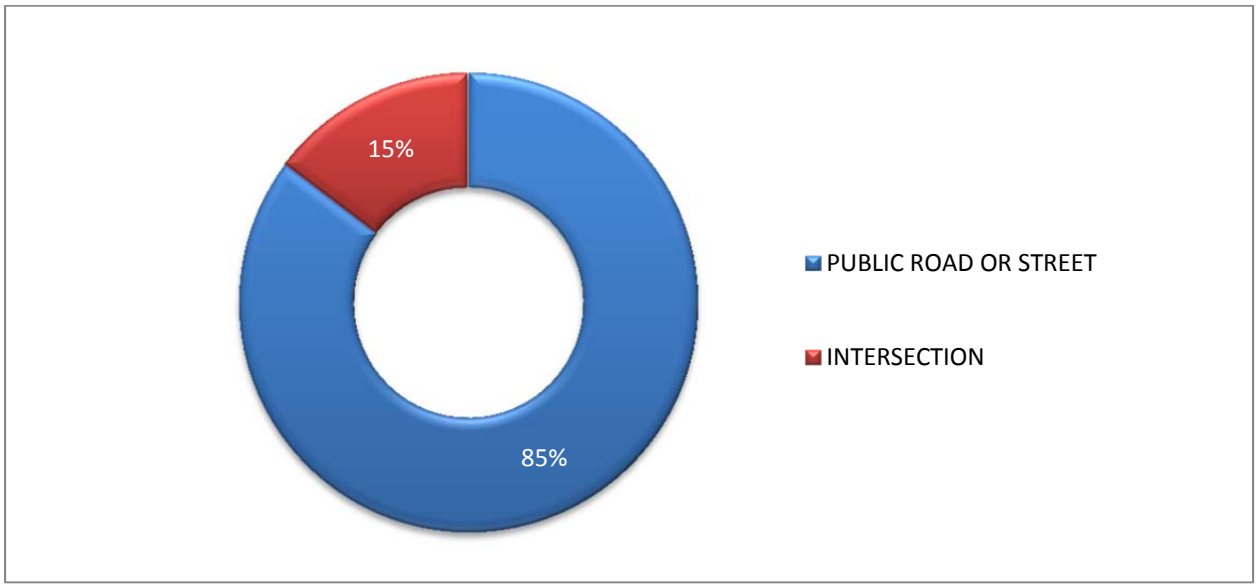

Figure 1: Percent of pedestrian crashes based on location

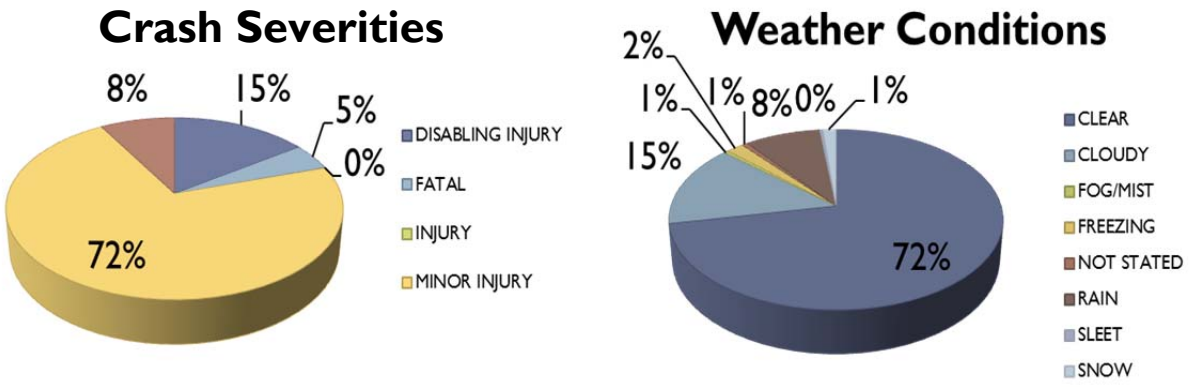

Figure 2: Percent of various (a) crash severities, and (b) weather conditions among pedestrian crash data in the city of St. Louis

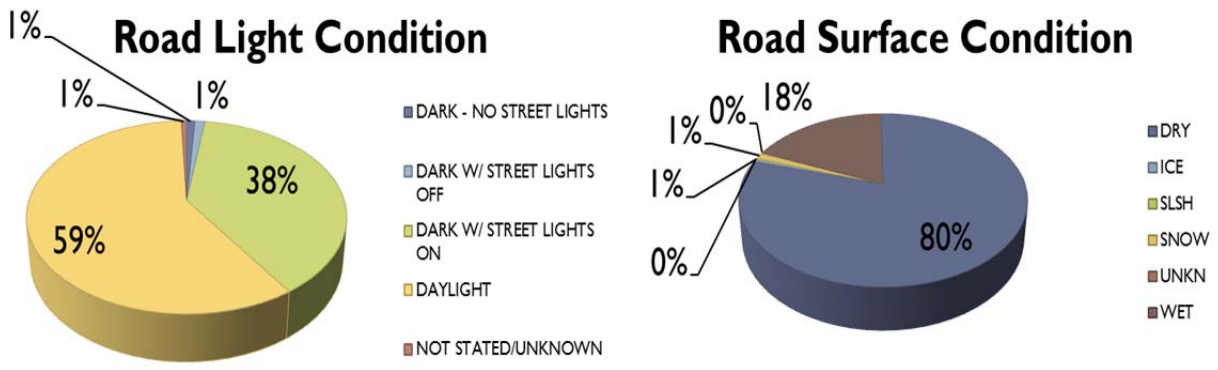

Figure 3: Percent of various (a) light conditions, and (b) road surface conditions among pedestrian crashes data in the city of St. Louis

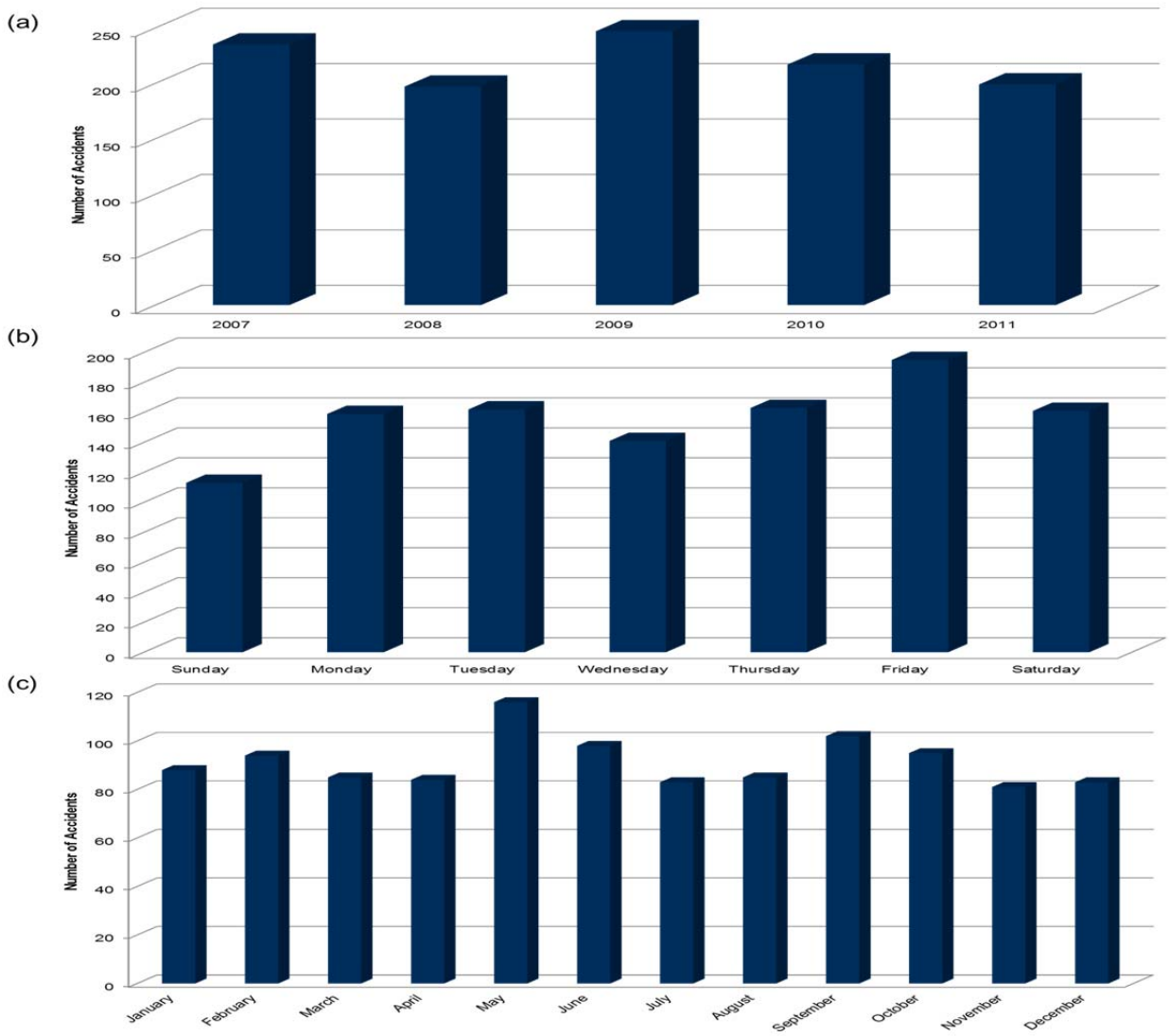

Figure 4: Pedestrian crash frequency (a) from 2007 to 2011, (b) during weekdays, and (c) during months in the city of St. Louis

Network Kernel Density Estimation

Traditionally, planar Kernel Density Estimation (KDE) has been developed and utilized to find spatial point event patterns over a 2-D geographic space. However, point events such as pedestrian crashes cannot be analyzed in a planar surface. Recently spatial scientists developed Network KDE to examine the network's events in the proper 1-D space, which instead of calculating the density over area unit estimate the density over a linear unit. Below is the Network KDE formula:

$$\lambda(s) = \sum_{i=1}^{n} \frac{1}{r} k(\frac{dis}{r})$$

Where $\lambda(s)$ is the density at the location s, r is the search radius of the KDE, and k is the weight of the point i at distance dis to location s.

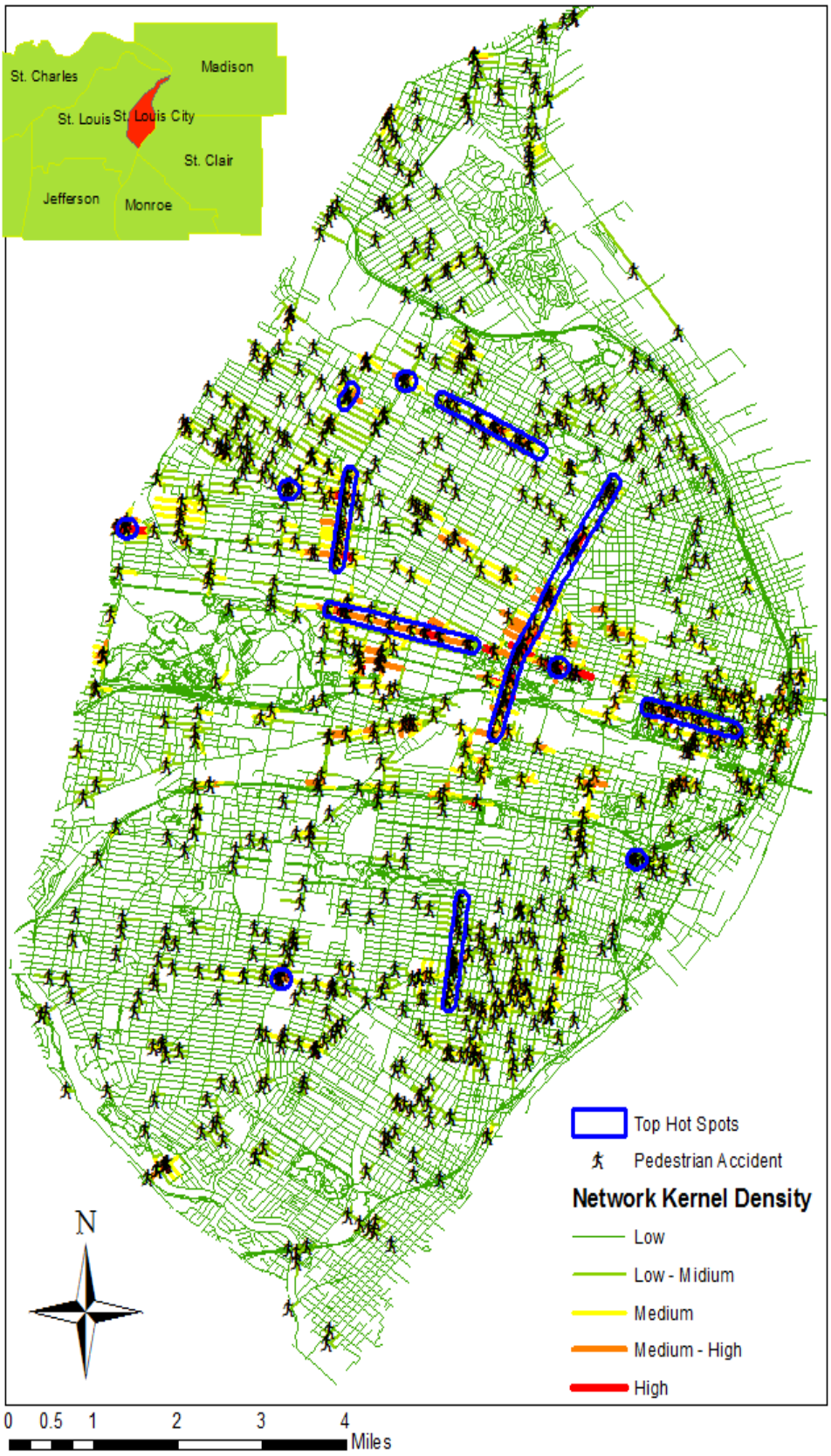

Figure 5: Network Kernel Density of pedestrian crashes in St. Louis City

Visual Analysis

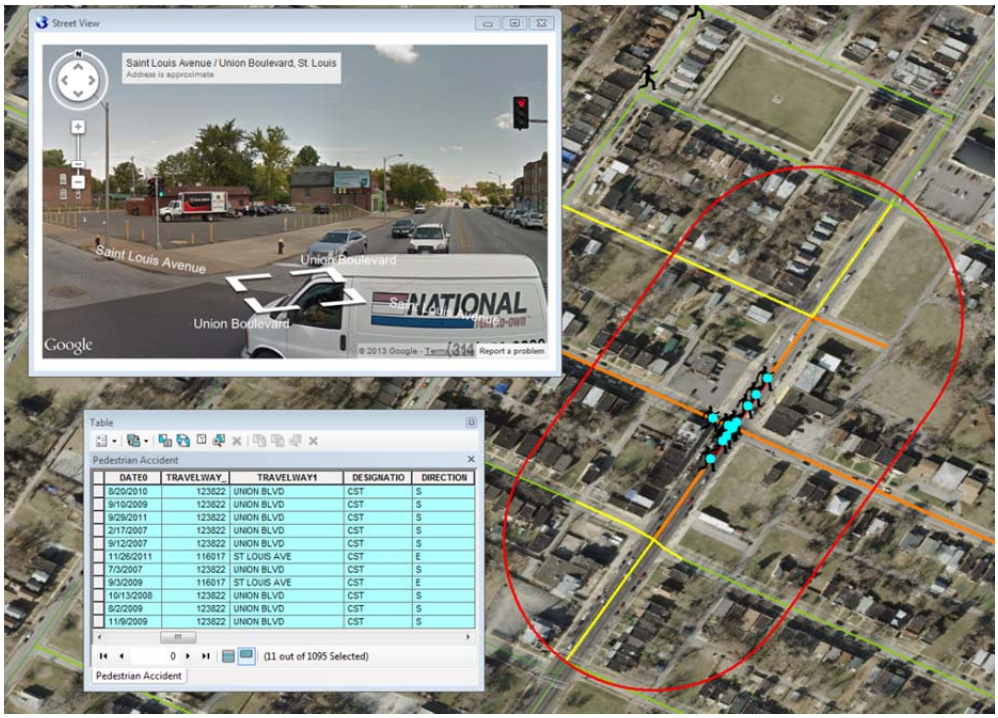

Figure 6: Visual scrutinizing of pedestrian crash data by using ESRI ArcGIS, Google Earth and Google Street View

For implementing Network KDE, GeoDa Net software developed by the GeoDa Center at Arizona State University has been utilized. The results are used to identify the most dangerous road segments as well as intersections along the Saint Louis City network.

Network KDE result map besides count function available in ArcGIS utilized to rank top road segments which need special attention in terms of improving pedestrian safety.

Table 1: Top hot road segments for pedestrians safety improvement in the city of St. Louis

Street Name	From	To	Length (mile)	No of Acc.
Grand Blvd	Chouteau Ave	Harper Street	2.7	56
North Kingshighway	Martin Luther King Drive	Washington Place	0.9	32
Missouri 115	Harris Ave	Shreve Ave	1	30
South Grand Blvd	Arsenal Street	Dunnica Ave	1.1	26
Lindell Blvd	North Vandeventer Ave	Kingshighway Blvd	1.3	25
Market Street	10th Street	20th Street	0.9	20

Table 2: Top hot road intersections for pedestrians safety improvement in the city of St. Louis

Intersect ID	On the Street	At Crossing with	No of Acc.
263533	Missouri 115	Newstead Ave	12
262069	Union Blvd	Saint Louis Ave	10
289913	South Kingshighway Blvd	Lindenwood Ave	10
267045	North Kingshighway Blvd	Page Boulevard	9
261368	Missouri 115	North Kingshighway Blvd	8
268627	North Skinker Blvd	Delmar Blvd	8
268829	North Grand Blvd	Montgomery Street	7

Conclusions and Future Work

The results of this research can not only assist traffic engineers in developing appropriate countermeasures but also help the City of St. Louis determine the priority of allocating resources and implementing various crash reduction programs to improve pedestrian safety. Developing cost effective countermeasures is key to reducing the number of pedestrian fatalities and injuries. In this regard, examining different options among pedestrian safety countermeasures as well as assigning a more appropriate type to each hazardous segment and intersection should be studied in the continuation of this research.

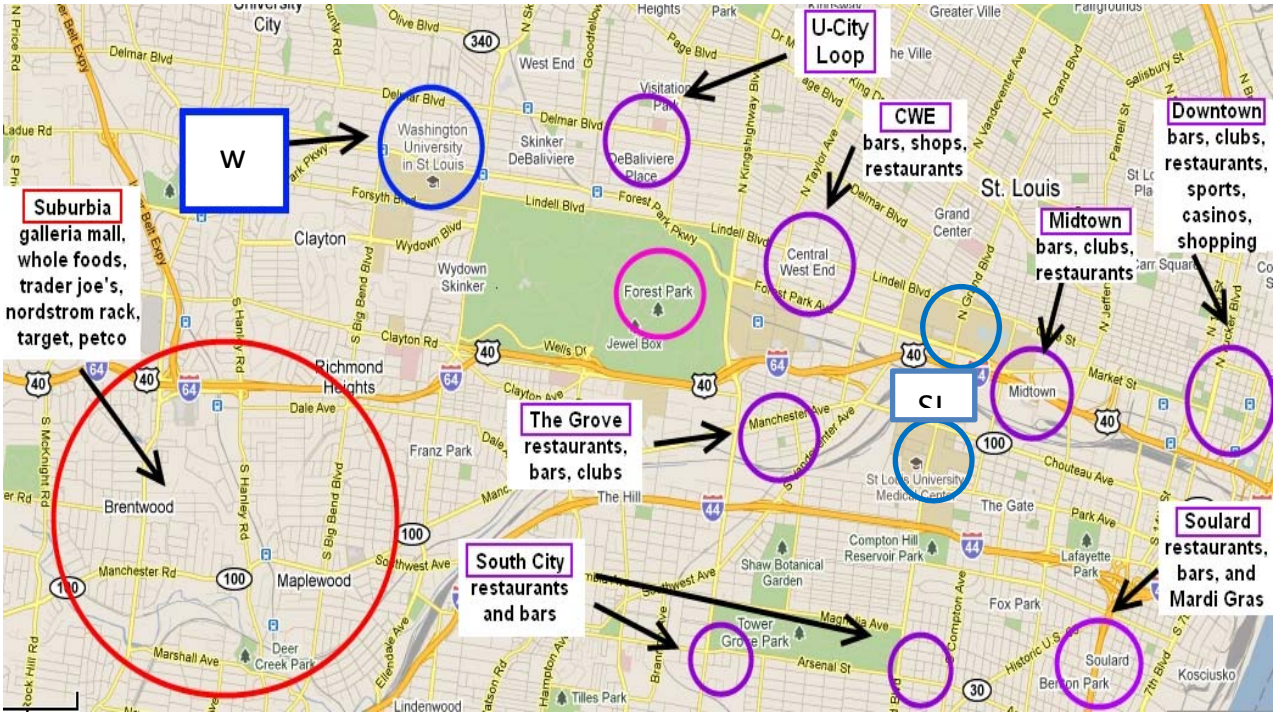

Figure 7: Finding factors correlated with pedestrian crashes (land use, walkable places vs. population density, schools, bars, bus stops, etc.)

Acknowledgement

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