Report No. UT-23.19

SAFE ROUTES UTAH PLANS AND ACTIVE TRANSPORTATION SAFETY

Prepared For:

Utah Department of Transportation
Research & Innovation Division

Final Report
December 2023

RESEARCH
UDOT Keeping Utah Moving
Utah Department of Transportation - Research Division
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DISCLAIMER

ACKNOWLEDGMENTS

The authors acknowledge the Utah Department of Transportation (UDOT) for funding this research, and the following individuals from UDOT on the Technical Advisory Committee for helping to guide the research:

- Travis Jensen, UDOT Research Consultant Project Manager
- Travis Evans, UDOT Active Transportation Safety Program Manager
- Kristen Hoschouer, UDOT Safety Outreach Administrator
- Jim Price, Mountainland Association of Governments Senior Planner
- Ron Litchfield, Utah State Board of Education Pupil Transportation Specialist
- Michael Blanchette, UDOT Statewide Signal Engineer
- Suyanka Neupaney, UDOT Data and Safety Manager
- Anne Ogden, UDOT Region 4 Traffic Engineer

TECHNICAL REPORT ABSTRACT

1. Report No. UT-23.19	2. Government Accession No. N/A	3. Recipient's Catalog No. N/A
4. Title and Subtitle SAFE ROUTES UTAH PLANS AND ACTIVE TRANSPORTATION SAFETY		5. Report Date December 2023 6. Performing Organization Code N/A
7. Author(s) Shaunna Burbidge, PhD, Collin Gee, David Bezzant, P.E., and Nate Lant		8. Performing Organization Report No. N/A
9. Performing Organization Name and Address Avenue Consultants 6605 South Redwood Rd. Suite 200 Taylorsville, Utah, 84123		10. Work Unit No. 5H08858H 11. Contract or Grant No. 23-8606
12. Sponsoring Agency Name and Address Utah Department of Transportation 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410		13. Type of Report & Period Covered Final Dec 2022 to Dec 2023 14. Sponsoring Agency Code UT22.315

15. Supplementary Notes
Prepared in cooperation with the Utah Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration

16. Abstract
The goal of Utah's Safe Routes to School program is to "help children get to and from school safely" (UDOT, 2022). To that end, state law dictates that each school must maintain a safe routes map showing students the safest route to access the school from their homes. This research examined existing safe routes maps and investigated whether schools that have a detailed safe routes map and plan experience increased safety over schools that have a less detailed or no existing safe routes map and associated plan. This research utilized several different datasets and analysis techniques to compile all Safe Routes to School plans and the non-motorized crash history for the sample area. Analysis methods also include multinomial logistic regression models to isolate significant factors that are not mutually exclusive but create an impact due to their presence together, such as position of school crossings and other roadway infrastructure. Final elements of this research included evaluation of outputs, then drafting conclusions and recommendations. Analysis identified that the transportation environments surrounding the sample schools differed across the sample both within 0.5 miles and one mile of the schools. There were very few designated school crossings and mid-block crossings present. The number of intersections varied across the sample, and more than half of the schools have a sidewalk, trail, or bike lane within one mile. Statistical analysis determined that urban areas experienced significantly more active transportation crashes within one mile of schools than rural areas. Additionally, schools surrounded by a larger number of intersections experienced significantly more nearby active transportation crashes. Regression analysis determined that Title I schools experienced significantly more student-involved active transportation crashes within one mile when controlling for other environmental factors.

17. Key Words Traffic Safety, School Routes, School Safety, SNAP, Pedestrian, Traffic, Infrastructure, Pedestrian Infrastructure		18. Distribution Statement Not restricted. Available through: UDOT Research Division 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410 www.udot.utah.gov/go/research		23. Registrant's Seal N/A
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 71	22. Price N/A	

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LIST OF ACRONYMS

ANOVA	Analysis of Variance
AADT	Annual Average Daily Traffic
DTS	Department of Technology Services
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
SRTS	Safe Routes to School
SRU	Safe Routes Utah
SNAP	Student Neighborhood Access Plan
TAC	Technical Advisory Committee
UDOT	Utah Department of Transportation
UGRC	Utah Geospatial Resource Center
UTA	Utah Transit Authority

EXECUTIVE SUMMARY

The goal of Utah's Safe Routes to School (SRTS) program is to "help children get to and from school safely" (UDOT, 2022). State law dictates that each school (excluding high schools) must maintain a safe routes map showing students the safest route to access the school from their homes. This research examines existing safe routes maps and correlates if schools in Utah that have a detailed safe routes map and plan experience increased safety over schools that have a less detailed or no existing safe routes map and associated plan. Several analysis methods were employed in this research to identify trends in the data and answer the research questions. These included summary statistics, Chi-Square, independent samples t-Tests, Analysis of Variance (ANOVA), and Least Squares regression analysis to isolate significant factors that are not mutually exclusive but create an impact due to their presence together, such as position of school crossings and other roadway infrastructure.

A significant amount of previous literature exists regarding SRTS programs across the US, particularly about their direct effects on safety. SRTS programs may have a notable impact on safety and health in communities and have been the focus of many studies in the past. SRTS programs have been found to have an impact on school safety and have been effective in reducing risk of injuries or fatalities for pedestrian and bicyclist students while increasing the number of students walking and biking to school (DiMaggio et al., 2016 and McDonald et al., 2014). As a result, a wide number of SRTS programs have been implemented nationwide.

The Utah SRTS program, also known as Safe Routes Utah (SRU) has already been in place for a number of years. However, certain challenges may exist in the implementation of an SRTS program, and determining the actual efficacy of an SRTS program may be difficult. The safety effects of such programs may be presumed, more so than studied (Dumbaugh and Frank, 2006). There is also less previous research into the aspects of program implementation and what may pose challenges to implementation. Previous research has identified that disadvantaged communities with fewer resources may also struggle to develop an SRTS program (Elliot et al., 2022). However, other research has indicated that disadvantaged communities have been able to develop and implement SRTS programs successfully when resources are available and effort from involved parties is sufficient (McDonald et al., 2013, and Stewart et al., 2014). More research and study into the factors of SRTS development and implementation would be valuable in providing information on what challenges may exist and to learn which schools and communities have been able to implement such programs effectively. This would also help to determine the effectiveness of Utah-based SRTS programs and their impacts on school safety.

Roadway, trails and pathways, pavement messages, and intersections datasets were imported into the project database. The 79 sample school locations were imported into the project as well and included in each map. A buffer geoprocessing function in ArcGIS Pro was used to place a one-mile buffer around each school location. This buffer layer was then used to clip each of the datasets, creating datasets which show the distribution of each dataset feature within one mile of the 79 school locations. Using the clipped one-mile datasets, the needed remaining shapefiles were extracted. This was performed using the select-by-features and export-data functions in ArcGIS Pro. The attribute information for each dataset was used to select the desired features (i.e., mid-block crossings from the one-mile intersections dataset). The export-data function then created a new separate shapefile showing school crosswalks, mid-block crossings, bike lanes, and sidewalks. The final output created a database which shows each of the geographic features within one mile of the 79 selected school locations.

Analysis identified that the transportation environments surrounding the sample schools differed across the sample both within 0.5 miles and one mile of the schools. Very few (<35%) schools had designated school crossings within a mile and there were mid-block crossings within a mile for only 5.2% of schools. The number of intersections varied across the sample, and more than half of the schools have a sidewalk, trail, or bike lane within one mile. Statistical analysis determined that urban areas experienced significantly more active transportation crashes within one mile of schools than rural areas. Additionally, schools surrounded by a larger number of intersections experienced significantly more nearby active transportation crashes. Likewise, a regression analysis determined that Title I schools (schools with large percentages of students from lower-income households which qualify for federal financial assistance) experienced significantly more student-involved active transportation crashes within one mile when controlling for other environmental factors. Based on the analysis and data reviewed in the research process, recommendations were identified and an implementation plan to improve safe routes planning was developed.

1.0 INTRODUCTION

1.1 Problem Statement

The goal of Utah's Safe Routes to School program is to "help children get to and from school safely" (UDOT, 2022). To that end, state law dictates that each school must maintain a safe routes map showing students the safest route to access the school from their homes. These plans have been implemented with success throughout the U.S. previously (DiMaggio et al., 2016 and McDonald et al., 2014). However, challenges may remain in the development and successful implementation of SRTS plans, limiting their impact. This research will examine existing safe routes maps and correlate if schools in Utah that have a detailed safe routes map and plan experience increased safety over schools that have a less detailed or no existing safe routes map and associated plan. Such research will help better determine the effectiveness of such plans in the state and highlight where strengths and weaknesses in SRTS plans may exist.

While each school (excluding high schools) is legally required to have a Safe Routes to School (SRTS) plan and map, the quality and depth of those plans vary widely. According to the Safe Routes Utah (SRU) program, "School leadership officials have a significant influence on the way students travel to and from school. Policies, procedures, and projects can be promoted at the school and district level that address concerns, improve safety, increase physical activity and encourage students to walk and bike more often." School administrations and local city officials play a significant role in the quality of school plans. Some schools have a very comprehensive plan and accompanying map that clearly outline facilities and routes and identify recommendations and areas for improvement. Alternatively, many schools have no plan and only a simple map that lacks detail. Still others have nothing at all. While many resources are also available through the SRTS program, including assemblies and curriculum that promote safe walking and biking, these programs are dependent upon teachers and administrators who are actively working to promote safety to engage these resources.

SRTS plans and programs are linked to infrastructure improvements. When an SRTS plan clearly outlines recommendations and necessary improvements, cities and other municipal governments can easily respond to local needs. Additionally, funding provided through the SRTS

Grant Program requires an existing SRTS plan and map, and a coordinated local effort to identify needs. If local support is not in place, it is incredibly difficult to secure funding or planning for improvements to school walking and biking routes. Traditionally, many communities that have the largest need for safe walking and biking routes (low income, minority, single parent households, etc.) are in areas with the least ability to provide support for these efforts. Administrators at Title I schools likely have more pressing concerns than completing their SRTS Plan, and these areas are also less likely to have parent or community volunteers to assist in these efforts.

1.2 Objectives

This research will evaluate existing SRTS plans and maps for a sample area. The level of detail and depth will be determined and then correlated to safety data for the associated school/area. It is hypothesized that areas without an SRTS plan and those with lower levels of detail will be correlated to a higher safety risk near the school as well as potentially lower quality/outdated infrastructure.

By determining if areas without a current SRTS plan or those with a lower-quality plan have an increased risk of bicycle/pedestrian crashes or reduced safety, the Utah Department of Transportation (UDOT) can better determine how to provide assistance to these schools/communities. For example, if lower-income Title I schools have an increased risk of safety issues in their surrounding areas, UDOT may identify ways to provide local assistance in creating higher quality SRTS plans and maps and work with local communities to implement recommendations from the plan.

1.3 Scope

This research uses several different datasets and analysis techniques to compile all SRTS plans and the non-motorized crash history for the sample area. Analysis methods also include t-Tests, analysis of variance (ANOVA), and multinomial logistic regression models to isolate significant factors that are not mutually exclusive but create an impact due to their presence together, such as position of school crossings and other roadway infrastructure. Final elements of this research include evaluation of outputs, then drafting conclusions and recommendations.

1.4 Outline of Report

The report is organized into five additional chapters, as follows:

- Chapter 2 provides a literature review examining characteristics on current SRTS plans in Utah, research on the effectiveness of SRTS plans overall, and potential challenges in the implementation of SRTS plans.
- Chapter 3 presents the data collected and provides summary characteristics for the study sample.
- Chapter 4 presents a quantitative analysis of data pertaining to SRTS plans.
- Chapter 5 provides conclusions based upon the data analysis.
- Chapter 6 outlines recommendations and the implementation plan.

2.0 RESEARCH METHODS

2.1 Overview

This chapter provides a brief overview of existing literature as it relates to SRTS plans including the Utah process, and the challenges associated with creating and implementing plans. Analysis methods are identified and described including how they will be used to address the research problem proposed in the prior chapter.

2.2 Literature Review

This literature review details existing literature on SRTS programs, the Utah SRTS program, and effectiveness of such programs.

2.2.1 Literature Review Introduction

Walking to school, which was once a commonplace rite of passage, now accounts for only a small minority of school trips. By 2004 fewer than 13% of school trips were made using active modes of transportation, compared to over 50% in 1969 (Mohai, Kweon, Lee and Ard, 2011). According to Kerr et al., the main reason students no longer walk or bike to school is parental concerns about safety (Kerr et al., 2006). Multiple studies have shown those concerns are strongly linked to the physical environment that exists between home and school, including the speed and volume of traffic students would encounter, the potential for encountering crime, and even the impact of weather. Declines in students walking to school, even those who live very close to schools, are significant (FHWA, 2019). This is the case, even though children who are driven to school miss out on the significant health benefits walking to school provides (Heelan et al., 2008).

SRTS programs have been developed, in part, due to declines in the number of students walking to school and to improve the safety and effectiveness of walking to school for students. Utah has developed its own SRTS program with this goal, and hundreds of projects of varying types and expense have been funded through these programs in Utah and throughout the United States. Projects enacted through SRTS include but are not limited to improvements to signage, striping, on- and off-street active transportation infrastructure, and traffic calming measures. These projects are designed to create safer options for students walking to school, encourage more walking to school, and increase active transportation among students generally. Published literature and previous studies reveal that SRTS programs have been effective in reducing the risk of injury or fatality for pedestrian and bicyclist students and increasing the number of students walking and biking to school (DiMaggio et al., 2016 and McDonald et al., 2014).

Despite these successes, challenges may exist in implementing an effective SRTS program. Schools with more resources and community involvement may be more likely to implement an SRTS program. Schools may also have trouble enacting an SRTS program if administrators are unable to devote time and effort to the initiative without support from teachers and parents or guardians. Previous research has also found that implementation of SRTS programs faces many challenges among low-income communities, communities of color, non-English speakers, etc., and that past studies on creating SRTS programs in disadvantaged communities are limited (Elliot et al., 2022). Research and analysis on the enaction of SRTS programs at Utah schools is required to understand better how many schools are taking advantage of SRTS resources to create a program and what factors may prevent this from happening.

2.2.2 Utah Safe Routes to School Program

According to the 2017 National Household Travel Survey, only 10.4% of students ages 5-12 currently walk or bike to school, compared to 13.7% in 2001; this is down from 48% in 1975 (FHWA, 2019 and Tudor-Locke, Ainsworth, and Popkin, 2001). This is despite the same dataset showing that 80.9% of children who live “very close” to school (0.25 miles or less) walk on a usual school day (FHWA, 2019). As a result of the overall decline in active transportation, and to improve safety for children wanting to walk or bike to school, several SRTS programs have been developed at the federal and state level. This includes the program in Utah.

Since its inception, the UDOT program has provided Utah schools with walking and biking safety resources through the Student Neighborhood Access Program (SNAP) and Utah’s SRTS program. Recently, Utah’s SRTS program was overhauled to be more comprehensive and inclusive. It is now known simply as Safe Routes Utah or SRU. The main goal of the SRU program is to assist and encourage students living within one and a half to two miles of their school to walk or bike to school safely (UDOT, 2018). It includes both encouragement and educational programs, as well as a funding program for construction and implementation projects. In recent years, UDOT has seen great value in incorporating SRU with other existing programs. Recently the SRU program began working cooperatively with the Zero Fatalities Program and Move Utah.

Through the SRU funding program, municipalities or other agencies may apply for funding of non-infrastructure (education and encouragement programs) and infrastructure (physical improvements - primarily new sidewalks, etc.) projects, based on an allotment of both state and federal funds. A review panel screens funding applications to determine which projects will provide the best return on investment for improving school safety. Projects are selected and funded on a three-year rolling funding cycle through a project reimbursement program, which means that the city pays initial construction costs and is reimbursed by UDOT when the project is completed to standard.

Within SRU programs, eligible infrastructure projects that improve safety of school routes for Utah students include bike parking facilities, sign installments, on-street bike facilities, off-street bike/pedestrian facilities, crossing improvements, street striping, signals, signage, traffic calming devices, and increased placement of sidewalks. Project budgets typically range between $50,000 and $200,000. Individual SRU improvement plans enacted through the program should work to fill in gaps or hazards identified through a school's SNAP map to create safer routes and walking options. The SRU program also may work in conjunction with the Utah Safe Sidewalk Program. This program provides a legislative funding source for construction of new sidewalks adjacent to state routes where sidewalks do not currently exist and where major construction or reconstruction of the route at that location is not planned for 10 or more years.

2.2.3 Effectiveness of SRTS Programs

While SRTS projects aim to improve safety and accessibility for students to walk and bike to school, how effective are these projects, and to what degree have they been implemented by schools and communities? The premise of an SRTS program is the net benefit to the communities relative to safety, health, and quality of life. For example, an examination of New

York's SRTS program found that the program was associated with a net social benefit of $230 million and 2,055 quality-adjusted life years gained in New York City" (Muennig, Epstein, Li and DiMaggio, 2014).

Research has also shown that students typically walk and bike more after an SRTS project has been completed in the area. A study by Boarnet et al. (2005), examined 10 sites in California where SRTS funding was used for construction projects. The research team surveyed 1,244 parents one to 18 months after the completion of project construction and asked them to identify whether their children walked and biked more or less frequently after the project's completion. Their analysis determined that approximately 10.6% of students walked or biked more after construction, and that the proportion of children who walked or biked more after construction was "significantly greater among children for whom the project location was along their usual route." Additionally, 15.4% of children who passed the project site on the way to school walked more following construction, compared to 4.3% of children who did not pass the project site. A separate study of projects completed in Eugene, Oregon, determined that SRTS infrastructure improvements were associated with increases in walking and biking of 5-20% (McDonald, Yang, Abbott, and Bullock, 2013).

Direct comparative analysis also indicates that SRTS programs can encourage more walking and biking through other efforts in addition to infrastructure. Such a study examined more than 800 schools in multiple US states with and without SRTS; findings indicated that engineering improvements combined with educational outreach for the students resulting from an SRTS program could lead to a 25% increase in student active transportation users (McDonald et al., 2014). Outside of simply increasing the number of students walking or bicycling to school, SRTS programs can lead to health and wellness benefits due to increased activity for students. Buttazzoni et al., identified that participation in walking or bicycling to school can help children achieve up to 30% of their daily recommended physical activity and is associated with increased fitness levels, reduced stress, improved mental health, and increased positive emotions (Buttazzoni et al., 2018).

While an entire program can be seen for a net benefit, it can be more difficult to determine the efficacy and outcomes of construction projects relative to improved safety. Since the main goal of the SRTS program is improved safety, it is important to quantify the actual impacts these projects have on student safety and not just identify changes in student walking and biking behavior (although this can often serve as a surrogate for improved perceptions of safety). Dangerous environments such as road barriers and busy highways or arterial roads often prevent parents from allowing their children to walk or bike to school (Timperio et al., 2006). Therefore, can projects that remove such barriers improve safety and encourage safe walking and biking? Boarnet et al. (2005) found that replacing four-way stop signs with traffic signals increased the number of children walking. However, there is a lack of evidence regarding the effectiveness and safety improvements of SRTS infrastructure projects. Dumbaugh and Frank (2006) claim that "substantive discussions of traffic safety are largely absent from the Safe Routes to School literature." Their review of SRTS literature determined that the safety benefits of SRTS projects are largely presumed, and only raised medians and sidewalks were found to reduce pedestrian-vehicle crashes. As a result, more research to fill gaps in empirical knowledge by evaluating non-motorized safety before and after the construction of an SRTS-funded infrastructure project is needed.

2.2.4 Challenges in the Implementation of SRTS Programs

A major factor regarding SRTS programs is how effectively they have been implemented. SRTS programs offer many benefits as previously discussed, with numerous studies and literature reflecting this. To be successful, however, SRTS depends on community involvement and effort from a school. Actual study into the implementation of SRTS programs appears to have been somewhat more limited compared to studies examining the benefits of existing programs. Past research that has examined the implementation of SRTS programs has identified potential challenges to program success, particularly when focusing on implementation of SRTS programs within disadvantaged communities.

Disadvantaged communities with fewer resources may also struggle to implement an SRTS program in certain cases. Without appropriate efforts or resources available to implement program structure, it is unlikely that the benefits of an SRTS program will be enjoyed by a community. Literature on this subject is somewhat more limited than projects analyzing the overall effectiveness of SRTS programs generally. An extensive study by Elliot et al. (2022), found that there is little existing evidence concerning SRTS programming being directed toward disadvantaged or underserved communities; only 13 out of 51 states (including Washington, D.C.) support equitable SRTS programs, and only 19 out of 51 states reported the use of special considerations for SRTS funding for higher-need communities.

This study also found that federal guides on SRTS programs may be outdated and unable to assist communities in need. A lack of government oversight on SRTS programs and lack of quality in available resources may negatively impact the ability of communities to implement such programs. Elliot et al. also found that major barriers to implementing an STRS program in underserved and low-income communities include lack of qualified individuals to run the program and apply for funding, inability to pay the community-match portion of the SRTS budget, lack of staff/parent/guardian capacity, and other issues (Elliot et al., 2022). The authors suggest that SRTS and state officials should promote resources on engaging communities in these programs and analyze what specific needs are present.

Somewhat in contrast to such research, a study on SRTS programs in California found that low-income schools were overrepresented among schools with these programs, while a similar study in Washington found mixed results, though schools with SRTS programs were typically located in areas with larger minority households and lower incomes (McDonald et al., 2013). Another study by Stewart et al. found that schools in six participating states which implemented SRTS in areas with higher percentages of non-English speaking or low-income households saw increases in student active participation similar to other areas (2014). These mixed results perhaps indicate that when an effort is made to implement SRTS programs in low-income communities, despite the particular challenges, the program can still be successful.

A major key to the implementation of an effective SRTS program seems to be effort and ability of the school and surrounding community. Appropriate interest and effort invested by a community will be essential to the successful implementation of an SRTS program and can ensure that the program will function properly despite potential barriers or challenges. It has been found that disadvantaged communities may face more challenges in creating an SRTS program that will improve safety and accomplish its goals (Elliot et al., 2022). However, it seems the initiative to create and successfully sustain an SRTS program will ultimately depend on the degree of effort the school and community expend. Further research and study into the implementation of SRTS programs is needed to find more information on the challenges that school districts and communities may face in developing and implementing these programs, and to find examples of how to overcome such issues.

2.2.5 Literature Review Conclusion

A significant amount of previous literature exists regarding SRTS programs across the US, particularly about their direct effects on safety. It is clear to see that SRTS programs can have a notable impact on safety and health in communities, and as a result have been the focus of a number of studies over the years. SRTS programs have been found to have an impact on school safety and, in many cases, have been effective in reducing the risk of injuries or fatalities for pedestrian and bicyclist students, while increasing the number of students walking and biking to school (DiMaggio et al., 2016 and McDonald et al., 2014). As a result, a wide number of SRTS programs have been implemented nationwide.

Utah's SRU program has already been in place for a number of years. However, certain challenges may exist in the implementation of SRTS programs, and determining the actual efficacy of an SRTS program may be difficult. The safety effects of such programs may be presumed more so than actually studied (Dumbaugh and Frank, 2006). There is also less previous research into the aspects of program implementation and what may pose challenges to implementation. Previous research has identified that disadvantaged communities with fewer resources may also struggle to develop an SRTS program and that resources for SRTS programs that are aimed toward such communities are limited (Elliot et al., 2022).

However, other research has indicated that disadvantaged communities have been able to develop and implement SRTS programs successfully when resources are available and effort from involved parties is sufficient (McDonald et al., 2013, and Stewart et al., 2014). As a result, it can be said that more research and study into the factors of SRTS development and implementation would be valuable in providing information on what challenges may exist and to learn which schools and communities have been able to implement such programs more effectively. Such research would be particularly effective for the state of Utah to identify what resources have been effective in assisting schools and communities to develop SRTS programs and what may pose a barrier to their implementation. Identifying how to best create and enact SRTS programs will provide great benefits in safety and health to Utah school districts and their surrounding communities.

2.3 Analysis Methods

Several analysis methods were employed in this research to identify trends in the data and answer the research questions. These include summary statistics, Chi-Square, independent samples t-Tests, ANOVA, and Least Squares regression analysis.

2.3.1 Summary Statistics

Summary Statistics are used to provide a quick and simple description of the data without any predictive component or significance testing. They may include mean (average), median (center point of data), mode (most frequently occurring value), minimum value, maximum value, value range, standard deviation, and frequency percentages. Summary statistics were used in this analysis to provide context for the crash data and demographics.

2.3.2 Chi-Square Test

A Pearson's Chi-Square Test is used on categorical data to compare an observed distribution to a theoretical one (measuring goodness of fit) for one or more categories. The events included must be mutually exclusive (e.g., weather cannot be clear and raining at the same time) and have a total probability of 1 (Greene, 2015).

Model:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

where

χ^2 is the chi-square value

Σ is the summation sign

O is the observed frequency

E is the expected frequency

2.3.3 Independent Samples t-Test

An independent samples t-Test compares the means of two independent groups (e.g., urban vs. rural schools) to determine whether there is statistical evidence that the associated population means are significantly different. The independent samples t-Test is a parametric test. It can compare the means for two and only two groups. It cannot make comparisons among more than two groups (which would require ANOVA).

Model:

When the two independent samples are assumed to be drawn from populations with identical population variances (i.e., $\sigma_1^2 = \sigma_2^2$), the test statistic t is computed as:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left[\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}\right]\left[\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}\right]}}$$

where

x_1 = Mean of first sample.

x_2 = Mean of second sample.

n_1 = Number of observations in the first sample.

n_2 = Number of observations in the second sample.

s_1^2 = Variance of first sample.

s_2^2 = Variance of second sample.

s_p = Pooled standard deviation.

The calculated t value is then compared to the critical t value from the t distribution table with degrees of freedom $df = n_1 + n_2 - 2$ and chosen confidence level. If the calculated t value is greater than the critical t value (≈1.7-2.0 depending on the sample size), then we reject the null hypothesis (Greene, 2015).

Assumptions:

- Dependent variables must be continuous (e.g., interval or ratio level).

- Independent variables are categorical.
- Cases have values on both the dependent and independent variables.
- Independent samples/groups.
- There is no relationship between the subjects in each sample.
- No influence between groups or subjects.
- Random sample of data from the population.
- Normal distribution (approximately) of the dependent variable for each group.
- Homogeneity of variance across groups.
- Few outliers.

The Independent Samples t-Test will be used to compare the rural to urban schools, as well as the Title I vs. non-Title I schools. The goal of this analysis is to identify significant differences between the two groups.

2.3.4 Analysis of Variance (ANOVA)

ANOVA is a statistical technique that assesses whether the means of several groups are equal. A one-way ANOVA analyzes just one independent variable (e.g., gap duration). The null hypothesis for an ANOVA is that there is no significant difference in the means of the groups. The alternative hypothesis assumes that there is at least one significant difference among the groups. After cleaning the data, the researcher must test the assumptions of ANOVA, then calculate the F-ratio and the associated probability value (p-value). The one-way ANOVA model is given below.

$$Y = \mu_i + \varepsilon$$

Where: Y is the quantitative dependent variable (usually called the response variable in ANOVA).

μ_i is the true mean value of the dependent variable for the i^{th} population, where there are k populations.

ε is the random error in the response not attributable to the independent variable.

Like in regression models, the error is assumed to be normally distributed with constant variance.

2.3.5 Least Squares Regression

Least Squares Regression is used to predict a continuous dependent variable given one or more independent variables. The model studies the relationship between a dependent variable and one or more independent variables, expressed as

$$y=x_1\beta_1+x_2\beta_2+\cdots+x_K\beta_k+\epsilon$$

where *y* is the dependent, or endogenous variable (sometimes termed the regress) and the *x* variables are the independent, or exogenous variables, often termed the regressors or covariates. This of course presumes that the relationship only involves one endogenous variable, and that is in fact the setting for the classical linear regression model. If there are multiple endogenous variables in a relationship (as there would be in a demand curve, or a macro consumption function) then we must use more advanced regression techniques to deal with that endogeneity, or in economic terms simultaneity.

When we apply the regression methodology to data, we presume there is a sample of size *n*, representing observations on $y_i, x_{i1}, x_{i2}, \ldots, x_{iK}$, $i=1, \ldots, n$. Our goal is to estimate the *K* parameters of the regression equation, $\beta_1, \ldots, \beta_K$, as well as the error variance, σ^2_ϵ. We may want to use the point and interval estimates of the βs to make inferences about the validity of an economic theory (Greene, 2015).

Assumptions:

- Linearity: The model specifies a linear relationship between *y* and $x_1, x_2, \ldots, x_K$.
- Full rank: There is no exact linear relationship among any of the independent variables of the model.
- Strict exogeneity of x: $E[\epsilon_i | x_{j1}, x_{j2}, \ldots, x_{jK}] = 0, \; \forall i, j$. The distribution of ϵ does not depend on past, present, nor future *x* values.

- Spherical disturbances: The covariance matrix of the vector ϵ is $\sigma 2In$. The error terms are identically and independently distributed (*i.i.d.*).
- Stochastic regressors: These *fx* variables may include both fixed numbers and random variables, but the data-generating process underlying any random *x* is independent of that generating ϵ.
- Normally distributed errors: For the purpose of generating interval estimates and hypothesis tests, the distribution of ϵ is assumed to be normal.

2.4 Summary

This chapter provides a brief overview of existing literature as it relates to SRTS plans including the SRU process in Utah, and the challenges associated with creating and implementing plans. Analysis methods are identified and described including how they will be used to address the research problem proposed in the prior chapter.

3.0 DATA COLLECTION

3.1 Overview

This chapter provides a summary of data collected for the project. This includes specifics on both existing SRTS plans and their quality, as well as appropriate characteristics of the built environment surrounding the sample schools. Lastly, the data includes a sample of non-motorist crashes that occurred within one mile of the sample schools.

3.2 Data Collection Process

The following sections detail the collection process and determination of data which was used in this study.

3.2.1 Title I and Rural Schools vs. Urban Schools

For this study, the research team sought to include a representative group of schools across multiple spectrums. To sample the diversity of Utah schools adequately, a number of Title I schools were included. Title I is a federally funded program aimed at helping students meet state academic standards by providing funding to supplement schools with high percentages of students from low-income families (Office of the State Auditor). SRU plans from these Title I schools typically see lower parent involvement and subsequent community investment, based on previous observations. Because of the hypothesized difference in parental involvement and community investment between Title I and non-Title I schools, it is important to include a sub-sample of these schools for evaluation. This will allow the research team to identify any significant differences in the quality of SRU plans between Title I and non-Title I schools.

Next, the team identified sub-samples of schools in rural and urban communities. Due to the unique challenges faced in rural areas, the research team determined that it was important to have a representation of schools in these communities. Urban communities are defined by the U.S. Census definition, having a population of over 10,000 people. Concomitantly, rural communities have fewer than 10,000 people.

After evaluating all Utah public schools based on the above criteria, a sample of 79 schools was identified. Each school was separated into one of four groups:

1. Title I and Rural.
2. Title I and Urban.
3. Non-Title I and Rural.
4. Non-Title I and Urban.

Table 3.1 below shows the 79 sample schools, their location, their school district, and their category.

Table 3.1 Data Collection Locations

School	City	District	Urban	Title I
Adams Elementary	Layton	Davis School District	Y	N
Adams Elementary	Logan	Logan School District	Y	Y
Amelia Earhart	Provo	Provo City District	Y	Y
Barnett Elementary	Payson	Nebo School District	Y	Y
Barratt Elementary	American Fork	Alpine School District	Y	N
Belknap Elementary	Beaver	Beaver School District	N	Y
Big Water Elementary	Big Water	Kane School District	N	Y
Black Ridge Elementary	Eagle Mountain	Alpine School District	Y	N
Bluff Ridge Elementary	Syracuse	Davis School District	Y	N
Bonneville	Orem	Alpine School District	Y	Y
Bountiful Jr High	Bountiful	Davis School District	Y	N
Bridger Elementary	Logan	Logan School District	Y	Y
Bruin Point Elementary	East Carbon	Carbon School District	N	Y
Burch Creek Elementary	Ogden	Weber School District	Y	Y
Castle Heights Elementary	Price	Carbon School District	N	Y
Cedar Ridge Elementary	Hyde Park	Cache County School District	N	N
Centennial Elementary	Roosevelt	Duchesne School District	N	Y
Century Elementary	Bear River City	Box Elder School District	N	N
Cherry Hill School	Orem	Alpine School District	Y	Y
Circleville Elementary	Circleville	Piute School District	N	Y
Coral Cliffs Elementary	St George	Washington School District	Y	Y
Cottonwood Elementary	Salt Lake City	Granite School District	Y	N
Creekview Elementary	Price	Carbon School District	N	Y
Crestview Elementary	Salt Lake City	Granite School District	Y	N
Delta South Elementary	Delta	Millard School District	N	Y
Discovery Elementary	Vernal	Uintah School District	N	N
Duchesne Elementary	Duchesne	Duchesne School District	N	Y
Eagle Bay Elementary	Farmington	Davis School District	Y	N
East Elementary	Roosevelt	Duchesne School District	N	Y
Endeavour Elementary	Kaysville	Davis School District	Y	N
Enoch Elementary	Enoch	Iron School District	N	Y
Escalante Valley	Beryl	Iron School District	N	Y
Fairview Elementary	Fairview	North Sanpete School District	N	N
Fountain Green Elementary	Fountain Green	North Sanpete School District	N	Y
Franklin	Provo	Provo City District	Y	Y
Fremont Elementary	Sunset	Davis School District	N	Y
Granger Elementary	West Valley City	Granite School District	Y	Y
Greenwood Elementary	American Fork	Alpine School District	Y	Y
Heartland Elementary	West Jordan	Jordan School District	Y	Y
Holbrook Elementary	Bountiful	Davis School District	Y	N

Holt Elementary	Clearfield	Davis School District	Y	Y
Iron Springs Elementary	Cedar City	Iron School District	Y	N
Jim Bridger Elementary	West Jordan	Granite School District	Y	N
Juab Junior High School	Nephi	Juab School District	N	N
Kay's Creek Elementary	Kaysville	Davis School District	Y	N
Lake View Elementary	Brigham City	Box Elder School District	Y	Y
Lakeside Elementary	West Point	Davis School District	Y	N
Legacy Preparatory Academy	North Salt Lake	Legacy Preparatory Academy	Y	N
Margaret L. Hopkin Middle School	Moab	Grand School District	N	N
McPolin Elementary	Park City	Park City School District	N	Y
Milford Elementary	Milford	Beaver School District	N	Y
Mona Elementary	Mona	Juab School District	N	Y
Mountainside Elementary	Mendon	Cache County School District	N	N
Myton Elementary	Myton	Duchesne School District	N	Y
Nebo View Elementary	Nephi	Juab School District	N	Y
New Kanab Elementary	Kanab	Kane School District	N	N
North Elementary	Cedar City	Iron School District	Y	N
North Rich	Laketown	Rich School District	N	N
North Sanpete High School	Mt Pleasant	North Sanpete School District	N	N
North Star Elementary	Salt Lake City	Salt Lake School District	Y	Y
Oscarson Elementary	Marysvale	Piute School District	N	Y
Parkside Elementary	Clinton	Davis School District	Y	N
Plymouth Elementary School	Taylorsville	Granite School District	Y	Y
Rich High School	Randolph	Rich School District	N	N
River Heights Elementary	Logan	Cache County School District	Y	N
Sally Mauro Elementary	Helper	Carbon School District	N	Y
Shadow Valley Elementary	Ogden	Ogden School District	Y	Y
Snow Horse Elementary	Kaysville	Davis School District	Y	N
South Weber Elementary	South Weber	Davis School District	N	N
Voyage Academy	Clinton	Voyage Academy	Y	N
Wasatch Elementary	Clearfield	Davis School District	Y	Y
Wasatch Peak Academy	North Salt Lake	Wasatch Peak Academy	Y	N
West Hills Middle School	West Jordan	Jordan School District	Y	N
West Jordan Middle School	West Jordan	Jordan School District	Y	N
Western Hills	Kearns	Granite School District	Y	Y
Westridge Elementary School	Provo	Provo City School District	Y	N
Whittier Elementary	Salt Lake City	Salt Lake School District	Y	Y
Willow Springs Elementary	Draper	Canyons School District	Y	N
Windridge Elementary	Kaysville	Davis School District	Y	N

Table 3.2 shows the frequency of rankings among the four groups.

Table 3.2 Frequency Table

Group	Frequency in Sample
Title I and Urban	20
Title I and Rural	21
Non-Title I and Urban	26
Non-Title I and Rural	12

3.2.2 Ranking Existing SRU Plans

The state of Utah requires an SRU plan and map for each public school in the state (excluding high schools). As a part of this project, the research team evaluated each school's SRU plan. For each school in the sample, the SRU plan was evaluated and ranked on a scale from 0-4 according to the following criteria:

0. No plan.
1. Has an SRU map but is lacking notes.
2. Has both a map and notes, but the details are minimal.
3. Has a detailed map with thorough notes.
4. Has a detailed map with detailed notes, and has additional resources provided including recommendations, school information, committee member information, and signatures.

Table 3.3 shows the breakdown of plan quality for the sample schools.

Table 3.3 School Statistics

Safe Routes Plan Quality	Frequency	Percent
0	17	21.8
1	21	26.9
2	17	21.8
3	13	16.7
4	11	12.8
	N=79	

3.2.3 Crash Data

Crash data was downloaded from the *AASHTOWare Safety Powered by Numetric* crash database. Data for the Numetric website is derived from Utah crash reports (DI-9 Form). These reports are completed by Utah law enforcement officers who investigate crashes on public roadways. The crash events submitted by law enforcement officers later go through a manual quality control provided by the Utah Department of Public Safety and the Utah Transportation and Public Safety group.

For this study, 12-year data for severe non-motorist crashes was downloaded. The following filters were used in the crash query tool of the AASHTOWare Safety database to extract the crashes relevant to this project:

1. Year = between 2010 and 2021 (both inclusive).
2. Crash severity = fatal or suspected serious injury.
3. Pedestrian involved = Y, or Bike involved = Y

With these filters, 2,525 severe non-motorist crashes were identified. A summary of the key variables collected from the crash database is provided below:

» **Crash ID:** Unique identification assigned to each crash record.

» **Time Information:** Crash Date and Crash Time fields were extracted to identify the crash years, time of day, and day of week.

» **Location Data:** Columns that were used to extract and validate location information were Full Route Name, Mile Point, Latitude, and Longitude.

» **People Data:** This information was collected to evaluate the correlation between driver characteristics and observed crashes. Columns that were used to extract characteristics information for the people involved were Age, Gender (Female/Male), and Person Type (Driver/Passenger).

» **Crash Characteristic:** To capture the crash characteristics, the following fields were collected from the crash database:

1. <u>Crash Severity</u>: This column documents the severity of crashes into five separate categories - No Injury, Possible Injury, Suspected Minor Injury, Suspected Serious

Injury, and Fatal. Suspected Serious Injury and Fatal crashes together form severe crashes.

2. Light Condition: This column documents the light condition into seven separate categories – daylight, dark – not lighted, dark – unknown light, dark – lighted, dawn, dusk, and other.
3. Weather Condition: Based on the crash report, this field mentions whether it was clear, cloudy, rainy, or snowing at the time of the crash.
4. Roadway Surface Condition: This field provides information on the roadway surface condition (i.e., dry, wet, slippery, etc.).
5. First Harmful Event of Crash: This field lists the first event that results in any level of injury or damage. For pedestrian- and bicycle-related crashes, the first harmful event is "pedestrian" or "pedalcycle."
6. Pedestrian Involved: This is a binary field (Y/N) used to identify the crashes that involved at least one pedestrian.
7. Bicycle Involved: This is a binary field (Y/N) used to identify crashes that involved at least one bicyclist.
8. Estimated Travel Speed: This field includes the estimate of the travel speed for all vehicles which are involved in a crash.
9. Speed Involved: This is a binary field (Y/N) used to spot crashes that were identified by the law enforcement officer to be excessive travel-speed related.
10. Intersection Involved: This is a binary field (Y/N) used to indicate if a crash occurred at an intersection.
11. DUI Involved: This is a binary field (Y/N) used to identify crashes that had Driver Condition described as "Under the Influence of Alcohol/Drugs/Medications," or where the alcohol or drug test result is positive for the driver.
12. Vehicle Maneuver: This is the information on the controlled maneuver for the motor vehicle involved in a crash prior to the beginning of the sequence of events.
13. Non-Motorist Contributing Circumstances: This field lists any relevant condition of the non-motorist (first person listed) that is directly related to the crash as reported by the law enforcement officer.

Additionally, crashes were filtered to represent school demographics more appropriately. The crash database was sorted to identify crashes that occurred from mid-August (August 15) to mid-June (June 15) which represents the majority of the school year in most Utah school districts. Next, crashes were filtered by time of day, to include only those crashes which occurred between 7:00 a.m. and 5:00 p.m. These hours encompass the bulk of school day travel for all school age groups (5 to 18 years). Lastly, crashes within these filters that involved a non-motorist under the age of 18 (school aged) were identified. This subset of crashes was then geographically filtered within 0.5 miles and one mile from the study area schools (0.5 miles was felt to best represent students who likely walk to school, with one mile for students who utilize bicycles or other forms of active transportation). This group of crashes will provide additional insight into potential relationships between SRU plans and student safety in the areas surrounding the schools.

3.2.4 Built Environment Data

The eight roadway data files used in this research are: Annual Average Daily Traffic (AADT), Speed Limits, Intersections, Shoulders, Lanes, Medians, Driveway, and Functional Class (for state routes only). All these files have previously been accessible to the public via the UDOT Open Data Portal (UDOT, 2022). However, at the time of this report (May 2022), UDOT and the Department of Technology Services (DTS) were going through a migration process and some of these datasets (Intersections, Shoulders, Lanes, Medians, and Driveway) were unavailable on the website. The AADT map was available from the UDOT open data portal. The Functional Class data was available through the Utah Geospatial Resource Center (UGRC) (UGRC, 2022) website. Data files utilized are discussed in more detail in the following subsections (see Table 3.4 for compiled data files):

Presence of Sidewalks: The shapefile containing the presence of sidewalks comes from the Road Centerlines GIS Data Layer as part of the Roads and Highway System. Updates to this dataset are published every month (UGRC, 2023).

Presence of Bike Lanes: The shapefile containing the presence of bike lanes comes from the Road Centerlines GIS Data Layer as part of the Roads and Highway System. Updates to this dataset are published every month (UGRC, 2023).

Presence of Street Trees: This shapefile was created from manual identification of trees near schools based on satellite imagery from Google Earth.

Presence of Special Pedestrian Treatments: This shapefile is a collection of two other shapefiles hosted by UDOT including Pavement Messages and Intersections.

- Pavement Messages: This data contains pavement messages located along Utah state highways. Descriptive information includes message type and crosswalk length. Location information includes x,y and route and milepost. It will be useful to identify mid-block crosswalks. The data is hosted by UDOT and was last updated August 11, 2022.

- Intersections: This data contains intersections located along Utah state highways. Descriptive information includes signalization and state route intersection flags. Location information includes x,y and route and milepost. It will be useful to identify mid-block crosswalks. The data is hosted by UDOT and was last updated August 11, 2022.

AADT Map: Traffic volumes for crash locations were collected from the UDOT AADT map. AADT is the total volume of vehicle traffic of a highway or road for a year divided by 365 days. It is meant to represent traffic on a typical day of the year. The AADT reports and map are updated annually by UDOT and are available in the summer/fall after the completed year.

Intersection Shapefile: This dataset was last updated in April 2020 and contains a record for every intersection on every Utah state route. The Intersection shapefile provides the main route number and milepost of the intersection and a brief description of the intersection type and traffic control used, which are crucial variables identified by the research team. The file also contains columns that include intersection latitude and longitude, and the UDOT region and maintenance station in which the intersection lies. These geolocation information points are later used to connect intersection information to individual crashes.

Shoulders Shapefile: The Shoulder shapefile was last updated by UDOT in April 2020. The file contains detailed information on the presence/absence of shoulders, their locations, shoulder type, and shoulder width.

Lanes Shapefile: The Lanes shapefile contains information for homogeneous stretches of state routes based on their number of lanes and lane width. Each segment has a route number, direction, beginning milepost, and ending milepost. The roadway information collected from this dataset for further analysis was presence of a pedestrian island and number of lanes for different lane types on that segment (e.g., through lanes, right-turn lanes, left-turn lanes, etc.).

Speed Limit Shapefile: The Speed Limit shapefile downloaded in February 2022 provides the speed limit and the beginning and ending mileposts for segments on all state routes in Utah. This file was most recently updated in 2019.

Median Shapefile: The Median shapefile contains information on homogeneous stretches of medians on state routes based on median type, width, and whether the median is protected or unprotected. This file also contains information on the traffic island type at that location. The information collected at the crash locations is presence/absence of median, median width, and presence/absence of traffic island. This dataset was most recently updated in November 2019.

Driveway Shapefile: This dataset is in the form of a statewide map showing the various access points present on the state routes and their access categories. The file also has columns that include Route ID, beginning mile points, ending mile points, and whether a sidewalk is present at that location. This dataset was last updated by UDOT in November 2019.

Functional Classification Data: The UDOT Functional Classification Map shows the classes into which public streets and highways are grouped, based on their function within the overall roadway network. This dataset also defines the federal-aid system. Within an urban boundary, roadways classified as minor collectors or higher are federal-aid eligible. In rural areas, roadways classified as major collectors or higher are federal-aid eligible. This data alongside "Route ID" from the crash database is used to associate the functional classification data with individual crashes.

Table 3.4 Roadway Characteristics Data Sources

Data	Shapefile/Database Name	Source
Roadway Junction Type	Intersection Shapefile	UDOT Open Data Portal
Route Type	Crash Database	Numetric
Traffic Control Device	Intersection Shapefile	UDOT Open Data Portal
Pedestrian Island	Lanes Shapefile	UDOT Open Data Portal
Shoulder Presence	Shoulder Shapefile	UDOT Open Data Portal
Shoulder Width	Shoulder Shapefile	UDOT Open Data Portal
Number of Through Lanes	Lane Shapefile	UDOT Open Data Portal
Speed Limit	Speed Limit Shapefile	UDOT Open Data Portal
Median Presence	Median Shapefile	UDOT Open Data Portal
Median Width	Median Shapefile	UDOT Open Data Portal
Traffic Island Presence	Median Shapefile	UDOT Open Data Portal
Driveway/Access Location	Driveway Shapefile	UDOT Open Data Portal
Right-Turn Lanes	Lanes Shapefile	UDOT Open Data Portal
Left-Turn Lanes (protected/permissive)	Lanes Shapefile	UDOT Open Data Portal
Roadway Volume (AADT)	AADT Map	UDOT Traffic Data Website
Functional Classification of Roadway	UDOT Functional Classification Map	UGRC
Presence of Sidewalks	Roads Centerlines Shapefile	UGRC
Presence of Bike Lanes	Roads Centerlines Shapefile	UGRC
Presence of Mid-Block Crosswalks	Pavement Messages/Intersections Data Sets	UDOT
Presence of Street Trees	Street Trees Shapefile	Google Earth

3.2.5 Data Compilation Plan and Summary

After data collection, the raw data files must be combined and analyzed to produce the input for the statistical models. The input to the statistical models will be the SRU plan dataset with the crash and built environment data associated with them. To assign these characteristics to the schools, raw data files of both crash and built environment characteristics were brought into ArcGIS, and analysis in ArcMap was performed to integrate the data. Table 3.5 outlines the data compilation plan to form the geodatabase which will later be used for statistical analysis. The Attribute column mentions the information that will be integrated into the database, the Shapefile/ Database Name column identifies the data file to be used, the Column Names column indicates the fields to be used from the shapefiles, the Condition column mentions the conditions to be used to filter out the data (if any), and the Join Radius shows the radius to be used for spatial joins.

Table 3.5 Data Compilation Outline

Data Type	Attribute	Shapefile/ Database Name	Column Names	Condition	Join Radius
Roadway & Traffic Characteristics	Intersections	Intersection Shapefile	INT_Type, TRAFFIC_CO	-	250 ft
	Pedestrian Island	Lane Shapefile	PNT_ISL_CN	-	250 ft
	Shoulder Presence	Shoulder Shapefile	-	-	-
	Shoulder Width	Shoulder Shapefile	Shoulder Width	-	-
	Number of Lanes	Lane Shapefile	TotCNT	-	-
	Speed	Speed Limit Shapefile	Speed	-	-
	Median	Medians Shapefile	Median_Typ, TRFISL_Typ	-	-
	Driveway/Access	Driveway Shapefile	Access_Typ	-	-
	Right-Turn Lanes	Lane Shapefile, Intersection Shapefile	RT_CNT	Filter: Intersection Involved Crashes	-
	Left-Turn Lanes	Lane Shapefile, Intersection Shapefile	LT_CNT	Filter: Intersection Involved Crashes	-
Roadway Infrastructure	Bike Lane	Bike Lanes Shapefile	-	-	-
	Trails and Pathways	Utah_Trails_and_Pathways Shapefile	CartoCode	-	250 ft
	Crosswalk	Pavement Messages Shapefile	TYPE	Select: TYPE that contains "Crosswalk"	250 ft
	Ped Bridges	UDOT Structures Shapefile	STRUCT_NAM	Select: STRUCT_NAM that contains "Ped"	250 ft
	Sidewalk	Utah Roads Shapefile	-	-	-
Location & Demographic	Municipalities	Municipalities Shapefile	-	-	-
	Urban/Rural	ESRI Shapefile	-	-	-
	Census Block	2020 U.S. Census Bureau Data	-	-	-
	Region	Regions Shapefile	-	-	-
	County	UtahCounties Shapefile	-	-	-

The data essential for further statistical analysis are collected from open data sources available from UDOT, UGRC, and UTA. Each data file provides unique and important information on school route safety in Utah. Data on school types (Title I and non-Title I) and communities (urban and rural) are important for understanding existing SRU routes, whereas roadway and location characteristics are important to understand the implication of surrounding environment on route safety.

3.3 Database Setup Process

The data essential for further statistical analysis within this project were collected from open data sources available from UDOT and UGRC. Multiple data types were considered for this study at the outset for performing statistical analysis. Ultimately, the final data files which were chosen for inclusion in the database include the following described below. Some of these files were incorporated into the study and database in their original format. Others were derived from existing datasets, as outlined below (more information on file preparation is included later in this section).

3.3.1 Database Files

- School Locations: A shapefile containing the location of all 79 schools chosen for this study in the data collection phase. Each school has attribute information indicating whether it is a Title I school and information on school name, school district, urban vs. rural, a link to the current school SRU plan (if available), and other information.

- School Crosswalks: A shapefile containing the presence of school crosswalks present near the chosen schools. Primary crosswalks for schools (a crossing traversing a major roadway) and school crosswalks – side streets (a crossing traversing a minor roadway) are included. This shapefile was extracted from a pavement messages dataset provided by UDOT.

- Mid-Block Crossings: A shapefile containing the presence of mid-block crossings near schools on major highways. The Mid-Block Crossings file shows crossings which traverse roadways away from an intersection. This shapefile was derived and extracted from the intersections dataset.

- Intersections: A shapefile containing the location of roadway intersections located along Utah state highways. These include four-way and three-way intersections. Location information includes latitude and longitude, route, milepost, and signalization.

- Presence of Bike Lanes: The shapefile containing the presence of bike lanes comes from the Road Centerlines GIS Data Layer as part of the Roads and Highway System. This shapefile was derived and extracted from the roadway centerline shapefile.

- Presence of Sidewalks: The shapefile containing the presence of sidewalks comes from the Road Centerlines GIS Data Layer as part of the Roads and Highway System. This shapefile was derived and extracted from the roadway centerline shapefile.

    - During data processing, it was found that a subset of the sidewalk data titled ‘pedestrian restricted’ was present. The research team and UDOT Technical Advisory Committee (TAC) guiding this research were unable to determine what set these restricted sidewalks apart from others, as there was not a visual consistency to what a restricted sidewalk was. To make sure all data was included, this subset of data was included in the overall sidewalks dataset.

- Trails and Pathways: A shapefile showing the locations of designated trails and pathways near schools. These trails may include hiking and biking trails, footways, public access trails, and other types. Attribute information is included for trail name, surface type, county location, and other information.

- Roadway Centerline Shapefile: A shapefile showing the position of roadways near schools. This data file was used to extract information for a few of the other data files mentioned above (sidewalks, bike lanes, etc.). It was included to provide a base for any further needs and/or analysis, and also provides an idea of the road network around school areas.

3.3.2 Database and Data Processing

To prepare this data and create the overall database, an ArcGIS Pro project was set up and used for processing. The original roadway, trails and pathways, pavement messages, and intersections datasets were imported into the project. These datasets were in separate maps for data processing work. The 79 school locations were imported into the project as well and included in each map. The buffer geoprocessing function in ArcGIS Pro was used to place a one-mile buffer around each school location. This buffer layer was then used to clip each of the datasets, creating datasets which show the distribution of each dataset feature within one mile of the 79 school locations.

Using the clipped one-mile datasets, the needed remaining shapefiles were extracted. This was performed using the select-by-features and export-data functions in ArcGIS Pro. The attribute information for each dataset was used to select the desired features (i.e., mid-block crossings from the one-mile intersections dataset). The export-data function then created a new separate shapefile showing the mid-block crossings. This was performed to create the school crosswalks, mid-block crossings, bike lanes, and sidewalks shapefiles.

The output of this process provided the data shapefiles listed in the 'database files' section previously. The newly extracted datasets were then placed in the same map within the ArcGIS Pro project. The ability of ArcGIS Pro to assign varying symbology was used to distinguish between the various geographic features within one mile of schools. The final output created a database which shows each of the geographic features (see Figure 3.1) within one mile of the 79 selected school locations (see Figures 3.2 through 3.5). Overall, the process of data geoprocessing led to the successful creation of the database, which can be used for spatial analysis of the various infrastructure features within one mile of the school locations.

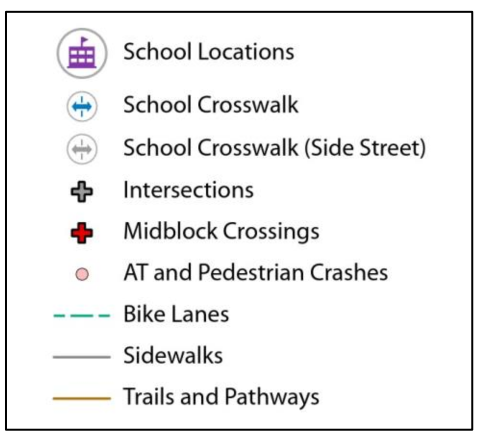

Figure 3.1 Database Features Symbology

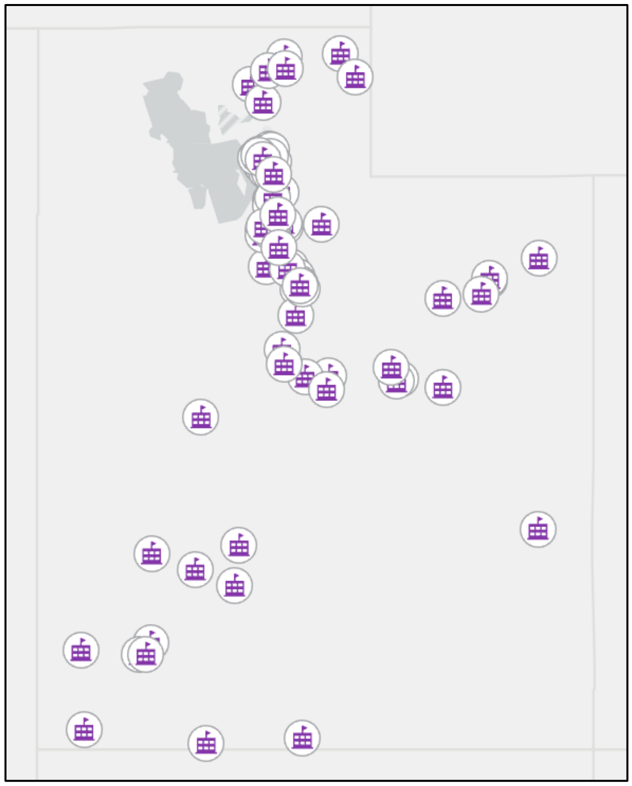

Figure 3.2 Database and School Locations Overview

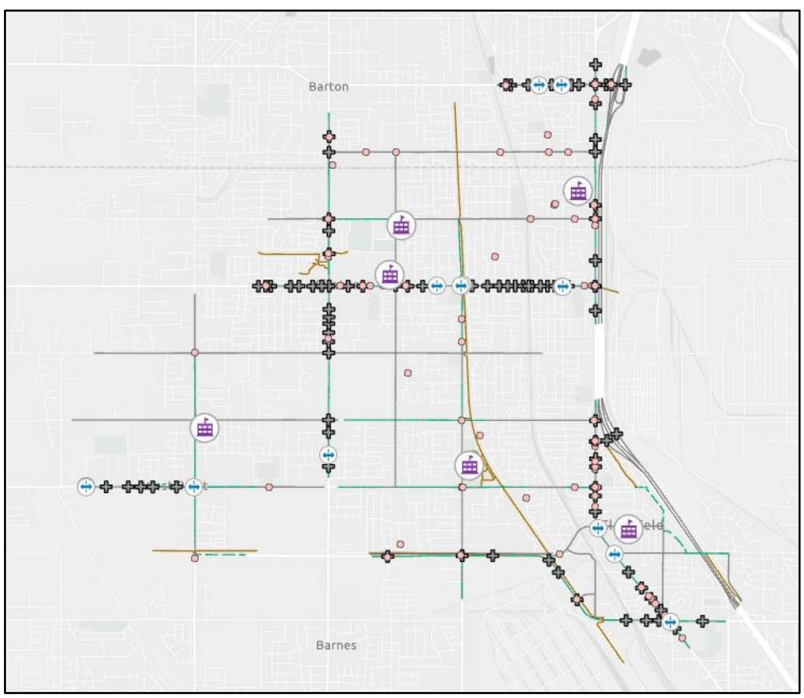

Figure 3.3 Database Sample – West Davis County

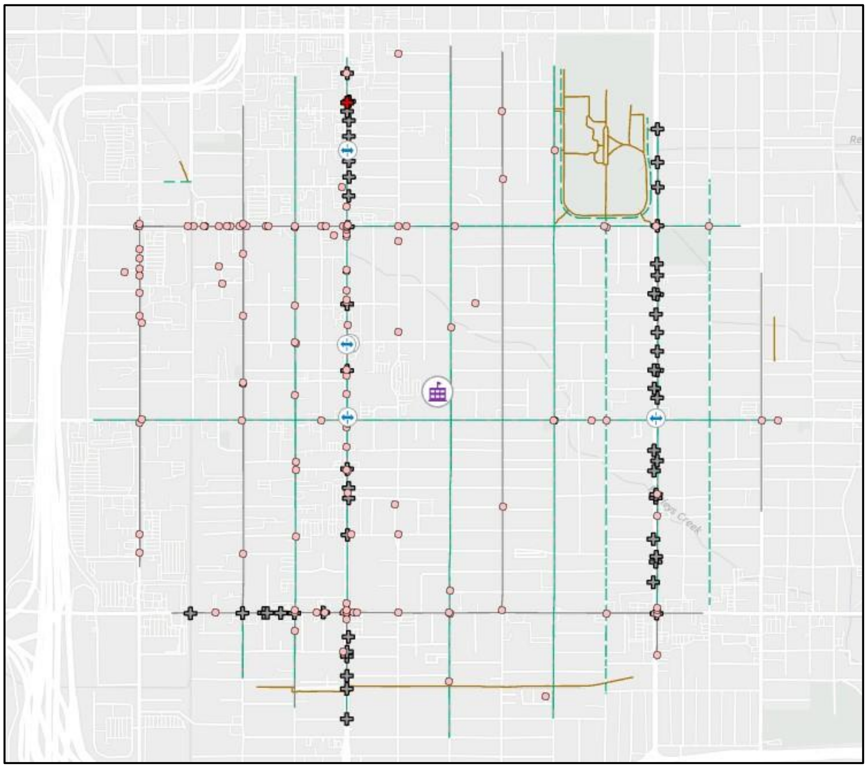

Figure 3.4 Database Sample – South Salt Lake City

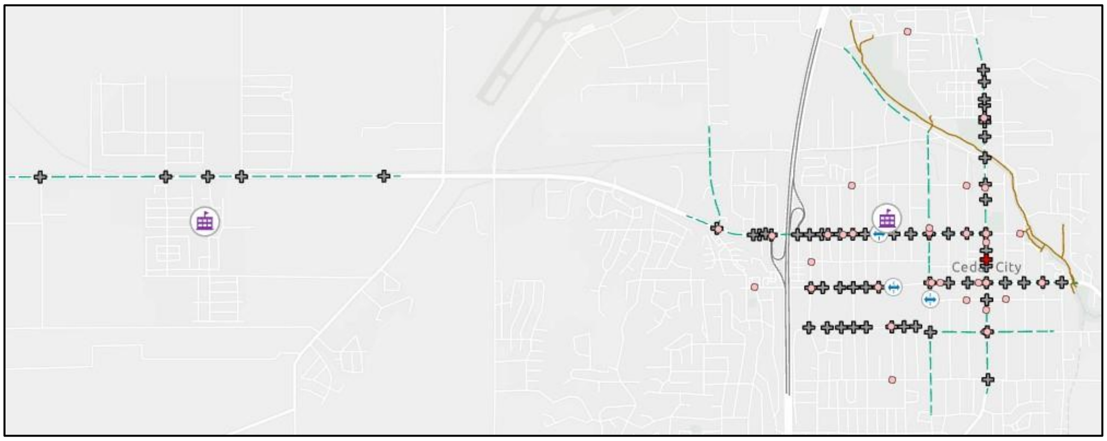

Figure 3.5 Database Sample – Cedar City

3.4 Initial Findings

The database described in Sections 3.2 and 3.3 will provide a platform on which more advanced statistical analysis can be performed. Even before this analysis is performed, some initial findings are apparent after the successful setup of the database. Those findings are outlined here.

- 104 total school crossings are located within one mile of the sample schools.
    - 26 of these crossings are side street crossings.
- Only five mid-block crossings were identified as within one mile of the 79 schools included in the sample.
    - Mid-block crossings may provide useful pedestrian infrastructure, giving pedestrians a more direct route to their destinations over high-volume streets. The lack of mid-block crossings near the sample schools highlights the potential for more such crossings to be installed, or for a reconsideration of code guiding mid-block crossing requirements to take place.
- Most schools (particularly in northern Utah) have trail and bike lane access within one mile.
    - Trails may provide an opportunity to create safe routes away from major roadways, reducing potential risks to pedestrians.
    - Bike lane access provides safe infrastructure for bicyclists on school routes, lessening the risk of vehicles moving into bicyclists.
- Rural schools typically have less available pedestrian infrastructure overall in comparison to urban schools, particularly in southern and central Utah.
    - Rural schools had less access to bike lanes and trails, less consistent sidewalks, fewer crossings, etc. Some rural schools do not have school crossings of any kind nearby.

    - The lack of pedestrian infrastructure in rural areas may create increased safety risks for students walking to and from schools in this area.

- Some data included in this study may be incomplete. Sidewalk data in particular has not been completed for all roadway areas. As a result, there may be some infrastructure present that is not captured in this study.

3.5 Summary

This chapter provides a summary of data collected for the project, including specifics on both existing SRU plans and their quality, as well as appropriate characteristics of the built environment surrounding the sample schools. Additionally, the data summarizes a sample of non-motorist crashes that occurred within one mile of the sample schools. The chapter concluded with a summary of initial findings from the data collection.

4.0 DATA EVALUATION

4.1 Overview

This chapter provides summary statistics as well as more complex statistical models to evaluate relationships between the transportation environments, the quality of the SRU plans, school characteristics (e.g., urban, rural, and Title I designation), and active transportation crashes, including those potentially involving students.

4.2 Summary Statistics

The initial analysis performed in this study involved developing basic summary statistics based on data analysis. These summary statistics provide more information on basic relationships between the schools, their plans, and parameters.

4.2.1 Infrastructure Statistics – School Crossings

As described in Chapter 3, several built environment and transportation factors were identified in the areas surrounding the sample schools. School crossings are designated by specific striping, signage, and typically include a crossing guard. These areas often have reduced-speed zones surrounding the crossings (Utah Code 41-6a-303). Figure 4.1 below shows an example of a school crossing in Herriman, Utah. School crossings are not present for all schools but can provide increased safety through visibility and crossing assistance for students.

Figure 4.1 School Crossing in Herriman, Utah (Source: Herriman City)

Table 4.6 below provides a summary of the presence of school crossings within the sample areas. Only 32.9% of schools had a school crossing within 0.5 miles of the school, while 48.1% had a designated school crossing within one mile.

Table 4.1 Presence of School Crossings

Characteristic	Within 0.5 miles (%)	Within 1 mile (%)
School Crossing	32.9	48.2
0	67.1	51.9
1	15.2	15.2
2	8.9	5.2
3	3.9	16.5
4	1.6	3.8
5	1.6	2.5
6	0.0	1.6
7	1.6	1.6
8	0.0	1.6
		N=79

4.2.2 Mid-Block Crossings

Mid-block crossings can contribute to safe conditions for children walking and biking to school by allowing them to cross safely at mid-block locations to access their destinations. However, additional enhancements may be needed at mid-block crossings to ensure drivers are aware of their presence, as they are more likely to expect pedestrian crossing at intersections. Figure 4.2 below shows an example of a mid-block school crossing on 300 West in Salt Lake City.

Figure 4.2 Mid-Block School Crossing 300 West, Salt Lake City (Source: UDOT)

Table 4.7 below provides a summary of the presence of mid-block crossings within the sample areas. Only 2.5% of schools had a mid-block crossing within 0.5 miles of the school, while 5.1% had a mid-block crossing within one mile.

Table 4.2 Presence of Mid-Block Crossings

Characteristic	Within 0.5 miles (%)	Within 1 mile (%)
Mid-Block Crossing	2.5	5.1
0	97.5	94.9
1	2.5	3.8
2	0	1.3
		N=79

4.2.3 Infrastructure Statistics – Intersections

Prior research has determined that intersection density can impact active transportation safety. While a larger number of intersections on major state routes equates to potentially greater exposure to vehicle traffic, higher density also improved connectivity, providing shorter and more direct access to destinations (EPA, 2014).

Figures 4.3 and 4.4 below show the distribution of the number of major route intersections within one mile and 0.5 miles of the sample schools. Approximately 11% of schools (nine) had no major route intersections within one mile of the school while 32% (25) had no major intersections within 0.5 miles of the school. On average, there were 5.34 major intersections within 0.5 miles and 17.35 within a mile of the schools in the study.

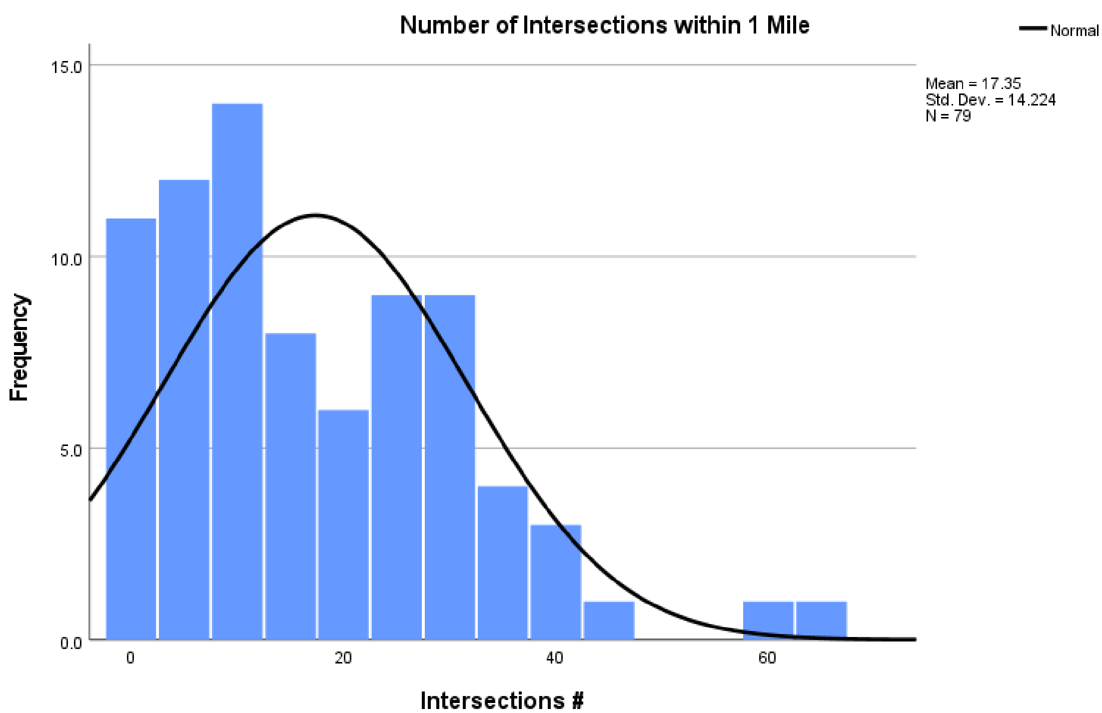

Figure 4.3 Intersections Within 1 Mile: Frequency with Distribution Curve

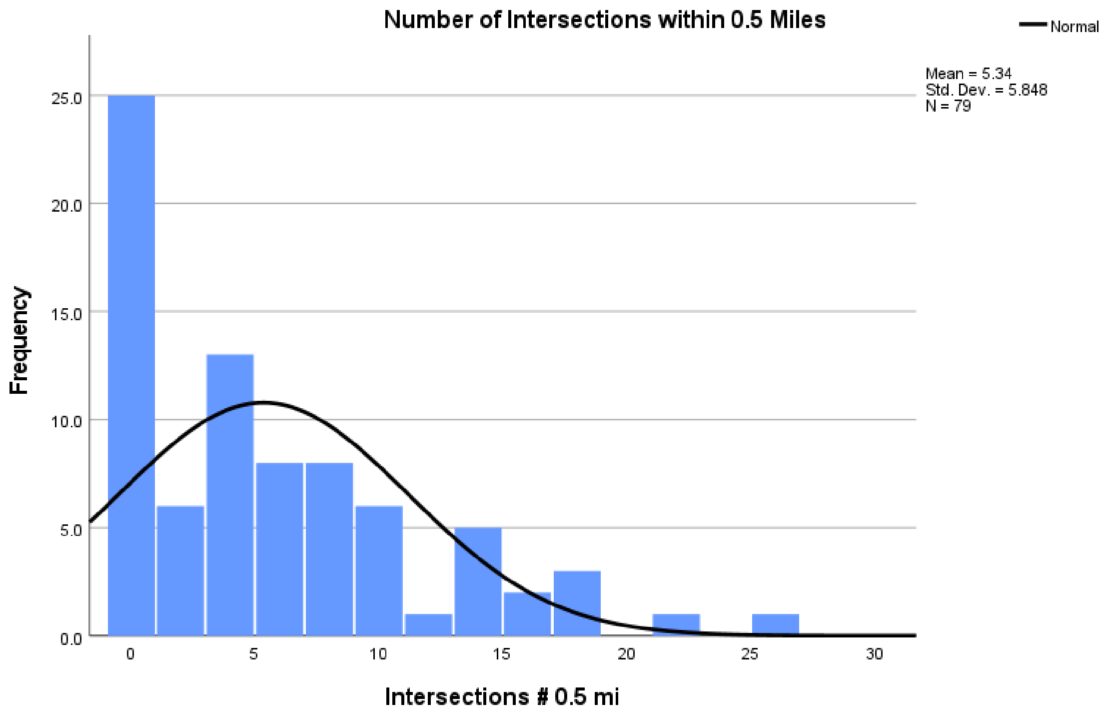

Figure 4.4 Intersections Within 0.5 Miles: Frequency with Distribution Curve

<u>4.2.4 Sidewalks, Trails, and Bike Lanes</u>

Sidewalks, trails, and bike lanes all provide a designated right-of-way for non-motorists. These facilities can dramatically improve safety. Figures 4.5, 4.6, and 4.7 show examples of how these facilities can be effectively used to create safe travel corridors for students.

Figure 4.5 Students Using Local Sidewalks in Cedar City, UT (Source: Cedar City News)

Figure 4.6 Children using a Local Trail (Source: St. George Spectrum)

Figure 4.7 Separated Right-of-Way Path in Garden City, UT (Source: www.bearlake.org)

81% of the sample schools have sidewalks within one mile, while approximately 66% have sidewalks within 0.5 miles. Bike lanes were more prevalent with 95% of schools having a bike lane within one mile, and 86% within 0.5 miles. Trails are less accessible for school students. As shown below in Table 4.3, 77% of schools have a trail or pathway within one mile and only 57% within 0.5 miles.

Table 4.3 Presence of Sidewalks, Trails, and Bike Lanes

Characteristic	Within 0.5 miles (%)	Within 1 mile (%)
Sidewalks	65.8	81.0
Trails/Pathways	57.0	77.2
Bike Lanes	86.1	94.9
		N=79

4.2.5 Active Transportation Crashes

The presence of active transportation crashes (including cyclists and pedestrians) near the sample schools was considered next. Approximately 78.5% of schools experience active transportation crashes within one mile of the school, while 68% of schools experience at least one active transportation crash within 0.5 miles of the school. As described in Section 3.2.3, the crash database was further distilled to identify potential student-involved crashes. These include crashes that occurred during the school year (mid-August to mid-June), during normal school hours (7 a.m. to 5 p.m.) and involved a non-motorist under the age of 18. On average, the sample of schools experienced 4.25 student-involved crashes within one mile, and 1.42 within 0.5 miles annually. Figures 4.8 to 4.11 below show the number of student-involved, non-motorist crashes by school.

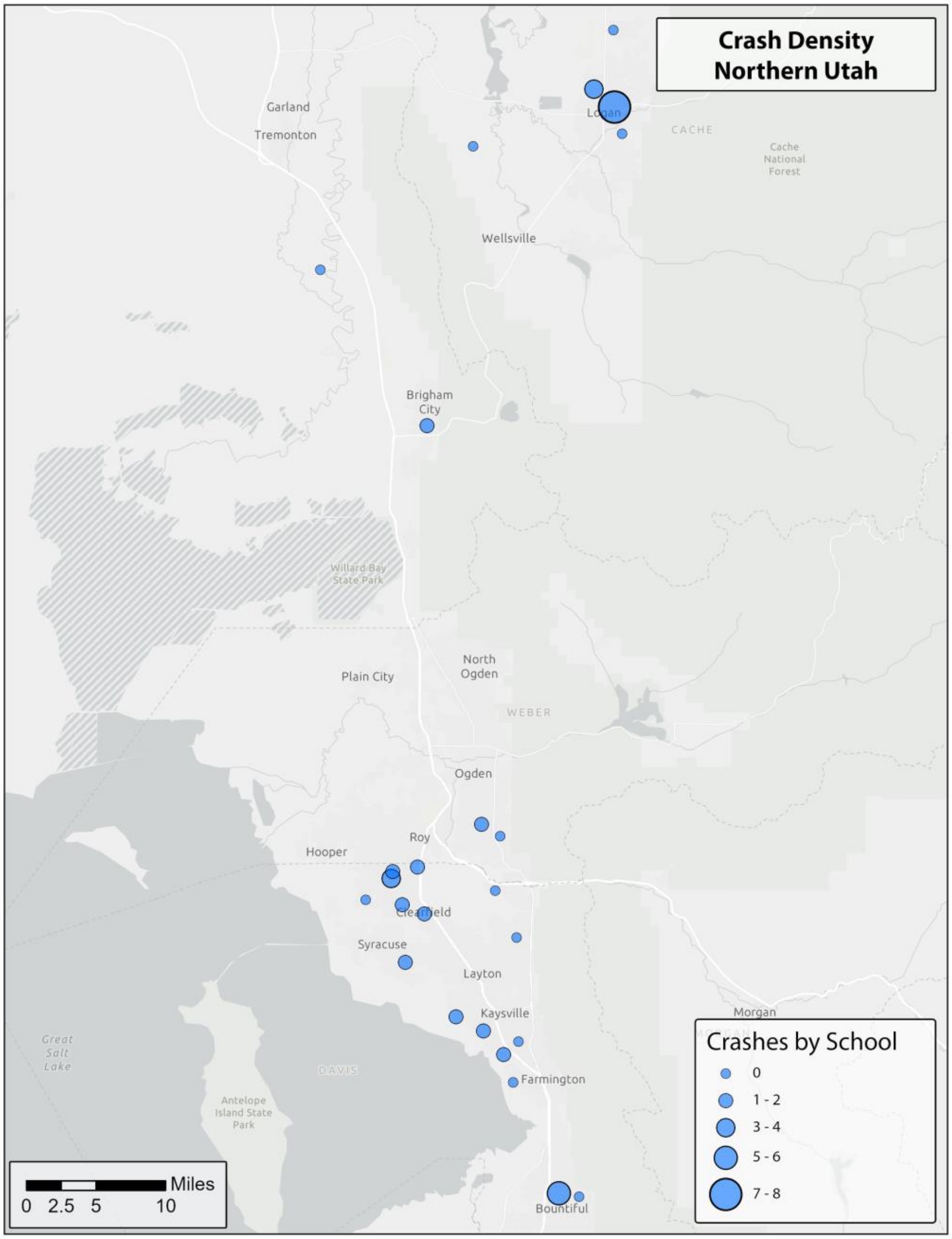

Figure 4.8 Northern Utah Schools - Student Crashes

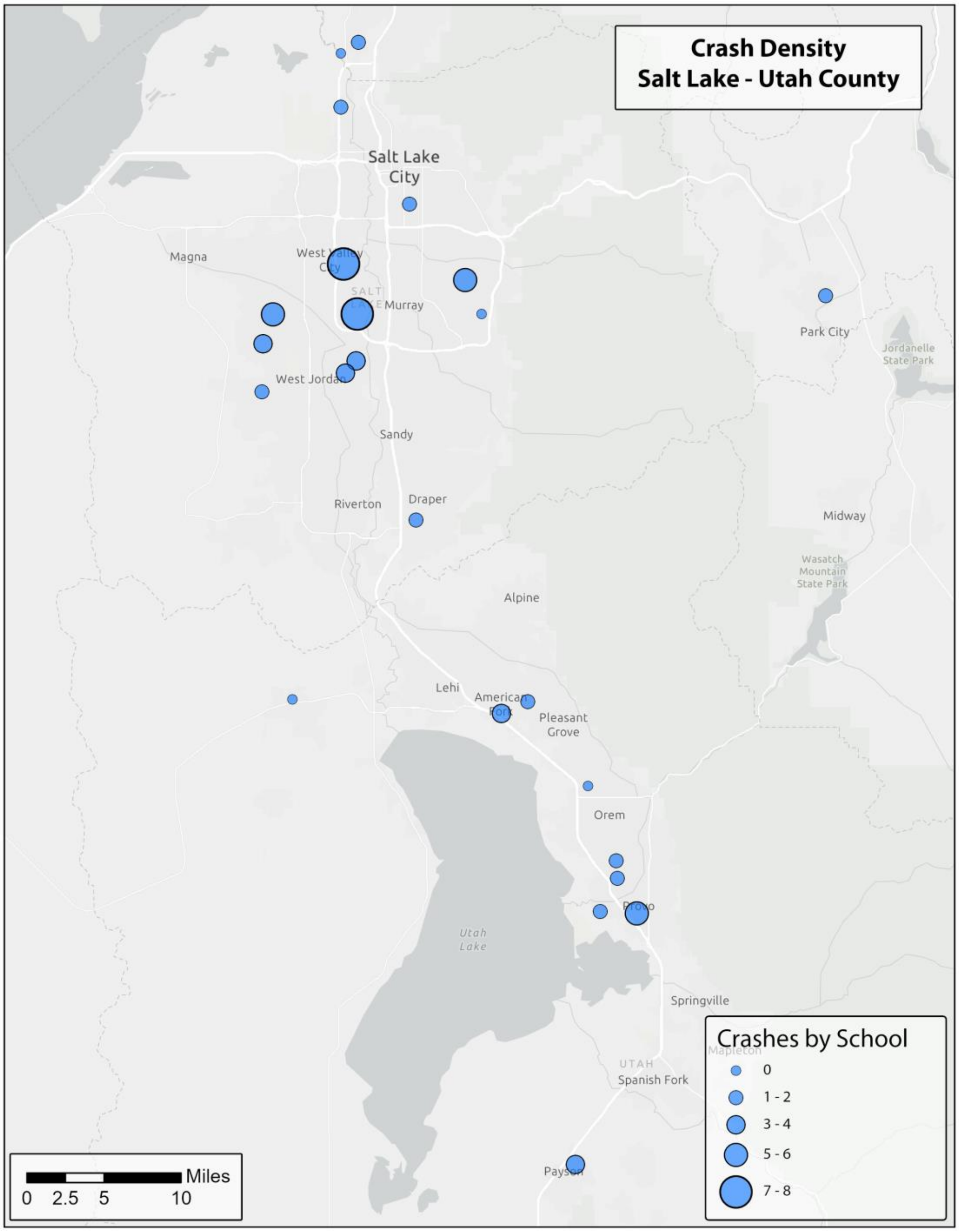

Figure 4.9 Salt Lake and Utah Counties' Schools - Student Crashes

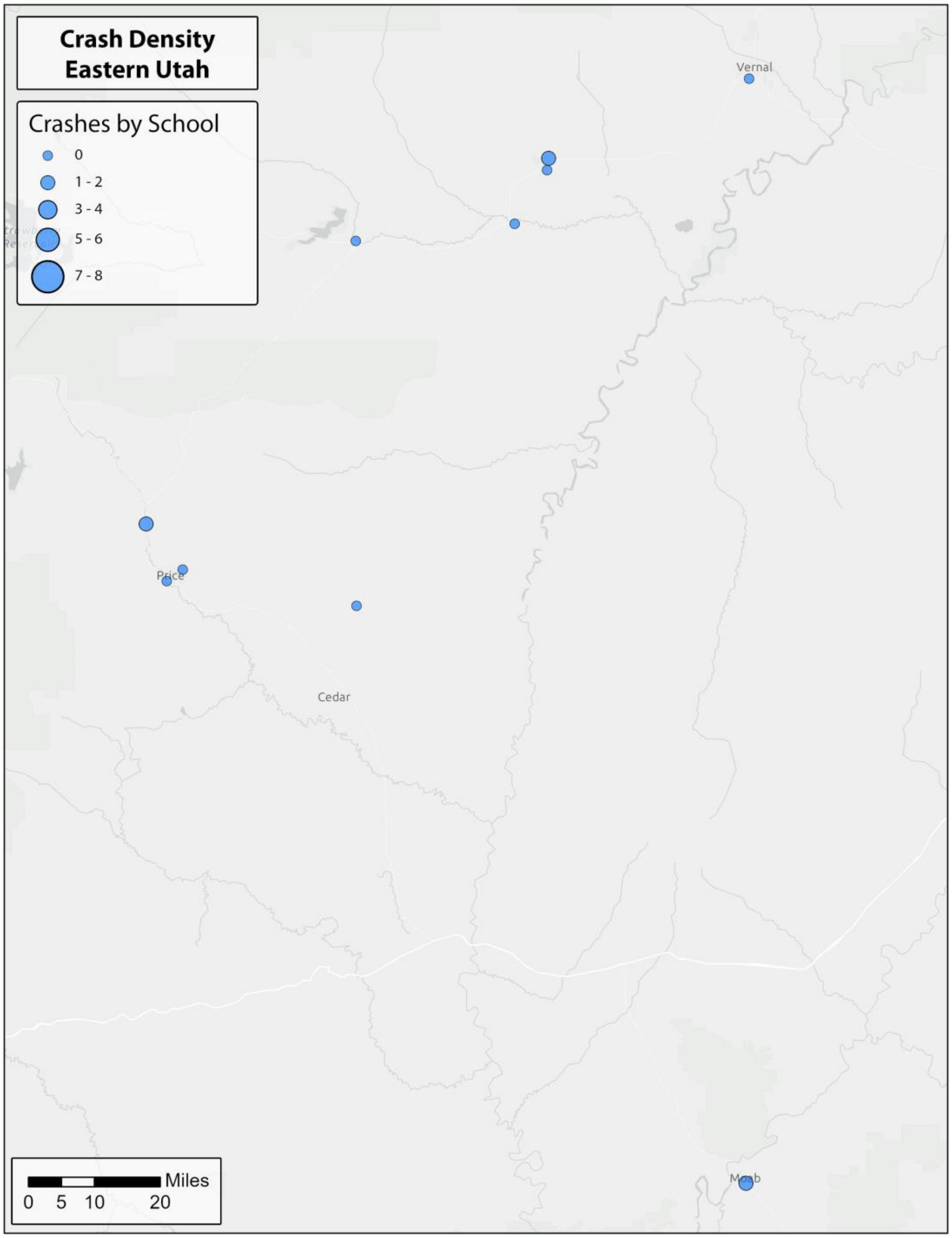

Figure 4.10 Eastern Utah Schools - Student Crashes

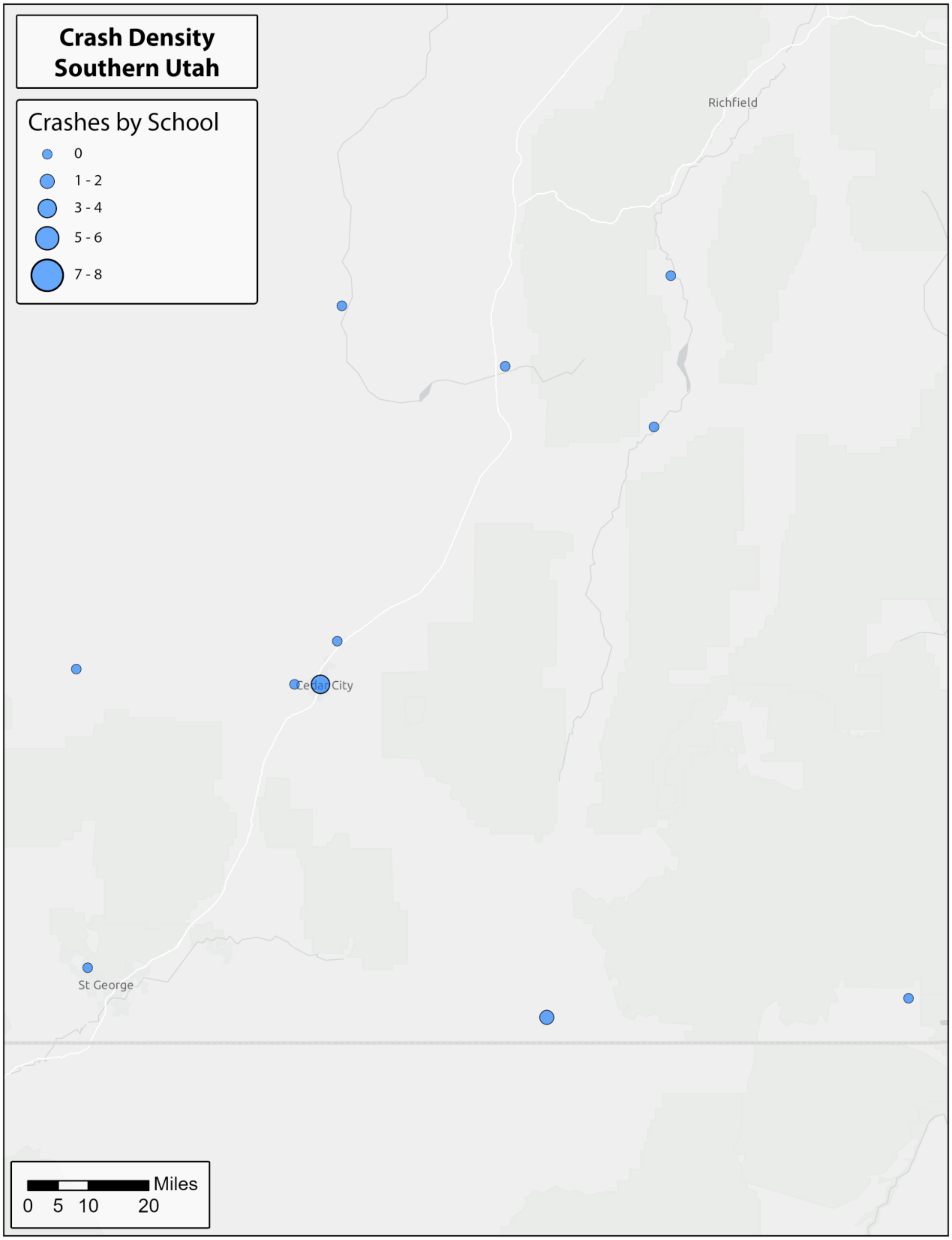

Figure 4.11 Southern Utah Schools - Student Crashes

4.3 Statistical Analysis

The main goal of this research is to identify how various safety characteristics may correlate to the quality of a school's SRU plan, as well as examining how Title I and rural schools may differ from their counterparts. The following sections employ statistical models to identify relationships between the variables that have been presented in prior sections.

4.3.1 Plan Quality and Active Transportation Crashes

Active transportation crashes were examined based on the quality of the SRU plan for each school. Table 4.4 below shows both the average number of active transportation crashes (within one mile and 0.5 miles) and the average number of crashes that potentially involve a student.

Table 4.4 Plan Quality and Mean AT Crashes

Plan Quality	Mean AT Crashes, 1 mile	Mean AT Crashes, 0.5 miles	Mean Student Crashes, 1 mile	Mean Student Crashes, 0.5 miles	*N*
All	11.94	3.27	4.25	1.42	79
0	9.18	2.24	3.47	1.35	17
1	15.57	4.95	5.33	1.81	21
2	13.41	3.25	4.29	1.18	17
3	7.62	2.15	3.15	1.31	13
4	12.80	3.70	4.80	1.30	11
f	0.559 *p*=0.693	0.873 *p*=0.506	0.482 *p*=0.749	0.273 *p*=0.895	

ANOVA identified no statistical significance in the variation of crashes by plan quality (4 = high quality, 0 = no plan). This means that schools with a higher- or lower-quality plan do not necessarily have a significantly different number of crashes in the areas surrounding the school. However, more robust statistical analysis will examine this further below.

Next, a Least Squares Regression model was used to evaluate the relationship between plan quality and the number of active transportation and student crashes near the schools in the sample. Table 4.5 below shows the correlation coefficients for all active transportation crashes within one mile of the sample schools during school hours (7 a.m. to 5 p.m.). Transportation system characteristics were included as control variables.

Table 4.5 Regression Analysis: Plan Quality and AT Crashes Within 1 Mile

Characteristics	*β*	*t*	Sig. (*p*)
(Constant)		-0.697	0.488
Plan Quality Ranking	-0.030	-0.351	0.726
This Location is Urban	0.368	3.520	<0.001*
Title I School	0.252	2.692	0.009*
School Xing #	-0.009	-0.087	0.931
Mid-Block Xing #	-0.032	-0.335	0.739
Intersections #	0.561	4.990	<0.001*
Sidewalk Presence	0.032	0.349	0.728
Bike Ln Presence	-0.108	-1.181	0.242
Trails/Pathways Presence	0.162	1.538	0.129
		R^2=0.532	*N*=79

*Significant above the 0.05 level

The regression analysis identified no statistically significant correlation between SRU plan quality and the number of active transportation crashes within one mile of the school. However, several control variables were significant. Urban areas experienced significantly more active transportation crashes within one mile of schools than rural areas. Additionally, schools surrounded by a larger number of intersections experienced significantly more active transportation crashes. Notably, Title I schools experienced significantly more crashes within one mile of the school than non-Title I schools. This trend will be further discussed in a subsequent section.

A second Least Squares Regression model was used to evaluate the relationship between plan quality and the number of active transportation crashes within 0.5 miles of the sample schools. Table 4.6 below shows the correlation coefficients for all active transportation crashes within 0.5 miles of the sample schools during school hours (7 a.m. to 5 p.m.). Transportation system characteristics were included as control variables.

Table 4.6 Regression Analysis: Plan Quality and AT Crashes Within 0.5 Miles

Characteristics	*β*	*t*	Sig. (*p*)
(Constant)		-1.520	0.133
Plan Quality Ranking	-0.016	-0.185	0.854
This Location is Urban	0.408	3.797	<0.001*
Title I School	0.181	1.869	0.066
School Xing #	0.134	1.386	0.170
Mid-Block Xing #	-0.056	-0.534	0.595
Intersections #	0.438	3.675	<0.001*
Sidewalk Presence	0.174	1.629	0.108
Bike Ln Presence	-0.161	-1.509	0.136
Trails/Pathways Presence	0.116	1.179	0.243
		R^2=0.513	*N*=79

*Significant above the 0.05 level

The regression analysis identified no statistically significant correlation between SRU plan quality and the number of active transportation crashes within 0.5 miles of the school. However, several control variables were significant. Similar to the prior model, this analysis determined that urban areas experienced significantly more active transportation crashes within 0.5 miles of schools than rural areas. Additionally, schools surrounded by a larger number of intersections experienced significantly more active transportation crashes.

Next, the research team evaluated the relationship between plan quality and the number of potential student-active-transportation crashes within one mile of the sample schools. Table 4.7 below shows the correlation coefficients for all potential student crashes (under the age of 18) within one mile of the sample schools during school hours (7 a.m. to 5 p.m.). Transportation system characteristics within one mile were included as control variables.

Table 4.7 Regression Analysis: Plan Quality and Student Crashes Within 1 Mile

Characteristics	*β*	*t*	Sig. (*p*)
(Constant)		-1.213	0.229
Plan Quality Ranking	-0.011	-0.143	0.887
This Location is Urban	0.475	5.070	<0.001*
Title I School	0.172	1.968	0.053*
School Xing #	0.249	2.726	0.008*
Mid-Block Xing #	-0.035	-0.394	0.694
Intersections #	0.303	2.796	0.007*
Sidewalk Presence	0.053	0.642	0.523
Bike Ln Presence	-0.083	-1.006	0.318
Trails/Pathways Presence	0.140	1.433	0.156
		R^2=0.630	*N*=79

*Significant above the 0.05 level

The regression analysis identified no statistically significant correlation between SRU plan quality and the number of student crashes within one mile of the school. However, several control variables were significant. This model determined that urban areas experienced significantly more student crashes within one mile of schools than rural areas. Additionally, Title I schools, schools with a greater number of school crossings, and schools surrounded by a larger number of intersections experienced significantly more student crashes.

Lastly, a regression model was used to evaluate the relationship between plan quality and the number of potential student-active-transportation crashes within 0.5 miles of the sample schools. Table 4.8 below shows the correlation coefficients for all potential student crashes (under the age of 18) within one mile of the sample schools during school hours (7 a.m. - 5 p.m.). Transportation system characteristics within 0.5 miles were included as control variables.

Table 4.8 Regression Analysis: Plan Quality and Student Crashes Within 0.5 Miles

Characteristics	*β*	*t*	Sig. (*p*)
(Constant)		-0.957	0.342
Plan Quality Ranking	-0.059	-0.700	0.486
This Location is Urban	0.461	4.506	<0.001*
Title I School	0.132	1.434	0.156
School Xing #	-0.092	-0.927	0.357
Mid-Block Xing #	0.281	3.041	0.003*
Intersections #	0.352	3.107	0.003*
Sidewalk Presence	0.148	1.454	0.151
Bike Ln Presence	-0.158	-1.553	0.125
Trails/Pathways Presence	0.101	1.075	0.286
		R^2=0.630	*N*=79

*Significant above the 0.05 level

The regression analysis above identified no statistically significant correlation between SRU plan quality and the number of student crashes within 0.5 miles of the school. However, several control variables were significant. This model once again determined that urban areas experienced significantly more student crashes within 0.5 miles of schools than rural areas. Additionally, schools with a greater number of mid-block crossings, and schools surrounded by a larger number of intersections experienced significantly more student crashes.

4.3.2 Plan Quality Among Title I Schools

Another goal of this research was to determine if Title I schools differ in the quality of their SRU plans. It was hypothesized that Title I schools may have lower-quality plans due to inherently lower community investment, such as fewer parent volunteers, to assist in plan creation. An independent samples t-Test was used to determine if there was a significant difference in average plan quality among Title I schools (1.58) vs. non-Title I schools (1.87). As shown below, although the average plan quality was higher for non-Title I schools, the difference was not statistically significant (t=-0.059, p=0.333).

4.3.3 Plan Quality Among Urban vs. Rural Schools

A second independent samples t-Test was employed to determine if there was a significant difference in the average plan quality between urban and rural schools. The analysis found no significant difference in the mean plan quality between urban schools (1.73) and rural schools (1.70). In fact, the differences were minimal (t=-0.119, p=0.906).

4.3.4 Title I Schools and Active Transportation Crashes

An independent samples t-Test evaluated potential significant differences in the mean number of active transportation crashes (all ages) surrounding Title I and non-Title I schools. Within one mile of sample schools, there was no significant difference in the average number of active transportation crashes between Title I (15.17) and non-Title I (8.45) schools (t=-1.747, *p*=0.085). Likewise, there was no significant difference in the average number of active transportation crashes within 0.5 miles between Title I (4.20) and non-Title I (2.42) schools (*t*=-1.506, *p*=0.136).

A secondary t-Test analysis looked at potential student crashes near the sample schools. Within one mile of sample schools, there was no significant difference in the average number of student active transportation crashes between Title I (4.78) and non-Title I (3.68) schools (*t*=0.941, *p*=0.0.350). Likewise, there was no significant difference in the average number of student active transportation crashes within 0.5 miles between Title I (1.63) and non-Title I (1.18) schools (*t*=-1.0, *p*=0.320).

4.3.5 Urban Schools and Active Transportation Crashes

Next, an independent samples t-Test evaluated potential significant differences in the mean number of active transportation crashes (all ages) surrounding urban vs. rural schools. Within one mile of sample schools, there was a highly significant difference in the average number of active transportation crashes between urban (19.02) and rural (2.06) schools (*t*=4.881, *p*= <0.001). Likewise, there was a significant difference in the average number of active transportation crashes within 0.5 miles between urban (5.22) and rural (0.73) schools (*t*=4.091, *p*= <0.001).

A secondary t-Test analysis looked at potential student crashes near the sample schools. Within one mile of sample schools, there was a highly significant difference in the average number of student active transportation crashes between urban (6.78) and rural (0.73) schools (*t*=6.265, *p*= <0.001). Likewise, there was a significant difference in the average number of student active transportation crashes within 0.5 miles between urban (2.22) and rural (0.30) schools (*t*=4.745, *p*= <0.001).

4.4 Summary

The transportation environments surrounding the sample schools differed across the sample both within 0.5 miles and one mile of the schools. There were very few designated school crossings (<35% schools with a designated crossing) and only a scant number of mid-block crossings (<5.2% of schools). The number of intersections varied across the sample, and more than half of the schools have a sidewalk, trail, or bike lane within one mile.

Statistical analysis determined that urban areas experienced significantly more active transportation crashes within one mile of schools than rural areas. Additionally, schools surrounded by a larger number of intersections experienced significantly more nearby active transportation crashes. Likewise, a regression analysis determined that Title I schools experienced significantly more student-involved active transportation crashes within one mile when controlling for other environmental factors.

5.0 CONCLUSIONS

5.1 Summary

This research has evaluated existing SRU plans and maps for a sample of 79 schools located across Utah. The level of detail and depth of each plan was identified and correlated to crash data for each school area. It was initially hypothesized that by determining if areas without a current SRTS plan or those with a lower-quality plan have an increased risk of bicycle/pedestrian crashes or reduced safety, UDOT can better determine how to provide assistance to these schools/communities.

5.2 Findings

Based on the research questions posed in Chapter 1, there are several key takeaways from this work. These include relationships between infrastructure near schools, urban vs. rural schools, and plan quality and safety as described below.

5.2.1 Infrastructure Near Schools

The presence and quality of infrastructure varied across the sample. Only one-third of sample schools had a designated school crossing, and a very small percentage possessed mid-block crossings within walking distances of 0.5 miles. Approximately half of the schools analyzed had a sidewalk, bike lane, or trail within one mile. This finding emphasizes the reality that many schools do not have adequate nearby active transportation infrastructure. This type of infrastructure is critical to promote safety by providing a designated right-of-way for active travelers. It is noteworthy that the presence of active transportation infrastructure was not significantly correlated to a decrease in active transportation crashes near schools. However, a lack of active transportation infrastructure can reinforce environmental perceptions that encourage parents to drive their children to and from school. This is often seen in attitudes such as, “I would let my kids walk to school, but it isn’t safe.” A lack of safe infrastructure or corridors can inhibit the choice to use active transportation modes, particularly for children.

5.2.2 Urban and Title I Schools

This research determined that within one mile of sample schools, there was a highly significant difference in the average number of active transportation crashes between urban and rural schools (by a magnitude of 9x). A similar finding was identified within 0.5 miles (4x). Additionally, within one mile of sample schools, there was a highly significant difference in the average number of student active transportation crashes between urban and rural schools (7x). A more complex regression analysis also identified that both general active transportation crashes and student-involved active transportation crashes were significantly more prominent in urban areas than rural areas.

An initial hypothesis of this research assumed that Title I schools may differ in safety and plan quality from other schools. While comparisons between Title I and non-Title I schools did not identify significant differences, a more complex regression model did determine that Title I schools were significantly correlated to an increase in student-involved active transportation crashes within one mile of the sample schools. However, it should be noted that there are several potential factors that could be present near a Title I school that would impact safety that were not included in this analysis. For example, because Title I schools are likely located in lower income areas, these areas may exhibit older infrastructure, a lack of facility improvements, higher-speed streets surrounding the schools, and higher traffic volumes.

5.2.3 Safe Routes Utah Plan Quality and Safety

The analysis found no significant difference in the mean plan quality between urban schools in the sample. Additionally, although the average plan quality was higher for non-Title I schools, the difference was not statistically significant. A complex regression analysis identified no statistically significant correlation between SRU plan quality and the total number of active transportation crashes within 0.5 or one mile of the school. Likewise, a regression analysis identified no statistically significant correlation between SRU plan quality and the number of student-involved active transportation crashes within 0.5 miles or one mile of the school.

5.3 Limitations and Challenges

As this project was completed, several limitations and challenges were identified. While every care was taken to address them as they came up, some are inherent in the nature of the data or are unavoidable circumstantial limitations. Each challenge is identified and described below.

The first limitation in this analysis is that the project was unable to evaluate all 1,260 public schools statewide due to budget and time constraints. Relying on a sample of schools, rather than evaluating all schools, results in some validity constraints. For example, while care was taken to identify schools that had representative environments, every school has unique circumstances. The built environment around each school will inherently differ simply due to development patterns. Although many are in neighborhoods, not all neighborhoods are planned, developed, and maintained equally. Likewise, one school located in an urban environment or along an arterial roadway will still differ in the total environment from another school, even if their circumstances are similar. Therefore, while some generalizations can be made based upon environmental characteristics (urban vs. rural), each school's environment should be considered unique, and solutions and recommendations for each school's SRU plan should be individualized.

The second limitation of this research included limitations to the sidewalk dataset. UDOT has historically struggled to compile quality sidewalk data. This is because changes are constantly occurring to the sidewalk network as gaps are filled and as projects remove portions of sidewalk. Also, cities and other municipal governments are typically responsible for sidewalks. If a city or town does not keep an accurate inventory of its sidewalks, that information cannot be filtered up to the UDOT database. This can result in gaping holes in the database where entire cities or towns have provided no data apart from the UDOT facilities.

The final challenge of this research involved a lack of volume data and information on both the number of students per school, and the number of students who walk or bike. The number of students attending each school is a difficult metric to gather. The student population fluctuates throughout the school year and most schools do not make that information available publicly. The Utah State Board of Education makes enrollment numbers public by school district (available at: https://www.schools.utah.gov/data/reports?mid=1424&tid=4), but enrollment is not provided by school. An attempt was made to reach out to several schools early in the data collection process, but there was low responsiveness. Additionally, there is no data available regarding student travel modes. Non-motorist volumes are correlated to crash risk, as exposure rates increase. Without having accurate student travel behavior information, the research team was unable to identify a safety risk rate based on the number of crashes per walking/biking students. For future research, an additional data collection step should include outreach to the schools in the sample not only to gather student population information, but also to complete a survey which measures the number of students who walk or bike on a typical day.

6.0 RECOMMENDATIONS AND IMPLEMENTATION

6.1 Recommendations

Based on the analysis and data reviewed in the prior chapters, the following recommendations have been identified by the Technical Advisory Committee with input from the project team:

- Promote the new SRU Portal which will assist schools with creating and implementing their SRU plans.
- Provide additional assistance and outreach to schools in urban areas which experience significantly more (7x) student-involved active transportation crashes within one mile of schools.
- Provide additional assistance and outreach to Title I schools which experience significantly more student-involved active transportation crashes within one mile of schools than non-Title I schools.
- Work with cities and towns to improve infrastructure near schools, as only half of the schools analyzed had a sidewalk, bike lane, or trail within one mile.

6.2 Implementation Plan

The following implementation goals were identified by the UDOT Project Management Team.

1. Refine and perfect the Safe Routes Utah planning portal and encourage schools to use the new system to complete all three steps in creating a Safe Routes map and plan (Kristen Hoschouer).
2. Identify baseline number of schools that have a current safe routes plan and map and increase the percentage by 5% per year (Kristen Hoschouer).
3. Conduct follow-up research to identify the top 5-10 schools statewide with the highest number of student-involved crashes for further outreach and assistance (Travis Evans and Kristen Hoschouer).

4. Create a workshop to guide cities/schools through the process of creating a safe routing plan. Integrate the process with the existing regional safety summits (Kristen Hoschouer).
5. Utilize existing Safe Routes grants to support infrastructure projects for high-risk schools (Travis Evans).
6. Evaluate augmenting existing staff to manage and support implementation of items 1-5 above (UDOT Traffic and Safety Division).

REFERENCES

Boarnet, M.G., C.L. Anderson, K. Day, T. McMillan, and M. Alfonzo. (2005a). Evaluation of the California Safe Routes to School Legislation. American Journal of Preventive Medicine. 28(22), 134-140.

Buttazzoni, A. N., Coen, S. E. and J. A. Gilliland. (2018). Supporting active school travel: A qualitative analysis of implementing a regional safe routes to school program. Social Science & Medicine. 212. 181-190. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0277953618303848

Dumbaugh, E. and L. Frank. (2006). Traffic and Safety and Safe Routes to Schools: Synthesizing the empirical evidence. Paper presented at the 85th Annual Meeting of the Transportation Research Board.

DiMaggio, C., Frangos, S. and G. Li. (2016). National Safe Routes to School program and risk of school-age pedestrian and bicyclist injury. Annals of Epidemiology. 26(6). 412-417. Available at: https://www.sciencedirect.com/science/article/abs/pii/S1047279716300837

Elliot, L. D., Lieberman, M., Rovniak, L. S., Bose, M., Holmes, L. M. and M. Bopp. (2022). What are States Doing to Encourage Safe Routes to School Programming in Disadvantaged Communities? Findings From a U.S. Mixed-Methods Survey. Transportation Research Record: Journal of the Transportation Research Board. Available at: https://doi.org/10.1177/03611981221140363

EPA. (2014). Pedestrian-Oriented Street Intersection Density. Environmental Protection Agency. Enviro Atlas. Available at: https://enviroatlas.epa.gov/enviroatlas/DataFactSheets/pdf/Supplemental/PedestrianOrientedStreetIntersectionDensity.pdf

FHWA. (2019). Children’s Travel to School. FHWA NHTS Brief. Available at: https://nhts.ornl.gov/assets/FHWA_NHTS_%20Brief_Traveltoschool_032519.pdf

Google. (2022). Google Earth, Version 7.3.6.9345. Google. https://www.google.com/earth/

Greene, W.H. (2018). Econometric Analysis. Pearson Education Limited. Pearson Education, Inc. India.

Heelan, K. A., Unruh, S. A., Combs, H. J., Donnelly, J. E., Sutton, S. and B. M. Abbey. (2008). Walking to School: Taking Research to Practice. Journal of Physical Education, Recreation & Dance. 79(6). 26-41. Available at: https://doi.org/10.1080/07303084.2008.10598197

McDonald, N.C., Y. Yang, S.M. Abbott, and A.N. Bullock. (2013). Impact of the Safe Routes to School Program on Walking and Biking: Eugene, Oregon study. Transport Policy. 29, 243-248. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0967070X13000942

McDonald, N. C., Steiner, R. L., Lee, C., Smith, T. R., Zhu, X. and Y. Yang. (2014). Impact of the Safe Routes to School Program on Walking and Bicycling. Journal of the American Planning Association. 80(2). 153-167. Available at: https://doi.org/10.1080/01944363.2014.956654

McDonald, N. C., Barth, P. H. and R. L. Steiner. (2013). Assessing the Distribution of Safe Routes to School Program Funds, 2005–2012. American Journal of Preventive Medicine. 45(4). 401-406. Available at: https://doi.org/10.1016/j.amepre.2013.04.024

Mohai, P., Kweon, B., Lee, S. and Ard, K. J. (2011). Air pollution around schools affects student health and performance. Health Affairs, 852-862.

Muennig, P.A., M. Epstein, G. Li, and C. DiMaggio. (2014). The Cost Effectiveness of New York City's Safe Routes to School Program. American Journal of Public Health. 104(7): 1294-1299.

Stewart, O., Moudon, A. V. and C. Claybrooke. (2014). Multistate Evaluation of Safe Routes to School

Programs. American Journal of Health Promotion. 28(3) suppl. Available at: https://doi.org/10.4278/ajhp.130430-QUAN-210

Timperio, A. D. Crawford, A. Telford, and J. Salmon. (2003). Perceptions about the Local Neighborhood and Walking and Cycling Among Children. Preventive Medicine. 38(1), 39-47.

Tudor-Locke, C., B.E. Ainsworth, and B.M. Popkin. (2001). Active Commuting to School: An overlooked source of children's physical activity? Sports Medicine. 31:309-313.

UDOT. (2018). UDOT Safe Routes to School Program. Utah Department of Transportation. https://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:1388

UDOT. (2022). UDOT Open Data Portal. Utah Department of Transportation. https://data-uplan.opendata.arcgis.com/

UDPS. (2021). AASHTO Ware Safety Numetric Crash Data. Utah Department of Transportation. https://udot.aashtowaresafety.com/crash-query#/metrics

UTA. (2022). UTA Open Data Portal. Utah Transit Authority. https://data-rideuta.opendata.arcgis.com/

UGRC. (2022). Utah Geospatial Resource Center. https://gis.utah.gov/data/