1st World Congress on Industrial Engineering and Operations Management
October 9-11, 2024
Publisher: IEOM Society International, USA DOI: 10.46254/WC01.20240124
Published: October 09, 2024

Spatial Analysis of Traffic Crashes in Proximity to High Schools: A Case Study in an Urban Area

Tehetna Suraphel Hailu
Ph.D. Candidate, Construction Management
GameAbove College of Engineering and Technology
Eastern Michigan University
Ypsilanti, MI 48197, USA
thailu@emich.edu

Suleiman Ashur
Professor of Civil Engineering and Construction Management
GameAbove College of Engineering and Technology
Eastern Michigan University
Ypsilanti, MI 48197, USA
sashur@emich.edu

Abstract

Traffic safety in urban areas, particularly near high schools, is a pressing concern. This study examines traffic crashes involving young drivers in the high school zones of Ann Arbor, Michigan, over five years, specifically focusing on the timeline before, during, and after the COVID-19 pandemic. Utilizing Geographic Information Systems (GIS) for spatial analysis, this research investigates the frequency and severity of crashes involving young drivers. The primary objective is to identify patterns related to the timing and location of these incidents, thereby enhancing the understanding of the traffic safety dynamics that affect young drivers. This ongoing research is crucial for urban planners and traffic management stakeholders, providing insights that can benefit various organizations, including municipalities and counties across the United States. In addition, the study aims to significantly contribute to traffic safety in urban settings, particularly for inexperienced drivers. Ultimately, the findings may inform evidence-based strategies designed to improve road safety near high schools, focusing on reducing the number and severity of crashes involving young drivers and ensuring safer commutes for all students. The researchers will share the results of this ongoing study and outline the objectives for future research in this critical area.

Keywords

Traffic Crashes, Crash Severity, GIS, High Schools, Young Drivers

1. Introduction

Traffic safety in urban areas, particularly near high schools, is a significant challenge, especially given the vulnerability of young, inexperienced drivers. The risk of accidents in these zones endangers young drivers, pedestrians, and other road users. This paper addresses traffic crashes involving young drivers in Ann Arbor, Michigan, over five years, focusing on changes before, during, and after the COVID-19 pandemic. Understanding the dynamics of these traffic incidents is crucial for urban planners and traffic management officials. This research highlights young drivers' challenges in high school zones, underscoring the need for effective strategies to enhance safety for all road users. The subsequent sections will outline the study's objectives and discuss the implications for future research and traffic safety policies.

1.1 Background

To contextualize this issue, we focus on Ann Arbor, a vibrant city about 45 miles west of Detroit, Michigan, often referred to as "Tree Town." Spanning 28 square miles and with a population nearing 120,000 (U.S. Census Bureau, 2022), Ann Arbor serves as a hub of education, prominently featuring the University of Michigan, which significantly impacts local traffic dynamics, especially around high schools. The city's road infrastructure, including major highways like Interstate 94 and US Route 23, shapes traffic patterns and contributes to the complexities of urban mobility. Traffic crashes in Ann Arbor are influenced by various factors, including traffic volume, infrastructure, driver behavior, and weather conditions. Despite ongoing safety improvement efforts, traffic volume fluctuates due to the time of day, special events, and construction activities. Key contributors to accidents include poor road conditions, adverse weather, and human factors such as age, aggressive driving, and distractions, particularly from electronic devices. Inexperienced drivers and deteriorating road conditions further complicate the safety landscape.

In response to these challenges, Ann Arbor employs a multifaceted approach to enhance traffic safety. This includes strict law enforcement against reckless driving, public awareness campaigns, and infrastructure improvements. Data analysis plays a crucial role in identifying high-risk areas for targeted interventions. Particularly, in June 2021, the city adopted the “Vision Zero” initiative, aiming to eliminate traffic fatalities and serious injuries by 2025, alongside goals for carbon neutrality in transportation by 2030. This initiative emphasizes safety, mobility, and community collaboration, reflecting Ann Arbor’s commitment to creating a safer and more sustainable urban environment.

1.2 Objectives

In this context, the study aims to investigate the spatial and temporal dynamics of traffic crashes near Ann Arbor high schools, focusing on their impact on young driver safety. By assessing and comparing the frequency and severity of these crashes, the research seeks to uncover patterns that can inform traffic safety strategies in school zones. The findings, once the research is completed, will provide valuable insights for urban planning and traffic management strategies, particularly those implemented by the Michigan Department of Transportation (MDOT), to reduce risks for young drivers in areas frequented by high school students. Utilizing advanced Geographic Information Systems (GIS) techniques, the study will enhance understanding of spatial trends in traffic incidents and support evidence-based interventions for improved road safety around Ann Arbor high schools.

Problem Statement

Despite these initiatives, Ann Arbor has witnessed a concerning surge in traffic crashes following the relaxation of pandemic-related restrictions. This uptick underscores the urgent need to delve into the spatial and temporal dynamics of traffic incidents near high schools, revealing a significant gap in comprehending the factors influencing road safety risks for young drivers. While previous studies have conducted spatial analyses, a comprehensive five-year examination that incorporates the unique impacts of the COVID-19 pandemic is warranted. This research gap highlights the critical necessity of exploring the repercussions of traffic-related disruptions on road safety within high school zones, particularly regarding incidents involving young and inexperienced drivers. Moreover, the underutilization of advanced Geographic Information Systems (GIS) techniques in past research underscores the importance of integrating GIS for thorough spatial assessment. Thus, the overarching challenge remains the insufficient understanding of the spatial and temporal patterns of traffic crashes near Ann Arbor high schools, mandating a holistic study to bridge this crucial knowledge gap and inform targeted interventions for enhanced road safety.

2. Literature Review

Teen drivers, particularly those aged 16 to 19, are among the most vulnerable groups on the road due to factors such as inexperience, risk-taking behaviors, and distractions. The rising trend of fatal crashes involving teen drivers in urban areas like Ann Arbor highlights the urgent need for targeted interventions and community awareness programs. In Michigan, traffic crashes are the leading cause of death for adolescents aged 15 to 20, a demographic that often exhibits hazardous behaviors such as speeding, distracted driving, and driving under the influence of substances (Centers for Disease Control and Prevention [CDC], 2021). In Ann Arbor, recent data indicates that although overall crash rates have changed, the involvement of teen drivers in fatal crashes remains a critical concern based on the city transportation manager, Raymond Hess (Stanton 2023).

However, longitudinal studies specifically tracking these trends in urban settings like Ann Arbor are limited, making it difficult to assess the long-term effectiveness of interventions.

2.1 Factors Contributing to Fatal Crashes

Inexperience: Inexperience plays a significant role in the high rate of fatal crashes among teens. Research indicates that newly licensed drivers are more prone to judgment errors and reaction times than their more experienced counterparts (Simons-Morton et al. 2011). The lack of practical driving experience exacerbates this issue, particularly in complex urban environments. Furthermore, while many studies highlight the statistical relationship between inexperience and crash rates, qualitative research is needed to explore the underlying reasons behind this inexperience.

Risk-Taking Behaviors: Teens are likelier to engage in risk-taking behaviors, such as speeding and aggressive driving. A study by the Insurance Institute for Highway Safety (IIHS) (2020) found that teen drivers are involved in a disproportionate number of fatal crashes related to speeding. In Ann Arbor, this trend is evident, with speed being a factor in numerous teen-related fatalities. However, existing literature often overlooks the social and psychological motivations that drive these risky behaviors, highlighting a gap for further exploration.

Distractions: The prevalence of mobile device use among adolescents contributes significantly to distracted driving incidents. According to the Michigan Office of Highway Safety Planning (2022), texting while driving increases the likelihood of crashes among teen drivers by a substantial margin. This factor is particularly critical in urban settings, where the complexities of navigating through traffic can lead to increased distractions. The role of emerging technologies in mitigating these distractions remains under-explored in current research.

Substance Use: The impact of substance use, including alcohol and marijuana, cannot be overlooked. Research shows that teens who consume alcohol or use drugs are significantly more likely to be involved in fatal crashes (National Highway Traffic Safety Administration [NHTSA], 2021). In Ann Arbor, the legalization of recreational marijuana has raised concerns regarding its influence on driving behaviors among youth (Michigan Department of State Police, 2023). However, there is insufficient evaluation of how these substances use trends specifically impact teen driving behavior in localized contexts.

The KABCO severity scale is a widely recognized system used to classify injury severity in traffic incidents, helping to better assess and understand the impact of crashes. This classification system, established by the U.S. Department of Transportation and the Federal Highway Administration [FHWA], 2017), categorizes injuries as follows:

- **K**: Fatal injury (Killed)
- **A**: Incapacitating injury (Serious injury)
- **B**: Non-incapacitating injury (Moderate injury)
- **C**: Possible injury (Minor injury)
- **O**: No injury (Property damage only)

Recent traffic data from Ann Arbor demonstrates concerning trends involving teen drivers. Between 2018 and 2022, the city reported several fatal crashes involving adolescents. In 2021, the number of fatal crashes involving teen drivers reached an alarming peak, correlating with increased traffic as pandemic restrictions were lifted (Stanton 2023). While the total number of crashes has varied, the proportion involving teen drivers indicates a persistent challenge. The need for comprehensive policy evaluations specific to the teen demographic in Ann Arbor remains evident.

Ann Arbor has implemented several community initiatives to address the growing concern of fatal crashes among teen drivers. These include:

Education and Awareness Programs: Programs aimed at educating teens about the risks associated with distracted driving and substance use have been introduced in local schools. Research shows that educational interventions can significantly reduce risky driving behaviors among adolescents (Classen et al., 2019). However, the effectiveness of these programs has not been systematically evaluated, highlighting a gap in understanding their true impact.

Graduated Driver Licensing (GDL): Michigan's GDL program is designed to reduce the risks associated with inexperienced drivers by introducing a phased approach to gaining full driving privileges. Studies have shown that GDL systems effectively reduce crash rates among teen drivers (U.S. Department of Health and Human Services, 2015). However, further research is needed to assess the program's effectiveness, specifically within the context of Ann Arbor.

Community Engagement: Collaborations between law enforcement, schools, and local organizations aim to promote safe driving behaviors. For example, events that promote seat belt use and discourage distracted driving have been organized to engage teens and their parents (Ann Arbor Police Department 2022). More localized studies comparing Ann Arbor's initiatives with those in similar cities could yield insights into tailored interventions.
The 5-year 2018 – 2022 Motor Vehicle crashes by municipality excluding Ann Arbor township are reported in Table 1.

Table 1. Five-year Traffic Crash Report

Year	Total Count
2018	3,486
2019	3,676
2020	1,789
2021	2,404
2022	2,506

To reduce fatal crashes involving teen drivers in Ann Arbor, a multifaceted approach is needed to address inexperience, risk-taking, and distractions. Ongoing data monitoring and targeted education are essential. Implementing evidence-based strategies and fostering community involvement will help improve safety while addressing research gaps is crucial for effective interventions.

3. Research Methods

Study Design

This ongoing study analyzes traffic crash frequencies near the three largest and most densely populated public schools in Ann Arbor—Huron, Pioneer, and Skyline High Schools—over a five-year period (2018-2022). The objective is to identify patterns and trends in traffic incidents within a half-mile radius of these schools, with a focus on critical factors such as time of occurrence, crash severity, types of collisions, and driver demographics. This data-driven approach aims to enhance understanding of traffic safety issues in school zones and inform potential interventions.

Research Questions

What are the trends and patterns in traffic crash frequencies near Huron, Pioneer, and Skyline high schools, and how do these trends vary by time (month and weekday)?
What factors (such as crash severity, type, and involvement of young drivers) contribute to the frequency of traffic crashes near these high schools?
How do environmental conditions (including weather, lighting, and road conditions) influence the occurrence and severity of traffic crashes near these schools?

Data Collection

Traffic crash data and traffic records were obtained from local law enforcement agencies. The dataset included the following variables:

- Date and time of the crash
- Location (specific to the half-mile radius around each school)
- Severity of the crash (e.g., no injury, possible injury, suspected minor or serious injury, fatal)
- Type of crash (e.g., rear-end, angle, single motor vehicle)
- Driver demographics (age and involvement of young drivers aged 16-24)
- Weather conditions at the time of the crash
- Lighting conditions (daylight, dusk, dark-lighted, dark-unlighted)
- Road conditions (dry, wet, icy, snowy)

The data included for the analysis were all traffic crashes occurring within a half-mile radius of the selected high schools from January 1, 2018, to December 31, 2022. However, the non-motor vehicle incidents (e.g., bicycle or pedestrian-only incidents) were excluded.

4. Data Analysis

4.1. Utilization of GIS Mapping Software

Advanced GIS software was employed to conduct a thorough spatial analysis. This technology facilitated the effective visualization of crash data about geographic features, enhancing the interpretability of findings.

Mapping Crash Data: The 781 crash incidents were mapped alongside the locations of Ann Arbor high schools. This visualization provided a clear view of spatial patterns and correlations between crashes and educational institutions.

Buffer Zone Analysis: A spatial analysis was conducted within a ½-mile buffer zone surrounding Huron, Pioneer, and Skyline high schools as shown in Figure 1. This targeted approach helped identify spatial distribution patterns and potential crash hotspots in areas with high youth traffic.

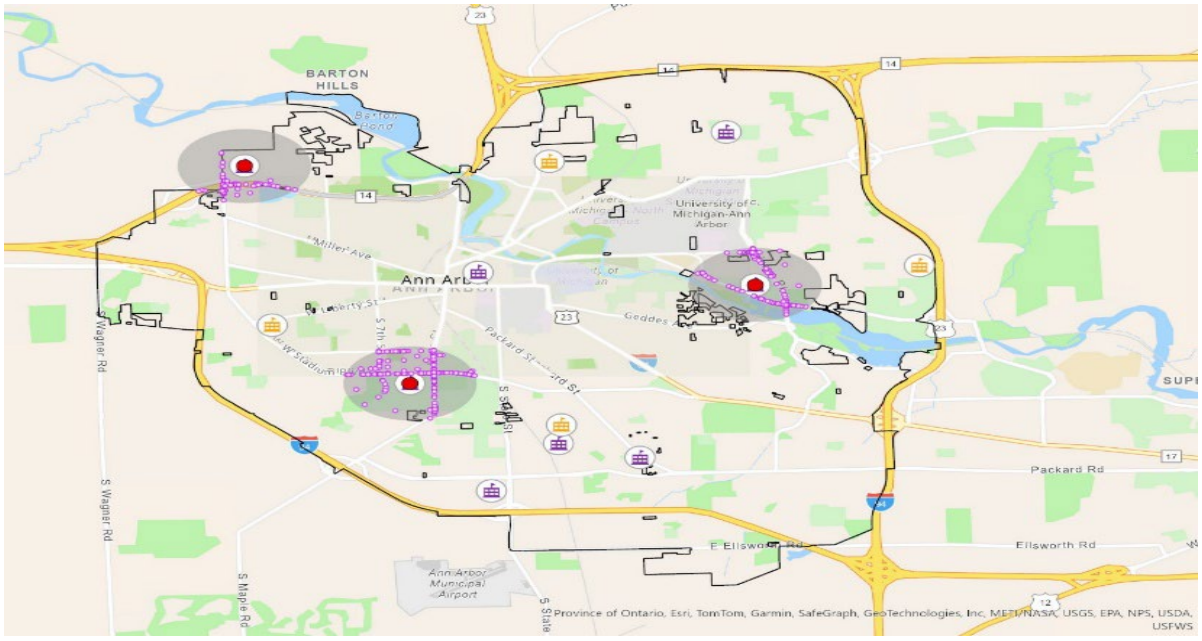

Figure 1. ArcGIS Map of 3 Selected High School Crash Data

5. Results and Discussion

Traffic Crashes within a half-mile radius of High Schools

Figure 2 presents the traffic crash frequencies in the vicinity of Huron, Pioneer, and Skyline high schools from 2018 to 2022, revealing a total of 781 incidents. Crashes peaked in 2018 (191) and decreased to 98 in 2020, likely due to pandemic-related traffic reductions—before rising again to 159 in 2022. Pioneer High School had the highest crash count (466, 60% of the total), followed by Huron (221) and Skyline (94), which saw a notable decline in crashes. These findings highlight the urgent need for targeted safety interventions, particularly near Pioneer High School.

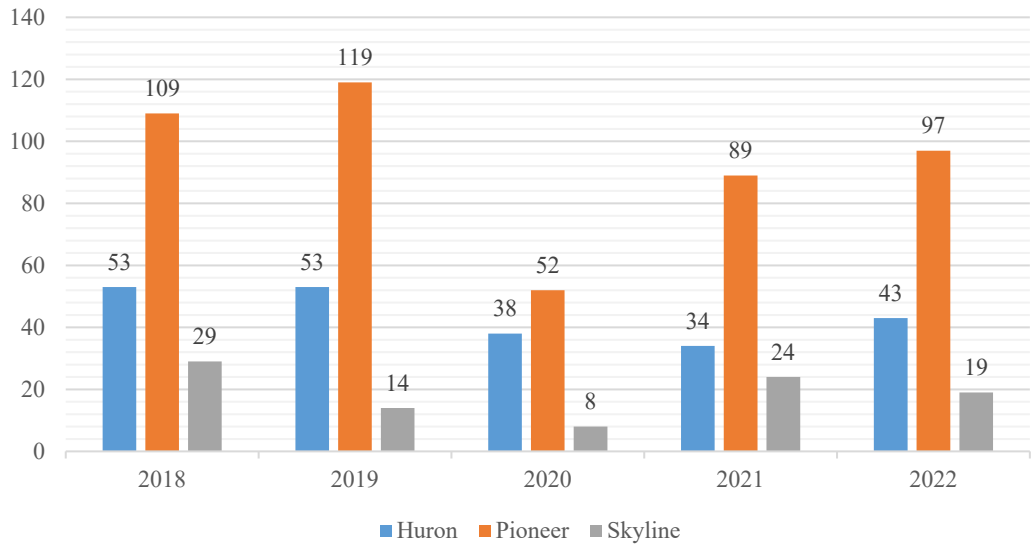

Figure 2. Traffic Crashes Near High Schools Over Five Years

Traffic Crashes by Month

The study examined monthly traffic crash frequencies around the three High Schools. As shown in Figure 3, November had the highest crashes (94), followed by September (81) and October (80), likely due to increased school activities, while July recorded the fewest (36). Pioneer High School consistently reported the most crashes, peaking in November (55) and October (52). Huron had notable increases in January (25) and November, whereas Skyline had the least overall, with a peak of 14 in September. These results underline the need for targeted traffic safety measures during peak months, particularly around Pioneer High School.

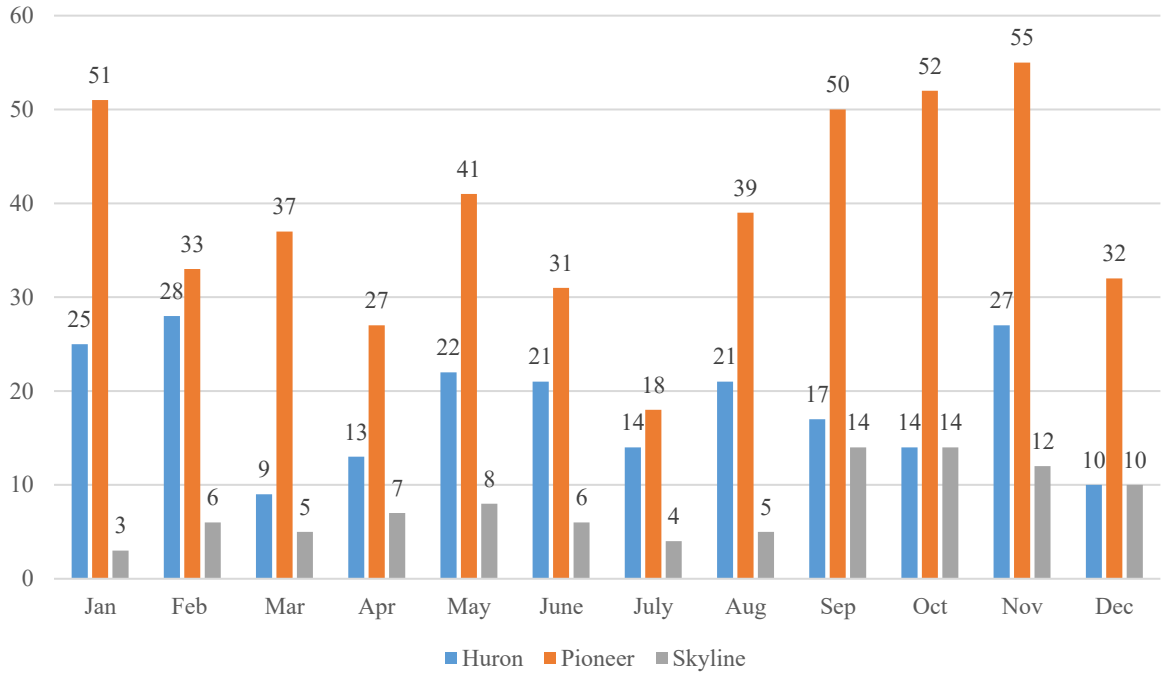

Figure 3. Traffic Crashes by Month

Traffic Crashes by Weekday

Figure 4 presents the traffic crash frequencies by weekday, totaling 623 incidents across the three High Schools, resulting in having Tuesday with the highest number of crashes (159), followed by Thursday (141) and Wednesday (115). Pioneer had the highest crash counts, peaking on Tuesday (83) and Thursday (76). Huron also experienced higher crash rates, especially on Tuesday (53) and Monday (37), while Skyline reported the fewest overall (80), with its highest count on Tuesday (23). These results emphasize the need for targeted traffic safety measures on busy days to improve safety for students and drivers.

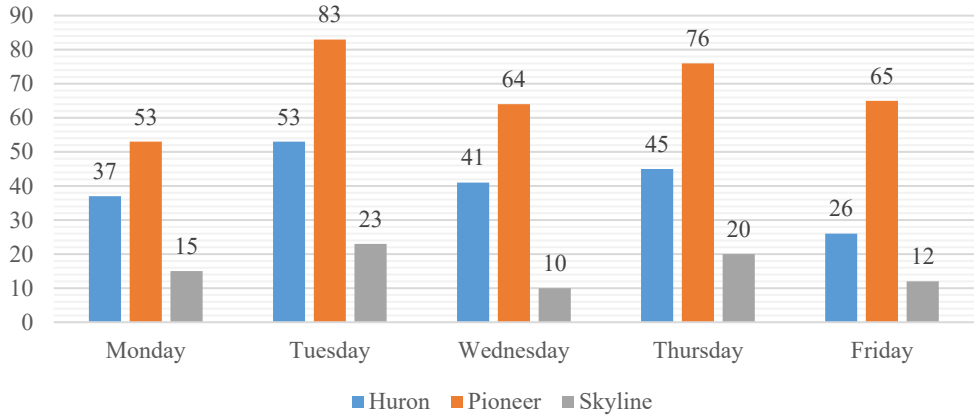

Figure 4. Traffic Crashes Near High Schools During Weekday

Severity of Crashes Near High Schools

This study revealed that 655 incidents (83.8%) were classified as "No Injury" (O) as shown in Figure 5. Pioneer recorded the highest number of no-injury crashes (392), followed by Huron (180) and Skyline (83). Additionally, there were 74 possible injury incidents (C), predominantly at Pioneer (45), and 46 suspected minor injuries (B), primarily at Pioneer (27) and Huron (18). Six crashes were classified as suspected serious injuries (A), with no fatalities reported.

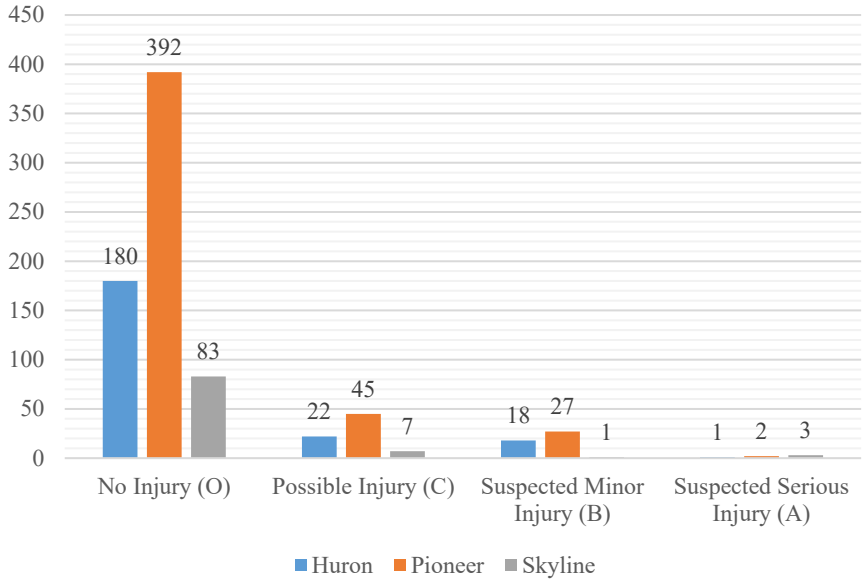

Figure 5. Observed Crash Severity

Observed Crash Type

The result of the analysis in Table 2 shows that the most frequent crash type was "Rear End," totaling 377 incidents (48.3%), with Pioneer reporting the highest count (241). "Angle" crashes followed with 107 incidents, predominantly at Pioneer (72), and "Sideswipe-Same" crashes totaled 118, again led by Pioneer (69). The "Single Motor Vehicle" category accounted for 116 crashes, with Huron (39) and Pioneer (49) reporting notable frequencies. Less common crash types included "Backing" (16), "Head On" (4), and "Unknown" (6). These findings highlight the majority of rear-end and angle collisions.

Table 2. Frequency of Traffic Crashes Based on Crash Type Near High Schools

Crash Type	Huron	Pioneer	Skyline	Grand Total
Angle	22	72	13	107
Backing	4	9	3	16
Head On	2	1	1	4
Head On-Left Turn	1	6		7
Other	4	9	1	14
Rear End	112	241	24	377
Rear End-Left Turn	2	1		3
Rear End-Right Turn	3		2	5
Sideswipe-Opposite	2	5	1	8
Sideswipe-Same	29	69	20	118
Single Motor Vehicle	39	49	28	116
Unknown	1	4	1	6
Grand Total	221	466	94	781

Traffic Crash by Young Drivers (16 -24)

This study analyzes the involvement of young drivers (aged 16-24) in traffic crashes across the different schools is shown in Figure 6. There were 161 crashes (20.6%) involved young drivers, with Pioneer reporting the highest count (104, 22.3% of its total). Huron had 42 incidents (19%), while Skyline recorded 15 (16%). The majority of crashes (620, 79.4%) did not involve young drivers. These findings highlight the significant involvement of young drivers, particularly at Pioneer, emphasizing the need for targeted safety interventions and educational programs to improve driving practices among this demographic.

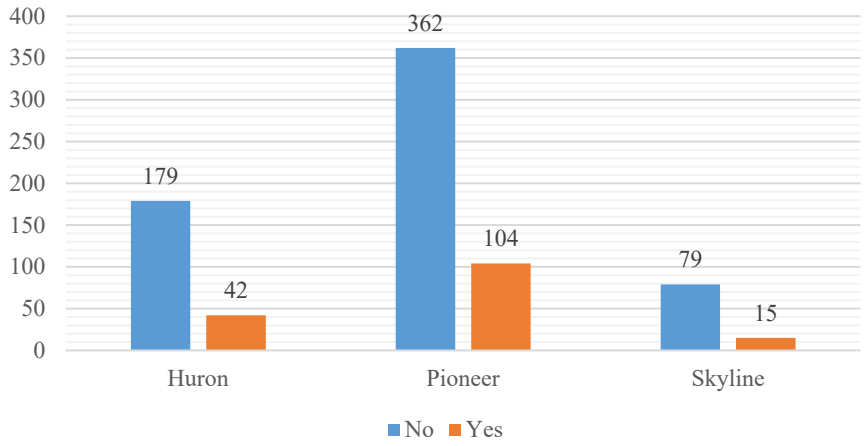

Figure 6. Traffic Crash by Young Drivers (16 -24)

Traffic Crashes by Weather Conditions

This study analyzes the influence of weather conditions on traffic crashes as shown in Figure 7. The majority occurred in Clear conditions (464), with Pioneer reporting the highest count (281). Cloudy weather accounted for 155 crashes, while Rain contributed to 70 cases, mainly at Pioneer (45). Snowy conditions led to 56 crashes, with Pioneer again

experiencing the most (35) crashes. Other conditions, such as Fog and Sleet, resulted in minimal crashes. These findings highlight that while most crashes occur in clear weather, adverse conditions like rain and snow significantly affect crash frequency, emphasizing the need for enhanced safety measures during inclement weather.

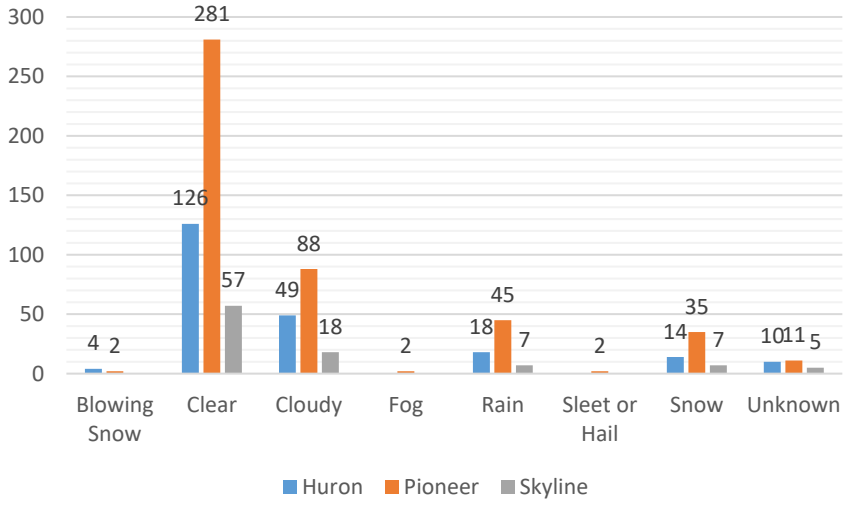

Figure 7. Traffic Crashes by Weather Conditions

Traffic Crashes by Lighting Conditions

Table 3 shows the results of the impact of lighting conditions on traffic crashes. Most crashes occurred during daylight (572, 73.2%), with Pioneer reporting the highest count (339). There were 118 crashes in Dark-lighted conditions, mostly at Pioneer (92). Dark-unlighted areas accounted for 44 crashes, while Dusk contributed to 18, primarily at Pioneer (13). Dawn conditions resulted in 7, and the "unknown" category included 22 crashes. These findings highlight that, while daylight is the safest condition, significant crashes occur in low-light situations, emphasizing the need for enhanced lighting and safety measures in poorly lit areas.

Table 3. Frequency of Traffic Crashes Based on Lighting Condition

	Huron	**Pioneer**	**Skyline**	**Grand Total**
Dark-lighted	15	92	11	118
Dark-Unlighted	19	11	14	44
Dawn	4	1	2	7
Daylight	173	339	60	572
Dusk	3	13	2	18
Unknown	7	10	5	22
Grand Total	221	466	94	781

Traffic Crashes by Road Conditions

Figure 8 shows the impact of road conditions on traffic crashes near the three schools resulting in the majority occurring on Dry roads (536), with Pioneer reporting the highest count (312). Wet conditions contributed to 138 crashes, mainly at Pioneer (87). Ice was a factor in 32 crashes, specifically 23 counts at Pioneer, while Snowy conditions resulted in 42 crashes, again highest at Pioneer (27). Slushy roads accounted for 5 cases, and 28 were recorded under “unknown” conditions. This suggests that while dry roads may seem safer, awareness is crucial across all conditions, and practical measures should be taken to address safety during adverse conditions.

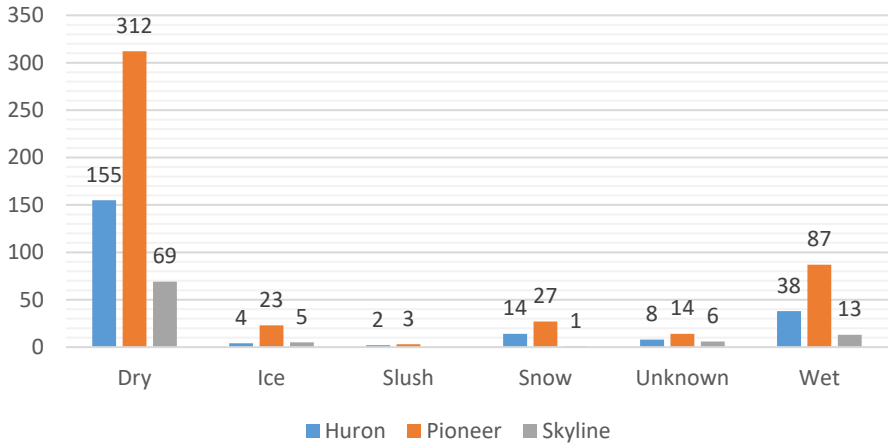

Figure 8. Traffic Crashes by Road Conditions

Impact of Speeding on Traffic Crash Count

The data reveals a significant correlation between speeding and traffic crashes, with many occurring under various conditions across all schools as shown in Figure 9. Most crashes occurred on Dry roads (536), with only 3 crashes linked to speeding across all conditions. Specifically, 533 crashes did not involve speeding in Dry conditions, while 4 crashes were attributed to speeding under Wet conditions. In Snowy conditions, 10 out of 42 crashes were associated with speeding, and 8 out of 32 crashes occurred on Icy roads. These findings suggest that speeding is a minor factor in most crashes, particularly on Dry roads, though its impact becomes more definite in adverse conditions. This implies that while speeding contributes to traffic incidents, other factors may also play a significant role.

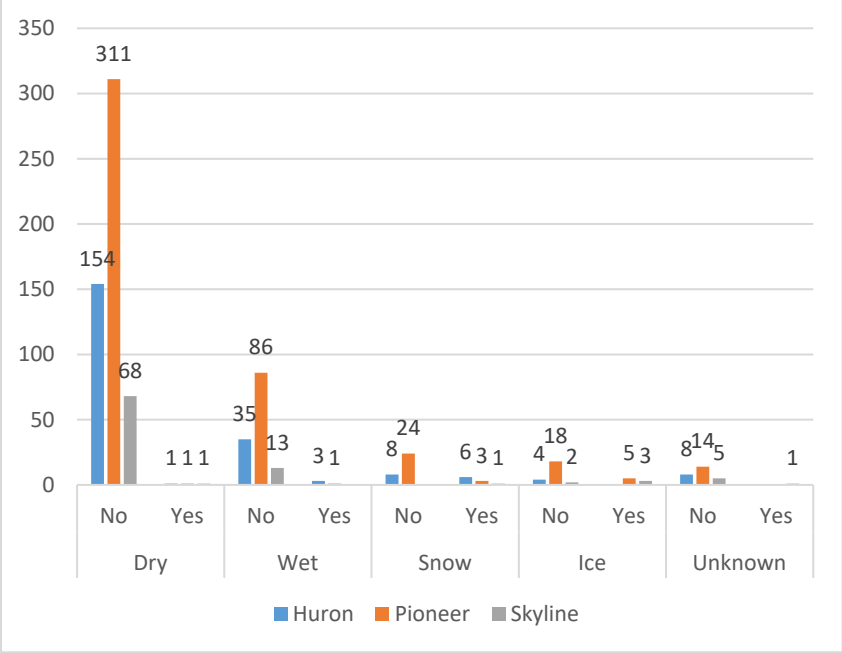

Figure 9. Traffic Crashes Related to Speeding vs. Road Conditions

6. Conclusion and Future Studies

This study analyzes traffic crash frequencies near Huron, Pioneer, and Skyline high schools from 2018 to 2022, revealing key patterns and vulnerabilities. Of the 781 crashes recorded, Pioneer High School accounts for 60%, with

significant peaks occurring in November and on Tuesdays, linking school activities to increased traffic risks. Most incidents resulted in no injuries, but the involvement of young drivers highlights the need for targeted safety education. While crashes predominantly occur in clear weather, adverse conditions and poor lighting contribute significantly to frequency. The relationship between road conditions and speeding suggests that strategies should address this issue, especially under adverse circumstances. Immediate interventions are essential, particularly near Pioneer High School, including educational programs for young drivers, improved signage, and infrastructure enhancements to ensure safer environments for students and the community.

Future Studies

Future studies should build on these findings by evaluating the effectiveness of educational programs for young drivers near Pioneer High School and investigating how weather conditions impact traffic incidents. Understanding young drivers' behaviors through surveys and assessing infrastructure improvements, such as signage and lighting, could inform better safety measures. Incorporating AI tools to analyze traffic patterns and predict incident hotspots will enhance our understanding of these issues. Comparative studies across schools may reveal unique risk factors while exploring parental involvement, which could further enhance community safety efforts. Integrating traffic volume data with crash statistics would clarify the link between traffic flow and accidents, and gathering qualitative insights from community members could provide valuable perspectives on safety perceptions. These approaches will help improve traffic safety in school zones.

In addition, the following additional research questions are currently under consideration for further analysis:

A comparative study of traffic crashes before, during, and after the COVID-19 pandemic.

An assessment of the impact of COVID-19 lockdowns on traffic crash rates and patterns.

Identify factors contributing to fatal and severe crashes near high schools.

References

Ann Arbor Police Department. (2022). Community Engagement and Traffic Safety Initiatives. Retrieved from https://www.a2gov.org/departments/police/community-engagement/Pages/default.aspx

Classen, S., Winter, S. M., Brown, C., Morgan-Daniel, J., Medhizadah, S., & Agarwal, N. (2019). An integrative review on teen distracted driving for model program development. *Frontiers in Public Health, 7,* Article 111. https://doi.org/10.3389/fpubh.2019.00111

Centers for Disease Control and Prevention. (2021). *Web-based injury statistics query and reporting system (WISQARS)*. https://www.cdc.gov/injury/wisqars/index.html

Federal Highway Administration (FHWA). (2017). *Highway safety improvement program manual, chapter 4.* Model Minimum Uniform Crash Criteria (MMUCC) Guidelines. Retrieved from https://highways.dot.gov/safety/data-analysis-tools/rsdp/rsdp-tools/model-minimum-uniform-crash-criteria-mmucc

Insurance Institute for Highway Safety (IIHS). (2020). Speeding and Teen Drivers. Retrieved from https://www.iihs.org/topics/teenagers

Michigan Department of State Police. *Cannabis & driving*. AAA Exchange. (2022). Retrieved from https://exchange.aaa.com/safety/substance-impaired-driving/cannabis-driving/

Michigan Office of Highway Safety Planning (OHSP). (2022). Michigan State Police. Retrieved from https://www.michigan.gov/mspnewsroom/news-releases/2022/04/04/law-enforcement-to-focus-on-reducing-distracted-driving-crashes-during-upcoming-initiative.

National Highway Traffic Safety Administration (NHTSA) National Center for Statistics and Analysis. (2023, Revised). State alcohol-impaired-driving estimates: 2021 data (Traffic Safety Facts. Report No. DOT HS 813 472).

Sentiance. (2022). *Not your average crash detection and reporting*. Coverager. https://coverager.com/not-your-average-crash-detection-and-reporting/

Simons-Morton, B. G., Hartos, J. L., & Becker, K. (2011). *Novice drivers' risky driving behavior: The role of peer passengers*. *Traffic Injury Prevention, 12*(3), 235-241. https://doi.org/10.1080/15389588.2011.563451

Stanton, R. (2023). *Ann Arbor Traffic Crash trends*. Michigan Live. https://www.mlive.com/news/ann-arbor/2023/01/heres-what-a-new-report-says-about-ann-arbor-traffic-crash-trends.html

U.S. Census Bureau quick facts: Ann Arbor City, Michigan; Washtenaw County, Michigan. (2022). https://www.census.gov/quickfacts/geo/faq/annarborcitymichigan,washtenawcountymichigan/POP715221

U.S. Department of Health and Human Services. (2015). *Graduated drivers licensing programs reduce fatal teen crashes*. National Institutes of Health. https://www.nih.gov/news-events/news-releases/graduated-drivers-licensing-programs-reduce-fatal-teen-crashes

Acknowledgments

The authors would like to thank to Baylee Van Ells at the Michigan Crash Analysis Tool Law Enforcement Office (MiCAT) for access to crucial data and to Greg Olsen from Numetric for training on the traffic safety analytics platform. Additionally, I thank the Michigan State Police and the Michigan Department of Transportation for their essential resources and support.